Shareholder Litigation and Corporate Innovation*

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Abstract

We examine whether and to what extent shareholder litigation shapes corporate innovation. We use the staggered adoption of the universal demand (UD) laws in 23 states from 1989 to 2005. These laws impose obstacles against shareholders filing derivative lawsuits thereby significantly reducing a firm's litigation risk. Following the passage of the UD laws, firms have invested more in R&D, produced more patents based on new knowledge and more patents in new technological classes, generated more patents that have a large number of citations, and achieved higher patent value. Our findings suggest that the external pressure imposed by shareholder litigation discourages managers from engaging in explorative innovative activities.

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I. Introduction

How much does shareholder litigation matter for firm's innovation activities? Research in finance so far provides little evidence to this question. Starting from seminal studies in law and finance (La Porta *et al.* 1997, 1998), the existing literature suggests that shareholder litigation helps revolve agency problems arising from the separation of ownership and control. When officers and directors breach their fiduciary duties and abuse the power of their positions, shareholders are entitled to file legal claims against the wrongdoers. Yet, a prevailing concern among scholars is that a large proportion of shareholder lawsuits tend to be frivolous and waste firm's assets (Romano 1991). The burden imposed by shareholder litigation on the managers worsens their incentives in experimenting new ideas (Kinney 1994). Some managers considered the excessive shareholder litigation as an "uncontrolled tax on innovation".[1]

We investigate the impact of shareholder litigation on corporate innovation by relying on a staggered law change that reduces a manager's exposure to shareholder litigation.[2] We explicitly test two conflicting hypotheses that can be drawn from the literature. The "disciplining hypothesis" argues that the threat of shareholder litigation acts to discipline a manager's behavior and stimulates corporate innovation. According to the agency view, without proper oversight, managers will shirk their responsibilities by reducing their efforts or by engaging in self-dealing behavior (Jensen and Meckling 1976; Jensen 1986). The threat of shareholder litigation mitigates concern over the moral hazard problem and might keep managers focused on innovative activities.

[1] Silicon Graphics' CEO McCracken testified that shareholder litigation creates an "uncontrolled tax on innovation." His statement was part of a Congressional Subcommittee hearing on private litigation under the federal securities law (Seligman 1994).

[2] Other studies emphasize how legal institutions that protect corporate stakeholders, such as creditors and employees, affect innovation (Acharya and Subramanian 2009; Acharya *et al.* 2014). In contrast, we contribute to the literature by focusing on the effect of the shareholder protection laws, in particular the right of shareholder litigation, on innovation.

Importantly, when the exposure to shareholder litigation is reduced, managers might also abandon efforts to engage in explorative innovation search.

Other studies predict the opposite. The "pressure hypothesis" suggests that limitations on managerial discretion, resulting from the threat of shareholder litigation, stifle corporate innovation. First, the option to file a lawsuit makes the shareholder less tolerant of failure and undermines managerial incentive for explorative innovation. Theories and empirical evidence underscore the importance of the tolerance for failure in motivating innovation (Azoulay, Graff Zivin and Manso 2011; Manso 2011; Tian and Wang 2011). The process of innovation involves the possibility of project failure and inadequate economic results (Holmstrom 1989). For example, only 10.4% to 15.3% of drug candidates[3] can be eventually approved by US Food and Drug Administration (Hay *et al.* 2014). Innovation failures usually translates into a decline in stock prices. As a typical example, the stock price of the biotech company Alnylam Pharmaceuticals crashed by about 50% after a failed clinical trial.[4] Investors who cannot fully understand the innovative process could attribute negative performance to a breach of fiduciary duty and file the shareholder suit. This process can be illustrated by the example of Tesla Motors. Tesla's innovations on electric vehicles, such as battery and charging technology, have transformed the landscape of the auto industry. But back in 2013, multiple battery fires on Tesla Model S raised investors' concern about the safety of the electric cars and sent Tesla's stock tumbling. Triggered by the drops in stock price, a derivative lawsuit was filed against Tesla's management including CEO, Elon Musk, alleging that they breached their fiduciary duties and significantly and materially damaged the Company.[5] And stock price drops are frequently mentioned as evidence of

[3] Drugs that are classified as new molecular entities (NMEs)
[4] See in http://fortune.com/2016/10/06/alnylam-patient-deaths/
[5] The allegations usually include information related activities, value-destroying investment decisions or issues about mismanagement.

wrongdoing. Asserted by some senators in congress, "companies, particularly growth firms, say they are sued whenever their stock drops"[6] (Seligman 1994). Managers thus complained that "companies can become more reluctant to take business risks, for each time a business fails, subject to a suit for fraud".[7]

Second, the "pressure hypothesis" is in accord with the adverse effects emerging from "frivolous" shareholder lawsuits.[8] Shareholder lawsuits are frequently instituted because self-interested attorneys urge the shareholders to file them with only minimal evidence indicating there is a breach of fiduciary duty (Macey and Miller 1991; Romano 1991). The resulting lawsuits tend to only benefit plaintiff's attorneys and impede normal business (Swanson 1992; Rhode 2004). In addition, the cost of shareholder suits is enormous. Shareholder litigation distracts managers' attention, involve settlement fees, cause the deterioration of a company's reputation, and result in a higher financing cost (Fich and Shivdasani 2007; Deng, Willis and Li 2014). The career concerns arising from shareholder litigation threat creates a typical "managerial myopia" problem (Stein 1988, 1989). To avoid the cost incurred by litigation, managers are more likely to play it safe and overemphasize on avoiding risk-taking strategy instead of on far-sighted innovation (Block, Radin, and Maimone 1993; Kinney 1994; Manso 2011). Importantly, although not every firm will be sued in a shareholder suit, shareholders can exercise their rights of instituting a lawsuit whenever needed. Therefore, managers are sensitive to shareholder litigation. For example, prior studies documented

[6] Also see the statement from Edward R. McCracken, President of Silicon Graphics: "companies can be exposed to potential litigