THREE ESSAYS IN FINANCIAL REPORTING

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By

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Abstract

This thesis investigates three important topics on financial reporting and information environment: 1) the timing of patent disclosure and its effect on the cost of equity capital; 2) how CEO mobility affects innovation through changes in firm information environment and incentive structure, and 3) how variability of tort law at the state level affects financial reporting opacity.

In a natural experiment setting, the first essay shows that early disclosure of patent information reduces firms' cost of equity capital. A notable feature of the American Inventors Protection Act (AIPA) is used, which separates the patent publication date from its grant or issue date. Using this feature as an exogenous shock, it is posited that patent disclosure choice in the patent application influences firms' information environment by signaling firm's proprietary information. Consistent with extant disclosure literature, this essay finds that early patent disclosure around the exogenous shock of regulatory change is associated with reduction in implied cost of equity capital. In light of scant prior literature on timing of patent disclosure, this essay offers empirical evidence that benefits of early patent disclosure outweigh the costs. This is the case even after adjusting for a real option to delay inherent in the AIPA. To exclude alternative explanations, I run a battery of robustness and sensitivity tests and the results of early patent disclosure still hold. This essay provides new evidence on the timing of proprietary disclosure that is of practical significance and importance to investors, policy makers, and regulators.

Using Inevitable Disclosure Doctrine (IDD) as an exogenous shock, the second essay provides direct evidence of how external CEOs increase technology spillover and spur innovation. In particular, two channels which have received theoretical support from extant literature are examined. The first channel is technology spillover and the second one is income

inequality. My results show that external CEOs, relative to internal CEOs, increase both technology spillover and income inequality. Moreover, I find direct causal evidence linking the technology spillover with innovation. On the other hand, I do not find similar evidence for income inequality. My results remain substantially unchanged for alternative measures of technology spillover and identification strategies. I also find that CEO's industry origin is an important factor. Specifically, CEOs from the same or similar industries drive the results.

In the third essay, I examine how the changes in U.S. state-level liability regimes affect the firm-level financial reporting opacity in the US banking industry. Using tort reform as an exogenous shock, it is found that banks located in states adopting tort reforms have more opacity (greater earnings management) than those located in non-adopting states. Further analyses suggest that banks in the adopting states also smooth earnings more than those in the non-adopting states. I conduct additional analyses to test for the exogeneity of tort reform and test alternative proxies for earnings management. The results from these tests further reinforce the main results. Given the scarcity of evidence on the effects of state-level laws, this study adds to our understanding in this area and informs the stakeholders such as bank regulators and legislators.

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Chapter 1: Introduction

This thesis investigates three important related issues in the broad field of financial accounting. The first essay is related to the timing of patent disclosure and its effect on the cost of equity capital. The second essay examines how CEO mobility affects innovation through changes in firm information environment and incentive structure. The third essay explores how variability of tort law at state level affects bank accounting opacity. I present these three essays in Chapters 2, 3, and 4 respectively. In this chapter, I highlight the major findings along with motivation, research background, and contributions.

The first essay examines how the timing of proprietary disclosure has capital market consequences. Specifically, I investigate and find evidence that early disclosure of patent information results in benefits to firms by reducing their cost of equity capital. My analysis exploits an exogenous regulatory shock known as the American Inventors Protection Act (AIPA) of 1999. A key feature of the AIPA is it separates the patent publication date from the grant or issue date for US applications that are not filed abroad. A firm has two choices for disclosure: it can publish the patent information eighteen months after application filing date or can wait until the patent is granted. The lag between these two events could be months or even years. This creates a real option to delay, which could potentially be valuable. By disclosing early, the firms are either forfeiting the real option or optimally exercising it early.

Early disclosure of patent provides trade-off between proprietary cost and capital market benefits. On the one hand, firms may incur significant proprietary costs due to expropriation by competitors as patent applicant has to share substantial information publicly. On the other hand, it could reduce information asymmetry with potential beneficial consequences such as reduction in firm’s cost of capital (Verrecchia, 1983). However, the empirical link between proprietary cost, proprietary disclosure, and capital market effects is not clear (Leuz, 2004; Li et al., 2018). In this research, I address this challenge using a research design with several key features. First, I use the introduction of the AIPA, an exogenous setting. Given that AIPA offers protection from expropriation in the form of *prior art* (Section 102 (e)), AIPA potentially reduces proprietary cost. Second, I use trade secrets protection in the form of IDD setting at the state level that is also exogenous. Protection by the AIPA at the federal level and adoption of the IDD at the state level substantially, if not fully, block the channel through which competitors expropriate a firm's secret information. This separates the proprietary disclosure from the proprietary cost and gives me a clean setting to test the effect of patent disclosure on cost of equity capital.

In that clean setting, I conduct following analyses using a series of difference-in-difference-in-difference (DDD) models. First, I investigate whether early disclosure of patents affects firms' cost of equity capital. Since the information environment and proprietary costs are affected by the AIPA at the federal level and by IDD and UTSA at the state level, I include proxies for all these federal and state-level regulations. Second, I examine the implications of a unique feature of AIPA, which gives the firms a real option to disclose. Under Section 122 of the AIPA, the patent applicant has the option to not disclose any patent information before grant date. On the other hand, those who promptly choose to disclose cannot reverse their decision. Thus, introduction of AIPA results in both irreversibility and disclosure choice. These features along with uncertainty in the market give rise to real options (e.g., Dixit and Pindyck, 1994; Abel et al.,1996). If information uncertainty resolution outweighs the disadvantage of competitors' adverse actions and the value of real option, disclosure is likely to lower the cost of equity capital. Third, I offer an explanation for a possible channel through which early patent disclosure can reduce cost of equity capital. One such channel is reduction in information uncertainty. There exist numerous studies which suggest that greater disclosure reduces information uncertainty (Zhang, 2006). I compute firms' implied cost of equity capital based on common models suggested in the literature (e.g., Gode and Mohanram, 2003; Hail and Leuz, 2006). Following Grullon et al. (2012), I use idiosyncratic volatility to measure the impact of real option as option theory suggests that option value is a positive function of volatility. For information uncertainty, I use two measures: analysts' forecast dispersion and total stock return volatility following Zhang (2006).

My findings suggest that early disclosure of patent information relative to non-disclosure decreases implied cost of equity capital after controlling for common risk factors. The results have both statistical and economic significance. Keeping the possibility in mind that early disclosers may self-select their disclosure decision, I run regressions after adjusting for self-selection bias (Heckman et al., 1997). The results remain substantively similar in these regressions. I also check for the effect of real option versus sunk cost inherent into the AIPA. I find that early disclosing firms optimally exercise the real option to delay as evident from reduction in cost of equity capital. I find that information uncertainty, measured by both analysts' forecast dispersion and total stock return volatility, has gone down for disclosing firms in a post-AIPA period. Taken together, these results suggest that early patent disclosure had a negative relationship with cost of equity capital through the reduction of information uncertainty. I run a variety of robustness and sensitivity checks to exclude alternative explanations, and my results remain largely unchanged.

This essay makes several contributions to the literature. First, it contributes to the empirical literature on proprietary information. I use a research design which separates the proprietary disclosure from proprietary cost and demonstrate the effect of proprietary disclosure on cost of equity capital. This essay provides important empirical evidence on the economic consequence of proprietary disclosure as prior literature shows that it is difficult to separate proprietary disclosure from proprietary cost because of its unobservability (Leuz, 2004; Li et al., 2018). Second, Beyer et al. (2010) report that there exist only a few studies that cover non-financial disclosure. By investigating the timing of patent disclosure, I contribute to the accounting literature on the consequence of non-financial disclosure of intangibles. Since firm value is increasingly driven by intangible assets, the disclosure of proprietary information of intangibles has substantial economic significance (Lev and Gu, 2016). Third, prior evidence suggests an inverse link between disclosure and cost of capital (e.g., Botosan, 1997; Hail, 2002, Francis et al., 2005). However, most of these studies are based on financial disclosure. Moreover, most studies concentrate on amount of disclosure or other disclosure characteristics (Heflin et al., 2016) and not on the timing. The timing of disclosure is an important attribute since market participants and regulators depend on timely information for their decision-making. This study provides important evidence on the timing of proprietary information.

The second essay examines how external CEOs affect firms' innovation activities. Specifically, I find that external CEOs are associated with higher technological spillover, which in turn increases innovation as measured by patent counts and citation-weighted patents. While prior literature argues that external CEOs bring in new knowledge and skillsets that may boost firm-level outcome variable including innovation (Custodio et al., 2018), we do not have direct causal evidence of how the linkage works. For example, it is possible that the firm's new increased R&D that contributes to innovation. However, it is also possible that the improvement in the quality of R&D due to 'incremental' knowledge that actually spurred the innovation. Thus, there remains a possibility of an omitted variable problem. Disentangling that causality would mitigate the problem and would give us a transmission channel through which new CEOs, external or internal, affects innovation. I motivate this study to provide direct evidence of how external CEOs increase innovation-related knowledge and in turn spur innovation.

In this essay, I look at the possible channels through which external CEOs affect innovation. I argue that external CEOs bring their unique skillsets, professional network, and experience and positively affect firms' information environment. Specifically, these CEOs generate positive externality in the form of technological spillover. This spillover helps spur the innovative activities. I measure technology spillover following Bloom et al., (2013). I also investigate an alternative channel. Prior literature has identified that external CEOs receive higher pay, which may increase the income inequality in the firm. There are theoretical arguments, which suggest that higher inequality may affect firm-level performance outcomes (Lazear and Rosen, 1981; Akerlof and Yellen, 1990). I examine how external CEOs affect firm-level inequality as measured by CEO payslice and variability in the pay of other members of the top management team. Further, I empirically test whether such inequality positively or negatively affects firms' innovation activities.

I have the following major findings in this essay. First, consistent with prior studies (e.g., Custodio et al., 2018), I find that external CEOs increase both patent counts and citation-weighted patens significantly during the sample period 1976-2006. Second, consistent with my prediction, I find that external CEOs increase technological spillover significantly. I also document that technological spillover has a positive and significant effect on innovative activities. Third, I investigate the effect of income inequality as a second channel. My findings suggest that an external CEO's appointment increases income inequality measured by CEO pay slice. However, I do not find any causal link between income inequality and innovation for my sample. Aside from my results, I also conduct several additional analyses. First, I conduct similar regressions for external CEOs who hail from a similar industry and those who come from a different industry background. As CEOs from the same industry are expected to possess a substantially greater industry-specific knowledge, my prediction is they will have a more favorable effect on technology spillover and innovation.

Consistent with this prediction, I find that CEOs from the similar industry increase both technology spillover and innovation significantly. On the other hand, I do not find any significant relationship for external CEOs from a different industry background. Second, I investigate the causal link using Heckman treatment effect model and find that the results remain substantially similar.

Moreover, propensity-score matched sample lends support to the effect of external CEOs on innovation. Lastly, I test whether the innovation outcomes are driven by the level of R&D activities for an external-CEO-only sample and not by technology spillover. The results from this test suggest that for external CEOs, the level of R&D does not make any significant differences. We, however, need to be cautious about interpreting this result since it is a univariate analysis based on R&D deciles only.

This second essay offers the following contribution. First, prior literature offers both theoretical arguments and empirical evidence linking CEO origin and innovative activities. I document new evidence of a channel through which such effect takes place. The evidence offered in this essay is rooted in sound theoretical foundations and based on solid empirical measures. Second, I also show that an external CEO's effect on innovation differs with respect to the industry origin. I argue that because of their deep understanding and broad industry-specific knowledge, external CEOs from a similar industry will have a positive effect on innovation, an argument supported by evidence in this essay.

In the third essay, I study how state-level liability affects bank reporting opacity. Specifically, I find that changes in the state-level tort law in the USA increases bank reporting opacity. Prior research suggests that stakeholders including the auditors respond to changes in legal environment affecting litigation risk (Anantharaman et al., 2016; Palmrose, 1988). Auditors in particular respond to such changes, among other, by conducting a high-quality audit (Venkataraman et al., 2008). This, in turn, improves the client firm's quality of financial statements.

Prior literature also suggests that firms and auditors face significant litigation risk both at the federal level and state level (Gaver et al., 2012). While the banks (firms) may have direct contractual obligation to their customers, shareholders, and regulators for reporting transparency, they may be influenced by their auditors' actions such as high or low efforts to ensure audit quality. It is well-documented in the audit literature that auditors use a number of different approaches to minimize litigation risk (Anantharaman et al., 2016). One such approach is to enhance the quality of audit (Venkataraman et al., 2008). This in turn puts pressure on the banks to enhance the quality of the financial statements as well (Gaver et al., 2012).

I exploit the variations in the state-level changes in the tort law. Specifically, I use the move from *joint-and-several liability doctrine* to a *proportionate liability doctrine* of liability sharing standard as an exogenous shock. Under the former doctrine, a plaintiff can claim and recover full damages from any of the defendants irrespective of proportional fault of each liable party (Feinman, 2015). Accounting practitioners suggest that accounting firms face significant financial burden as they are considered to have 'deep pockets' when the client firms remain in a distressed condition. Tort reforms tend to redress this situation by moving toward a proportionate liability doctrine. Under this regime, liability and damages to be paid would proportional to the degree of fault as decided by the court of law (Craig, 1990; Mednick and Peck, 1994; Peck, 1999). While the move would ease the burden on the auditors, it is also conceivable that the auditors would no longer face the pressure to conduct high-quality audit job. Prior literature indicates that a high litigation risk environment significantly impacts audit quality (Francis, 2011). Given the new regime, it is possible that auditors, as rational economic agents, would put a lower audit effort to minimize cost. Since the client banks will now have diminished scrutiny, bank managers will have the opportunity to engage in actions such as earnings management that reduce financial reporting transparency.

For my identification strategy, I use a difference-in-difference model to incorporate different adoption period of tort reform at the state level (Imbens and Wooldridge, 2009). The main variable of interest is an indicator variable representing tort reform. I use tort reform data from the Database of State Tort Law Reforms (DSTLR) to make sure a complete inclusion of tort reform sample for the period between 1980 and 2012. Legal scholars consider this database to be the most comprehensive one on tort reform (Avraham, 2007). As the measure of financial reporting opacity, I use discretionary component of banks' loan loss provision (LLP). This is a widely used proxy for earnings management in the banking literature (Beatty and Liao, 2014). A higher magnitude of earnings management would be indicative of higher opacity. Prior studies suggest that LLP has a number of distinct advantages as an earnings management proxy. In addition to being the largest and most important accrual for banks, it is also an industry-specific measure, which offers a more clear distinction between normal and abnormal accruals. Moreover, since US banking system has a distinct state-wise separation to a large extent, the effects of the state-level changes in tort reform would be clearly discernible.

I use bank financial statements from Call Reports between 1980 and 2012 to test the predictions. Using a final sample of 264,299 bank-year observations, I find that earnings management via abnormal loan loss provision (ALLP) increases for banks in states that adopted the tort reform relative to banks in the non-adopting states during the post-adoption period. The results are statistically significant at 0.01 level. Further I test whether the tort reform has any effect on either the income-increasing (negative) abnormal LLP or income-decreasing (positive) abnormal LLP. To do that, I divide the sample into two subsamples: one for income-increasing (negative) abnormal LLP and one for income-decreasing (positive) abnormal LLP. Again, I find that income-increasing (negative) earnings management via abnormal LLP is greater for banks with headquarters located in states adopting tort reform than non-adopting states. The coefficient of interest is still significant at 0.01 level. Likewise, I conduct a similar test for income-decreasing (positive) abnormal LLP and find similar results: income-increasing earnings management is greater for banks states adopting tort reform.

Taken together, these regression models point out to earnings smoothing by the banks. I therefore test for earnings smoothing following Kanagaretnam et al. (2010). I interact the tort reform variables with earnings before provision (EBP). The result of the interaction is not only statistically significant but also has positive sign, which indicates that abnormal LLPs are used to smooth earnings.

Overall, the results of these main tests consistently suggest that tort reforms result in more earnings management. Alternatively stated, financial opacity seems to have increased for the banks in the tort reform adopting states relative to those in non-adopting states. This evidence is consistent with the prediction that a decrease in litigation risk reduces the quality of financial statement numbers. I also conduct several additional analyses. First, while a difference-in-difference test mitigates the possibility of endogeneity emanating from reverse causality, I further test the parallel trend assumption and exogeneity of tort reform following Klasa et al. (2018). The regression results are consistent with expectation, confirming exogeneity of the tort reform variable. Second, I use an alternative specification for abnormal LLP following Kanagaretnam et al. (2010) and find that the coefficient for tort dummy has a positive sign, which is consistent with expectation that tort reform increases opacity. Third, I test whether there is any differential impact on banks audited by Big4 versus non-Big4 audit firms. The results suggest that audit by Big4 does not have significant effect for my sample of banks. Thus, these results further lend support to the conclusion that diminished litigation risk in the form of tort reform leads to greater earnings management and higher opacity in financial reporting.

This third essay makes several contributions to the literature. First, tort reforms covering all states in the USA are used as an exogenous shock. This identification strategy, along with a comprehensive dataset, ensures a clean setting to capture the effects of changes in litigation risk on bank reporting opacity. Second, focusing on a single industry provides a number of distinct advantages. For one, loan loss provision can be used as the single, industry-specific measure of accruals, which enables me to clearly separate abnormal accruals from normal accruals. On the other hand, multiple industries would have introduced errors in this measure. For another, US banking system, unlike many other in the world, has distinct state-wise separation. Thus, a state-level change could be more clearly mapped into the financial reporting of banks than in other industries where such state-level demarcation does not exist. Lastly, there has been a dearth of research linking state law and factors such as auditor discipline affecting financial reporting quality (Francis, 2011). This essay examines the state-level tort reforms and its effect on the financial reporting quality and shows that these regulatory effects, and the resultant change in litigation risk, have a clear impact on the financial reporting opacity.

The rest of the thesis is organized as follows. Chapter 2 examines the effect of the timing of patent disclosure on cost of equity capital. Chapter 3 discusses which channels external CEOs use to affect innovation, and Chapter 4 presents the effect of enforcement of contracts by state courts on the transparency of bank reporting. Chapter 5 concludes.

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Chapter 2: The Timing of Patent Disclosures and Cost of Equity Capital

2.1 Introduction

This essay examines economic consequences of disclosing proprietary information in capital market within the framework of a natural experiment. Specifically, I investigate and find evidence that early disclosure of patent information results in incremental benefits to firms by reducing their cost of equity capital. My analysis exploits a notable feature around an exogenous regulatory shock (a natural experiment) known as the American Inventors Protection Act (AIPA) of 1999. The AIPA separates the patent publication date from the grant or issue date for US applications that are not filed abroad[1]. A firm has two choices for disclosure: it can publish the patent information eighteen months after application filing date or can wait until the patent is granted. The lag between these two events could be months or even years. This creates a real option to delay[2], which could potentially be valuable. By disclosing early, the firms are either forfeiting the real option or optimally exercising it early.

Early disclosure of patent entails two possible consequences. First, it could reduce information asymmetry with potential beneficial consequences such as reduction in firm's cost of capital (Verrecchia, 1983). Second, firms may incur significant proprietary costs possibly due to expropriation by competitors as patent applicant has to share substantial information publicly.[3] However, there is a protective provision for the early disclosers in the AIPA (Section 102 (e)): the published patent application becomes a *prior art*[4], which establishes the right of the disclosers and keeps others from getting a similar patent. Moreover, even if there is no patent, a firm can protect its intellectual property

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[1] Please see *Figure 3.1* for the disclosure choice facing the patent applicant.

[2] AIPA requires that patentees disclose information after 18 months from the application date if the patentee is also filing in other jurisdictions. Other major jurisdictions such as EU, Japan and Canada already have a similar requirement. If not, patentees can ask for non-publication before grant date. On the other hand, once a patentee chooses to disclose, the decision becomes *irreversible.* Thus, disclosure decision results in a *real option* (See Dixit and Pindyck, 1994).

[3] To be more specific, once a patent is published, anyone including the competitors can view and download the entire file history of the patent application using public portal of Patent Application Information Retrieval (PAIR) system of the U.S. PTO. Moreover, they can view all of the Office Actions sent by the by the US Patent Office rejecting the patent application and all the responses/Amendments filed with the US Patent Office.

[4] Prior art is the earlier reference of knowledge that prevents a patent from issuing. Thus, if an application is considered a prior art, a competitor will be denied for a similar patent claim.

as trade secrets. Trade secret laws such as the Uniform Trade Secrets Act (UTSA) and stringent enforcement by a court applying Inevitable Disclosure Doctrine (IDD) can protect the firm from expropriation[5].

The empirical link between proprietary cost, proprietary disclosure, and capital market effects is not as straightforward as predicted by the theoretical literature (Leuz, 2004; Li et al., 2018). One complicating factor is the unobservability of proprietary cost, which leads researchers to use proxies that are less than precise. Li et al. (2018) argue that the proxies used in the literature such as industry structure may capture omitted variable effects. For example, high competition in an industry may lead to a lower level of disclosure due either to high proprietary costs or low capital market benefits. In this research, I address this challenge using a research design with several key features. First, I use the introduction of the AIPA, an exogenous setting. Given that AIPA offers protection from expropriation in the form of *prior art*, AIPA potentially reduces proprietary cost. Second, I use trade secrets protection in the form of IDD setting at the state level that is also exogenous. Protection by the AIPA at the federal level and adoption of the IDD at the state level substantially, if not fully, block the channel through which competitors expropriate a firm's secret information. This separates the proprietary disclosure from the proprietary cost and gives me a clean setting to test the effect of patent disclosure on cost of equity capital.

Analytical models in accounting provide several links between disclosure and cost of capital. Disclosure (or a commitment to disclosure) reduces information asymmetries (Verrecchia, 2001), increases liquidity (Diamond and Verrecchia, 1991) and decreases the cost of capital (Botosan, 1997). Increased disclosure can also reduce non-diversifiable estimation risk (Barry and Brown,1985), increase firm visibility in a capital market with incomplete information thereby enlarging investor base

[5]Under the UTSA, which has been adopted by most U.S. states, an aggrieved party can claim injunctive and damages remedies for misappropriation of trade secrets. On the other hand, IDD is a doctrine under common law. Under IDD, the employer only needs to show that eventually the employee will disclose the secrets to the new employer. Thus, the application of IDD provides expanded coverage of the UTSA for the protection of trade secrets. See Klasa et al. (2018) for details.

and improve risk sharing (Merton,1987). Despite these theoretical predictions, how the empirical link between *early* patent disclosure and cost of capital would be is uncertain for many reasons. It may so happen that a *timing* difference in patent disclosure may give rise to insignificant variability in nondiversifiable risk or the risk may be entirely diversifiable (Hughes et al., 2007). Similarly, it is also possible that other risk proxies absorb the effects. Thus, the link between the timing of patent disclosure and cost of capital is an open empirical question.

In this study, I conduct three specific analyses. First, I investigate whether early disclosure of patents affects firms' cost of equity capital. Since the information environment and proprietary costs are affected by the AIPA at the federal level and by IDD and UTSA at the state level, I include proxies for all these federal and state-level regulations. Second, I examine the implications of a unique feature of AIPA, which gives the firms a real option to disclose. Under Section 122 of the AIPA, the patent applicant has the option to not disclose any patent information before grant date. On the other hand, those who promptly choose to disclose cannot reverse their decision. Thus, introduction of AIPA results in both irreversibility and disclosure choice. These features along with uncertainty in the market give rise to real options (e.g., Dixit and Pindyck, 1994; Abel et al.,1996). If information uncertainty resolution outweighs the disadvantage of competitors' adverse actions and the value of real option, disclosure is likely to lower the cost of equity capital. Third, I offer an explanation for a possible channel through which early patent disclosure can reduce cost of equity capital. One such channel is reduction in information uncertainty. There exist numerous studies which suggest that greater disclosure reduces information uncertainty (Zhang, 2006). With reduction in information uncertainty, information risk goes down. Thus, investors would require a lower rate of return, thereby resulting in a negative relation between patent disclosure and cost of equity capital.

For empirical analysis, my strategy involves a difference-in-difference-in-difference (DDD) setting as prior studies show that this setting better captures the effect of exogenous shocks (Angrist and Krueger, 2001; Imbens and Wooldridge, 2009; Katz, 1998). To that end, I exploit the choice firms exercise in disclosing patent information before and after the AIPA becomes effective. I compute firms' implied cost of equity capital based on common models suggested in the literature (e.g., Gode and Mohanram, 2003; Hail and Leuz, 2006). Following Grullon et al. (2012), I use idiosyncratic volatility to measure the impact of real option as option theory suggests that option value is a positive function of volatility. For information uncertainty, I use two measures: analysts' forecast dispersion and total stock return volatility following Zhang (2006).

My findings suggest that early disclosure of patent information relative to non-disclosure decreases implied cost of equity capital after controlling for common risk factors. The results have both statistical and economic significance. Given the average cost of equity of 8.7% in my sample, the magnitude of change, 0.019, is substantial. Keeping the possibility in mind that early disclosers may self-select their disclosure decision, I run regressions after adjusting for self-selection bias (Heckman, 1997). The results remain substantively similar. I also check for the effect of real option versus sunk cost inherent into the AIPA. I find that early disclosing firms optimally exercise the real option to delay as evident from reduction in cost of equity capital. I find that information uncertainty, measured by both analysts' forecast dispersion and total stock return volatility, has gone down for disclosing firms in a post-AIPA period. Taken together, these results suggest that early patent disclosure had a negative relationship with cost of equity capital through the reduction of information uncertainty. When AIPA was passed in 1999, the secondary effects of disclosure was not immediately visible. I run a variety of robustness and sensitivity checks to exclude alternative explanations, and my results remain largely unchanged.

This study contributes to the literature on the economic consequence of disclosure. First, this study contributes to the empirical literature on proprietary information, an area of significant interest in the accounting literature (Dye, 1986). By using a research design which disentangles the proprietary disclosure from proprietary cost, I demonstrate the effect of proprietary disclosure on the cost of equity capital. Given the difficulty in separating proprietary disclosure from proprietary cost because of its unobservability, this study provides important empirical evidence on the economic consequence of proprietary disclosure. Second, Beyer et al. (2010) report that there exist only a few studies that cover non-financial disclosure. By investigating the timing of patent disclosure, I contribute to the accounting literature on the consequence of non-financial disclosure of intangibles. Since firm value is increasingly driven by intangible assets, the disclosure of proprietary information of intangibles has substantial economic significance (Lev and Gu, 2016). Third, prior evidence suggests an inverse link between disclosure and cost of capital (e.g., Botosan, 1997; Hail, 2002, Francis et al., 2005). However, most of these studies are based on financial disclosure. Moreover, most studies concentrate on amount of disclosure or other disclosure characteristics (Heflin et al., 2016) and not on the timing. The timing of disclosure is an important attribute since market participants and regulators depend on timely information for their decision-making. This study provides important evidence on the timing of proprietary information.

The remainder of the essay is arranged as follows. *Section 2.2* discusses the institutional setting. *Section 2.3* reviews the relevant literature. *Section 2.4* develops the hypotheses while *Section 2.5* outlines research methods. Results are discussed in *Section 2.6,* and *Section 2.7* outlines the robustness and sensitivity tests. *Section 2.8* concludes.

2.2 Institutional Setting

2.2.1 Patent Law

In the US, patents are governed by Federal regulations. Under the Patent Act of 1952, inventors could keep their patent applications secret until the final patent was granted[6]. Patent applications filed in all European countries, Canada, Japan, and Australia are published 18 months after their earliest

[6] By using a continuation, continuation-in-part, or a division, assignees were thus able to keep a pending patent application secret for an extended period of time while maintaining the early priority (See Graham, 2004).

application date (called "priority date") by patent offices in those jurisdictions. In contrast, US patent applications were published by the USPTO only upon the granting of the patent; the technical knowledge represented in the patent application, the filing date of the patent application, and even the inventor's decision to seek a patent generally remained secret until the grant of the application. However, patent applications filed for simultaneous protection in the US and other countries were published by the patent offices in these those countries 18 months after the priority date. With a view to harmonizing the US law with regulations in other major jurisdictions, the US Congress passed the AIPA in 1999. The difference in timeline for patent disclosure is provided in Figure 2.1.

[Insert Figure 2.1 about here]

The Act requires that US patent applications filed on or after November 29, 2000 be published by the US Patent and Trademark Office (USPTO) 18 months after application date. However, there were some concerns that disclosure before grant date may adversely affect the inventions of small inventors[7]. In a departure from international norm, the Congress allowed a provision, whereby inventors could opt out of the 18-month disclosure if they do not file for protection in foreign countries.

2.2.2 Trade Secrets Law

In contrast to the patents, trade secrets are under state jurisdictions in the US. A new law, the Uniform Trade Secrets Act (UTSA), was proposed and recommended by the National Conference of Commissioners on Uniform State Laws in 1979 for adoption by the states in lieu of the common law. The new law offered several advantages for trade secrets over the common law. It broadened the definition of a trade secret and misappropriation. The aggrieved party can claim injunctive and damages remedies for misappropriation. Thus, UTSA not only expanded the legal protection of trade secrets but also added clarity and reduced uncertainty (Png, 2016). By 2010, a law similar to UTSA was enacted by forty-four states. On the other hand, four states-Alabama, North Carolina, South

[7] A letter signed by 26 Nobel Laureates protested the 18-month rule, arguing that it is going to reduce the protection for small inventors and stifle the flow of new innovation (Modigliani et al., 1999).

Carolina, and Wisconsin adopted state laws that are different from the UTSA. Png (2016), using a self-constructed index of legal protection based on the differences in substantive law, time limitations, and injunctive and damages remedies, shows that there is significant variation in protection both across states and over time.

2.2.3 Inevitable Disclosure Doctrine (IDD)

In the US court system, historically common law dictated the protection of trade secrets. Courts still use common law to interpret laws such as UTSA. One such example is Inevitable Disclosure Doctrine or IDD, which is applied based on 'threatened misappropriation' (Klasa et al., 2018). In the Court of Law, the employer does not need to prove that the employee has actually disclosed any secret. The employer only needs to show that eventually the employee will disclose the secrets to the new employer and harm the competitive advantage of the plaintiff (Wiesner, 2012). Legal literature shows that other protective mechanisms such as Non-disclosure Agreements (NDA) or Covenants not to Compete (CNCs) have limitations. For example, firms need to demonstrate actual violation in case of NDA while the effectiveness of CNCs is limited within the jurisdiction of a state (Klasa et al., 2018; Garmaise, 2011; Malsberger, 2004)). On the contrary, an employer's trade secret receives protection from IDD even if the departing employee will be working in a state that has not adopted IDD (Klasa et al., 2018). Thus, the application of IDD provides expanded coverage of the UTSA for the protection of trade secrets.

2.3 Literature Review

2.3.1 Patents

Extant archival evidence suggests that patents are associated with many different financial variables. One strand of literature investigates how various economic incentives and factors affect innovation activities and patents. These include product market competition (Aghion et al., 2005), institutional ownership (Aghion, 2013), analysts' coverage (He and Tian, 2013), market for corporate control (Bena and Li, 2014), financial market development (Hsu et al., 2014), and stock liquidity (Fang et al., 2014). Another strand of literature deals with patent litigation and enforceability. Lanjouw and Schankerman (2004) study the determinants of patent lawsuits and their outcomes and find that the litigation risk is higher for individuals and smaller firms relative to firms with a large portfolio of patents. Similarly, Galasso et al. (2013) study the link between the market for innovation and enforcement of patent rights and show that patents with commercial value increase litigation. Importantly, they also find that the propensity for litigation goes down with advantages in enforcement. On a slightly different note, Serrano (2010) explores the transfer and renewal of U.S. patents and identifies that patent trading depends on factors such as patent age, citations and patent generality.

A handful of studies have examined the linkage between patents and capital markets outcomes, an area of examination most relevant to this essay. These studies find that capital market participants appear to incorporate the valuation implications of patents. In an earlier study using NBER patent data, Hall et al. (2005) assess the importance of patent on market value of firms. They test the association between Tobin's q and the ratios of R&D to total assets, patents to R&D, and citations to patents. The paper finds that each of the examined ratio significantly affects market value. In a similar vein, several recent studies evaluate the link between patents and stock return and reach similar conclusion. First, Hsu (2009) proposes that technological innovations increase expected stock returns and premiums at the aggregate level. Using a multi-country setting, Hsu (2009) reports that patent shocks and R&D shocks positively explains U.S. market returns and premiums. Moreover, he finds a similar pattern for other G7 countries, China, and India. Hirshleifer et al. (2013), on the other hand, focus on the US market. The study uses data from US patents or patent citations scaled by research and development expenditures as a measure of innovation (they use the term ‘innovation efficiency’). Hirshleifer et al. (2013) suggest that innovation efficiency is a positive predictor of forward-looking stock returns even after controlling for firm characteristics and risk. Finally, Kogan et al. (2016) use an event study design to test the stock market response to news about patents. They find that the estimates of abnormal returns around patent publications are positively linked with the scientific value as measured by patent citation. Furthermore, they report that technological innovation explains aggregate economic growth and total factor productivity (TFP) when aggregated at the economy level. This study also examines the economic consequences of patents, but it specifically focuses on patent disclosure decision and its link to the information environment.

Many legal scholars consider the American Inventors Protection Act an important legislation as it brought about major changes in the patenting process (Hegde and Luo, 2016). However, empirical studies on its effects have been limited so far. Johnson and Popp (2003) conclude that changes in disclosure of patent filing in AIPA will result in faster knowledge diffusion. More recently, Graham and Hegde (2015) investigate the *disclosure versus secrecy* choice made by inventors and conclude that increase in disclosure relative to secrecy is substantial. Hegde and Luo (2016) find that post-AIPA US patent applications are likely to be licensed before grant date. Saidi and Zaldokas (2016) address the innovation disclosure issue surrounding the AIPA and find that AIPA-induced increase in innovation disclosure helps firms switch lenders and reduce cost of debt. Mohammadi et al. (2018) also use the AIPA as an exogenous shock to study the causal effect of patent on information uncertainty. Their evidence suggests that patent indeed reduces information uncertainty. While my essay follows a similar approach, I explicitly examine the trade-off between proprietary cost and capital market benefits of patent disclosure.

2.3.2 Voluntary Disclosure

Voluntary disclosure literature is considerably large. Thus, I focus on the part of literature that deals with proprietary information and cost of capital. Analytical models in accounting suggest that disclosure may have a beneficial effect on cost of capital. Dye (1986) models the disclosure policies arising from the tradeoff between protecting firms' proprietary information and making value-increasing disclosures. He shows that when managers have both proprietary and nonproprietary information, nondisclosure or partial disclosure may be optimal. Disclosure (or a commitment to disclosure) reduces information asymmetries (Verrecchia, 2001), increases liquidity (Diamond and Verrecchia, 1991) and decrease the cost of capital (Botosan, 1997). Early empirical studies such as Lang and Lundholm (1996) and Botosan (1997) show positive impact of disclosure on firms' information environment and outcome variables such as analyst following and cost of capital.

Lang and Lundholm (2000) study corporate disclosure activity around seasoned equity offerings and its relationship with stock prices. Lang and Lundholm (2000) find that firms significantly increase their disclosure activity within legally allowed timeframe before seasoned equity offerings (SEO). They also find that firms that have a consistent level of disclosure see price increases before the offering, and a slight price drop during the offering announcement compared to the control firms. The authors suggest that the results may be due to a decrease in information asymmetry. On the other hand, firms that substantially increase their disclosure activity to 'hype the stock' experience much larger price drop at the announcement date, suggesting that the market may have corrected for the earlier price increase. Moreover, firms with a consistent disclosure level do not experience unusual return behavior relative to the control firms in the subsequent period while firms that hyped suffer negative returns. This suggests that firms that hyped were able to lower the firms' cost of equity capital temporarily.

Using a sample from 34 countries, Francis et al. (2005) find that firms in industries requiring higher external financing have greater voluntary disclosure levels. Moreover, consistent with prior research, a policy of greater disclosure level leads to a lower cost of capital. Moreover, they also find that voluntary disclosure incentives seem to act independently of country-level factors; hence, voluntary disclosure helps in lowering cost of external financing around the world.

Ellis et al. (2012) study the choice facing the managers between the benefits of decreasing information asymmetry and the cost of strengthening the competitors by revealing proprietary information. The study finds that the probability of a firm not revealing the identity of a major customer varies significantly with the potential proprietary costs faced by the firm. They document that firms with high research and development (R&D) expenditures, high levels of intangible assets net of goodwill, and high advertising expenditures are more likely not to reveal their major customers' identities.

Shroff et al. (2013) examine the effect of the Securities Offering Reform of 2005, which allows firms greater freedom of disclosing information before equity offerings, on voluntary disclosure behavior and its economic consequences. They find that firms provide significantly more preoffering disclosures after the Reform. In addition, the paper finds that both information asymmetry and cost of equity capital are inversely related to disclosure.

Core et al. (2015) investigate the relationship among insider ownership, disclosure quality and the cost of capital, using a sample across 35 countries between 1990 to 2004. They document a negative relation between country-level disclosure regulation and both insider ownership, and firms' implied cost of capital and realized returns. They find that in contrast to the direct negative effect of disclosure on the cost of capital, the indirect effect of disclosure via ownership is positive. This latter result indicates that disclosure quality and ownership act as a substitute. However, direct effect dominates the indirect effect by a ratio of about five to one.

2*.3.3 Real Option*

Real option model has been used to study firms' investment incentives and behavior. Real option literature studies the interaction of uncertainty over future returns to capital, irreversibility of investment and the option to defer the investment. Abel, Dixit, Eberly, and Pindyck (1996) argue that real option values such as call and put affect the incentive to invest and current investment cost include this option value. Pindyck (2005) offers a similar argument about real options. He shows that if the firms do not exercise the option, it becomes part of the sunk cost. This cost in turn then adds to the total cost of investment.

Several empirical studies looked into the relationship among irreversibility, uncertainty and the opportunity to delay. Many of these papers study firm's entry-exit decisions and find that firms weigh their decision heavily on real option values. Berger, Ofek, and Swary (1996) investigate whether investors price the option to abandon a firm at its exit value and find evidence for abandonment option theory. Bloom and Van Reenen (2002) show that patents have economically and statistically significant effect on firm-level productivity and market value. They also find that real options inherent in patents allow firms to delay investment. When uncertainty increases, the value of this real option increases, which reduces the effect of new patent on productivity. Miller and Folta (2002) discuss the embedded option in firm's entry decision. They argue that optimal timing for exercising real options to entry depends on several factors such as current dividends, preemption, and nature of option.

Folta, Johnson, and O'Brien (2006) examine empirically the interactive effects of uncertainty and irreversibility on the likelihood of entry into new business by diversified firms. They investigate both industry and firm-specific factors influencing the degree of investment irreversibility. In general, they find that real options value affects the likelihood of entry. Bulan, Mayer, and Somerville (2009), using a Canadian sample, examine the effect of uncertainty on delaying investment. Further, they study the effect of competition on this relationship. They find that increases in both idiosyncratic and systematic risk increase the value of the real option and lead property developers to delay new real estate investments. However, the number of potential competitors affect this relationship. More specifically, the negative relationship between risk and investment is dampened in the presence of the high number of competitors. Thus, competition reduces the value of real option.

Several papers decompose uncertainty into components such as market, industry and firm-specific, and then try to link it with investment and return in a real option framework. These papers find evidence that support the prediction of real option theory. Bulan (2005), for example, presents evidence that shows that uncertainty and investing are negatively linked. She decomposes total uncertainty into three different components: market, industry, and firm-specific. She finds a negative relation between investment and industry and firm-specific uncertainty. Specifically, firm's investment-to-capital ratio goes down by 6.4% when industry uncertainty increases by one standard deviation. Likewise, investment decreases by 19.3% when firm-specific uncertainty goes up by one standard deviation. Grullon et al. (2012) study the relationship between return and firm-level volatility. They hypothesize that the positive relation between firm-level returns and firm-level volatility may be due to real options that firms possess. With real options, firms can adapt to changing situation. If there is bad news, the firm can delay investment or scale back operations. On the other hand, it can amplify a good situation by expanding production or expediting investments. Thus, increased volatility in the underlying process such as overall profit volatility can increase the value of the firm.

Some studies focus on the difference between the systematic risk of firms with real options and those only with assets in place. Bernardo et al. (2007) observe firms with more growth opportunities have higher betas for two reasons. First, growth opportunities also entail real options. These embedded options have implicit leverage, which means the systematic risk of these opportunities is likely to be higher than similar assets in place. Second, growth opportunities have cash flows with a longer duration. Thus, firms having these opportunities are more sensitive to changes in interest rates. Therefore, they have higher betas.[8]

[8] Likewise, Da et al. (2012) argue that as stocks have real options to change current projects and take up new projects, the expected returns of stocks will likely not satisfy the CAPM.

2.4 Hypothesis Development

2.4.1 Timing of Patent Disclosure and Cost of Equity Capital

Patents offer several benefits, the principal of which is an exclusive right to a technology. As this right is legally enforceable, it provides the patentee monopolistic power over competitors (Png, 2015). Moreover, patents entail some distinct legal advantages as patentees can resort to the U.S. Federal Court while trade secrets can use the Federal Courts only under special circumstances[9]. However, by choosing to patent and then disclose 18 months after patent filing date, the firm is committing to share substantial amount of proprietary information.

Based on theoretical literature on disclosure, I hypothesize that firm's trade-off the capital market benefits and the proprietary costs[10] (e.g., Verrecchia, 1983) in patent disclosure. This hypothesis yields, among other, the following testable prediction: If proprietary cost is low, firms disclose more information which provides capital market benefits. In fact, Verrecchia (1983) shows that if the proprietary cost is zero, his model is fully reconcilable with full disclosure, as suggested by Grossman (1981) and Milgrom (1981). Empirical link between proprietary cost, proprietary disclosure, and capital market benefits is not as straightforward as predicted by the theoretical literature. Li et al. (2018) argue that proprietary cost is unobservable and the proxies used in the literature such as industry structure may capture omitted variable effects. For example, high competition in an industry may lead to a lower level of disclosure due either to high proprietary costs or low capital market benefits.

The proprietary costs, and also the capital market benefits of specific disclosures, depend on what potential safeguards are available against expropriation or competitive harm. If, for instance, there exist regulatory safeguards against competing firm expropriating proprietary information after

[9] Owners can sue in federal court if the misappropriator of trade secret lives in a different state.

[10] While it can stem from different stakeholders (Verrecchia, 1983; Leuz, 2004), proprietary costs of patent almost always result from the adverse actions taken by competitors, not investors.

their disclosure, proprietary costs would be low. One of the unique features of the AIPA (Section 102 (e)) is it recognizes the disclosed patent as *prior art*, which establishes the right of the disclosers and keeps others from getting a similar patent during the interregnum. Moreover, the disclosing firms receive the protection of trade secrets from the Inevitable Disclosure Doctrine. Protection by the AIPA at the federal level and adoption of the IDD at the state level substantially, if not fully, block the channel through which competitors expropriate a firm's secret information. For this reason, the competitive harm (i.e., proprietary cost) of early patent disclosures is likely to be low.

Disclosing the innovation can nevertheless generate capital-market benefits. It avoids the costs for acquisition of private information which creates cost savings for investors and financial analysts and reduces risk (e.g., Diamond, 1985). There are several other studies which show that disclosure has a positive effect on liquidity and cost of equity capital (e.g., Verrecchia, 1991; Diamond and Verrecchia, 1991), a prediction well-supported by quite a few empirical studies (e.g. Botosan, 1997; Botosan and Plumlee, 2005; Hail and Leuz, 2006). Consistent with this accounting literature, early disclosure of patent information has the potentials to reduce cost of equity capital. Therefore, I conjecture that cost of equity capital will go down for firms that choose to disclose early compared to firms that choose to disclose later in a post-AIPA environment. I posit Hypothesis 1 the following way:

H1*: Firms that disclose patent data early in post-AIPA period will have a lower cost of equity capital relative to firms that do not disclose.*

2.4.2 Real Option to Disclose and Cost of Equity Capital

Under Section 122 of the AIPA, the patent applicant has the option to not disclose any patent information before grant date. On the other hand, those who promptly choose to disclose cannot reverse their decision. Thus, introduction of AIPA results in both irreversibility and disclosure choice. In particular, this unique feature along with uncertainty in the market gives rise to real options (e.g., Dixit and Pindyck, 1994; Abel et al.,1996). An important question here is how the cost of capital will be impacted. I argue that there is a tension between the value of real option of not disclosing and the benefit of early disclosure including resolution of information uncertainty and legal coverage in the form of prior art and protection from IDD. If the value of real option is substantial because the innovation will lose value if disclosed early, the non-disclosing firms can have their cost of capital reduced. On the other hand, the disclosure informs the market about the value of innovation. At the same time, competitors come to know substantial information about the patent and can take advantage. There is an additional layer of uncertainty as well. Since these real options are unobservable, disclosing early may indicate that firm is either forfeiting the real option or optimally exercising it early. If information uncertainty resolution outweighs the disadvantage of competitors' negative actions, disclosure is likely to have a negative effect on cost of equity capital. Given the tension, how cost of equity will be affected by the real option of disclosure may ultimately be an empirical question. However, it is possible that firms are either willing to sacrifice the real option value (or exercising optimally at an early period) to take advantage of resolution of information uncertainty. I posit my hypothesis the following way:

> ***H2***: *In the post-AIPA, early disclosure benefits outweigh the benefits of real option to delay*.

2.4.3 Channels for Patent Disclosure: Information Uncertainty

Theoretical literature in accounting suggests that timing of disclosure reduces information uncertainty (Verrecchia, 1983; Diamond, 1985). I define information uncertainty the similar way to Zhang (2006): "..ambiguity with respect to the implications of new information for a firm's value, which potentially stems from two sources: the volatility of a firm's underlying fundamentals and poor information." It seems patent disclosure reduces the ambiguity on both counts. By early disclosure of patent, a firm sharing substantial information that is critical to its competitive edge. Thus, it sends unambiguous signal to the market and its competitors about its fundamentals. With reduction in information uncertainty, the estimation risk goes down. Information risk also goes down, allowing investors to require lower rate of return. Therefore, I expect a negative relation between patent disclosure and information uncertainty. I state the hypothesis in the alternate form:

H3: *Patent disclosure has a negative relation with information uncertainty.*

2.5 Research Design

2.5.1 Data

For information on patents, I draw on the dataset provided by Graham and Hegde (2015), which covers patents granted up to the year 2011 and contains patent information for more than 1.8 million patents. Patent data sets suffer from a lag between application and grants (Lerner and Seru 2015). Thus, following Graham and Hegde (2015), I use patents with application date up to the year 2006. As my focus is on the firm-level cost of equity, I have to link the application data to the firm level. While the USPTO publishes all patent application data, it does not provide company identifiers. Moreover, many patentees later assign their patents to other entities. To ensure inclusion of as many companies as possible, I merge the Graham and Hegde dataset with that of Kogan et al. (2016) data to incorporate the unique company identifier, *permno*. Further, I compare the merged data with that of Hall et al. (2001). These two steps provide a dataset with more than seven-hundred thousand patent information along with company identifiers. Using the company identifier, I match the merged dataset with Compustat, CRSP, and IBES for estimating the dependent and control variables. I require that at least three analysts follow the firm to ensure that I can estimate the forecast dispersion.

My main dependent variable is implied cost of equity capital, which I estimate using data from IBES, CRSP, and Compustat. I follow prior literature and specifically estimate three measures: Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005) as implemented by Gode and Mohanram (2003) and Easton (2004). Consistent with other studies, I average these estimates, and construct my main dependent variable implied cost of equity capital, *CoC_avg*. The key treatment variable *disc_dum* is a binary variable with value one for the firms choosing to disclose eighteen months after their application date (early disclosers). The control group includes firms that do not disclose early. For the time dimension, I use a second binary variable, *post_aipa*. Years before the enactment of AIPA is coded as zero while years after AIPA is coded one. As trade secrets are the states' jurisdiction, I also use IDD as the strength of trade secret at the state level following Li et al. (2018) and Klasa et al. (2018). I follow Klasa et al. (2018) to use IDD as a proxy for state-level protective measure against expropriation of competitive information. While patent data are published pending the application, the firms or patentees receive protection from IDD at the state level. Using court cases, Klasa et al. (2018) identify 21 states where IDD was adopted. I set the IDD indicator as one for these states from the year IDD was adopted. For other years, IDD would have a value of zero. However, three states rejected IDD after their initial adoption by court (Florida in 2001, Michigan in 2002, and Texas in 2003). IDD indicators for these states are one when IDD was in effect and zero for other years. For the remaining 29 states, the indicator is zero throughout. Consistent with prior literature in accounting and finance, I also estimate the standard control variables using the above data sources. I follow Grullon et al. (2012) and use the idiosyncratic volatility to measure the effect of real options. Data definitions are provided in Table 2.1.

2.5.2 Empirical Specifications

My research design uses the feature that AIPA separates the patent publications date from the grant date for US applications that are not filed in a foreign jurisdiction. The treatment sample consists of firms that disclose patent information 18 months after the application date. The control sample, on the other hand, consists of firms that keep the information secret until the grant date. I analyze the effect on cost of capital as a function of this before-and-after variation in the timing of patent publications. I control for common risk factors, industry and year fixed effect. I use robust standard errors clustered at the state level. To test the hypotheses, I use the following specification (firm and time subscripts are intentionally suppressed for better readability) following Katz (1998) and Imbens and Wooldridge (2009):

$$CoC = \beta_0 + \beta_1\, PostAIPA + \beta_2\, Disclosure\ Dummy + \beta_3\, IDD + \beta_4\, PostAIPA \times Disclosure\ Dummy + \beta_5\, IDD \times Disclosure\ Dummy + \beta_6\, PostAIPA \times IDD + \beta_7\, PostAIPA \times Disclosure\ Dummy \times IDD + \beta_8\, UTSA + Other\ Controls + \sum_i k_i\, SIC + Year\ fixed\ effect + \varepsilon \quad (2.1)$$

The coefficient of interest, β_7, is our difference-in-difference-in-difference (DDD) estimator. I use this model as I need to control for the differences in trade secrets law across states in addition to the changes in disclosure rule at the Federal level. Imbens and Wooldridge (2009) show that such a specification provides a more robust analysis when we are using both different states and control group within the same state.

2.5.3 Treatment effect regression for self-selection.

Since AIPA provides a disclosure timing choice, it is possible that early disclosing firms self-select themselves to disclose. These firms might be characteristically different from non-disclosing firms. This creates an endogeneity problem, which would bias the OLS results. To address that, I use the Heckman treatment effect regression as evidence alludes more unobservable characteristics driving the results. However, finding out appropriate instruments is a challenge in accounting research. As pointed out by Lennox et al. (2012) and Larcker and Rusticus (2010), instruments should have strong theoretical motivation and well-reasoned economic justification.

For this study, I follow the patent literature in economics, which suggests that firms are more likely to disclose if patents are valuable. One common set of proxy is citations by other patents and citation by patent examiners. In both cases, the value of the patent derives from validations by parties other than the firm itself. The second set includes claims allowed and patent renewals. To maximize the probability of higher allowed claims, a firm is likely to make more claims. Thus, allowed claims are a direct function of number of claims made by the company. Likewise, a company (or a patentee) would only renew patents that are deemed valuable. Graham and Hegde (2016) also use two other measures for disclosure choice: small size and pendency lag and their interactions. I use all these proxies as instruments except citation because of its documented link with firm value. One concern with these instruments is that most of them are ex-post except allowed claims. I ran a number of sensitivity tests to mitigate the concern, and my results remain largely unchanged even after the sensitivity tests.

2.6 Results

2.6.1 Descriptive Statistics

Table 2.2 shows the distribution of patent application by year from 1996 to 2006. The number of patents disclosure substantially increased after 2000. Moreover, it is apparent that most patentees opt for early disclosure relative to secrecy. For example, the percentage of early patents disclosure increased from 6.95 percent in 2000 to a whopping 50.98 percent in 2001. This indicates that AIPA has a positive effect on patent disclosure. It also shows that patent applicants are overwhelmingly convinced that the AIPA's safeguards against proprietary cost will work.

[Insert Table 2.2 about here]

Table 2.3 shows the descriptive statistics for implied cost of equity capital. Unlike Table 2, the statistics are on firm-year level basis. The results show that after AIPA was passed, the largest largest change in cost of equity capital takes place in the state with weak enforcement. While late-disclosing firm have 8.7% cost of equtiy capital in pre-AIPA period, it increases to 9.2% in post-AIPA period. This difference is statistically significant at 5% level. Similarly, early-dislcosing firms see cost of equity decrease from 8.8% to 8.7%. However, this result is not statistically significant[11]. However, these are univariate results, and therefore the results could be confounded by other variables. Table 2.4, on the other hand, shows the descriptive statistics for selected control variables to identify the firm characteristics of early disclosers, non-disclosers and foreign protection firms respectively. From this

[11] t-values are 2.80 for the first test and -0.156 for the second test, respectively

Table, it is apparent that these three groups have different observable firm characteristics. Moreover, t-test shows that the differences are statistically significant.

[Insert Table 2.3 about here]

[Insert Table 2.4 about here]

2.6.2 Regression Results

Table 2.5 shows the main results, where the treatment group is the early discloser firms while the control group is the non (or late) discloser firms. Model 1 shows the effect of early disclosure on cost of equity capital. Specifically, early disclosure reduces cost of equity capital by 0.019 at 1% significance level. Model 2 includes more control variables with similar result. The reduction in cost of equity capital caused by early disclosure is statistically significant. Moreover, the magnitude is substantial and thus has economic significance as well. With an average of 8.7% cost of equity capital, the decrease is 11.78% which is nontrivial. Overall, these results support the assertion in Hypothesis 1 (H1). The control variables also exhibit expected relationship. Leverage, return volatility (*retvol*), and book-to-market (*BM)* have a positive and significant result. On the other hand, turnover (*turnover_a*), which I use to control for liquidity, shows an expected negative and significant relationship.

[Insert Table 2.5 about here]

Table 2.6 shows the results of the treatment effect regression. All the models show that rho is significantly different from zero. Even after adjustments for self-selection, the coefficient of interest shows a negative and statistically significant results. Thus it seems the results are not driven by selection bias. I also run a number of sensitivity checks on selection models and find that my conclusions remain largely the same.

[Insert Table 6 about here]

2.6.3 Effects of real option of disclosure on cost of equity capital

The unique nature of the AIPA offers real option to delay to the patenting firms. The patenting firms have the choice of disclosing 18-month after application date or delay it until the grant date. These features make this real option akin to an American option as opposed to a European option. If a firm chooses to disclose early (i.e., 18 months after application date), there are two possible scenarios. First, it is possible that he firm is forfeiting a potentially valuable option, which might be costly in the sense that it increases sunk cost. This, in turn, may increase cost of equity capital. Second, it is also possible that firms exercise it early as it finds the option optimal at that point in time. In the latter case, I expect that an optimal exercise would be beneficial, for example, in the form of a reduction in cost of equity capital.

As the value of an embedded real option is unobservable, I follow prior literature such as Grullon et al. (2014) to indirectly estimate the effect of real option on cost of equity using idiosyncratic volatility. This proxy is used as option value is a positive function of volatility. I divide my sample into two parts to run the regression. The first subsample consists of the early disclosing firms while the second subsample is composed of non (or late) disclosers. Thereafter, I test for the equality of coefficients of interest for these two regressions. A significant difference would indicate that what kind of effect option had on the cost of equity capital.

The results of the regressions are provided in Table 2.7. It is evident that cost of equity capital decreases significantly for early disclosers for both Models 1 and 2. On the other hand, late disclosers do not have any significant change. The test for equality of coefficients for $\beta7$ shows that the difference is statistically significant. Thus, the firms disclosing early exercised the option optimally.

[Insert Table 2.7 about here]

2.6.4 Transmission Channels for Patent Disclosure: Information Uncertainty

Following Zhang (2006), I use two proxies for information uncertainty. The first one is analyst forecast dispersion (DISP). As mentioned in Section 2.5.1, I choose firms that are followed by at least three analysts so that I can estimate the forecast dispersion. In addition, I use controls that are documented to have affected information uncertainty: number of analysts following the firm (NUMEST), stock return volatility, earnings volatility, and inverse of firm age. All these variables are likely to affect information uncertainty of a firm. Table 2.8 reports the regression results. The coefficient of interest has a negative sign and a statistically significant result. Thus early disclosure of patent information reduces information uncertainty relative to non (or late) disclosers.

[Insert Table 2.8 about here]

My second proxy is stock return volatility. I measure it as the annualized daily stock return volatility. I also use the control variables used for the previous regression to tease out the effect of early disclosure. Table 2.8 reports the regression results. The DDD results show that the coefficient of interest is negative and statistically significant for both measures. This implies that disclosing early reduces information uncertainty relative to the late disclosure.

These results combined with the main regression where I find a negative effect of disclosure on cost of equity capital suggest that early patent disclosure reduces cost of equity capital through decreasing information uncertainty.

2.7 Sensitivity and Robustness Checks

To rule out the alternative explanations that the decrease in cost of equity capital is not caused by early disclosure of patent information, I conduct a number of robustness and sensitivity checks. I report the results in Tables 2.9 and 2.10.

2.7.1 Future realized returns

Prior literature examines the construct validity of implied cost of equity capital using realized return

(Easton and Monahan, 2005). In that spirit, I use excess returns from two models: market and Fama-French/Carhart 4-factor models. Results are reported in Table 2.9. As the highlighted portion shows, the coefficient of interest has a negative sign with statistically significant result for both proxies.

[Insert Table Table 2.9 about here]

2.7.2 Foreign versus non-disclosers

Applicants seeking foreign protections had to disclose 18-month after patent application date even before the enactment of AIPA. If we want to rule out that the observed difference between early discloser and non-disclosers was not induced by the change in the AIPA, we should expect similar results for foreign protection and non-disclosing firms. However, regression results show an insignificant coefficient of interest Moreover; the magnitude is quite small.

[Insert Table Table 2.10, Panel A about here]

2.7.3 In-time placebo

I argue that the exogenous shock in the form of a regulatory change provides us a natural experiment setting. Therefore, a cut-off period other than this change period is not expected to produce any result. To test that, I change the event date and find no results, which is consistent with expectation.

[Insert Table Table 2.10, Panel B about here]

2.7.4 Industry effects

While I controlled for industry effects by using fixed effects for Fama-French 48 industries, it is possible that the effect on cost of equity is driven by industries that rely heavily on intellectual capital and patents. To test that, I use sub-samples specifically for those industries. First, I construct a sample for following industries: Drug (FF-48: 13), Communication (FF-48: 32), Computer (FF-48: 35 and 36). In addition, I create three other subsamples based on the USPTO definition of patent classification: Computer and Communication, Drugs and Medical and Electrical and Electronics. If the results are driven by industry effects, regressions on these patent-heavy subsamples should capture those effects.

None of the regression coefficients for the industry subsamples are significant, and therefore, the results are not driven by any particular industry but by the timing of patent disclosure.

[Insert Table Table 2.10, Panel C about here]

2.7.5 Sensitivity tests for selection models

To exclude the possibility that the selection models reported earlier show significant results for the regression equation because of a choice of a particular instrument, I run sensitivity analysis for the selection models by using several combinations of instruments. First, in addition to the original instruments, I include all the independent variables. The results show that the coefficient of interest has expected negative sign although the results are significant at an elevated level (>10%). Second, I exclude one instrument at a time, starting with pendency lag. The results are still statistically significant at 10% level. Third, I exclude the binary variable small and its interaction with allowed claims, with results still remaining significant. Lastly, I keep only proxies that represent an internal validation of patent value: allowed claims and renewals, along with independent variables. The results of the regression equation remain largely unaffected by the instrument choices. Thus, we can conclude that the effect of timing of disclosure on cost of equity capital is robust to the choice of instruments and correction of selection bias.

[Insert Table Table 2.10, Panel D about here]

2.8 Conclusion

This essay examined economic consequences of nonfinancial disclosure in the capital market in the framework of a natural experiment. I expected that the timing of disclosure of patent information explains the cost of equity capital beyond traditional proxies for firm risk. Consistent with expectation, my findings suggest that early disclosure of patent information relative to non-disclosure decreases implied cost of equity capital after controlling for common risk factors. Given the possibility that early disclosers may self-select their disclosure decision, I run regressions after adjusting for self-selection bias with similar results. I find that early disclosing firms optimally exercise the real option to delay as evident from reduction in cost of equity capital vis-à-vis the non-disclosing firms. I find that information uncertainty has gone down for disclosing firms in a post-AIPA period. Taken together, these results suggest that early patent disclosure had a negative effect on cost of equity capital through the reduction of information uncertainty.

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Appendix 2A

A Brief Description of the Domestic Publication Requirements of the American Inventors Protection Act (AIPA) of 1999

One important aspect that distinguishes U.S. Patent law with that of the rest of the world is confidentiality. Unlike many other countries, the applicant's patent information is not disclosed for the patent that is never granted. Thus, only the inventors could decide whether they would disclose any details about the invention[12]. AIPA changed the disclosure requirement, and therefore, any information contained in a utility patent application will be published promptly after the expiration of 18 months from the earliest claimed filing date (Section 122(b)). Moreover, an applicant can request the Patent Office to publish before the 18-month period for a nominal fee (Section 122 (b)(1)(A)).

A pertinent question is: what does publication imply? Essentially, it means significant disclosure of the huge amount of information publicly. To be more specific, once it is published, anyone including the competitors can view and download the entire file history of the patent application using the public portal of Patent Application Information Retrieval (PAIR) system of the U.S. PTO. Moreover, they can view all of the Office Actions sent by the US Patent Office rejecting the patent application and all the responses/Amendments filed with the US Patent Office. The published patent application also becomes *prior art*[13] for any later filed patent applications.

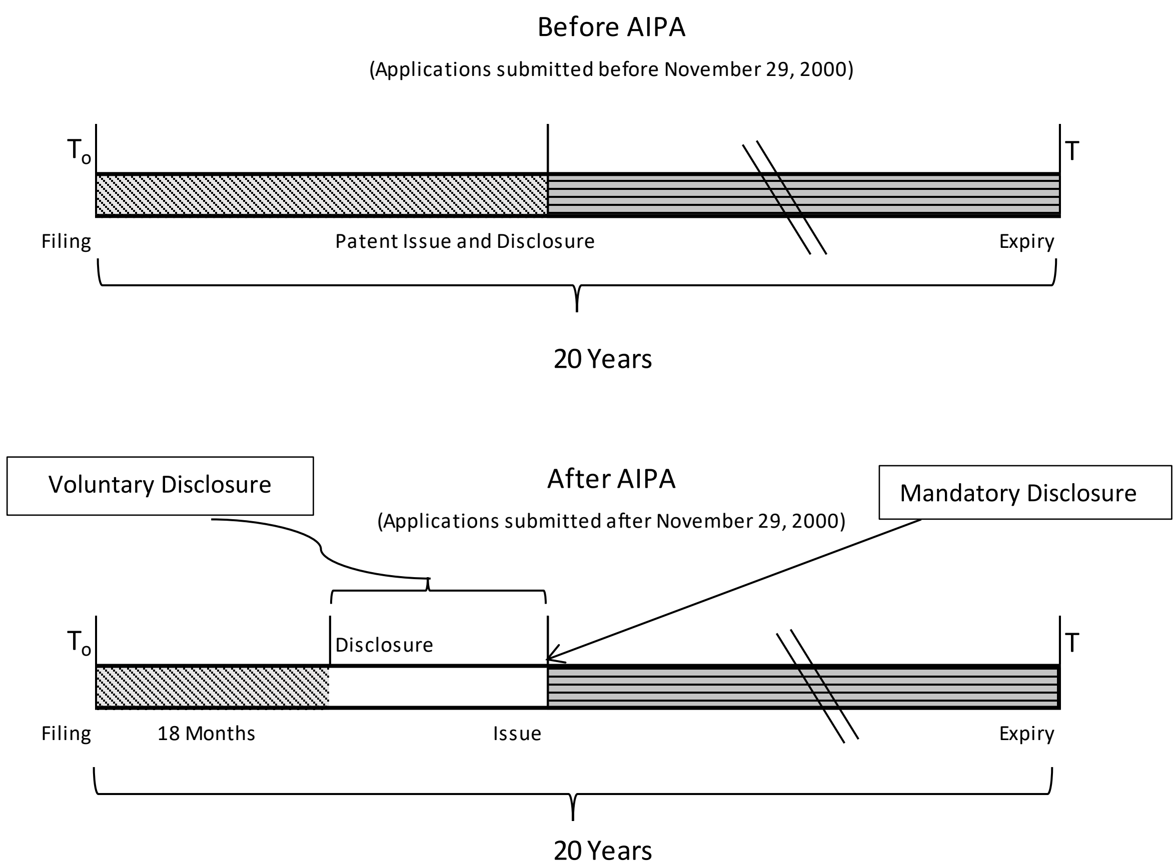
There are several benefits of publications from a legal perspective. First, the applicant may receive provisional rights during the period between publication and the grant of a patent. The applicant can receive reasonable payments from the date of publication if the patent was ultimately issued and patent rights are found to be infringed upon (See 35 U.S.C. 154(d)). Second, the publication of a patent application results in a prior art, based on which the U.S. Patent Office may reject other third-party applications for similar technology even if the application was not ultimately granted.
There are some exceptions to the publications rule. First, the publication rules only apply to utility patent applications. Design patents and provisional patent applications are not subject to publication. The filing of a provisional application, however, will start the clock on the 18-month period if the benefit of the filing date is later claimed in a non-provisional patent application. Second, US patent applications containing technical information deemed sensitive and detrimental to national security are not published. Finally, applicants may avoid publication of their application by certifying that they have not and do not intend to file a foreign patent application (Section 122 (b)(2)(B)(i)). This certification and request not to publish must be made at the time their US patent application. The penalty for filing in a foreign jurisdiction that has 18-month publication without rescinding the certification is severe—abandonment of the US application (Section 122 (b)(2)(B)(iii)). The applicant, however, has the option to rescind the decision not to publish any time before the grant date (Section 122 (b)(2)(B)(ii)).

[12] For example, Section 122 (a) reads: 'Except as provided in sub-section (b), applications for patents shall be kept in confidence by the PTO and no information concerning the same given without authority of applicant or owner……'. Sub-section (b) describes 18-month publication requirement.

[13] Prior art is the earlier reference of knowledge that prevents a patent from issuing.

Figure 2.1

Patenting timeline before and after AIPA



Source: United States Patent and Trademark Office and Graham and Hegde (2016)

Table 2.1
Variable Definitions

Dependent Variables	
CoC_avg	Average of the cost of capital estimates from following methods: 1. Gebhardt et al. (2001); 2. Ohlson and Juettner-nauroth (2005); 3. Easton (2004).
$ExcessReturn_{CAPM}$	One-year ahead excess return using CAPM
$ExcessReturn_{FFC4}$	One-ahead excess return using the Fama-French/Carhart 4-factor model
Variables of Interest	
Post_AIPA	A binary variable with value 1 if patent application date is on or after November 29, 2000; zero otherwise.
Disc_dum	A binary variable with value 1 if patent disclosure occurs before grant date; zero otherwise.
UTSA_strength	Strength of the state trade secret law based on the index constructed by Png (2016).
Inevitable Disclosure Doctrine (IDD)	State-level variable based on court rulings in favor or against Inevitable Disclosure Doctrine (IDD) following Klasa et al. (2018)
Other Variables	
Size	Log (Total Asset) based on Compustat data.
Leverage	Short-term Debt+Long-term Debt scaled by Total Asset based on Compustat
Earnings Volatility	5-year rolling standard deviation of EPS based on Compustat data.
Return Volatility	Standard deviation of return over prior 12-month period based on CRSP data
Turnover	Annual share trading volume
Industry Dummy	Industry dummy based on Fama-French (1997) 48 Industry Classification

Table 2.1 (Cont.)

Other Variables	
Idiosyncratic Volatility	Fama-French three-factor adjusted Variability of daily stock return multiplied by the total number of trading days in a year (Grullon et al., 2012).
Total Return Volatility	Return volatility from daily stock return, annualized using number of trading days in a year following Zhang (2006)
B_MKT, B_SMB, and B_HML	Fama-French 3-factor beta following Fama and French (1992, 1993) from the website of Kenneth French
Renewal_1, Renewal_2	Average number of first and second renewals of patent by firm scaled by total number of patents following Graham and Hegde (2016)
Allowed_claims	Log of average number of claims allowed for each firm following Graham and Hegde (2016)
Pendency_lag	Log of the average difference between application date and grant date following Graham and Hegde (2016)
Small	An indicator variable with value 1 if the *size* is less than the median value; zero otherwise. Constructed from Compustat data.
Inverse of Firm Age	Inverse of the difference between current period and the year the firm was first included in the CRSP sample following Zhang (2006)
Analyst Following	Number of analysts (forecasts) for each firm from IBES
A*nalyst Forecast Dispersion*	Standard deviation of analyst forecast or standard deviation scaled by prior period stock price following Zhang (2006)

Table 2.2

Distribution of Patent Applications

		Foreign Protection	Secrecy	Disclosure	Total
1996		12489	14208	0	26697
	%	46.78	53.22	0	
1997		14185	19239	2	33426
	%	42.44	57.56	0.01	
1998		13661	20112	15	33788
	%	40.43	59.52	0.04	
1999		15129	22247	134	37510
	%	40.33	59.31	0.36	
2000		15674	21691	2790	40155
	%	39.03	54.02	6.95	
2001		15565	4787	21165	41517
	%	37.49	11.53	50.98	
2002		15724	4414	21469	41607
	%	37.79	10.61	51.6	
2004		14464	3731	20921	39116
	%	36.98	9.54	53.48	
2005		12051	3655	18168	33874
	%	35.58	10.79	53.63	
2006		10903	2959	16403	30265
	%	36.03	9.78	54.2	
	Total	139845	117043	101067	357955

This table presents distribution of patent application by year from 1996 to 2006. Foreign protection refers to patents that are filed in foreign jurisdictions such as EU, Japan, and Canada. Secrecy refer to patents that exercise the opt-out option and do not disclose until the grant date. Disclosure refers to the patents which forego the opt-out option and disclose before the grant date.

Table 2.3

Distribution of Implied Cost of Equity Capital

			N	*Mean*	*Std Dev*	*Min*	*Max*
Pre-AIPA	Foreign protection	Weak Protection State	3601	0.080	0.029	0.033	0.413
		Strong Protection State	2984	0.084	0.027	0.030	0.284
	Late Disclosers	Weak Protection State	3814	0.088	0.035	0.031	0.413
		Strong Protection State	4674	0.087	0.029	0.027	0.364
	Early Disclosers	Weak Protection State	13	0.088	0.023	0.041	0.125
		Strong Protection State	16	0.075	0.026	0.046	0.131
Post-AIPA	Foreign protection	Weak Protection State	3172	0.082	0.032	0.030	0.413
		Strong Protection State	3000	0.083	0.027	0.019	0.306
	Late Disclosers	Weak Protection State	598	0.092	0.032	0.029	0.238
		Strong Protection State	1947	0.079	0.025	0.027	0.261
	Early Disclosers	Weak Protection State	3813	0.087	0.033	0.032	0.253
		Strong Protection State	4116	0.087	0.029	0.021	0.253

This table presents descriptive statistics for implied of equity capital, CoC_avg on the firm-year level. Data definitions are provided in Table 1. I estimate CoC_avg by taking the mean of Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before November 29, 2000, while post-AIPA is after that date. . Early Disclosers refer to the firms which forego the opt-out option for their patents and disclose 18-months after the application date. Non-disclosers are the firms that do not disclose before the grant date. Foreign protection refers to patents that are filed in foreign jurisdictions such as EU, Japan, and Canada. Strong and weak secrecy law are dummy variables based on Png (2016).

Table 2.4

Difference in Firm Characteristics across Different Groups

Variables	Early Discloser (1)	Non-discloser (2)	Foreign Protection (3)	Difference (1)-(2)	p-value	Difference (1)-(3)	p-value	Difference (3)-(2)	p-value
B_mkt	1.0669	1.1548	1.0584	-0.0878***	<.0001	0.0085	0.3024	-0.0963***	<.0001
BM	0.3092	0.2783	0.2871	0.0309***	<.0001	0.0221***	<.0001	0.00882***	0.0011
size	9.3587	8.8977	9.2031	0.461***	<.0001	0.1556***	<.0001	0.3054***	<.0001
leverage	0.2511	0.2235	0.2801	0.0276***	<.0001	-0.029***	<.0001	0.0566***	<.0001
retvol	0.0832	0.1157	0.0908	-0.0325***	<.0001	-0.00761***	<.0001	-0.0249***	<.0001
earnvol	0.829	1.337	1.2491	-0.5079***	<.0001	-0.4201***	<.0001	-0.0878***	0.001
turnover	1.6269	1.8737	1.2636	-0.2468***	<.0001	0.3633***	<.0001	-0.6101***	<.0001

This table presents descriptive statistics for selected control variables and t-test for mean differences among early disclosers, non-disclosers and foreign protection firms. Early Disclosers refer to the firms which forego the opt-out option for their patents and disclose 18-months after the application date. Non-disclosers are the firms that do not disclose before the grant date. Foreign protection refers to patents that are filed in foreign jurisdictions such as EU, Japan, and Canada. Data definitions are provided in Table 1. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 2.5

Dependent Variable: Implied cost of equity capital (*Coc_avg)*

		Control group	Non-disclosers		
		(1)		(2)	
	Parameters	Estimate	p-value	Estimate	p-value
Intercept	β_0	0.0503636***	0.0002	0.0467132***	0.0003
post_aipa	β_1	-0.000024	0.9942	-0.001868	0.5808
disc_dum	β_2	0.0025781	0.2642	0.0026904	0.4236
IDD	β_3	-0.0032411	0.1013	-0.0049321**	0.0377
post_aipa*disc_dum	β_4	0.0031878	0.2464	0.0040074	0.2709
disc_dum*IDD	β_5	0.0168506**	0.0217	0.0146184*	0.0579
post_aipa*IDD	β_6	0.0055979***	0.0027	0.00573***	0.0013
post_aipa*disc_dum*IDD	β_7	**-0.0190073*** **	**0.0024**	**-0.01745*** **	**0.0066**
UTSA_strength	β_8	0.0033295	0.3242	0.0026444	0.3873
B_MKT	β_9			0.0015287	0.4673
B_SMB	β_{10}			0.0019361	0.3209
B_HML	β_{11}			0.0038785**	0.0213
Size	β_{12}	-0.0003148	0.7454	0.000485	0.5957
BM	β_{13}	0.0540266***	<.0001	0.0492301***	<.0001
Leverage	β_{14}	0.03439***	<.0001	0.0269834***	<.0001
Earnvol	β_{15}	0.0009638	0.1626	0.0008853	0.2134
turnover_a	β_{16}	-0.000952*	0.0933	-0.0011538**	0.036
Retvol	β_{17}	0.0706085***	0.0028	0.0748969***	0.0036
Year Fixed effect		Y		Y	
Industry Fixed effect		Y		Y	
R-Square		0.402		0.4201	
N		13876		13469	

This table presents regression analysis of the impact of patent disclosure on the implied cost of equity capital. I estimate *CoC_avg* by averaging the cost of capital estimates following Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before 2000 while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *UTSA_strength* is the strength of trade secret law in US states as constructed by Png (2016). *Size* is log (Total Asset). *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. *BM* is book-to-market ratio. *Leverage* is total debt scaled by total assets. *Earnings volatility* is rolling 5-year standard deviation of EPS. *Turnover* is the annual trading volume estimated from CRSP monthly file. *Return variability* is standard deviation of return over prior 12-month period. B_MKT, B_SMB, and B_HML are Fama-French three-factors betas. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 2.6
Treatment Effect Model
Dependent Variable=Implied Cost of Equity Capital; Control Group: Non-disclosers

	Model 1			**Model 2**		
	Estimate	Robust SE	p-value	Estimate	Robust SE	p-value
Regression equation						
post_aipa*disc_dum*IDD	**-0.01087*** **	**0.003171**	**0.00100**	**-0.01117***	**0.005957**	**0.06100**
Other Controls	Yes			Yes		
Selection Equation						
Ln(allowed claims)	0.224776***	0.082048	0.00600	0.225568***	0.081565	0.00600
Renewal_1	-0.31242***	0.120877	0.01000	-0.36852***	0.12024	0.00200
Renewal_2	-2.96073***	0.049595	0.00000	-2.92155***	0.050426	0.00000
Small	-1.63042**	0.687288	0.01800	-2.00903***	0.677898	0.00300
Small*Ln(allowed claims)	0.38723***	0.108565	0.00000	0.350083***	0.108763	0.00100
Pendency Lag	-0.88778***	0.097179	0.00000	-0.77884***	0.097434	0.00000
Small* Pendency Lag	0.05719	0.112413	0.61100	0.126611	0.111474	0.25600
Intercept	6.774847***	0.572902	0.00000	6.050537***	0.576823	0.00000
Rho	-0.43147	0.020952		-0.40119	0.021278	
Sigma	0.026343	0.000358		0.025282	0.000371	
Lambda	-0.01137	0.000611		-0.01014	0.000599	
Wald test of rho=0			321.61			280.93
Prob>chi2			0.00000			0.00000
N			13522			13522

This table presents treatment effect model to control for the self-selection bias. Thus, the results show the impact of patent disclosure on the implied cost of equity capital after correction for self-selection by firms to disclose early. For the selection model, *Renewal_1* and *Renewal_2* indicate the average number of first and second renewals of patent by firm scaled by total number of patents. *Allowed_claims* is the log of average number of claims allowed for each firm. *Pendency_lag* is the log of the average difference between application date and grant date. *Small* is an indicator variable with value 1 if the *size* is less than the median value; zero otherwise. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 2.7
Real Option of Disclosure Regression

Dependent variable: Implied cost of equity capital

		Early Discloser		Non-discloser		Early Discloser		Non-discloser	
	Parameters	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
post_aipa*IDD*Idiosyncratic Vol	**β7**	**-0.3392*** **	**0.007**	**-0.0052**	**0.7765**	**-0.3550*** **	**0.0014**	**-0.0056**	**0.752**
Other Controls		Y		Y		Y		Y	
Year Fixed effect		Y		Y		Y		Y	
Industry Fixed effect		Y		Y		Y		Y	
R-Square		0.4175		0.4485		0.4028		0.4288	
N		5644		7452		5644		7452	
Z-Test for equality of β7			-2.95585				-3.66256		

This table presents regression analysis of the impact of embedded option of disclosure on implied cost of equity capital. *Idiosyncratic Volatility* is the Fama-French three-factor adjusted variability of daily stock return multiplied by the total number of trading days in a year. Other variables are as defined in previous regression tables. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 2.8
Information Uncertainty Regression

		Return Volatility		Forecast Dispersion	
	Parameters	Estimate	p-value	Estimate	p-value
post_aipa*disc_dum*IDD	**β7**	**-0.0954942***	**0.0763**	**-0.4586648***	**0.0597**
Other controls		Y		Y	
Year Fixed effect		Y		Y	
Industry Fixed effect		Y		Y	
R-Square		0.7437		0.4211	
N		10388		10408	

This table presents the regression analysis for the transmission channel, information uncertainty, for patent disclosure. Following Zhang (2006) I measure information uncertainty as the analyst forecast dispersion which is measured as either the standard deviation of analyst forecast or standard deviation scaled by prior period stock price. .*Analyst Following* is the number of analysts following the firm, *Total Return Volatility* is the annualized daily return volatility, and *Inverse of Firm Age* is the inverse of the difference between current period and the year the firm was first included in the CRSP sample. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 2.9

Regression on Realized Return

	One-year ahead excess return from CAPM	p-value	One-year ahead excess return from FF/Carhart 4-factor	p-value
post_aipa	-0.0502*	0.129	0.0109	0.857
disc_dum	0.0947*	0.121	0.0738*	0.146
post_aipa*disc_dum	0.0523	0.299	0.0448	0.528
IDD	-0.0716	0.224	-0.094*	0.129
post_aipa*IDD	0.217****	0.01	0.161*	0.106
disc_dum*IDD	0.0493	0.41	0.173*	0.137
post_aipa*disc_dum*IDD	**-0.138****	**0.054**	**-0.209***	**0.113**
UTSA_strength	-0.0835**	0.056	-0.147****	0.005
Size	-0.00658	0.521	-0.0196****	0.002
BM	0.352***	0.023	0.0917	0.268
Leverage	-0.162**	0.057	-0.107*	0.109
Earnvol	-0.0511**	0.087	-0.0273**	0.056
turnover_a	-0.00925*	0.131	0.00906	0.269
Retvol	0.0859	0.816	-0.107	0.788
Constant	0.0159	0.885	0.263****	0.000
Observations	12,766		15,097	
R-squared	0.168		0.113	
Industry FE	YES		YES	
Year FE	YES		YES	

This table presents regression analysis of the impact of patent disclosure on future realized return, a proxy for cost of equity following Easton and Monahan (2005). I estimate one-year ahead realized return using either a market model (CAPM) or Fama-French/Carhart 4-factor model. Pre-AIPA is the time period before 2000 while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. All other control variables are defined in Table 1. Robust standard errors are clustered at the state level. ****, ***, ** and * represent statistical significance at 1%, 5%, 10%, and 15% respectively.

Table 2.10

Panel A

		Dependent Variable= Implied Cost of Equity Capital			
		Treatment: Foreign Protection and control: Non-disclosers			
		(1)		(2)	
	Parameters	Estimate	p-value	Estimate	p-value
post_aipa*disc_dum*IDD	β_7	**-0.0005536**	**0.8562**	**-0.0028069**	**0.3783**
Controls		Y		Y	
Year Fixed effect		Y		Y	
Industry Fixed effect		Y		Y	
R-Square		0.3533		0.3681	
N		17459		16964	

This table presents regression analysis of the impact of patent disclosure on the implied cost of equity capital. I estimate *CoC_avg* by averaging the cost of capital estimates following Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before 2000 while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. All other control variables are defined in Table 1. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Panel B

In-time placebo		Dependent Variable= Implied Cost of Equity Capital			
		(1)		(2)	
	Parameters	Estimate	p-value	Estimate	p-value
post_aipa*disc_dum*IDD	β_7	**0.0045694**	**0.2557**	**0.0031335**	**0.4159**
Controls		Y		Y	
Year Fixed effect		Y		Y	
Industry Fixed effect		Y		Y	
R-Square		0.4036		0.4228	
N		13876		13469	

This table presents regression analysis of the impact of patent disclosure on the implied cost of equity capital. I estimate *CoC_avg* by averaging the cost of capital estimates following Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before ***2002*** while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. All other control variables are defined in Table 1. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Panel C

Results for high-tech industry

		High-tech (FF-48:13, 32, 35, 36)		Computer and Communication		Drugs and Medical		Electrical and Electronics	
	Parameters	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
post_aipa*disc_dum*IDD	β_7	**-0.0014664**	**0.7782**	**0.0166322**	**0.1663**	**-0.0041796**	**0.6597**	**0.0033693**	**0.6716**
Controls		Y		Y		Y		Y	
Year Fixed effect		Y		Y		Y		Y	
Industry Fixed effect		N		Y		Y		Y	
R-Square		0.3721		0.5023		0.453		0.4378	
N		4618		3450		2137		2650	

This table presents regression analysis for the impact of patent disclosure on the implied cost of equity capital for four different sample of high-tech industries. I estimate *CoC_avg* by averaging the cost of capital estimates following Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before 2000 while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. All other control variables are defined in Table 1. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Panel D

Sensitivity Tests for Instruments

	1			***2***			***3***		
		Robust			Robust			Robust	
	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Regression equation									
post_aipa*disc_dum*IDD	**-0.01097***	**0.006547**	**0.09400**	**-0.0111***	**0.006566**	**0.09100**	**-0.01092***	**0.006564**	**0.09600**
Selection Equation									
Ln(allowed claims)	0.28219***	0.077892	0.00000	0.506919***	0.062817	0.00000	0.502705***	0.062392	0.00000
Renewal_1	0.391432***	0.122017	0.00100	0.341736***	0.122276	0.00500	0.356272***	0.121633	0.00300
Renewal_2	-2.82275***	0.051136	0.00000	-2.80278***	0.05056	0.00000	-2.80653***	0.050481	0.00000
Small	-1.15637***	0.32115	0.00000	0.061586	0.042607	0.14800			
Small*Ln(allowed claims)	0.408805	0.107938	0.00000						
Controls	Y			Y			Y		
Rho	-0.39477	0.020186		-0.39746	0.020054		-0.39355	0.019487	
Sigma	0.025172	0.000369		0.025183	0.000369		0.025171	0.000367	
Lambda	-0.00994	0.00057		-0.01001	0.000567		-0.00991	0.000551	
Wald test of rho=0		304.73			311.91			325.47	
Prob>chi2		0.00000			0.00000			0.00000	
N		13522			13522			13522	

This table presents sensitivity analysis for the treatment effect model. In particular, it examines sensitivity of the results for the impact of patent disclosure on implied cost of equity capital after correcting for the self-selection bias. I estimate *CoC_avg* by averaging the cost of capital estimates following Gebhardt et al. (2001), Ohlson and Juettner-nauroth (2005), and Easton (2004). Pre-AIPA is the time period before 2000 while post-AIPA is after that date. *Disc_dum* is a binary variable with a value 1 if firm discloses the patent information early; otherwise zero. *IDD* is a binary variable with value 1 if the state court enforces Inevitable Disclosure Doctrine (IDD); otherwise zero. For the selection model, *Renewal_1* and *Renewal_2* indicate the average number of first and second renewals of patent by firm scaled by total number of patents. *Allowed_claims* is the log of average number of claims allowed for each firm. *Pendency_lag* is the log of the average difference between application date and grant date. *Small* is an indicator variable with value 1 if the *size* is less than the median value; zero otherwise. All other control variables are defined in Table 1. Robust standard errors are clustered at the state level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Chapter 3: How Do External CEOs Spur Innovation?

3.1 Introduction

In this study, I examine how external CEOs affect firms' innovation activities. Specifically, I find that external CEOs are associated with higher technology spillover, which in turn increases innovation as measured by patent counts and citation-weighted patents. In a recent paper, Custodio et al. (2018) show that external CEOs spur innovative activities. They argue that external CEOs have general ability or skills as opposed to firm-specific skills possessed by internal CEOs. They further argue that the broad experience and skill sets the external CEOs have make them less susceptible to the risk of termination and provide them with greater outside option. Thus, the external CEOs have a higher tolerance for failure which could foster innovation (Manso, 2011).

While prior literature argues that external CEOs bring in new knowledge and skillsets that may boost firm-level outcome variables including innovation (Custodio et al., 2018), we do not have direct causal evidence of how the linkage works. For example, it is possible that the firm's new increased R&D under the external CEO contributes to innovation. However, it is also possible that the improvement in the quality of R&D is due to 'incremental' knowledge from the external CEO that actually spurred the innovation. Thus, there remains a possibility of an omitted variable problem. Disentangling the knowledge would mitigate the problem and would give us a transmission channel through which new CEOs, external or internal, affects innovation. I motivate this study to provide direct evidence of how external CEOs increase innovation-related knowledge and in turn spur innovation.

In this essay, I look at the possible channels through which external CEOs affect innovation. I argue that external CEOs bring their unique skillsets, professional network, and experience that positively affects firms' information environment. Specifically, these CEOs generate positive externality in the form of technological spillover. This spillover helps spur the innovative activities. I also investigate an alternative channel. Prior literature has identified that external CEOs receive higher pay, which may increase the income inequality in the firm. There are theoretical arguments, which suggest that higher inequality may affect firm-level performance outcomes (Lazear and Rosen, 1981; Akerlof and Yellen, 1990). I examine how external CEOs affect firm-level inequality as measured by CEO payslice and variability in the pay of other members of the top management team. Further, I empirically test whether such inequality positively or negatively affects firms' innovation activities.

I draw support for my arguments both from theoretical and empirical research on CEO succession (Berns and Klarners, 2017; Karaevli, 2007). Both resource-dependence (Pfeffer and Salancik, 1978) and upper echelon (Hambrick and Mason, 1984) perspectives highlight the advantages of hiring a CEO from outside the firm and the industry. The resource-dependence theory argues the replacement of top managers with those hired from outside the firm as a remedy for organizational difficulties, such as poor performance (Boeker and Goodstein, 1993; Datta and Guthrie, 1994; Helmich and Brown, 1972; Kosnic, 1987) and resistance to change to a shifting environment (Pfeffer and Salancik, 1978; Thompson, 1967; Virany, Tushmanm and Romanelli,1992). The upper echelon perspective suggests that internal CEOs are more likely to have narrow perspectives and psychological commitment to the status quo (Hambrick, Geletkanycz, and Frerickson, 1993; March and March, 1977; Katz, 1982). External or outsider CEOs do not have these problems. Outsider CEOs, on the contrary, are likely to be more open-minded, more willing to make major changes, and therefore less committed to the current strategies and courses of actions (Karaevli, 2007). Custodio et al. (2018) show that external

CEOs, with their generalist skills and broader experience in multiple fields, are more likely to have higher ‘tolerance for failure that could foster innovation’. This argument is also consistent with Manso (2011), who shows that innovation requires a mechanism, which tolerates early failure[14].

For my identification strategy, I use a difference-in-difference design with the Inevitable Disclosure Doctrine (IDD)[15] as the exogenous shock following Klasa et al. (2018). In the literature, IDD has been shown to have two effects. First, IDD negatively affects labor migration including CEO mobility. Second, IDD restricts the transfer of trade secrets of firms to competitors above and beyond the protection offered either by the Non-Disclosure Agreements (NDA) or Covenants Not to Compete (CNC) (Klasa et al., 2018; Li et al., 2018). Thus, using IDD as an exogenous shock helps me substantially block the channels, other than via the external CEOs, through which the firms receive the technological spillover. I run a series of difference-in-difference regressions, with a predicted positive sign for the external CEOs and IDD interactions term. The interpretation of the coefficient of interest is as follows: an external CEO, relative to an internal CEO, increases technological spillover significantly in a state that adopted IDD. Simply put, a positive, statistically significant coefficient implies an external CEO increases the technology spillover and therefore innovation activities. While the design addresses endogeneity, I still run a Heckman treatment effect model to remove the possibility of self-selection. To choose the appropriate instruments, I draw from the theoretical and empirical literature on CEO

[14] Also, see McGrath (2011) who argues that innovation requires risk-taking and tolerance for failure. Sitkin (1992) termed it as ‘intelligent failure’, which is a critical element for success. Babineux and Krumboltz (2013) also argue how ‘fail fast, fail often’ can bring in positive results.

[15] Inevitable Disclosure Doctrine (IDD) is a common-law doctrine in trade secrets law that grants the plaintiff (e.g., employer) the right to prevent the defendant (e.g., employees) from working for another firm if there is a possibility that the employee will ‘inevitably’ share some of plaintiff’s trade secrets in the ordinary course of the employee’s actions. This doctrine effectively places significant restraint on the employee mobility and therefore their labor market potentials. For details, see Klasa et al. (2018).

succession. The first construct that I consider is *turbulence*, which refers to instability or difficult-to-predict change in the environment (Wholey and Brittain, 1989). Multiple studies show that the firm-specific knowledge may prove to be insufficient to handle environmental turbulence (Finkelstein and Hambrick, 1996; Virany et al., 1992; Norburn and Birley, 1988). On the other hand, external CEOs usually are better suited to such a situation. I also use two other proxies, industry-adjusted return on assets (ROA) and return on sales (ROS), that measure firm performance as prior literature also shows a relationship between firm performance and hiring of external CEOs. I use these three variables in addition to the IDD dummy variable.

The major findings of this essay are: First, consistent with prior studies (e.g., Custodio et al., 2018), I find that external CEOs increase both patent counts and citation-weighted patents significantly during the sample period 1976-2006. Second, consistent with my prediction, I find that external CEOs increase technological spillover significantly. I also document that technological spillover has a positive and significant effect on innovative activities. Third, I investigate the effect of income inequality as a second channel. My findings suggest that an external CEO’s appointment increases income inequality as measured by CEO pay slice. However, I do not find any causal link between income inequality and innovation for my sample. Aside from my results, I also conduct several additional analyses. First, I conduct similar regressions for external CEOs who hail from a similar industry and those who come from a different industry background. As CEOs from the same industry are expected to possess a substantially greater industry-specific knowledge, my prediction is they will have a more favorable effect on technology spillover and innovation. Consistent with this prediction, I find that CEOs from the similar industry increase both technology spillover and innovation significantly. On the other hand, I do not find any significant relationship for external CEOs from a different industry background. Second, I investigate the causal link using Heckman treatment effect model and find that the results remain substantially similar. Moreover, propensity-score matched sample lend support to the effect of external CEOs on innovation. Lastly, I test whether the innovation outcomes are driven by the level of R&D activities for an external-CEO-only sample and not by technology spillover. The results from this test suggest that for external CEOs, the level of R&D does not make any significant differences. We need to be cautious about the interpretation of this result, however, since this result in based on univariate test on R&D deciles.

This essay makes the following contribution. First, prior literature offers both theoretical arguments and empirical evidence linking CEO origin and innovative activities. I document new evidence of a channel through which such effect takes place. The evidence offered in this essay is rooted in sound theoretical foundations and based on solid empirical measures. Second, I also show that an external CEO's effect on innovation differs with respect to the industry origin. I argue that because of their deep understanding and broad industry-specific knowledge, external CEOs from a similar industry will have a positive effect on innovation, an argument supported by evidence in this essay.

The remainder of the essay is arranged as follows. *Section 3.2* develops the hypotheses while *Section 3.3* outlines the research methods. Results are discussed in *Section 3.4,* and *Section 3.5* provides additional analysis. *Section 3.6* concludes.

3.2 Literature Review and Hypothesis Development

The Chief Executive Officer (CEO) is considered the most important leader in an organizational hierarchy as she makes the most important strategic and operational decisions. Therefore, the departure of the existing CEO or appointment of a new CEO is closely observed by investors and other stakeholders. Academic literature has also delved into this CEO succession topic for decades (Karaeveli, 2007; Berns and Klarner, 2017). In particular, the literature looks at how CEO succession affects firm performance. New CEOs, for instance, often initiate significant changes to the organizations they manage (Denis and Denis, 1995; Pan et al., 2015, 2018), creating uncertainty about firm's future performance. Clayton, Hartzell, and Rosenber (2005) and Pan et al. (2015) find that a firm's stock return volatility substantially increases around CEO turnover events. Pan et al. (2018) find that new CEOs significantly affect firms' cost of borrowing and financial policies. Prior research finds an increase in corporate restructuring activity (Denis and Denis, 1995), such as asset write-offs (Strong and Meyer, 1987), and divestiture (Weisbach, 1995). Pan et al. (2018) show that firms' financial policies change after CEO succession. However, the literature does not provide an unequivocal result with respect to firm performance following these strategic and operational changes.

More recently, researchers are also looking at more specific succession factors that may have moderated or mediated firm performance (Finkelstein and Hambrick, 1996). One such factor that has been investigated is the successor origin (Boeker, 1997; Boeker and Goodstein, 1993; Brady and Helmich, 1984; Zajac, 1990). The literature investigates whether firm performance is affected differentially by inside vs. outside CEOs or CEOs from the same industry (intra-industry CEOs) or a different industry (inter-industry). Researchers argue that CEO origin matters because they bring in different experience and skill sets (Harris and Helfat, 1997; Zhang and Rajagopalan, 2003, 2004, 2010; Custodio et al., 2018). These differences supposedly influence their strategic and operational decisions, which in turn affect firm performance.

Over time, both the CEO turnover and appointment of an external CEO have increased (Huson, Parrino, and Starks, 2001; Ferris, Jayaraman, and Lim 2015). However, Huson et al. (2001) find that the relationship between CEO turnover and firm performance measured by both accounting and stock return remained relatively stable. They interpret this evidence as a disconnect between firm performance and CEO turnover. In other words, they do not find statistically significant evidence that CEOs will be replaced because of their poor performance. Parrino (1997) shows that the industry structure plays a role. He finds that poor-performing CEOs are easier to identify and less costly to replace in industries with homogeneous firms relative to heterogeneous industries. A CEO in a homogeneous industry is more likely to be replaced by another CEO from the same or similar industry. Zhang and Rajagopalan (2010) study how external versus internally appointed CEOs affect firm-level resource allocation and performance. They find that there is an inverted U-shaped relationship between strategic change and firm performance such that " the positive effect of strategic change on firm performance when the level of change is relatively low and the negative effect of strategic change on firm performance when the level of change is relatively high are pronounced for outside CEOs than for inside CEOs."

3.2.1 Hypotheses Development

In this section, I develop the relevant hypotheses. I use the conceptual model presented in Figure 3.1 to explicate the relevant hypotheses. In brief, Figure 3.1 shows two relationships which work as the transmission channels through which external CEOs affect a firm's innovation activities. The first one is that external CEOs bring in new knowledge and network that affects a firm's technology spillover from other firms. This, in turn, impacts innovation positively. The second one is that the external CEOs affect the income inequality of the firm, which affects the efforts put in by other employees. As a result, innovation activities are affected. I develop the hypotheses in greater detail in Sections 3.2.1.1 and 3.2.1.2.

3.2.1.1 External versus Internal CEO, Innovation Channel, and Innovation

While choosing the CEO, a board has a number of options in terms of CEO origin. One possibility is to choose from within the firm (insider option). A second possibility is to search outside the firm (external option). Again the external CEO can be picked from the same industry (intra-industry succession) or a different industry (inter-industry succession) (Berns and Klarners, 2017). Both resource-dependence (Pfeffer and Salancik, 1978) and upper echelon (Hambrick and Mason, 1984) perspectives highlight the advantages of hiring a CEO from outside the firm and the industry. The resource-dependence theory argues the replacement of top managers with those hired from outside the firm as a remedy for organizational difficulties, such as poor performance (Boeker and Goodstein, 1993; Datta and Guthrie, 1994; Helmich and Brown, 1972; Kosnic, 1987) and resistance to change to a shifting environment (Pfeffer and Salancik, 1978; Thompson, 1967; Virany, Tushmanm and Romanelli, 1992).

The upper echelon perspective offers several justifications for the link between external CEO and performance relative to internal CEO. As internal CEOs have already served the firm for quite some time, and have had the chance to socialize substantially, they are more likely to have narrow perspectives and psychological commitment to the status quo (Hambrick, Geletkanycz, and Fredrickson, 1993; March and March, 1977; Katz, 1982). This may lead to a reduced amount and quality of information processing (Finkelstein and Hambrick, 1996; Tushman and Roamnelli, 1985). Moreover, they are unlikely to undertake major changes that upset the status quo and possibly the social relationship (Finkelstein and Hambrick, 1990; Gabarro, 1987; Wiersema and Bantel, 1993). External or outsider CEOs do not have these problems. Since they come from outside the firm, the external CEOs are less likely to have social ties within the firm. Nor are they committed to the entrenched status quo. Outsider CEOs are likely to be more open-minded, more willing to make major changes, and therefore less committed to the current strategies and courses of actions (Karaevli, 2007). Similar to Custodio et al. (2018), I argue that external CEOs are better at supporting innovation than internal CEOs. Custodio et al. (2018) show that external CEOs, with their general ability skills and broader experience in multiple fields, are more likely to manage innovative projects. They also argue that the experience and skillsets make these CEOs less sensitive to the risk of termination and provide greater outside option. Taken together, the external CEOs have higher 'tolerance for failure that could foster innovation.' This argument is also consistent with Manso (2011), who shows that innovation requires a mechanism, which tolerates early failure.

In this essay, I argue that the external CEOs positively influence innovation because they bring in their own set of knowledge, network, and skillsets to the new firm. This whole combination of transferred knowledge changes the information environment in which the firm works to innovate. In other words, external CEOs create a positive externality. I argue that CEO mobility increases the positive externality in the form of knowledge or technology spillover (e.g., Jaffe, 1986; Bloom et al., 2013). Therefore, my expectation is knowledge spillover will be higher for external CEOs.

On the other hand, inside successors offer few advantages of their own. First, the board is already familiar with them, which reduces information asymmetry substantially (Harris and Helfat, 1997; Tian, Haleblian, and Rajagopalan, 2011). Second, an inside successor has company specific and industry-specific knowledge and skills (Kotter, 1982) as well as social capital (Nahapiet and Ghoshal, 1998) such as social ties to employees (Finkelstein et al., 2009; Zajac, 1990). Third, the insider offers greater continuity and stability as insider CEOs are associated with fewer organizational changes such as changes in human resources (Helmich and Brown, 1972, Helmich,1975). Fourth, an insider CEO reduces the perception of higher risk as measured by audit pricing adjustment (Bills et al., 2017). Lastly, external CEOs, compared to the insiders, face greater pressure to provide a signal about their ability and skill. This may lead to short-termism in performance to avoid getting fired (Narayanan, 1985; von Thadden, 1995). Bebchuk and Stole (1993) show that information asymmetry along with short-termism may lead to suboptimal investment in long-term projects. Therefore, an alternative hypothesis is that internal CEOs, with their superior firm-specific skills, technical knowledge, and social network, can identify and promote innovation. Based on the above discussion, I state my hypotheses in the alternate form:

H1: An external CEO increases innovation relative to an internal CEO.

H1a: An external CEO increases technology spillover relative to an internal CEO.

H1b: A CEO- induced increase in technology spillover increases innovation.

3.2.1.2 External versus Internal CEO, Income Inequality, and Innovation

There is a growing literature dealing with firm-level income inequality and different market and firm characteristics (e.g., Bloom and Michel, 2002; Carpenter and Sanders, 2002; Hayward and Hambrick, 1997; Siegel and Hambrick, 2005). Despite its importance, few empirical studies have explicitly tested the links between firm-level income inequality and innovation. Aghion et al. (2016) is an exception, who use cross-state data and find that innovation and top-income inequality are positively related. Income inequality is of particular interest to policymakers, unions, and public in general because of its broader political implications. Another goal of this essay is to study empirically how income inequality affects innovation.

Income inequality between top executives and the average worker has received widespread attention lately from media, public, and regulators. The US Securities and Exchange Commission (US SEC) for example now requires that firms report the *cheap number*: the ratio of CEO pay over a median worker's pay. Over time, the inequality so measured has widened and received public indignation and complaints about the excessive pay of CEOs especially from the labor unions. According to the American Federation of Labor –Congress of Inustrial Organizations (AFL-CIO), CEOs at the largest companies received 42 times the pay of the average worker in 1980. In 2000 the gap hit a high, with CEOs making 525 times the average worker. In 2010, the gap somewhat narrowed, yet the CEOs still made 343 times the average worker[16]. If firm level CEO pay is consistent with performance, however, one can argue that it makes economic sense for the pay to be that high. Gabaix and Landier (2008) propose that line of argument and find that even a small dispersion of talent justifies large differences in pay. Overall they find that differences in firm size explain the differences in the level of CEO pay.

Innovation is a challenge for many firms as it involves a process that is long, complex and uncertain. It also has a high probability of failure (Manso, 2011; Holmstrom, 1989). Thus, managers, with a view to minimizing the risk of failure, avoid investing in innovation.. Instead, they focus on much less complicated routine but more certain tasks. This focus leads to managerial short-termism (or myopia) problem. One potential solution is to develop optimal

[16] Under a Dodd-Frank rule requiring the disclosure of CEO pay ratio vis-à-vis the pay of a median employee, companies for the first time started disclosing their CEO pay ratio for 2017. Deloitte compiled the pay ratio data for 294 S&P 500 companies for 2017 and found that the ratio ranged between 96:1 to 396:1, with the median value of 153:1. For details, see https://deloitte.wsj.com/riskandcompliance/2018/06/20/ceo-pay-ratio-disclosure-a-look-at-year-one-results/.

incentive scheme for innovation that would tolerate early failure and reward long-term success (Manso, 2011).

Prior research investigates whether innovation leads to a greater market value of firms. (Schankerman, 1998; Hall et al., 2005; Hsu, 2009; Hirshleifer et al., 2013). The basic idea is that firms can earn a supernormal profit and exploit growth opportunities if they create valuable knowledge and capture market value. Innovations are measured in a number of ways including Research and Development expenses. Recently, a number of studies used patents as a proxy for innovation (Hall et al., 2014). Some researchers consider patent as a better proxy than R&D as patents are the outputs of the innovative process while R&D expenses are inputs which might or might not necessarily lead to fruitful output.

Several authors attempt to link firm performance with wage differential. Akerlof and Yellen (1990) offer *fair wage-effort hypothesis* and argue that workers have a conception of a fair wage. If the actual wage is below this relative fair wage, workers exert suboptimal (less than normal) effort. Stated differently, wage inequality deemed unfair would likely result in low firm performance. On the other hand, Lazear and Rosen (1981) develop *tournament theory*, which predicts that differences in pay may induce strong incentives to put in greater effort and generate better performance outcome. In a later paper, Lazear (1989) argues that there is an element of interconnectedness in the top level management, which in turn depends on the culture of the firm. The tournament theory would work better for a firm that has a 'hawkish' culture. Conversely, pay differences may not contribute positively for firms that are rather 'dovish.' In the extant literature, both theories received some empirical support (Eriksson, 1999; Main et al., 1993; Fredrickson et al., 2010).

Manso (2011) argues that incentive schemes that motivate innovation should be structured differently than a standard pay-for-performance scheme used to induce effort or avoid tunneling. Optimal incentive scheme for innovation would tolerate early failure and reward long-term success. Under this incentive scheme, compensation depends not only on total performance but also on the path of performance. The paper shows that commitment to a long-term compensation plan, job security, and timely feedback on performance are essential to motivate innovation. Manso's (2011) analytical model seems to lend greater support toward lower pay inequality for motivating innovation. Another recent paper by Aghion et al. (2016), on the other hand, offers evidence that innovation and top income inequality are related[17]. However, Aghion et al. (2016) do not use firm-level innovation data. Rather their findings are based on a cross-state panel and cross US commuting-zone data. Based on the above discussion, the second hypothesis is stated below in alternative form:

H2: An external CEO increases income inequality relative to an internal CEO.

H2a: A CEO-induced increase in income inequality increases innovation.

3.3 Research Design

3.3.1 Data and Measurement of Variables

My sample consists of a panel of CEO-firm-years of Standard& Poor's EXECUCOMP database. While EXECUCOMP does not provide data before 1992, the existing database contains CEO joining date prior to that period. Thus, I could use the data between 1976 and 2006. In addition, I hand-collect data on CEO industry background and matched that with that of EXECUCOMP data based on 3-digit SIC code.

[17] Using a Schumpeterian model, they argue the following: " Facilitating innovation or entry increases the entrepreneurial share of income and spurs social mobility through creative destruction as employees' children more easily become business owners and vice versa." (p.2)

I use the NBER patent data to measure innovation. This database provides a unique identifier (GVKEY), which enables me to link the patent data with EXECUCOMP. I control for firm characteristics using financial statement data from COMPUSTAT.

3.3.1.1 External CEO

Following Ertimur et al. (2018), I define a CEO as External CEO if the difference between his/her joining the firm and becoming CEO is less one year. Of course, if the CEO joined and became CEO the same day, I also code that as External CEO. On the other hand, if the difference between these two dates is greater than a year, I code that CEO as 'internal.' If the joining date is missing, I consider that CEO's status as 'not available.' EXECUCOMP provides compensation data on CEOs since 1992; however, it provides the joining date and date becoming CEO from 1930 and 1945 respectively (there are some missing data, however). Given these dates, I could construct a dataset from 1976 to 2006.

3.3.1.2 Inevitable Disclosure Doctrine (IDD)

Inevitable Disclosure Doctrine (IDD) is a legal doctrine based on the English Common Law, which is applied based on 'threatened misappropriation' to protect the employers (Klasa et al., 2018). In the Court of Law, the employer merely needs to demonstrate that there is a likelihood of employee disclosing firm secret and harm the employer. In other words, the employer can receive legal redress even without any actual harm or expropriation taking place (Wiesner, 2012). Legal literature shows that IDD provides substantially expanded coverage for the protection of trade secrets (Klasa et al., 2018).

I follow Klasa et al. (2018) to identify 21 states where IDD was adopted. I set the IDD indicator as one for these states from the year IDD was adopted. For other years, IDD would have a value of zero. However, three states rejected IDD after their initial adoption by the court

(Florida in 2001, Michigan in 2002, and Texas in 2003). IDD indicators for these states are one when IDD was in effect and zero for other years. For the remaining 29 states, the indicator is zero throughout.

3.3.1.3 Measuring innovation

My measures of innovation are based on innovation output or patent counts and citations. The first measure is the number of patent applications filed by a firm in a given year (No. of patents). One issue with this number is the database includes only granted patents and there exists on average a two-year lag between application and grant date. Following Hall, Jaffe, and Trajtenberg (2001), I include year fixed-effects to address time truncation issues.

My second measure is the citations-weighted numbers of patents. Patent counts are an imperfect proxy of innovation as patent vary widely in their technological and economic relevance (Grilliches, Hall, and Pakes (1987)). A widely used measure is citation counts or number of citations subsequently received. Hall, Jaffe, and Trajtenberg (2005) show that citations are positively related to firm value.

3.3.1.4 Technology Spillovers

The following description of the Technology Spillover measure has been heavily borrowed from Bloom et al. (2013). For detailed technical analysis, please see Bloom et al., (2013). The main motivation behind this measure is the insight that a firm receives positive externality of the R&D of other firms if those firms are close in the technology space. Thus, a firm's aggregate positive externality from technology would be the sum of technology spillover from all other firms in that common technology space.

I estimate the technology spillovers the following ways. In the first step, I calculate technology proximity using the uncentered correlation between two firms using two measures:

the Jaffe measure (Jaffe (1986)) and the Mahalanobis measure (Bloom et al., 2013). With the Jaffe measure, technology spillovers are restricted to the same technology space, whereas with the Mahalanobis measure, technology spillovers are allowed across different technology spaces. The second step is the calculation of the R&D stocks of all other firms. The final step is the calculation of technology spillovers to a given firm from all other firms.

Jaffe Measure of Technology Spillovers

To construct the Jaffe measure, I use the technology class used by the United States Patent and Technology Office (USPTO). Altogether, there are 426 possible technology classes. A firm's technology activity is then estimated by the average share of the patents of the firm in a particular technology class over the period 1976-2006. A firm's technology activity is then characterized by a vector $T_i=(T_{i1},T_{i2},\ldots,T_{i426})$, where $T_{i\tau}$ is the average share of the patents of firm i in technology class τ. Thus, the technology closeness measure between firm i and firm j is then defined as the uncentered correlation between the two firms' technology activities:

$$TECH_{ij} = \frac{(T_i T_j')}{(T_i T_i')^{\frac{1}{2}}(T_j T_j')^{\frac{1}{2}}}$$

The Jaffe proximity of one firm with another firm is then defined as the uncentered correlation of the technology activities of the two firms. The Jaffe proximity measure can range between zero and one, with a higher value indicating greater closeness. In the next step, I estimate the R&D stocks of all other firms by capitalizing firms' R&D expense. To do that, I use the following formula: $G_{jt} = R_{jt} + (1–\delta)G_{jt-1}$, where G_{jt} is the R&D stock for firm j in year t, R_{jt} is the firm j's R&D expenditures in year t and δ is the depreciation rate. Following Bloom et al., (2013), I assume a depreciation rate of 15% (δ=0.15) for this capitalized R&D. Technology spillover from each firm is equal to the uncentered correlation multiplied by the R&D stock of that firm. In the final step, I estimate technology spillovers for a particular firm by summing up technology spillovers from all other firms.

$$SPILLTECH_{it}^{Jaffe} = \sum_{j \neq i} TECH_{ij} G_{jt}$$

Mahalanobis Measure of Technology Spillovers

The Mahalanobis measure of technology spillovers is different from the Jaffe measure in one important respect: it assumes that technology classes are non-orthogonal and there is knowledge complementarity across technology areas. For example, a firm may have patents on multiple technology classes. While the Jaffe measure assumes each of these classes is completely unrelated, Mahalanobis measure assumes that the colocated technology classes within a firm are possibly the result of related technologies. In other words, these colocated technology classes reflect technology spillovers across technology classes. I calculate the proximity of technology classes by first estimating the average share of each technology class for each firm determined by the following vector $X_\tau = (T_{1\tau}, T_{2\tau}, \ldots, T_{N\tau})$, where N is the number of firms and $T_{i\tau}$ is the average share of patents of firm *i* in technology class τ over the sample period. Then the proximity of two technology classes, say τ and ρ, is the uncentered correlation between these two technology classes:

$$X_{\tau\rho} = \frac{(X_\tau X'_\rho)}{(X_\tau X'_\tau)^{\frac{1}{2}} (X_\rho X'_\rho)^{\frac{1}{2}}}$$

In the next step, I construct a proximity matrix for all technology classes. Specifically, this is a 426×426 matrix $\Omega = X'X$ such that each element is the uncentered correlation measure between patent classes, $X_{\tau\rho}$. In other words, this matrix, Ω, represents correlation or proximity of all technology classes. After this step, I measure the technological proximity of firm *i* and firm *j* as follows:

$$TECH_{ij}^{Mahal} = \left(\frac{T_i}{(T_i T_i')^{\frac{1}{2}}}\right)\Omega\left(\frac{T_j'}{(T_j T_j')^{\frac{1}{2}}}\right)$$

Now the measure of technological proximity between two firms has the following components: one is the technological proximity between two firms[18], and the other one is the proximity of the technology classes. In the last step, the R&D stocks of all other firms are calculated of technology spillovers. Then I estimate the technology spillovers for a particular firm by summing up technology spillovers from all other firms.

$$SPILLTECH_{it}^{M} = \sum_{j \neq i} TECH_{ij} G_{jt}$$

3.3.1.5 Other explanatory variables

To explain patents or citation-weighted patents I include several firm characteristics as controls following Hall and Ziedonis (2001), Bloom et al. (2013), and Aghion, Van Reenen, and Zingales (2013). Firm size is proxied by total assets. Capital Intensity is proxied by the ratio of plant, property, and equipment (PPE) to sales. In addition, I control for total sales, the number of employees, R&D expenses, and R&D stock. I also include return on asset (ROA), capital expenditure (CAPEX), cash holdings (CASH) and Tobin's Q. Further, I use some CEO-specific variables that are shown to have an association with CEO pay such as CEO Age, CEO Age-squared and CEO Tenure.

[18] This is similar to the Jaffe measures as captured by *T*i and T_j vectors. Stated differently, Mahalanobis measure could be thought of as the function of Jaffe measure between two firms and non-orthogonal effect of technology classes.

3.3.2 Empirical Specifications

To test H1, I estimate the following difference-in-difference model that links log of patent counts (log of citation-weighted patents) to external CEOs as well as a set of control variables in year t:

$$Patent\_counts\ (Citation\_weighted\ Patents) = \beta_0 + \beta_1\ External\ CEO + \boldsymbol{\beta_2\ External\ CEO \times IDD} + \beta_3\ IDD + \beta_k \sum Controls + Fixed\ effects + \varepsilon \quad (3.1)$$

where Patent_counts (Citation-weighted Patents) is a measure of innovative output. In all regressions I control for the firm- and year fixed-effects. Thus, my identification exclusively exploits the variation of innovation and CEO mobility within the difference-in-difference design. Since the variable of interest, External CEO, is measured at the firm-level, I cluster standard errors by firm to account for possible correlation in error terms (Petersen, 2009). A positive and significant β_2 will be consistent with the hypothesis H1.

To test H1a, I estimate a similar model[19] that links technology spillover to external CEOs as well as a set of control variables in year t:

$$Technology\ Spillover = \beta_0 + \beta_1\ External\ CEO + \boldsymbol{\beta_2\ External\ CEO \times IDD} + \beta_3\ IDD + \beta_k \sum Controls + Fixed\ effects + \varepsilon \quad (3.2)$$

where technology spillover is the channel through which external CEOs affect innovation. In all regressions I control for the firm- and year fixed-effects and cluster standard errors by firm to account possible correlation in error terms. As in Model 1, a positive and significant β_2 will be consistent with the hypothesis H1a.

[19] One concern in this specification is the endogeneity. I tested for endogeneity using Sargan-Hansen (SH) statistics and found that p-value for the SH statistics is 0.1711. It does not reject the null that the regressor, CEO_DUM, is exogenous at .05 or even at 0.10 level. I still run Heckman endogeneity model and propensity-score matching to exclude the possibility of endogeneity emanating from self-selection as prior literature suggests that appointment of external versus internal CEOs is a choice variable (Karaevli, 2007). Please see section 5 for details.

To test H1b, I use a slightly different version as I test whether the channels in fact affect innovation outputs during the sample period:

$$\textit{Citation-weighted Patents} = \beta_0 + \beta_1 \textit{ External CEO} + \beta_2 \textit{ Log(SPILLTECH)} + \beta_3 \textit{ IDD} + \beta_4 \textit{ External CEO} \times \textit{IDD} + \beta_5 \textit{ External CEO} \times \textit{IDD} + \beta_6 \textit{ External CEO} \times \textit{Log(SPILLTECH)} + \beta_7 \textit{ External IDD} \times \textit{Log(SPILLTECH)} + \boldsymbol{\beta_8} \textbf{ External CEO} \times \textbf{IDD} \times \textbf{Log(SPILLTECH)} + \beta_k \sum \textit{Controls} + \textit{Fixed effects} + \varepsilon \quad (3.3)$$

I run the following model to test H2:

$$\textit{Income Inequality} = \beta_0 + \beta_1 \textit{ External CEO} + \boldsymbol{\beta_2} \textbf{ External CEO} \times \textbf{IDD} + \beta_3 \textit{ IDD} + \beta_k \sum \textit{Controls} + \textit{Fixed effects} + \varepsilon \quad (3.4)$$

In this model, β_2 is the coefficient of interest. A positive and significant value will be consistent with H2.

Similar to the model to test H1b, I use the following model to test H2a:

$$\textit{Citation-weighted Patents} = \beta_0 + \beta_1 \textit{ External CEO} + \beta_2 \textit{ Log(CEO Payslice)} + \beta_3 \textit{ IDD} + \beta_4 \textit{ External CEO} \times \textit{IDD} + \beta_5 \textit{ External CEO} \times \textit{IDD} + \beta_6 \textit{ External CEO} \times \textit{Log(CEO Payslice)} + \beta_7 \textit{ External IDD} \times \textit{Log(CEO Payslice)} + \boldsymbol{\beta_8} \textbf{ External CEO} \times \textbf{IDD} \times \textbf{Log(CEO Payslice)} + \beta_k \sum \textit{Controls} + \textit{Fixed effects} + \varepsilon \quad (3.5)$$

In these models, a positive and significant β_8 will be consistent with the hypotheses H1b and H2a.

3.4 Results

3.4.1 Descriptive Statistics

Table 2 reports the descriptive statistics for major variables. One noteworthy fact is around 21% of CEOs appointed came outside the firm. Also, an average firm has 39.75 patents with mean citations of 354.45. As for the income inequality, CEOs alone on average account for more than

30% of the total pay of remaining top management team or C-suite[20] members. The variability of pay among C-suite members on average is 0.42 with a standard deviation of 0.30.

[Insert Table 3.2 about here]

Table 3.3 reports the pair-wise Pearson correlation for the important variables. Note that External CEO and Log (SPILLTECH) has a positive relationship with non-negligible magnitude. We can also see that External CEO has a negative, but a low-magnitude association with Patent and Citations.

[Insert Table 3.3 about here]

3.4.2 External CEO and Innovation

In the first regression, I show the effect external CEOs have on innovation. Specifically, I regress all external CEOs in Model 1 on number of patents. In model 1, the coefficient for the interaction of external CEO and IDD is positive and statistically significant at 5% level. The magnitude of the coefficient is 0.357, which suggests that hiring an external CEO increases patents by 35.7% after the adoption of IDD in the state headquartering the firm. The increase is substantial in size and economically meaningful. Among control variables, *R&D stock* has a positive and significant relation while the current *R&D Flow* is insignificant. This indicates a firm's accumulated R&D investments positively affect innovation. Of the other control variables, *Log (Sales)* and *Tobin's Q* have a positive and significant relations. Model 2 reports the effect of external CEO hiring on log of citation-weighted patents as the proxy for innovation. Prior literature in patent shows that citation is a measure of patent value with higher citation meaning higher value. The results look similar to Model 1: external CEOs show a positive and significant effect on innovation. Specifically, the interaction coefficient is 0.821, which suggests

[20] Title names of the top management team start with letter C such as Chief Executive Officer, Chief Financial Officer, Chief Operating Officer and so on. Thus, the group of senior executives are also known as the C-suite.

that citation-weighted patents increase by 82.1% after an external CEO is hired in an IDD adopting state. Control variables including *R&D stock* has a similar sign and significance. Taken together, these results are consistent with Hypothesis 1 (H1).

[Insert Table 3.4 about here]

3.4.3. Channel: Technology Spillover

As I argued earlier, the external CEOs positively influence innovation because they bring in their own set of knowledge, network, and skillsets to the new firm. This whole combination of transferred knowledge changes the information environment in which the firm works to innovate. I use two proxies of technology spillovers: *SPILLTECH_Jaffe* and *SPILLTECH_Mahalanobis*, which I measure following Jaffe (1986) and Bloom et al. (2013). The first proxy, *SPILLTECH_Jaffe*, measures to what extent technology in the *same* field spilled over to the innovation of a firm from other firms. In other words, it shows the positive externality of innovation of other firms. The second proxy, *SPILLTECH_Mahalanobis*, extends the definition of spillover to include not only the same technology field but also in all related fields. One of the major premises of this essay is CEO mobility increases this positive externality. Therefore, my expectation is technology spillover will be higher for external CEOs. Empirically this should be reflected on the sign and significance in the regression coefficient.

Table 3.5 shows the regression results for technology spillover. Overall, the results support the predictions of Hypothesis 1a (H1a). As shown in Model 1, increase in *SPILLTECH_Jaffe* by the external CEOs is statistically significant. In other words, an external CEO increases technology spillover by 15.9% in a state with IDD enforcement, which is nontrivial and economically significant. Model 2 shows the results for the second proxy, *SPILLTECH_Mahalanobis*. The coefficient of interest is positive and statistically significant at the 5% level. The result shows that an external CEO increases technology spillover by 13.5% not only from the same technology field but also from related fields. Among the control variables, *R&D stock* and *Log(Sales)* are positively related with technology spillover. On the other hand, *Log(Employment)* has a negative sign, indicating an inverse relationship between technology spillover and number of employees.

[Insert Table 3.5 about here]

3.4.4 Channel: Inequality

Prior studies show that external CEO receive around 15% more pay (Murphy and Zabojnik, 2007). However, pay increase would not necessarily increase inequality if the pay for others also increases in the firm. Economic theory has a conflicting prediction about the consequence of higher inequality. Tournament theory by Lazear (1981) suggests that higher inequality leads greater effort. This in turn positively contributes to greater firm performance. If tournament theory were true, one could argue that higher inequality would lead to greater innovation. On the other hand, fair wage-effort hypothesis (Akerlof and Yellen, 1990) argue that higher inequality may be considered unfair, which in turn may induce employees to exert reduced effort. This will have a deteriorating effect on firm performance. Given the conflicting predictions, the relation between inequality and innovation may be an empirical question.

For this study, I use two proxies: CEO pay slice and coefficient of variation of pay of non-CEO C-suite members. A higher CEO pay slice will indicate higher inequality between CEO pay and other C-suite members. On the other hand, a higher coefficient of variation(CV) would indicate higher inequality among C-suite members. Table 3.6 reports the regression results for CEO pay slice. Consistent with results in prior regressions, external CEOs show a significant and positive relationship with CEO pay slice. External CEOs increase income inequality by

0.0414 points. With a mean value of 0.3206, this number translates into an increase of 12.91%, which is a non-trivial value. This result is consistent with Hypothesis 2 (H2). Table 3.6 also reports the results for the coefficient of variation of non-CEO C-suite members. As the Model 2 shows, none of the coefficients of interest has a statistically significant result. In other words, the hiring of a CEO from outside does not change the variability of income among C-suite members. One possible explanation is the incoming CEO is receiving the higher pay while the non-CEO senior executives do not experience a significant pay changes on a relative basis.

[Insert Table 3.6 about here]

3.4.5 Relative Effects of Technology Spillover and Inequality on Innovation

While the increase in both technology spillover and inequality show that external CEOs influence these variables, we need one additional piece of evidence to establish them as the channels through which external CEOs influence innovation. To that end, I regress citation-weighted patents on technology spillover for the sample period and inequality for the period between 1992 and 2006. If we find that technology spillover and inequality are positively related to innovation, we can conclude that these are indeed the channels. The results of the regressions are reported in Table 3.7.

[Insert Table 3.7 about here]

In both regressions, the coefficient of interest is the three-way interaction term. While it is positive and statistically significant for technology spillover, the term is not significant for inequality (it also has a negative sign contrary to expectation). Thus, the result is consistent with with H1B. However, the results linking external CEO, inequality, and innovation are not consistent with H2a. There could be multiple interpretations of this result. One possible interpretation is pay inequality as measured by pay slice may not necessarily affect innovation performance as relative inequality for other C-suite members remain unaffected as measured by *cofvar*. A second interpretation is consistent with other empirical studies testing the predictions of the tournament theory. As extant literature on labor economics shows, the evidence is largely mixed for tournament theory. However, it is safe to conclude that the major channel through which the external CEOs affect innovation is through their impact on technology spillover.

3.5 Additional Analyses

3.5.1 Industry Origin of External CEOs and Innovation

External CEOs may come with varied experience in multiple industries. Some CEOs may come from the same industry while others may have worked in a completely different industry. I divide the external CEO sample into two parts: those coming from the same industry and those coming from a different industry. I argue that industry knowledge is a key driver in the technology spillover process. Hence, CEOs coming from the similar industry can contribute more to the firm innovation process with their profound understanding of the dynamics of the industry in addition to whatever general managerial ability they may have. However, IDD plays a significant role as an impediment to the mobility of the CEOs. It is possible that external CEOs will be vetted more stringently with this risk in mind. Thus, CEOs from the same industry possibly belong to the unique pool who are unlikely to be a threat to trade secrecy to the prior employer but have the deep knowledge about the industry and competition. Moreover, they may possess superior general managerial ability compared to the internal CEOs. Based on this insight, I expect that external CEOs from a similar industry background will contribute positively to the innovation information environment and spur innovation. As for external CEOs from a different industry, it is unlikely that they have as profound understanding of the industry as the CEOs from a similar industry. However, they may have superior general managerial ability and assemble the right people to positively affect the innovation environment. Since it is difficult *ex-ante* to know how they will perform, it remains an open empirical question.

Table 3.8 reports the results for CEO industry origin, patent, and technology spillover regression. Models 1 through 4 show the effects of CEOs industry background on innovation measured by patent and citation-weighted patents. External CEOs from a different industry do not have a significant effect on innovation (Model 1). On the contrary, CEOs from a similar industry has a positive and significant effect. Consistent with our expectation, the coefficient of the interaction shows that an external CEO hired with a similar industry background increases patent count by 40.50% in the post IDD period. In a similar vein, external CEOs from a different industry do not have a significant effect on the citation-weighted patent measure. Moreover, the magnitude of the coefficient is also small. On the other hand, External CEOs from similar industries contribute significantly toward firm-level innovation. As the Model 4 shows, the coefficient is 0.906 or 90.6%. In other words, external CEOs increase 90.6% of citation-weighted patents in firms who hired CEOs from a similar industry. Models 5 and 6 show the effect of the external CEO industry origin on technology spillover. As is the case with patents, the spillover results are also driven by external CEOs from a similar industry. CEOs from a different industry do not seem to have any significant effect on the technology spillover proxy. On the contrary, external CEOs from a similar industry show a positive and significant result. The hiring of CEOs from similar industries increases technology spillover by 14.3%, an economically significant increase.

[Insert Table 3.8 about here]

I report the results of the effect of CEO industry origin on income inequality in Table 3.9. Income inequality seems to have similar results that I reported for technology spillovers. In this case, the external CEOs from a different industry does not seem to have any effect on CEO pay slice. The CEOs from the same industry has a significant and positive relationship. The coefficient is 0.0303: the hiring of a CEO from the same industry increases CEO pay slice by 9.45%. This number again is nontrivial with economic significance. However, industry origin does not have any effect on the COFVAR. Stated alternatively, CEO origin does not affect the variability of the pay for other C-suite members in my sample.

[Insert Table 3.9 about here]

3.5.2 Treatment effect regression for self-selection.

Since CEO appointment is a firm-level decision, there is a possibility of endogeneity arising from self-selection, which would bias the OLS results. While I use Inevitable Disclosure Doctrine (IDD) as an exogenous shock, I use other econometric tools to remove any residuals endogeneity concerns. In particular, I use both matching techniques such as propensity score matching and the Heckman treatment effect regression.If the differences between firms with external CEOs and internal CEOs are based on unobservable characteristics, Heckman model would work better (Imbens and Wooldridge, 2009; Lennox et al., 2012). However, a big challenge in implementing the Heckman model is to find out suitable instruments, which have strong theoretical support in the literature and well-reasoned economic interpretation (Lennox et al., 2012; Larcker and Rusticus, 2010)

For this study, I follow the CEO succession literature, which suggests that firms are more likely to choose an external CEO under certain circumstances (Karaevli, 2007). One such situation is environmental turbulence: the higher the turbulence in the industry or economy, the higher will be the likelihood of hiring an external CEO. The rationale is internal CEOs firm-specific skills are inadequate to handle the uncertainty created by the turbulence. As external

CEOs have more general skills, they are well-suited to lead the firm (Karaevli, 2007; Custodio, 2018). Firms are also likely to choose external CEOs when the performance outcomes are unsatisfactory especially under the helm of an existing internal CEO (Boeker and Goodstein, 1993; Guthrie and Datta, 1997). In this situation, the firm requires expertise and skills from outside and a leader who is not part of the 'status quo' (Hambrick and Mason, 1984). I, therefore, estimate a proxy for environmental turbulence called *turbulence* and *industry-adjusted ROA and ROS* following Karaevli (2013) to use as instrumental variables. The definitions of these variables are provided in Table 3.1.

Table 3.10 reports the results of the treatment effect models. As the highlighted portion shows, external CEOs increase technology spillover statistically significantly for both regression models. In other words, the hypothesis that technology spillover is causally related to external CEO is validated by the Heckman treatment effect models as well.

[Insert Table 3.10 about here]

3.5.3 Treatment Effect using Propensity Score Matching (PSM)

In section 3.5.2, I show that if there are difference due to unobservable factors, then the self-selection of external CEO sample could be corrected by using Heckman model. If, on the other hand, there are differences between firms with external CEOs and internal CEOs based on observable characteristics, matching is better suited to obviate the selection issues (Rosenbaum and Rubin, 1983; Imbens and Wooldridge, 2009). To exclude the possibility that the results are driven by self-selection based on observable characteristics, I estimate the effect of external CEOs on technology spillover relative to a propensity matched sample of internal CEOs. I follow Custodio et al. (2018) and Karaeveli (2007) to choose the variables on which to match the firms. In particular, I use four additional variables: CEO age to capture CEOs experience, Firm Age to capture whether the firm is in a stable state, Number of Segments to capture firm complexity, and Herfindahl index at the 3-digit SIC level to capture industry-wide concentration versus competition.

I report both the probit regression and average treatment effect of the treated for external CEOs versus internal CEOs in Table 3.11. As we can see, external CEOs increase both measures of technology spillover, namely SPILLTECH_JAFFE and SPILLTECH_MAHAL, relative to the propensity-matched internal CEOs. In other words, external CEOs are more effective in increasing the technology spillover than internal CEOs even after controlling for observed firm and CEO characteristics.

[Insert Table 3.11 about here]

3.5.4 R&D Investment and Innovation Outcomes for External-CEO-only Subsample

While I control for R&D investment in models, there is a possibility that the innovation outputs are not driven by external CEO's technology spillover. Rather, these are driven by the level of R&D investments. If that indeed is the case, a subsample consisting of only the external CEOs will show higher level of both patents and citation-weighted patents. If, on the other hand, the patent outcomes are driven by technology spillover above and beyond the R&D investments, I expect to see no noticeable differences in patient outcomes for differential level of R&D investments for external CEO subsamples.

To exclude this alternative explanation, I create deciles for both patents and citation-weighted patents based on R&D investments scaled by total assets. Then I run a t-test for the difference between the mean values for the highest (Decile 1) and lowest (Decile 10) deciles. The results of these tests are reported in Table 3.12. As the results show, there is no difference in patent outcomes for the differential level of R&D investments for the external CEO subsample.

The p-values are greater than 0.50 and 0.30 for patents and citation-weighted patents, respectively.

[Insert Table 3.12 about here]

3.6 Conclusion

In this study, I examined how the external CEOs affect innovation using the Inevitable Disclosure Doctrine (IDD) as the exogenous shock. Specifically, I show that external CEOs, relative to internal CEOs, affect two channels: technology spillovers and income inequality. I also provided evidence that the external CEOs increase innovation by bringing in external knowledge in the form of technology spillover. Furthermore, I showed that CEO industry origin matters as the results are mostly driven by CEOs from the same or similar industries. I ran several additional analyses to exclude the alternative explanation and to confirm the robustness of the results. The results from these additional analyses also indicate a substantively similar relationship. Overall, I offer new evidence of a channel through which external CEOs affect innovation. The evidence offered here is backed by theories on CEO succession and solid empirical measures, and based on the argument that external CEOs bring in their own set of knowledge, network, and skillsets to the new firm. This knowledge changes the information environment in which the firm works to innovate.

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Figure 3.1: Conceptual Model

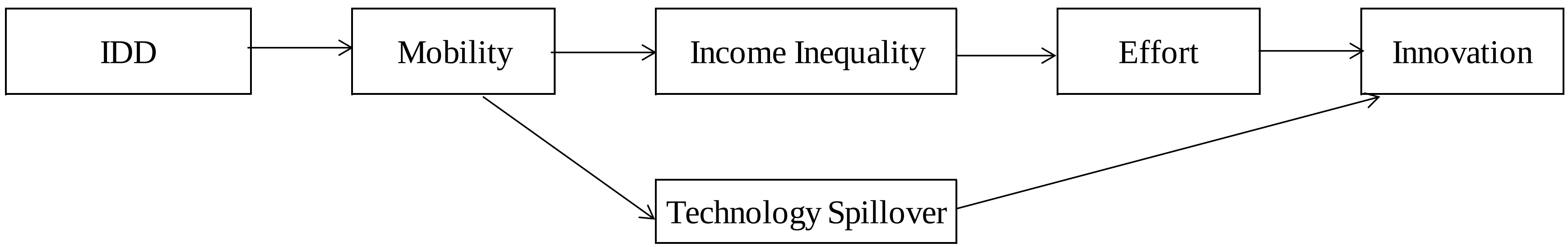

Table 3.1
Variable Definitions

Dependent Variables	
Patent	Log (1+Patent) where patent count data is sourced from the NBER database (1976-2006)
Citation-weighted Patents	Log (1+Citation-weighted Patents) where the number of citations and patent data are sourced from the NBER database (1976-2006)
SPILLTECH_Jaffe	Log (SPILLTECH) as measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text.
SPILLTECH_Mahalonabis	Log (SPILLTECH) as measured following Bloom et al. (2013), details of which is provided in-text.
CEO_Payslice	CEO total pay as a percentage of all non-CEO total pay using Execucomp data.
COFVAR	Coefficient of variation of non-CEO C-suite members pay
Variables of Interest	
External CEO `	A binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018) from the database.
External CEO_{SI}	A binary variable with value 1 if the CEO is hired externally from the same (or similar) industry; zero otherwise following Ertimur et al. (2018) from the Execucomp and hand-collected data.
External CEO_{DI}	A binary variable with value 1 if the CEO is hired externally from a different industry; zero otherwise following Ertimur et al. (2018) from the Execucomp and hand-collected data.
Inevitable Disclosure Doctrine (IDD)	A binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018).
Size	Log (Total Asset) based on Compustat data.

Table 3.1 (Cont.)

Other Variables	
Leverage	Short-term Debt+Long-term Debt scaled by Total Asset based on Compustat
R&D Stock	The stock of R&D with 15% annual depreciation rate following Bloom et al. (2013)
R&D Flow	R&D scaled by total assets
Tobin's Q	Sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D.
Sales	Log (Sales) based on Compustat
Capex	Capital Expenditure scaled by sales based on Compustat data.
Cash	Cash scaled by total assets based on Compustat.
Employment	Log (Employment) based on Compustat.
PPE	Log (Plant, Property, and Equipment) based on Compustat.
Industry Sale	Log (Industry Sale) based on 3-digit SIC based on Compustat.
ROA	Net income scaled by total assets
Tenure	Number of years as the CEO
Age	CEO current age.
Environmental Turbulence	Measured as the volatility of demand across time on 3-digit SIC level. Specifically, it is measured as the standard error of the regression coefficient scaled by the mean value from a 5-year-rolling time-series regression of sales data following Karaevli (2007) and Carpenter and Fredrickson (2001).
ROA_IA	Industry-adjusted return on assets on 3-digit SIC level.
ROS_IA	Industry-adjusted return on sales on 3-digit SIC level.

Table 3.2
Descriptive Statistics

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
CEO Variables					
Tenure	4782	6.28	7.45	1	52
CEO Total Pay	4881	5460.65	16805.4	0	655448
CEO AGE	4558	55.71	7.6	29	89
CEO Duality	4932	0.99	0.11	0	1
Payslice	4881	0.31	0.12	0	0.94
Coefficient of Variation (Non-CEO pay)	4884	0.42	0.3	0	2.27
Firm-level and Other Variables					
Cash and Equivalents	12585	369.05	1722.45	0	60592
Plant, Property and Equipment	12580	1353	5284.79	0	128063
Sale	12586	3757.94	11980.96	0	245308
R&D Flow	12586	163.22	572.94	0	12183
Capital Expenditure	12445	282.58	1223.15	0	33143
Employment	12296	22.25	60.43	0.01	1400
Tobin's Q	12578	6.35	34.04	0	1240.08
Leverage	12585	0.2	0.2	0	7.87
ROA	12585	0.08	0.25	0	0.91
Cash (% of Total Assets)	12585	0.17	0.2	0	1
Capital Expenditure (% of Total Assets)	12444	0.07	0.05	0	0.58
R&D Flow (R&D/Total Assets)	12585	0.07	0.09	0	2.09
Log (Sale)	12564	6.43	2.09	0	12.41
External CEO Dummy	6866	0.21	0.41	0	1
Patent_counts	12586	39.75	125.96	1	3505
Citation	12586	467.43	1632.16	1	45131
IDD	12586	0.34	0.47	0	1
Capitalized R&D (R&D Stock)	12586	354.45	1171.2	0	17587.44
Plant, Property and Equipment (PPENT/Sale)	12547	0.42	3.33	0.01	260.11
Log of Technology Spillover (SPILLTECH)	11460	17.71	1.49	12.05	21.07
Size (Log of Total Assets)	11460	6.61	1.89	-0.11	13.53

Table 3.3
Correlation Matrix

		1	2	3	4	5	6	7	8	9	10	11
1	External CEO	1										
2	IDD	-0.1274*	1									
3	Size	-0.1551*	0.1786*	1								
4	Log (Sale)	-0.2055*	0.1640*	0.9535*	1							
5	R&D Flow	0.1893*	-0.1087*	-0.3157*	-0.3904*	1						
6	R&D Stock	0.005	0.1160*	0.8348*	0.7648*	0.0715*	1					
7	Log (PPE)	-0.0434*	0.0947*	0.1882*	0.0158	0.0221*	0.1204*	1				
8	Log (Emp)	-0.2582*	0.1282*	0.8840*	0.9315*	-0.3986*	0.6920*	0.1151*	1			
9	ROA	-0.0620*	0.0387*	0.1987*	0.3303*	-0.5796*	0.0193*	-0.2466*	0.2884*	1		
10	Capital Expenditure	0.0298*	-0.0423*	-0.0309*	0.006	0.0157	-0.0328*	0.3581*	0.0737*	0.0920*	1	
11	Cash	0.3465*	-0.1245*	-0.3332*	-0.4713*	0.4585*	-0.0774*	-0.0839*	-0.5409*	-0.2643*	-0.1410*	1
12	Tobin's Q	0.1378*	-0.0379*	-0.1342*	-0.1897*	0.2258*	-0.0348*	-0.1011*	-0.2362*	-0.0766*	-0.0648*	0.4088*
13	Log (Citation-weighted Patent)	-0.0580*	0.0311*	0.5250*	0.5123*	-0.0215*	0.5892*	0.1602*	0.5593*	0.1120*	0.1747*	-0.1596*
14	Log (Patent)	-0.0686*	0.0730*	0.6307*	0.6050*	-0.0431*	0.6823*	0.1640*	0.6252*	0.1005*	0.1214*	-0.1749*
15	Log (Citation)	-0.0461*	0.0011	0.4345*	0.4307*	-0.0023	0.5073*	0.1490*	0.4948*	0.1143*	0.2092*	-0.1387*
16	Log (SPILLTECH)	0.2129*	0.1541*	0.2916*	0.2119*	0.1744*	0.4256*	-0.0949*	0.0262*	-0.1355*	-0.1843*	0.2013*

Patent count data is sourced from the NBER database (1976-2006) where patents are ultimately granted. *Citation* is the number of cumulative external citations received. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. * represent statistical significance at 5% level.

Table 3.4
External CEOs effect on Patent and Citation-weighted Patents

	(1)	(1)
VARIABLES	Log (1+No. of Patents)	Log (1+Citation-weighted Patents)
External CEO	-0.0787	-0.277
	(0.1590)	(0.3410)
External CEO × IDD	**0.357****	**0.821****
	(0.1780)	(0.4040)
IDD	-0.198***	-0.390**
	(0.0723)	(0.1700)
Size	0.0704	0.134
	(0.0780)	(0.2000)
Log(Sales)	0.286***	0.641***
	(0.1030)	(0.2450)
R&D Flow	0.588	1.163
	(0.3820)	(0.9610)
R&D Stock	0.237**	0.529***
	(0.0943)	(0.1950)
Log(PPE)	0.181**	0.505***
	(0.0768)	(0.1810)
Log (Employment)	0.0244	-0.00452
	(0.1240)	(0.2900)
ROA	-0.329*	-0.645
	(0.1910)	(0.4780)
Capital Expenditure	-0.680**	-1.820**
	(0.3460)	(0.8970)
Cash	0.314*	0.813*
	(0.1900)	(0.4580)
Tobin's Q	0.00220***	0.00670***
	(0.0008)	(0.0019)
Constant	0.0214	1.707
	(0.4840)	(1.1410)
Observations	6,257	6,257
R-squared	0.852	0.837
Firm FE	YES	YES
Year FE	YES	YES

Patent count data is sourced from the NBER database (1976-2006) where patents are ultimately granted. *Citation* is the number of cumulative external citations received. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.5

External CEOs and Technology Spillover

	(1)	(2)
VARIABLES	Technology Spillover-Jaffe	Technology Spillover-Mahalanobis
External CEO	-0.00462	-0.0021
	(0.0463)	(0.0415)
External CEO × IDD	**0.159*** **	**0.135** **
	(0.0578)	(0.0547)
IDD	-0.0162	-0.0074
	(0.0278)	(0.0238)
Size	0.0253	0.0138
	(0.0241)	(0.0210)
Log(Sales)	0.114***	0.0970***
	(0.0297)	(0.0221)
R&D Flow	-0.0597	-0.0291
	(0.1220)	(0.1120)
R&D Stock	0.0434*	0.0301
	(0.0223)	(0.0196)
Log(PPE)	-0.0121	-0.0033
	(0.0253)	(0.0211)
Log (Employment)	-0.118***	-0.0973***
	(0.0314)	(0.0285)
ROA	0.0169	0.0128
	(0.0509)	(0.0400)
Capital Expenditure	0.00177	0.0368
	(0.0991)	(0.0913)
Cash	-0.113**	-0.0786*
	(0.0507)	(0.0468)
Tobin's Q	-3.50E-05	0.00011

	(0.0002)	(0.0002)
Constant	13.83***	3.148***
	(0.1230)	(0.1010)
Observations	9,855	9,855
R-squared	0.987	0.997
Firm FE	YES	YES
Year FE	YES	YES

Technology Spillover-Jaffe and *Technology Spillover-Mahalonobis are* log transformed value of SPILLTECH which are measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.6
External CEOs and Income Inequality

	(1)	(1)
VARIABLES	CEO Payslice	COFVAR
External CEO	-0.0308*	0.085
	(0.0168)	(0.0895)
External CEO × IDD	**0.0414*** **	**0.0229**
	(0.0158)	(0.0708)
IDD	-0.00519	-0.0206
	(0.0071)	(0.0224)
Log (Tenure)	0.000431	-0.016
	(0.0040)	(0.0131)
CEO Age	0.00827	-0.00517
	(0.0056)	(0.0146)
CEO Age-squared	-7.69E-05	6.45E-05
	(0.0000)	(0.0001)
Log (CEO Compensation)	0.0740***	0.0148
	(0.0072)	(0.0095)
Size	-0.0280***	0.0276
	(0.0108)	(0.0333)
Log (Sale)	-0.0201**	-0.0126
	(0.0092)	(0.0304)
R&D Flow	-0.0903*	0.0265
	(0.0519)	(0.1180)
Log (PPE)	-0.011	0.0243
	(0.0080)	(0.0230)
Log (Employment)	-0.00285	0.00433
	(0.0075)	(0.0235)
ROA	-0.017	-0.0298
	(0.0269)	(0.0674)
Capital Expenditure	-0.0235	-0.068
	(0.0556)	(0.1290)
Cash	-0.0191	0.00493
	(0.0210)	(0.0638)
Tobin's Q	-0.000116**	0.000429
	(0.0001)	(0.0004)
Constant	-0.115	0.308
	(0.1620)	(0.4280)

Observations	6,408	6,362
R-squared	0.687	0.436
Firm FE	YES	YES
Year FE	YES	YES

CEO_Payslice is the CEO total pay as a percentage of all non-CEO total pay using Execucomp data. *COFVAR* is the coefficient of variation of non-CEO C-suite members pay *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. *Tenure* is the number of years as the CEO. *Age* is the current age of the CEO. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.7
Technology Spillover, Income Inequality, and Innovation
(Dependent Variable: Citation-weighted Patents)

VARIABLES	Spillover	Inequality
External CEO	-10.45***	-1.025*
	(2.1490)	(0.5930)
IDD	2.245*	-0.116
	(1.1940)	(0.3360)
Log (Spilltech)	-1.161***	
	(0.1900)	
CEO Payslice		-0.067
		(0.5950)
External CEO × IDD	-8.421**	
	(3.3510)	
External CEO × Log (Spilltech)	0.552***	
	(0.1160)	
IDD × Log (Spilltech)	-0.146**	
	(0.0663)	
External CEO × IDD× Log (Spilltech)	**0.497*** **	
	(0.1820)	
External CEO × IDD		1.755***
		(0.6080)
External CEO × CEO Payslice		0.148
		(0.9700)
IDD × CEO Payslice		-0.711
		(0.8500)
External CEO × IDD × CEO Payslice		**-1.152**
		(1.6830)
Constant	18.67***	3.96
	-2.775	-2.989
Observations	6,196	2,928
R-squared	0.842	0.893

Controls	YES	YES
Firm FE	YES	YES
Year FE	YES	YES

Patent count data is sourced from the NBER database (1976-2006) where patents are ultimately granted. *Citation* is the number of cumulative external citations received. *Technology Spillover* is the log-transformed value of SPILLTECH, which is measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text. *CEO_Payslice* is the CEO total pay as a percentage of all non-CEO total pay using Execucomp data. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.8
CEO Industry Origin and Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log (1+ Patent Count)		Log (1+Citation-weighted Patent)		Log (SPILLTECH)	
External CEO_{DI}	0.258		0.655		0.0947	
	(0.3330)		(0.7150)		(0.0854)	
External CEO_{DI}× IDD	0.108		0.103		0.0867	
	(0.2650)		(0.6380)		(0.0779)	
External CEO_{SI}		-0.219		-0.637*		-0.0264
		(0.1630)		(0.3580)		(0.0395)
External CEO_{SI}×IDD		**0.405****		**0.906****		**0.143****
		(0.2010)		(0.4410)		(0.0699)
IDD	-0.180**	-0.181**	-0.333*	-0.369**	-0.0108	-0.0154
	(0.0718)	(0.0715)	(0.1700)	(0.1710)	(0.0271)	(0.0279)
Size	0.112	0.0342	0.233	0.0334	0.0488*	0.0232
	(0.0910)	(0.0803)	(0.2290)	(0.2060)	(0.0290)	(0.0253)
Log(Sales)	0.332**	0.279***	0.709**	0.628**	0.103***	0.120***
	(0.1310)	(0.1070)	(0.3020)	(0.2530)	(0.0352)	(0.0315)
R&D Flow	0.504	0.624	1.144	1.301	0.0163	-0.0909
	(0.4070)	(0.4030)	(1.0790)	(1.0140)	(0.1490)	(0.1370)
R&D Stock	0.156	0.252***	0.371*	0.564***	0.0656**	0.0466**
	(0.0960)	(0.0967)	(0.1980)	(0.2000)	(0.0254)	(0.0230)
Log(PPE)	0.237**	0.192**	0.633***	0.547***	-0.00336	-0.00904
	(0.0920)	(0.0786)	(0.2150)	(0.1860)	(0.0220)	(0.0268)
Log (Employment)	-0.0276	0.0366	-0.118	0.0483	-0.139***	-0.116***
	(0.1480)	(0.1300)	(0.3400)	(0.3020)	(0.0354)	(0.0325)
ROA	-0.239	-0.253	-0.277	-0.403	0.0598	0.011
	(0.2170)	(0.2020)	(0.5510)	(0.5080)	(0.0532)	(0.0534)
Capital Expenditure	-0.403	-0.772**	-1.485	-2.120**	-0.0416	0.00891
	(0.3660)	(0.3460)	(0.9990)	(0.8990)	(0.1090)	(0.1010)
Cash	0.357	0.307	0.863	0.834*	-0.116*	-0.0933*
	(0.2240)	(0.1890)	(0.5390)	(0.4660)	(0.0639)	(0.0539)

Tobin's Q	0.00246**	0.00203***	0.00735**	0.00605***	0.000213	-4.35E-05
	(0.0010)	(0.0008)	(0.0029)	(0.0019)	(0.0003)	(0.0003)
Constant	-0.113	0.223	1.437	2.219*	13.71***	13.81***
	(0.5710)	(0.5020)	(1.3280)	(1.1890)	(0.1520)	(0.1270)
Observations	5,333	5,896	5,333	5,896	8,350	9,295
R-squared	0.864	0.851	0.846	0.835	0.988	0.987
Firm FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Patent count data is sourced from the NBER database (1976-2006) where patents are ultimately granted. *Citation* is the number of cumulative external citations received. *Technology Spillover* is the log-transformed value of SPILLTECH, which is measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text. *External* CEO_{SI} is a binary variable with value 1 if the CEO is hired externally from the same or similar industry; zero otherwise. *External* CEO_{DI} is a binary variable with value 1 if the CEO is hired externally from a different industry; zero otherwise. *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.9
CEO Industry Origin and Income Inequality

	(1)	(2)	(3)	(4)
VARIABLES	CEO pay slice		COFVAR	
External CEO_{DI}	-0.00249		-0.242	
	(0.0395)		(0.2110)	
External CEO_{DI}× IDD	0.0316		0.174	
	(0.0380)		(0.1480)	
External CEO_{SI}		-0.0373**		0.210**
		(0.0177)		(0.0905)
External CEO_{SI}×IDD		**0.0303***		**-0.036**
		(0.0176)		(0.0782)
IDD	-0.00631	-0.00519	-0.0135	-0.0192
	(0.0072)	(0.0072)	(0.0222)	(0.0223)
Log (Tenure)	0.00045	-0.000366	-0.0157	-0.0165
	(0.0044)	(0.0041)	(0.0141)	(0.0127)
CEO Age	0.00703	0.00808	-0.00333	-0.00276
	(0.0063)	(0.0056)	(0.0163)	(0.0144)
CEO Age-squared	-6.59E-05	-7.36E-05	4.85E-05	4.28E-05
	(0.0001)	0.0000	(0.0001)	(0.0001)
Log (CEO Compensation)	0.0773***	0.0760***	0.0232*	0.0240***
	(0.0060)	(0.0076)	(0.0124)	(0.0087)
Size	-0.0249**	-0.0289**	-0.0102	0.00681
	(0.0107)	(0.0113)	(0.0311)	(0.0334)
Log (Sale)	-0.0157	-0.0211**	0.0035	-0.00951
	(0.0111)	(0.0093)	(0.0307)	(0.0293)
R&D Flow	-0.0539	-0.0718	-0.119	0.0177
	(0.0553)	(0.0509)	(0.1290)	(0.1250)
Log (PPE)	-0.0108	-0.0107	0.039	0.0164
	(0.0098)	(0.0084)	(0.0269)	(0.0224)
Log (Employment)	-0.00739	-0.00474	0.0138	0.0255
	(0.0072)	(0.0074)	(0.0227)	(0.0247)
ROA	-0.0163	-0.0135	-0.0523	-0.0448

	(0.0301)	(0.0285)	(0.0814)	(0.0739)
Capital Expenditure	-0.0532	-0.0138	-0.0356	-0.0378
	(0.0701)	(0.0573)	(0.1500)	(0.1320)
Cash	-0.0322	-0.0256	0.0338	0.0053
	(0.0246)	(0.0224)	(0.0746)	(0.0667)
Tobin's Q	-0.000102	-8.03E-05	0.000276	0.000511
	(0.0001)	(0.0001)	(0.0003)	(0.0004)
Constant	-0.159	-0.104	0.416	0.197
	(0.1820)	(0.1620)	(0.4730)	(0.4170)
Observations	5,307	6,005	5,269	5,959
R-squared	0.678	0.694	0.452	0.449
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

CEO_Payslice is the CEO total pay as a percentage of all non-CEO total pay using Execucomp data. *COFVAR* is the coefficient of variation of non-CEO C-suite members pay *External* CEO_{SI} is a binary variable with value 1 if the CEO is hired externally from the same or similar industry; zero otherwise. *External* CEO_{DI} is a binary variable with value 1 if the CEO is hired externally from a different industry; zero otherwise. *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. *Tenure* is the number of years as the CEO. *Age* is the current age of the CEO. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.10
Heckman Treatment Effect Regression
(Dependent Variable: Technology Spillover)

	(1) Estimate	Robust SE	p-value	*(2)* Estimate	Robust SE	p-value
Regression equation						
Size	0.5422***	0.0495	0.0000	0.5480***	0.0478	0.0000
R&D Flow	1.3957***	0.2549	0.0000	1.0768***	0.2145	0.0000
R&D Stock	0.2054***	0.0234	0.0000	0.2699***	0.0220	0.0000
Log (Sale)	0.3505***	0.0375	0.0000	0.3480***	0.0329	0.0000
Log(PPE)	-0.3128***	0.0351	0.0000	-0.3444***	0.0340	0.0000
Log (Employment)	-0.5232***	0.0299	0.0000	-0.5789***	0.0284	0.0000
CapEx	-1.1846***	0.4327	0.0060	-0.5138	0.4099	0.2100
Cash	-1.0880***	0.1383	0.0000	-0.7957***	0.1252	0.0000
Tobin's Q	0.0014	0.0009	0.1180	0.0006	0.0008	0.4180
External CEO	**1.4332*** **	**0.0867**	**0.0000**	**1.1810*** **	**0.1320**	**0.0000**
Intercept	13.4266***	0.1620	0.0000	13.3616***	0.1551	0.0000
Selection Equation						
IDD	-0.0497	0.0468	0.2880	-0.2124***	0.0516	0.0000
Turbulence	0.1445*	0.0763	0.0580	0.1893***	0.0718	0.0080
ROS_{IA}	-0.0023*	0.0012	0.0560	0.0026	0.0039	0.5020
ROA_{IA}	0.1129***	0.0301	0.0000	0.1659***	0.0317	0.0000
Size	-0.0965	0.0725	0.1830			
R&D Flow	-1.4885***	0.3401	0.0000			
R&D Stock	0.3377***	0.0340	0.0000			
Log (Sale)	0.0500	0.0476	0.2940			
Log(PPE)	-0.1209***	0.0465	0.0090			
Log (Employment)	-0.2421***	0.0361	0.0000			
CapEx	2.9046***	0.5981	0.0000			
Cash	0.8621***	0.1874	0.0000			
Tobin's Q	-0.0027	0.0019	0.1520			
Intercept	-1.5411***	0.1863	0.0000	-1.1060	0.0437	0.0000
Rho	-0.5427	0.0335		-0.4214	0.0576	
Sigma	1.1221	0.0144		1.1008	0.0166	
Lambda	-0.6090	0.0428		-0.4639	0.0687	
Wald test of rho=0	Chi-square (d.f. 1)		41.94			14.73
Prob>chi2			0.0000			0.0001

N	5356	5356

Technology Spillover is log transformed value of SPILLTECH_JAFFE which is measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *IDD* is a binary variable with value 1 if state courts ruled in favor of Inevitable Disclosure Doctrine (IDD); zero otherwise following Klasa et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. *Turbulence* is measured as the standard error of the regression coefficient scaled by mean value from a 5-year-rolling time-series regression of sales data following Karaevli (2007) and Carpenter and Fredrickson (2001). *ROA_IA* is the industry-adjusted return on assets on 3-digit SIC level. *ROS_IA* is the industry-adjusted return on sales on 3-digit SIC level. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.11
CEO Industry Origin and Technology Spillover: Propensity Score Matching

	Coefficients	z-statistics	p-value
Size	0.2363	1.46	0.145
Log (PPE)	-0.2686**	-2.43	0.015
R&D Flow	-1.7003	-0.94	0.348
R&D Stock	0.2451*	1.85	0.064
Log(Employment)	-0.20002	-1.57	0.116
ROA	-0.3363	-0.72	0.47
Lagged ROA	-0.1324	-0.45	0.654
Capital Expenditure	3.5044***	2.69	0.007
Cash	0.1846	0.35	0.724
Tobin's Q	0.0068	1.41	0.159
CEO Age	-0.01183	-1.13	0.259
Firm Age	-0.0134**	-2.09	0.037
NumSeg	0.02545	0.37	0.711
Herfindahl	0.67363	0.45	0.653
Constant	-1.3896*	-1.91	0.056

	Average Treatment Effect of the Treated (ATET)					
	Spilltech_Jaffe	z stat	p-value	*Spilltech_Mahal*	z-statistics	p-value
External versus Internal	0.2166***	2.69	0.007	0.3219***	10.09	0.000

SPILLTECH_JAFFE and SPILLTECH_MAHAL ARE measured following Bloom et al. (2013) and Jaffe (1986), details of which is provided in-text. *External CEO* is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *Size* is the log of Total Assets. *Log (Sale)* is the logarithmic value of sales/turnover in Compustat. *R&D* is the research and development expense scaled by total assets. *R&D stock* is the capitalized R&D with 15% annual depreciation. *Log(PPE)* is the log-transformed value of plant, property, and equipment. *Log (Employment)* is the log-transformed value of the employment in Compustat. *ROA* is the return on assets, which is net income scaled by total assets. *Capital Expenditure* is the capital expenditure scaled by total sales. *Cash Holdings* is the cash and equivalents scaled by total assets. *Tobin's Q* is the sum of the values of common stock, preferred stock, total debt net of current assets divided by the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. *CEO Age* is the current age of the CEO, while *Firm Age* is the number of years the firm is in CRSP database. *NumSeg* is the number of operating segments. *Herfindahl* is the Herfindahl Index in 3-digit SIC level. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 3.12

R&D Investment and Innovation Outcomes for external CEO only Subsample

	R&D Deciles	N	Log (1+Patent)	Log (1+Cit_weighted Patents)
Highest	1	144	1.7943	5.3845
	2	145	1.8443	5.5153
	3	145	2.1483	6.1573
	4	144	2.1820	6.2841
	5	145	2.4163	6.4826
	6	145	2.2808	6.3557
	7	144	2.2550	6.1979
	8	145	2.1857	6.0150
	9	145	2.0026	5.5695
Lowest	10	144	1.8794	5.0512
Differenc (D1-D10)			-0.0851	0.3334
t-value			-0.66	1.03
p-value			0.5104	0.3028

External CEO is a binary variable with value 1 if the CEO is hired externally; zero otherwise following Ertimur et al. (2018). *R&D* is the research and development expense scaled by total assets. l. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Chapter 4: State-level Third Party Liability and Reporting Opacity

4.1 Introduction

In this essay, I study how state-level liability affects bank reporting opacity. Specifically, I find that changes in the state-level tort law[21] in the USA increases bank reporting opacity. Prior research suggests that stakeholders including the auditors respond to changes in legal environment affecting litigation risk (Anantharaman et al., 2016; Palmrose, 1988). Auditors in particular respond to such changes, among other, by conducting high-quality audit (Venkataraman et al., 2008). This, in turn, improves the client firm's quality of financial statements.

Prior literature suggests that firms and auditors face significant litigation risk both at the federal level and state level (Gaver, Paterson, and Pacini, 2012). While the banks (firms) may have direct contractual obligation to their customers, shareholders, and regulators for reporting transparency, they may be influenced by their auditors' actions such as high or low efforts to ensure audit quality. It is well-documented in the audit literature that auditors use a number of different approaches to minimize litigation risk (Anantharaman et al., 2016). One such approach is to enhance the quality of audit (Venkataraman et al., 2008). This in turn puts pressure on the banks to enhance the quality of the financial statements as well (Gaver et al., 2012).

I exploit the variations in the state-level changes in the tort law. Specifically, I use the move from *joint-and-several liability doctrine* to a *proportionate liability doctrine* of liability sharing standard as an exogenous shock. Under the former doctrine, a plaintiff can claim and recover full damages from any of the defendants irrespective of proportional fault of each liable

[21] Tort law is a law for civil wrong, whose evolution has been shaped by court cases. Prosser and Keeton (1984), a leading authority on tort law, defines it the following way: "Broadly speaking, a tort is a civil wrong, other than a breach of contract, for which the court will provide remedy in the form of an action for damages."

party (Feinman, 2015). Accounting practitioners suggest that accounting firms face significant financial burden as they are considered to have 'deep pockets' when the client firms remain in a distressed condition. Tort reforms tend to redress this situation by moving toward a proportionate liability doctrine. Under this regime, liability and damages to be paid would be proportional to the degree of fault as decided by the court of law (Craig, 1990; Mednick and Peck, 1994; Peck, 1999). While the move would ease the burden on the auditors, it is also conceivable that the auditors would no longer face the pressure to conduct high-quality audit. Prior literature indicates that a high litigation risk environment significantly impacts audit quality (Francis, 2011). Given the new regime, it is possible that auditors, as rational economic agents[22], would put lower audit effort to minimize cost. Since the client banks will now have diminished scrutiny, bank managers have the opportunity to engage in actions such as earnings management that reduce financial reporting transparency.

For my identification strategy, I use a multiple-event, multiple year difference-in-difference model to incorporate different adoption period of tort reform at the state level (Imbens and Wooldridge, 2009). The main variable of interest is an indicator variable representing tort reform. I use tort reform data from the Database of State Tort Law Reforms (DSTLR) to make sure a complete inclusion of tort reform sample for the period between 1980 and 2012. Legal scholars consider this database to be the most comprehensive one on tort reform (Avraham, 2007). As the measure of financial reporting opacity, I use discretionary component of banks' loan loss provision (LLP). This is a widely used proxy for earnings management in the banking literature (Beatty and Liao, 2014). A higher magnitude of earnings management would be indicative of higher opacity. Prior studies suggest that LLP has a number of distinct advantages

[22] Of course, the accountants are governed by ethics and professional code of conduct such as AICPA Code of Professional Conduct. Therefore there is a boundary within which this argument of rational economic agent works.

as an earnings management proxy. In addition to being the largest and most important accrual for banks, it is also an industry-specific measure, which offers a more clear distinction between normal and abnormal accruals. Moreover, since US banking system has a distinct state-wise separation to a large extent, the effects of the state-level changes in tort reform would more clearly be discernible.

I use bank financial statements from Call Reports between 1980 and 2012 to test the predictions. Using a final sample of 264, 299 bank-year observations, I find that earnings management via abnormal loan loss provision (ALLP)[23] increases for banks in states that adopted the tort reform relative to banks in the non-adopting states during the post-adoption period. The results are statistically significant at 0.01 level. Further, I test whether the tort reform has any effect on either the income-increasing (negative) abnormal LLP or income-decreasing (positive) abnormal LLP. To do that, I divide the sample into two subsamples: one for income-increasing (negative) abnormal LLP and one for income-decreasing (positive) abnormal LLP. Again, I find that income-increasing (negative) earnings management via abnormal LLP is greater for banks with headquarters located in states adopting tort reform than non-adopting states. The coefficient of interest is still significant at 0.01 level. Likewise, I conduct a similar test for income-decreasing (positive) abnormal LLP and find similar results: income-decreasing earnings management is greater for banks states adopting tort reform.

Taken together, these regression models point out to earnings smoothing by the banks. I therefore test the earnings smoothing following Kanagaretnam et al. (2010). I interact the tort reform variables with earnings before provision (EBP). The result of the interaction is not only

[23] For the pooled sample, I use *absolute value* of the abnormal LLP (ALLP) since my goal is to test the magnitude of the changes in ALLP. On the other hand, I use the signed ALLP to see if the ALLP was used to increase income or decrease income.

statistically significant but also has a positive sign, which indicates that abnormal LLPs are used to smooth earnings. Overall, the results of these main tests consistently suggest that tort reforms result in more earnings management. Alternatively stated, financial opacity seems to have increased for the banks in the tort reform adopting states relative to those in non-adopting states. This evidence is consistent with the prediction that a decrease in litigation risk reduces the quality of financial statement numbers.

I also conduct several additional analyses. First, while a difference-in-difference test mitigates the possibility of endogeneity emanating from reverse causality, I further test the parallel trend assumption and exogeneity of tort reform. Following Klasa et al. (2018), I regress abnormal LLP not only on tort dummy but also on the lagged values for the previous two year and lead values for the following two years. Before the tort reform, the auditors faced higher third-party liability, which would induce them to exert greater effort to avoid litigation. This implies a negative relation between abnormal LLP and lag variables of tort indicator variable.

Similarly, I expect a positive relation for the lead variables after the tort reform. The regression results are consistent with expectation, confirming exogeneity of the tort reform variable. Second, there is a possibility that the results may be spurious due to measurement errors in the abnormal LLP proxy. To exclude that possibility, I use an alternative specification for abnormal LLP following Kanagaretnam et al. (2010). Even after using this alternative proxy for abnormal LLP, I find that the coefficient for tort dummy has a positive sign, which is consistent with expectation. Third, I test whether there is any differential impact on banks audited by Big4 versus non-Big4 audit firms. The results suggest that audit by Big4 does not have significant effect for my sample of banks. Thus, these results further lend support to the conclusion that diminished litigation risk in the form of tort reform leads to greater earnings management and higher opacity in financial reporting.

This essay makes several contributions to the literature. First, I use tort reform covering all states in the USA as an exogenous shock. Anantharaman et al. (2016) suggest that association tests involving "…state-level measures of liability measures could be spuriously capturing the impact of other state-wide factors." My identification strategy, along with a comprehensive dataset, ensures a clean setting to capture the effects of changes in litigation risk on bank reporting opacity. Second, I focus on a single industry- US banks. Focusing on a single industry provides a number of distinct advantages. For one, I could use loan loss provision as the singles measure of accrual and clearly separate abnormal accruals from normal accruals.

On the other hand, multiple industries would have introduced errors in this measure. For another, US banking system, unlike many other in the world, has distinct state-wise separation. Thus, a state-level change could be more clearly mapped into the financial reporting of banks than in other industries where such state-level demarcation does not exist. Lastly, there has been a dearth of research linking state law and factors such as auditor discipline affecting financial reporting quality (Francis, 2011). I study the state-level tort reforms and its effect on the financial reporting quality and show that these regulatory effects, and the resultant change in litigation risk, have a clear impact on the financial reporting opacity.

The remainder of the essay is arranged as follows. *Section 4.2* discusses the institutional setting. *Section 4.3* reviews the relevant literature and develops the hypotheses while *Section 4.4* outlines the research method. *Section 4.5* describes sample selection issues. Results are discussed in *Section 4.6,* and *Section 4.7* outlines the robustness and sensitivity tests. *Section 4.8* concludes.

4.2 Institutional Setting

Under the legal system in the USA, the parties aggrieved by financial reporting quality can seek redress at both federal and state level. A client can file a civil suit under the law of contracts, and a third party may sue the auditor under the common law at the state courts and securities law at the federal level for fraud, negligence and negligent misrepresentation.

As auditor liabilities are governed by common law at the state level, there is significant variation because of a multiplicity of interpretations by state courts. State courts apply different standards for determining the liability of auditors. These standards could range from very restrictive to the most expansive with regard to affording auditors' fault (Feinman, 2015; Paschall, 1988). The *privity standard* is the most restrictive one, which requires a contractual relationship between the accountant and a third party before a court would hold the auditor liable. In other words, this standard is the least plaintiff-friendly and insulates auditor from most third party liability. The *near privity* standard relaxes the privity standard slightly by including third parties without a contractual relationship if the plaintiff is an 'intended third-party beneficiary'. In the 1960s the *near privity* standard was refined and codified into what is known as the *Restatement of Torts* Standard. Under this standard, an audit firm would be liable to third parties if it 'supplies false information for the guidance of other in their business transactions ….. if he fails to exercise reasonable care or competence in obtaining or communicating the information.' The third parties can sue if they are the targeted beneficiaries and they suffer the loss relying upon information provided by the auditors. In other words, this standard allows the third party liability for negligent misrepresentation. In the US, most jurisdictions have adopted this standard for auditor liability. The most expansive of the standard is the *foreseeability* standard (Feinman, 2015). For example, in *Citizens State Bank v. Timm, Schmidt &Company,* the Supreme Court of

Wisconsin in 1983 applied the ordinary principles of negligence law. The court concluded "… a tortfeasor is fully liable for all foreseeable consequences of his act except as those consequences are limited by policy factors." Similarly the Mississippi Supreme Court in 1987, in *Touche Ross & Company v. Commercial Union Insurance,* uses foreseeability standard and states: "an independent auditor is liable to reasonably foreseeable users of the audit, who request and receive a financial statement from the audited entity for a proper business purpose, and who then detrimentally rely on the financial statement, suffering a loss, proximately caused by the auditors negligence."

Once liability is established, a subsequent issue is how it is apportioned among different liable parties. Again there are alternative regimes that either favor or affect the auditors. The most plaintiff-friendly (and most adverse to auditors) is the *joint-and-several doctrine*. A plaintiff can claim and recover full damages from any of the defendants irrespective of the proportional fault of each liable party (Avraham, 2007). Thus, the third party can go after the defendant with the 'deep pocket'. Big audit firms are often targeted because they routinely buy malpractice insurance and considered generally to have 'deep pockets' although their proportionate responsibility might be limited. While tort reforms adopted by the states have several components or dimensions, the most common of these reforms is the reform of the limitation of joint and several liabilities. Forty-one states have adopted some variations of this reform. One that is favorable to the auditors is the *proportionate liability* regime. Under this method, liability and damages to be paid would be proportional to the degree of fault as decided by the courts. Moreover, there is a modified version of the joint-and-several liability, which is in-between the joint-and-several liability and proportionate liability method allowing for joint-and-several liability only if the defendant is responsible for a significant percentage of the harm, usually at least 50 percent (Feinman, 2015).

4.3 Literature Review and Hypothesis Development

4.3.1 Tort Reform

While the effort to reform tort law has had a long history, its intended outcomes or unintended consequences have received less scrutiny in the literature. Moreover, much of the literature delves into the medical malpractice liability in the healthcare industry (Avraham, 2007). Among the relatively new studies is Avraham (2007). He compiles and utilizes the most comprehensive database on tort reform, Database of State Tort Law Reforms (DSTLR), to study the impact of tort reform on the medical malpractice cases. His findings suggest that the reforms reduce the number of malpractice cases although the state-level average award does not decrease significantly. There are some studies which date back to 70s and 80s for which Zuckerman, Koller, and Bovbjerg (1986) provides a review. These studies examine the tort reform's impact and mostly have mixed results: some studies find no effect while other studies find that reforms reduce malpractice liability burden. The subsequent studies such as Adams and Zuckerman (1984), Danzon (1986), and Zuckerman, Bovbjerg, and Sloan (1990) also find that the effect of tort reform was mixed. Similarly, more recent studies such as Kessler and McClellan (1996, 2000, and 2002) also lead to a mixed conclusion. However, Avraham (2007) reports that many of those studies have methodological and data limitations.[24]

4.3.2 Tort Reform and Auditors

Although accountants are at the forefront of third party liability cases, there are only a few studies on this issue. Professional accountants, on the other hand, have long advocated for

[24] Avraham (2007) listed the following list of limitations: failure to properly reflect substantive changes in the law in the data, a focus on litigated as opposed to settled cases, small sample size, and inadequate model specifications.

reforms in tort law especially the joint-and-several liability (Craig, 1990). In fact, the American Institute for Certified Public Accountants (AICPA) formed a taskforce in 1985 to spearhead the AICPA 's effort to reform tort law (Craig, 1990). Craig (1990) also reports that accountants were adversely impacted by ever-increasing lawsuits under the joint-and-several liability doctrine, which in turn increased their malpractice premium significantly. There are several studies in the literature which also highlight the effects of tort law on the accountant's liability. Mednick and Peck (1994), for example, argue that accounting firms face significant financial burden as the joint-and-several liability "rewards the filing of lawsuits based on the ability to pay rather than on the level of culpability." They also argue that joint-and-several liability causes a huge number of lawsuits and creates "limitless exposure for accounting firms ……threatening the continued viability of the audit function." Likewise, Peck (1999) also suggests that the joint-and-several liability doctrine forces settlements from 'deep pocket' accountants and adversely affects the financials of accounting firms. He further argues that a system based on proportionate liability discourages abusive litigation. Alternatively, Paschall (1988) argues that managers expanded liability by applying *foreseeability* standard will enhance the quality of accounting services as accountants will be deterred by financial consequences of any mistake they make. This, in turn, would create greater public trust.

Many of the studies in accounting examine the relation between litigation risk and auditor behavior. For example, Palmrose (1988) suggests that there is an inverse relation between auditor quality and litigation. Auditors perform high quality audit to avoid the consequence of litigation from audit failure, a view corroborated by Francis (2011) as well. In a similar vein, Venkataraman, Weber, and Willenborg (2008) find that audit quality is higher in a higher-litigation environment. In other words, they suggest that the higher level of exposure to litigation risk change auditors' incentive for audit quality, and leads to higher quality audit. Pratt and Stice (1994) indicate that one way the audit firms respond to higher litigation risk is to charge higher audit fee. Further, they show that audit fees incorporate both costs for additional evidence collected and a premium for high litigation risk. Krishnan and Krishnan (1997) suggest that auditors can be more selective in choosing their clients and tend to move away from more high-risk engagements to avoid litigation risk. Their empirical evidence is consistent with this prediction. Lastly, Gaver, Paterson, and Pacini (2012) offer evidence on how liability standards at the state level influences auditor behavior. Their findings indicate that auditors demand more conservative accounting numbers if the risk of third-party liability is higher. Likewise, Anantharaman et al. (2016) in a recent paper reach a similar conclusion. Specifically, they examine how state liability regimes influence auditor reporting behavior and find that auditors are likely to issue a higher number of modified going-concern report in a higher liability state than in a relatively lower liability states.

4.3.3 State-level third-party liability regimes and Litigation Risk

As auditors provide verification of bank financial reporting, the auditor's incentives and behavior would likely affect the quality of financial reporting. Prior literature shows that the state-level liability regime with its expected legal consequences is likely to affect auditor behavior in multiple ways (Anantharaman et al., 2016). One way the auditors may respond to enhanced litigation risk is to put in greater efforts (Anantharaman et al., 2016; Bell, Landsman, and Shackelford, 2001; Venkatarman et al., 2008). With a greater level of scrutiny and enhanced verification by the auditors, the banks are likely to report financial numbers that better reflect the firm's condition and performance. One reason higher third-party liability increases audit effort is the auditors can argue that they performed an adequate audit (Anantharaman et al., 2016). This intuition receives support from the analytical model too. For example, Chan and Pae (1998) show that audit effort are lower under proportionate liability than under joint-and-several regimes.

To explicate the intuition of my prediction, I argue that: (1) banks' financial reporting transparency hinges on auditor effort; (2) Auditors' incentives and behavior alter in response to the existing or changing legal regime under which they work. To elaborate on the first point, it is well-documented in both financial accounting and audit literature that auditors play a significant role in enhancing financial reporting quality (DeFond and Zhang, 2014). Given the auditors' mandate, they have several avenues to ensure that the client company's financial reports have adequate transparency. Faced with the auditors' scrutiny, firms are expected to respond accordingly. Other things remaining the same, the more expanded the audit is, the higher will be the quality of numbers reported in the financial statements. In other words, if auditors' incentives behavior experience changes, financial reporting quality is expected to change as well.

On the second point, prior research stresses that auditors respond to changes in legal environment and the third party liability due to litigant's actions. In an environment where the plaintiffs have a built-in advantage afforded by the law, a third party litigant (and her lawyer) may start a lawsuit in order to collect money from the audit firm[25]. Audit firms may preemptively guard against such lawsuits by increasing audit efforts. On the other hand, the reforms in the regulatory regime are likely to ease the litigation risk for the auditors. For example, if it so happens that tort reform reduces the potential liability for the auditors or tightens the scope for a plaintiff to include the auditors in the litigation, auditors would try to take advantage of this situation as rational economic agents. Other things remaining the same, the auditors'

[25] Not all lawsuits will end up in trial; many are settled pre-trial by the plaintiff and the defendants (audit firms). Regardless, the audit firms have to pay substantial amount of money (Craig, 1990).

incentive to preemptively act by increasing audit efforts would be expected to diminish. Stated differently, the auditors would likely reduce audit efforts to minimize cost and maximize their returns.

How the auditors' response would play out for the financial reporting quality is an empirical question. There could be multiple scenarios as to how firms[26] (in this case, banks) would likely respond to the auditor's behavior. First, banks themselves might be concerned about their long-term reputation and ability to conduct continued business. Therefore they would ensure that the financial reporting transparency does not deteriorate. Moreover, the banks are still party to the contract with other stakeholders, who were likely to include the auditors in the litigation. While the tort reforms may obviate or reduce the liability of the auditors, the potential for facing litigation still prominently exist for the banks. Thus, the continued existence of this litigation risk may also dissuade the banks from taking actions to reduce the quality of their reports.

Second, the other scenario is that banks now no longer have to deal with the same range of scrutiny or verifications as they used to face before the change in legal regime. Faced with this new environment of diminished external control, bank managers are now equipped with the higher level of 'opportunity' to engage in less-than-optimal financial reporting practices. Of course, it is entirely possible that some managers do not take advantage of this opportunity. It is, however, also possible for other managers to have the motives to do so. In other words, auditors' response to the changed legal regime provides the clients (banks) the opportunity to undertake

[26] Firms including banks have contractual relations with many counterparties such as shareholders, creditors, depositors, and so on. Banks may face significant liability emanating from these contractual relations, which may have impact on the performance and reporting. Please see Honigsberg et al. (2014), for example, who study the effects of state contract law on debt contracts. In this essay, I choose to focus on the effects of third party liability on reporting opacity assuming the effects of those contractual obligations are given.

greater earnings management. Given the above prediction, I posit my hypothesis in the alternate form:

H1*: Earnings management in bank accounting is likely to be higher in states with tort reform than in states without reform.*

H2*: Earnings smoothing in bank accounting is likely to be higher in states with tort reform than in states without reform.*

4.4 Research Design

In this section, I first discuss the conceptual relation between change in regulation for third party liability and earnings management. Second, I describe the empirical model used to estimate the abnormal LLP. Third, I describe the empirical model used to test possible linkages between tort reform and abnormal LLP.

The conceptual relation between auditors' third party liability is based the predictive model of Kinney and Libby (2002). Following prior research, I examine the theoretical constructs, economic bonds to the client and earnings management by the client. Since these constructs are unobservable, it is tricky to find a suitable proxy which leads to endogeneity concerns. I use an exogenous shock in the form of tort reform as proxy for changes in economic bond between auditors and clients. The logic is as follows: the goal of tort reform is to reduce the liability of auditors (or other professionals) from third-party litigation[27]. Prior literature shows that a higher likelihood of litigation induces auditors to ensure the quality of work to avoid the risk of litigation as much as possible. That, in turn, would be reflected in diminished opacity (lower earnings management). If, on the other hand, there is reform in tort law resulting in a

[27] Many professional associations including AICPA were part of the coalition such as the American Tort Reform Association to lobby for the reforms in Tort law (Craig, 1990). As Avraham (2007) points out, the objective of tort reform is to reduce third-party liability.

reduction of auditor's potential liability, it would make more sense for the auditors to put in less effort to save costs. As a result, banks would have the opportunity to engage in earnings management.

In this study, I code all types of restriction on the joint and several liability rules as a binary variable. One disadvantage of using a binary coding is the difficulty to tease out the distinct impact of each variant of reform. However, using a dummy variable introduces bias against finding any significant impact even where such an impact may exist. For, it is likely that the effects of successful reforms will be potentially watered down by the effects of the ineffective reforms. I use discretionary component of banks' LLP as a proxy for earnings management for a number of reasons. First, LLP is the largest and most important accrual for banks. Second, as prior research suggests (Kanagaretnam et al., 2010), discretionary LLP is a good proxy because this is an industry-specific measure, which offers a more clear distinction between normal and abnormal accruals. Third, since US banking system has a distinct state-wise separation to a large extent, the effects of the state-level changes in tort reform would more clearly be discernible. Following prior literature (e.g., Beatty and Liao, 2014; Kanagaretnam et al., 2010), I also use several bank-level control variables which are known to affect LLP. Lastly, the main relation that I study is between the exogenous change in tort reform and discretionary LLP.

4.4.1 Estimation of Abnormal Loan Loss Provision

I follow Beatty and Liao (2014) and estimate the normal or non-discretionary component of LLP by regressing LLP on change in non-performing loans during the year, size, change in total loans during the year, change in GDP of the state where bank's headquarters is located during the year, change in housing index return, change in state unemployment rate, state dummies and year dummies. The part of the LLP not explained by this regression is considered the discretionary or abnormal part of LLP. In other words, the residuals from the regression constitute the discretionary or abnormal LLP (ALLP). Specifically, I run the following OLS regression of LLP using equation 4.1:

$$LLP_{it} = \beta_0 + \beta_1 \Delta NPL_{it+1} + \beta_2 \Delta NPL_{it} + \beta_3 \Delta NPL_{it-1} + \beta_4 \Delta NPL_{it-2} + \beta_5\ SIZE_{it-1} + \beta_6\ \Delta LOAN_{it} + \beta_7\ \Delta ST\_GDP_{it} + \beta_8\ \Delta ST\_HPI_{it} + \beta_8\ \Delta ST\_UNEMP_{it} + \beta_8\ ST\_DUMMIES + \beta_8\ YEAR\_DUMMIES + \varepsilon_{it} \quad (4.1)$$

where LLP_{it} is loan loss provisions scaled by beginning total assets for bank *i* in year *t;* ΔNPL is the change in non-performing loans scaled by beginning total assets for bank *i* in year *t*; $SIZE_{it}$ is natural logarithm of total assets in year *t;* $\Delta LOAN_{it}$ is change in total loans in year t scaled by beginning value of total assets; ΔST_GDP_{it} is growth in state GDP where the bank's headquarters is situated in year t; ΔST_HPI_{it} is the annual growth in the return of the state housing price index; ΔST_UNEMP_{it} is the annual growth in unemployment rate for the state where the bank's headquarters is located; *ST_DUMMIES* and *YEAR_DUMMIES* are dummy variables for controlling state and year fixed effects. The fitted value of this regression represents normal LLP while the residuals represent the abnormal or discretionary LLP. Following Beatty and Liao (2014), I include ΔNPL_{it} and ΔNPL_{it+1} to reflect the 'possibility that some banks may use forward-looking information on non-performing loans (that are less discretionary and more timely) in estimating loan loss provision.' Likewise, I use the lagged ΔNPL (ΔNPL_{it-1} and ΔNPL_{it-2}) ' to capture the fact that some banks use past non-performing loan information to estimate loan loss provisions.' I also use $\Delta LOAN_{it}$ to reflect the possibility that banks loan growth could result from clients with questionable credit quality. I control for $SIZE_{it-1}$ as prior literature documented that bank size affects regulatory oversight (Kanagaretnam et al., 2010) and therefore loan quality.

4.4.2 Main Tests

My goal is to examine whether state-level tort reform affects financial reporting opacity of banks. I create TORT_DUMMY[28], an indicator variable that equals 1 for each state-year observation for adoption of tort reform and 0 otherwise. This multiple-event, multiple-year difference-in-difference design allows me to see whether the change in tort reform have unintended consequences in the form of increasing the abnormal LLP.

For the main tests, I estimate the model for the following samples: absolute value of ALLP from the pooled or whole sample, negative (income-increasing) ALLP sample, and positive (income-decreasing) ALLP sample. I control for firm size, levels of accruals, and performance. I use natural log of assets to measure firm size and represent performance by earnings before provision. I also use lagged LLP to control for reversals of accruals over time. I estimate the following model:

$$ALLP_{it} = \beta_0 + \beta_1 TORT\_DUMMYit + \beta_2 SIZE_{it} + \beta_3 LOAN_{it} + \beta_4 SIZE^2_{it} + \beta_5 EBP_{it} + \beta_6 SECURITIES_{it} + \beta_7 LLP_{it-1} + \beta_8 ST\_DUMMIES + \beta_9 YEAR\_DUMMIES + \varepsilon_{it} \quad (4.2)$$

Where $ALLP_{it}$ is the absolute value of abnormal LLP from equation (4.1) for the pooled sample and signed ALLP for the negative and positive ALLP samples. As my primary variable to indicate regulatory changes is *TORT_DUMMYit*, the coefficient of interest is β_1. For the pooled or the whole sample, a positive β_1 indicates that tort reform increases the absolute value of ALLP. In other words, a positive sign implies that tort reform increases opacity. A negative coefficient, on the contrary, indicates that the reform decreases earnings management. For the negative (income-increasing) ALLP, however, the interpretation is different. In this case, a negative

[28] Tort reform encompasses multiple dimensions such as such as joint-and-several liability, caps on noneconomic damages, caps on punitive damages, patient compensation fund reform, comparative fault reform and so on (Avraham, 2007). I concentrate on the reform on joint-and-several liability as this reform is considered one to affect the accounting profession significantly (Craig, 1990; Peck, 1999)

coefficient is consistent with reporting opacity and indicates that tort reform increases negative (income-increasing) ALLP. For positive (income-decreasing) ALLP, a negative sign is consistent with less opacity while a positive sign indicates more opacity or earnings management.

Prior research suggests that legal liability affects auditor's efforts and audit accuracy (Boritz and Zhang, 1997; De and Sen, 2002). Likewise, the legal environment influences auditors effort significantly (Kim et al., 2008). The advantage of the measure that I use is its exogenous nature. Legal scholars studied the effects of tort reform on professionals such as doctors and lawyers and offered evidence on its effect as an exogenous variable (Avraham, 2007). Additionally, I also test the robustness of this measure. I also use a set of controls following Kanagaretnam et al. (2010) and Altamuro and Beatty (2010): bank size ($SIZE_{it}$), bank loan ($LOAN_{it}$), earnings before provision (EBP_{it}), liquidity ($SECURITIES_{it}$), and lagged LLP (LLP_{it-1}). The possibility that there could be non-linearity inherent between bank size and LLP is controlled by the square of bank size. I also include state and year dummies to control fixed effects. Lastly, I cluster all standard errors at the bank level to control for correlation in errors. All data definitions are provided in Table 4.1.

4.5 Sample Selection

I select sample banks from the Call Reports from 1980-2012. I also collect the tort reform variables from 1980-2012 for different US states. Moreover, I collect state-level housing index data from Freddie Mac, state-level GDP data from the Bureau of Economic Affairs, and state-level unemployment data from the US Bureau of Labor Statistics. After matching and merging, the sample consists of 264,299 bank-year observations for the period between 1980-2012. I restrict my data from this period to reflect the inclusion of the main variable, *TORT_DUMMY*.

Table 4.2 reports the descriptive statistics for the scaled variables used in the regression. On average, the absolute value of the discretionary loan loss provision is 0.86 percent. Also, over 59% of the sample is covered by state-level reform in the tort variable. An average bank has 64.42% of assets as loans, 0.58 percent loan loss allowance and 1.05 percent non-performing loans. During the sample period, states had an average 2.3% GDP growth per year and 3.39% increase in the housing index. Table 4.3 reports the correlation for the scaled dependent and independent variables. As expected, LLP is positively correlated with non-performing loans (NPL) and net charge-off (NETCHARGEO). LLP is also positively correlated with total loans (LOANS) and individual loan categories. Lastly, LLP has a positive, but statistically insignificant, relationship with the tort variable (TORT_DUMMY).

[Insert Table 4.2 about here]

[Insert Table 4.3 about here]

4.6 Results

4.6.1 Estimation of Abnormal LLP

I report the estimation results for abnormal LLP in Table 4.4 following Beatty and Liao (2014). The t-statistics reported in Table 4.4 and other tables are based on standard errors adjusted for firm-level clusters. The results in Table 4.4 show that the coefficients on the determinants of LLP have the expected signs. The coefficients on ΔNPL_{t-1}, ΔNPL_{t-2}, and ΔLOAN are all statistically significant at 0.10 level while the coefficients on GDP growth, housing index growth, and lagged size are all significant at 0.01 level. The explanatory power of the model is high (Adj-R^2=0.5931), indicating that the model describes the variation in LLP quite well.

[Insert Table 4.4 about here]

4.6.2 *Association between tort reform and magnitude of abnormal LLP*

I present the results of regression relating abnormal LLP to tort reform in Table 4.5. The coefficients are reported in column 2. The coefficient on TORT_DUMMY is positive and significant at 0.01 level. This result suggests that earnings management via abnormal LLP increased for banks in states that adopted the tort reform compared to banks in the non-adopting states in the post-adoption period. This result support Hypothesis 1 (H1). In terms of the control variables, LOANS, SIZE, ROA, and SIZE_SQ are all significant. The coefficient for SIZE is negative, suggesting that small banks are more likely to be engaged in earnings management which is consistent with prior literature (Kanagaretnam, 2010). Also, the model describes the variation in abnormal LLP we ll as evidenced by adjusted R-square (Adj. R^2=0.701).

[Insert Table 4.5 about here]

4.6.3 Association between Income-increasing (Negative) Abnormal LLP and Tort Reform

I present the regression results for the association between income-increasing (negative) abnormal LLP to tort reform in Table 4.6. The results in Table 4.6 show that the coefficient on TORT_DUMMY is negative and significant at 0.01 level. This result is consistent with H1. In other words, this result indicates that the income-increasing earnings management via abnormal LLP is greater for banks in states adopting tort reform in the post-reform period. As expected, SIZE has a significant coefficient, indicating that smaller banks use income-increasing abnormal LLP to manage earnings. Other control variables also display sign consistent with expectations.

[Insert Table 4.6 about here]

4.6.4 Association between Income-decreasing (positive) abnormal LLP and tort reform

I present the regression results relating income-decreasing (positive) abnormal LLP to tort reform in Table 4.7. The results in Table 4.7 indicate that the coefficient on TORT_DUMMY is positive and significant at 0.05 level, which support the prediction in H1. This result implies that income-decreasing earnings management via abnormal LLP is greater for banks in states that adopted tort reform in the post-reform period vis-à-vis banks in non-adopting states. As in the previous regression models, the control variables have signs consistent with expectations and a statistically significant result. Overall, the model fits well too as indicated by adjusted R-square (Adj. R^2=0.6006).

[Insert Table 4.7 about here]

4.6.5 Association between tort reform and earnings smoothing

For consistency with prior research on bank, I also estimate the results to see if banks use the abnormal LLP to smooth earnings. To that end, I interact the main variable, TORT_DUMMY, with earnings before provision (EBP) scaled by lagged total assets. A positive coefficient would indicate that banks managers save earnings through LLP in good times and borrow earnings through LLP in bad times.[29] The results of the regression are reported in Table 4.8. Of particular interest is the coefficient on the interaction, TORT_DUMMY×EBP, which is positive and statistically significant at 0.05 level. The positive sign suggests that the abnormal LLPs are used to smooth earnings. These results support the prediction in Hypothesis 2 (H2). In other words, the results indicate that the banks in tort-reform states employ greater income smoothing relative to banks in the states not covered by tort reform in the post-reform period.

[Insert Table 4.8 about here]

4.7 Robustness and Sensitivity checks

I conduct several robustness and sensitivity checks that I describe below:

[29] This is because positive LLP represents income-decreasing component while negative LLP respresents income-increasing. When EBP is positive, the managers are using income-decreasing LLP to save for the futures. Likewise, when EBP is negative, they are using income-increasing or negative LLP.

4.7.1 Test for parallel trend

It is conceivable that the identification strategy that I use does not satisfy the parallel trend assumption of the difference-in-difference model. This may produce a spurious relation when there is no actual relation and will call into question the conclusion drawn from the evidence. To test that, I use the following specifications where I regress ALLP on not only the tort-dummy but also one-year lag ($Tort\_dummy_{t-1}$) and two-year lag ($Tort\_dummy_{t-2}$) of tort dummy. In addition, I also include one-year lead ($Tort\_dummy_{t+1}$) and two-year lead ($Tort\_dummy_{t+2}$) of tort dummy. The intuition is as follows: before the tort reform, the contracting parties (e.g., the banks, auditors, etc.) faced higher third-party liability. Therefore they would work to enhance (in concert or independently) the quality of financial reporting to avoid possible litigation. This implies a negative relation (i.e., a negative sign for the coefficient) between abnormal LLP and lag variables of tort dummy. Similarly, I expect a positive association (i.e., a positive sign for the coefficient) after the tort reforms are put in place, resulting in diminished risk of litigation for third party liability.

Results of this regression are reported in Table 4.9. The results are mostly consistent with expectations. The coefficients for lag variables have negative sign although only $Tort\_dummy_{t-1}$ is statistically significant at 0.05 level. Likewise, the lead variables have a positive sign as expected, though the only $Tort\_dummy_{t+1}$ is statistically significant at 10% level. Taken together, these results suggest that the parallel trend assumption of difference-in-difference is not violated, which lends credence to the empirical results.

[Insert Table 4.9 about here]

4.7.2 Alternative estimate for abnormal LLP

While my results are consistent with expectation for a large sample of banks, it is possible that the abnormal LLP proxy used may suffer from measurement error. To exclude that possibility, I use an alternative specification to estimate abnormal LLP following Kanagaretnam et al. (2010). In this specification, I estimate the normal LLP by regressing LLP on the lagged allowance for loan loss, net charge-off, lagged non-performing loans, change in total loans, change in non-performing loans, and different loan categories such as loans to real estate, commercial, agriculture, and loans to other depository institutions.

The results of the regression of LLP on these variables to estimate normal LLP is reported in Table 4.10. The coefficients have signs and significance that are mostly consistent with prior literature. Moreover, the model is well specified as the adjusted R-square ishigh (Adj. R^2=0.889). I then use the abnormal LLP (the residuals from the model) and regress on *tort_dummy* and other control variables similar to previous regressions. The results are reported in Table 4.11. The coefficient on the variable of interest, *tort_dummy*, is significant at 0.01 level. Moreover, the relationship is positive, which is consistent with the H1: earnings management is higher in states with tort reform than in states without reform. Thus, it reinforces the findings that banks in a state adopting tort reform have a lower level of transparency relative to banks in the state without undertaking the reform.

[Insert Table 4.10 about here]

[Insert Table 4.11 about here]

4.7.2 The Effect of Big Audit Firms

There exists a large body of empirical research documenting higher audit quality with Big4 audit firms (Palmrose, 1988; Khurana and Raman, 2006; Lennox and Pittman, 2010). These big audit firms have more resources, greater expertise, and the market incentives (e.g., reputation) to ensure audit quality. Therefore, one can argue that the reporting opacity may be largely driven by choice of Big4[30] versus non-Big4 audit firms. If this argument holds, we would have significant differential results for Big4 versus others. On the contrary, tort reforms affect auditors across the board. Therefore, it is also possible that the Big4 effect may be outweighed by the impact of tort reform.

To test this empirically, I construct an indicator variable, *BIG*, with value 1 for firms that are audited by Big4 audit firms and zero otherwise. I then interact *BIG* with *TORT_DUMMY*. The coefficient of this interaction variable will have a negative sign if Big4 audit firms mitigate the effects of tort reforms. The results of the regression are reported in Table 4.12. While the sign of the coefficient of interest, *BIG×TORT_DUMMY*, is negative, it is not statistically significant. Other variables, however, have expected signs and significant results. This result implies that Big4 firms have some impact. However, when I include the interaction with the main effects of tort reform, the impact completely dissipates. Thus, tort reform's effect remains significant even after controlling for the influence of Big4 audit firms.

[Insert Table 4.12 about here]

4.8 Conclusion

In this essay, I studied how state-level liability affects bank reporting opacity. Specifically, I find that changes in the state-level tort law in the USA increases bank earnings management, my proxy for opacity. Prior literature suggests that firms and auditors face significant litigation risk both at the federal level and state level (Gaver et al., 2012). I exploited the move from *joint-and-several liability doctrine* to a *proportionate liability doctrine* of liability sharing standard as an

[30] I use Big4 synonymously with Big5 or Big8 as these firms evolved during the sample period through mergers and acquisitions.

exogenous shock and used a multiple-event, multiple year difference-in-difference model to incorporate different adoption period of tort reform at the state level (Imbens and Wooldridge, 2009). Overall, the results of my tests consistently suggested that tort reforms result in more earnings management. Thus, financial reporting opacity seems to have increased for the banks in the tort-reform adopting states relative to those in non-adopting states. This evidence is consistent with the prediction that a decrease in litigation risk reduces the quality of financial statement numbers. I also conducted several additional analyses such as exogeneity of the tort reform variable and tests using an alternative measure for earning management. I still found similar results further lent support to the conclusion that diminished litigation risk in the form of tort reform leads to greater earnings management and higher opacity in financial reporting. This essay makes several contributions to literature. First, the identification strategy, along with a comprehensive dataset, ensures a clean setting to capture the effects of changes in litigation risk on bank reporting opacity. Second, a focus on a single industry ensured a clear mapping of the state-level changes into the financial reporting of banks. Lastly, this area is scarcely studied. I provided additional evidence which enhances our understanding in this area and informs the stakeholders.

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Table 4.1

Definitions of Variables

Variable	***Definitions***
LLP	Provision for loan losses divided by beginning total assets.
ALLP	Abnormal LLP, which is the residuals from model 1.
Tort_dummy	An indicator variable with value 1 if a state reformed joint and several liability in the year
Loans	Total loans outstanding divided by beginning total assets.
Size	Natural log of total assets of the bank.
EBP	Earnings before provisioning divided by beginning total assets.
Size_sq	Square of size.
Securities	1-[Securities/Total Assets] following Kanagaretnam et al., (2010).
LLP_lag	Lag value of loan loss provision scaled by beginning total assets.
LLA	Loan loss allowances scaled by beginning total assets.
NPL	Non-performing loans divided by beginning total assets.
Reloans	Real estate loans divided by beginning total assets.
Persloan	Personal loans divided by beginning total assets.
Agloans	Agriculture loans divided by beginning total assets.
Ciloans	Commercial and industrial loans divided by beginning total assets.
Deploans	Loans to other depository institutions divided by beginning total assets.
Netchargeo	Net charge-off divided by beginning total assets.
Chgunemp	Change in unemployment rate in the state.
Hindgrowth	Growth in the housing index for the state.
Sgdpgrowth	Annual GDP growth rate in the state.

Table 4.2
Descriptive Statistics

VARIABLE	N	Mean	Std. Dev.	Min	Max
Signed_ALLP	264,299	0.0000	0.0314	-8.1319	6.2665
ALLP	264,299	0.0086	0.0302	0.0000	8.1319
Tort_dummy	264,299	0.5944	0.4910	0.0000	1.0000
Loans	264,299	0.6389	2.2268	0.0000	856.59
Size	264,299	11.1600	1.3371	4.7185	21.3175
EBP	264,299	0.0180	0.0891	-3.4436	39.1794
Size_sq	264,299	126.3342	31.9300	22.2642	454.4367
Securities	264,299	0.7227	0.1500	0.0018	1.0000
LLP_lag	264,299	0.0090	0.0329	0.0000	8.7016
LLA	264,299	0.0058	0.0089	-0.0009	2.8856
NPL	264,299	0.0105	0.0495	0.0000	15.5957
Reloans	264,299	0.3389	1.8822	0.0000	655.1216
Persloans	264,299	0.1047	0.6721	0.0000	264.5352
Agloans	264,299	0.0625	0.1163	0.0000	32.5815
Ciloans	264,299	0.1197	0.9651	0.0000	419.6832
Deploans	264,299	0.0012	0.0209	0.0000	7.3913
LLA_lag	264,299	0.0054	0.0124	-0.0008	4.3746
Netchargeo	264,299	0.0079	0.0471	-0.0919	20.0285
Chgunemp	264,299	0.0078	0.1861	-0.4696	1.2258
Hindgrowth	264,299	0.0339	0.0516	-0.3000	0.5300
Sgdpgrowth	264,299	0.0230	0.0300	-0.2749	0.1456

LLP is provision for loan losses divided by beginning total assets; *Signed_ALLP* is discretionary LLP, which is residual from model 4.1. *ALLP* is absolute value of Discretionary LLP. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *ROA* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. *LLA* Loan is loss allowances scaled by beginning total assets. *NPL* is non-performing loans divided by beginning total assets. *Reloans* is real estate loans divided by beginning total assets. *Persloan* is personal loans divided by beginning total assets. *Agloans* is agriculture loans divided by beginning total assets. *Ciloans* is commercial and industrial loans divided by beginning total assets. DEPINS is loans to other depository institutions divided by beginning total assets. *Netchargeo* is net charge-off divided by beginning total assets. *Chgunemp* is the change in unemployment rate in the state. *Hindgrowth* is the growth in the housing index for the state. *Sgdpgrowth* is the annual GDP growth rate in the state.

Table 4.3
Correlation Matrix for dependent and independent variables

Variables	*ALLP*	*Tort_dummy*	*Loans*	*Size*	*EBP*	*Size_sq*	*Securities*
ALLP	1						
Tort_dummy	0.0034	1					
Loans	0.7263*	0.0041*	1				
Size	0.0162*	0.0533*	0.0390*	1			
EBP	0.4043*	-0.0016	0.7577*	0.0328*	1		
Size_sq	0.0233*	0.0460*	0.0412*	0.9940*	0.0359*	1	
Securities	0.0501*	0.0654*	0.0470*	0.1963*	0.0101*	0.1961*	1
LLP_lag	0.1115*	0.0169*	0.001	0.0024	0.0267*	0.0081*	0.0714*
LLA	0.2646*	-0.0093*	0.0926*	-0.0524*	0.0122*	-0.0439*	0.0141*
NPL	0.7547*	0.0043*	0.7838*	0.0257*	0.5692*	0.0296*	0.0660*
Reloans	0.6796*	0.0152*	0.9147*	0.0594*	0.5777*	0.0592*	0.0572*
Persloans	0.6195*	-0.0248*	0.8061*	0.0158*	0.7033*	0.0194*	0.0279*
Agloans	0.2380*	0.0753*	0.4288*	-0.2855*	0.5220*	-0.2698*	-0.0412*
Ciloans	0.6385*	-0.0029	0.9200*	0.0365*	0.7955*	0.0389*	0.0397*
Deploans	0.1884*	-0.0081*	0.2701*	0.0524*	0.2381*	0.0554*	0.0282*
LLA_lag	0.0247*	0.0067*	-0.0001	-0.0526*	0.0431*	-0.0471*	0.0011
Netchargeo	0.6745*	0.0045*	0.7203*	0.0253*	0.7586*	0.0317*	0.0606*
Chgunemp	0.0044*	0.0537*	0.0026	0.0654*	-0.0082*	0.0645*	0.0994*
Hindgrowth	-0.0587*	-0.1518*	0.0003	-0.0270*	0.0194*	-0.0262*	-0.0554*
Sgdpgrowth	-0.0342*	-0.0785*	0.0036	0.0069*	0.0193*	0.0055*	-0.0084*

	LLP_lag	*LLA*	*NPL*	*Reloans*	*Persloans*	*Agloans*	*Ciloans*
LLP_lag	1						
LLA	0.1257*	1					
NPL	0.0574*	0.2499*	1				
Reloans	-0.0044*	0.0697*	0.6336*	1			
Persloans	0.0128*	0.0927*	0.6638*	0.5599*	1		
Agloans	-0.0062*	0.0480*	0.3458*	0.2737*	0.4027*	1	
Ciloans	0.0035	0.1033*	0.8274*	0.7086*	0.8101*	0.4585*	1
Deploans	0.0052*	0.0761*	0.2416*	0.1897*	0.2438*	0.1150*	0.3017*
LLA_lag	0.6521*	0.2214*	0.0152*	-0.0084*	0.0117*	0.0301*	0.0031
Netchargeo	0.1103*	0.2990*	0.6991*	0.5097*	0.7451*	0.4520*	0.7750*
Chgunemp	-0.0294*	-0.1102*	-0.0056*	0.0097*	-0.0101*	-0.0130*	0.0005
Hindgrowth	-0.0616*	0.0399*	-0.0546*	-0.0085*	0.0176*	-0.0062*	0.0045*
Sgdpgrowth	-0.0270*	0.0527*	-0.0309*	-0.001	0.0170*	-0.0177*	0.0038*

	Deploans	*LLA_lag*	*Netchargeo*	*Chgunemp*	*Hindgrowth*	*Sgdpgrowth*
Deploans	1					
LLA_lag	0.0089*	1				
Netchargeo	0.2381*	0.0296*	1			
Chgunemp	-0.0112*	-0.0418*	0	1		
Hindgrowth	0.0130*	0.0352*	-0.0503*	-0.2967*	1	
Sgdpgrowth	0.0108*	0.0286*	-0.0315*	-0.3807*	0.4428*	1

Table 4.4

Results of Regression of LLP on determinants of Normal LLP

	Coefficient	t-statistics	p-value
ΔNPL_{t+1}	-0.0052*	-1.67	0.0950
ΔNPL_{t}	0.2803	1.11	0.2680
ΔNPL_{t-1}	0.0190*	1.80	0.0710
ΔNPL_{t-2}	0.0139*	1.84	0.0660
$Size_{t-1}$	0.0011***	7.66	0.0000
ΔLoan	0.0073*	1.85	0.0640
Sgdpgrowth	-0.0381***	-6.82	0.0000
Hindgrowth	-0.0397***	-11.32	0.0000
Chgunemp	-0.0008	-0.57	0.5680
Constant	-0.0077***	-2.68	0.0070
State FE	YES		
Year FE	YES		
N	264,299		
Adj. R-square	0.5931		

LLP is provision for loan losses divided by beginning total assets. *LOANS* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *NPL* is non-performing loans divided by beginning total assets. *Chgunemp* is the change in unemployment rate in the state. *Hindgrowth* is the growth in the housing index for the state. *Sgdpgrowth* is the annual GDP growth rate in the state. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.5

Results of Regression on Absolute Value of Abnormal Loan Loss Provision (ALLP)

	Coefficients	**t-statistics**	**p-value**
Tort_dummy	0.0008***	3.52	0.0000
Loans	0.0092***	10.79	0.0000
Size	-0.0075***	-4.32	0.0000
EBP	-0.1626***	-4.83	0.0000
Size_sq	0.0004***	5.25	0.0000
Securities	-0.0002	-0.23	0.8190
LLP_lag	0.0478***	3.09	0.0020
Constant	0.0780***	3.26	0.0010
State FE	YES		
Year FE	YES		
N	238,418		
Adj. R-Square	0.701		

ALLP is absolute value of abnormal LLP. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.6

Regression on Income-increasing (Negative) Abnormal LLP

	Coefficients	t-statistics	p-value
Tort_dummy	-0.0003***	-4.24	0.0000
Loans	-0.0085***	-10.12	0.0000
Size	0.0038***	3.71	0.0000
EBP	0.0640	1.59	0.1130
Size_sq	-0.0002***	-3.23	0.0010
Securities	0.0089***	10.98	0.0000
LLP_lag	0.0089	1.12	0.2610
Constant	-0.0365***	-5.08	0.0000
State FE	YES		
Year FE	YES		
N	160,709		
Adj. R-Square	0.9264		

Signed_ALLP is abnormal LLP, which is residual from model 4.1. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.7

Regression on Income-decreasing (Positive) Abnormal LLP

	Coefficients	t-statistics	p-value
Tort_dummy	0.0011**	2.06	0.0390
Loans	0.0125***	3.96	0.0000
Size	-0.0168***	-3.68	0.0000
EBP	-0.2804**	-2.50	0.0120
Size_sq	0.0008***	3.76	0.0000
Securities	0.0085***	2.67	0.0080
LLP_LAG	0.0602***	3.56	0.0000
Constant	0.0162	0.41	0.6850
State FE	YES		
Year FE	YES		
N	77,709		
Adj. R-Square	0.6006		

Signed_ALLP is abnormal LLP, which is residual from model 4.1. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.8

Results of Regression of Signed Abnormal LLP to test earnings smoothing

	Coefficients	t-statistics	p-value
Loans	-0.0057*	-1.90	0.0580
Size	-0.0046	-1.42	0.1560
EBP	0.1002	1.13	0.2590
Tort_dummy	-0.0028	-1.59	0.1120
Tort_dummy* EBP	0.2211**	2.31	0.0210
Size_sq	0.0002*	1.93	0.0530
Securities	0.0211***	7.34	0.0000
LLP_lag	0.0554*	1.73	0.0840
Constant	0.0657	1.10	0.2720
State FE	YES		
Year FE	YES		
N	238,418		
Adj. R-Square	0.3642		

Signed_ALLP is abnormal LLP, which is residual from model 4.1. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Robustness and Sensitivity Checks
Table 4.9
Test for parallel trend to rule out reverse causality

	Coefficients	t-statistics	p-value
$Tort\_dummy_{t-2}$	-0.00004	-0.13	0.8980
$Tort\_dummy_{t-1}$	-0.0006**	-2.07	0.0380
$Tort\_dummy_{t}$	-0.0000	-0.01	0.9910
$Tort\_dummy_{t+1}$	0.0005*	1.88	0.0600
$Tort\_dummy_{t+2}$	0.0002	0.69	0.4900
Loans	0.0091***	4.84	0.0000
Size	-0.0081***	-3.56	0.0000
EBP	-0.1625**	-2.34	0.0190
Size_sq	0.0004***	4.39	0.0000
Securities	-0.0006	-0.3	0.7630
LLP_lag	0.0546*	1.82	0.0690
Constant	0.0467***	3.25	0.0010
State FE	YES		
Year FE	YES		
N	165,155		
Adj. R-Square	0.6213		

ALLP is absolute value of abnormal LLP. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.10

Results of Regression of LLP on determinants of Normal LLP

	Coefficients	t-statistics	p-value
LLA_{t-1}	-0.0146	-1.28	0.2000
Netchargeo	0.7595***	6.75	0.0000
NPL_{t-1}	0.0999	1.29	0.1960
Loans	-0.0226	-1.48	0.1390
ΔLoans	-0.0031**	-2.52	0.0120
ΔNPL	0.1515***	2.59	0.0100
Reloans	0.02615*	1.8	0.0710
Persloans	0.0453***	3.18	0.0010
Agloans	0.0388***	2.66	0.0080
Ciloans	0.0267	1.45	0.1480
Deploans	0.0428	1.63	0.1030
Constant	-0.0019	-1.32	0.1870
State FE	YES		
Year FE	YES		
N	321,558		
Adj. R-Square	0.8899		

LLP is the provision for loan losses divided by beginning total assets. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *LLA* is loan loss allowances scaled by beginning total assets. *NPL* is non-performing loans divided by beginning total assets. *Reloans* is real estate loans divided by beginning total assets. *Persloan* is personal loans divided by beginning total assets. *Agloans* is agriculture loans divided by beginning total assets. *Ciloans* is commercial and industrial loans divided by beginning total assets. *Deploans* is loans to other depository institutions divided by beginning total assets. *Netchargeo* is net charge-off divided by beginning total assets.

Table 4.11

Results of Regression on ALLP

	Coefficients	t-statistics	p-value
Tort_dummy	0.0007***	6.68	0.0000
Loans	0.0014***	3.44	0.0010
Size	-0.0028***	-3.94	0.0000
EBP	-0.0244*	-1.85	0.0650
Size_sq	0.0001***	4.88	0.0000
Securities	0.0053***	11.28	0.0000
LLP_lag	0.0274***	3.07	0.0020
Constant	0.0394***	4.41	0.0000
State FE	YES		
Year FE	YES		
N	261,038		
Adj. R-Square	0.3115		

ALLP is the absolute value of Abnormal LLP. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. *EBP* is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Table 4.12

Results of Regression on ALLP to test the effects of BIG auditors

	Coefficients	t-statistics	p-value
Loans	0.0092***	10.79	0.0000
Size	-0.0078***	-4.32	0.0000
BIG	-0.0007	-0.59	0.5580
Tort_dummy	0.0008***	3.51	0.0000
Tort_dummy* BIG	-0.0003	-0.22	0.8230
EBP	-0.1626***	-4.83	0.0000
Size_sq	0.0004***	5.17	0.0000
Securities	-0.0002	-0.24	0.8130
LLP_lag	0.0478***	3.09	0.0020
Constant	0.0798***	3.35	0.0010
State FE	YES		
Year FE	YES		
N	238,418		
Adj. R-Square	0.701		

ALLP is the absolute value of Abnormal LLP. *Tort_dummy* is an indicator variable with value 1 if a state reformed joint-and-several liability in the year and onward; otherwise zero. *BIG* is an indicator variable with value 1 if the bank was audited by a Big4 (Big5 or Big8) audit firms; otherwise zero. *Loans* is total loans outstanding divided by beginning total assets. *Size* is natural log of total assets of the bank. EBP is earnings before provisioning divided by beginning total assets. *Size_sq* is squared value of size. *Securities* is 1-[Securities/Total Assets] following Kanagaretnam et al. (2010). *LLP_lag* is lagged value of loan loss provision scaled by beginning total assets. Robust standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% respectively.

Chapter 5: Conclusions

The three essays in this thesis examined three important topics in financial reporting: (1) the timing of patent disclosures and the cost of equity capital; (2) how external CEOs spur innovation; and (3) how the changes in the third-party liability affects reporting opacity.

The first essay examined the economic consequences of nonfinancial disclosure in capital market in the framework of a natural experiment. I expect that the timing of disclosure of patent information explains the cost of equity capital beyond traditional proxies for firm risk. Consistent with expectation, my findings suggest that early disclosure of patent information relative to non-disclosure decreases implied cost of equity capital after controlling for common risk factors. Given the possibility that early disclosers may self-select their disclosure decision, regressions were run after adjusting for self-selection bias, which showed a similar result. It is found that early disclosing firms optimally exercised the real option to delay as evident from reduction in cost of equity capital vis-à-vis the non-disclosing firms. Further, information uncertainty also went down for disclosing firms in a post-AIPA period. Taken together, these results suggest that early patent disclosure had a negative effect on cost of equity capital through the reduction of information uncertainty.

The second essay examined how the external CEOs affect innovation using the Inevitable Disclosure Doctrine (IDD) as an exogenous shock. Specifically, it is found that external CEOs, relative to internal CEOs, affect two channels: technology spillovers and income inequality. Evidence was also found that the external CEOs increase innovation by bringing in external knowledge in the form of technology spillover. Furthermore, it was also documented that CEO industry origin matters as the results are mostly driven by CEOs from the same or similar industries. Several additional analyses were conducted to exclude the alternative explanations and to confirm the robustness of the results. The results from these additional analyses also indicate a substantively similar relationship. Overall, new evidence of a channel through which external CEOs affect innovation is offered. The evidence offered here is backed by theories on CEO succession and solid empirical measures, and based on the argument that external CEOs bring in their own set of knowledge, network, and skillsets to the new firm. This knowledge changes the information environment in which the firm innovates.

The third essay examined how state-level liability affected bank reporting opacity. Specifically, it is found that changes in the state-level tort law in the USA increased opacity as proxied by bank earnings management. Prior literature suggests that firms and auditors face significant litigation risk both at the federal level and state level. Exploiting the move from *joint-and-several liability doctrine* to a *proportionate liability doctrine* of liability sharing standard as an exogenous shock and using a difference-in-difference model, the test results in this essay consistently suggested that tort reforms result in more earnings management. Thus, financial reporting opacity seems to have increased for the banks in the tort-reform adopting states relative to those in non-adopting states. This evidence is consistent with the prediction that a decrease in litigation risk reduces the quality of financial statement numbers. Additional analyses such as exogeneity of the tort reform variable and tests using an alternative measure for earning management were run. Overall, substantially similar results were found after these tests, which further lent support to the conclusion that diminished litigation risk in the form of tort reform leads to greater earnings management and higher opacity in financial reporting.

In sum, the results documented in this thesis provide evidence on how external or internal factors may affect a firm's information environment. The first essay demonstrated how an external regulatory change could have an unintended yet positive consequence. In a similar vein, the second essay demonstrated that the hiring of an external CEO created positive technology spillover and spur innovation. On the other hand, the consequence could be negative too as the third essay documented the increase in firm reporting opacity following regulatory change in the form of tort reform. Overall, the results documented in this thesis provide important evidence that add to our understanding of the link among these factors and information environment, and inform investors, regulators, and accounting professionals.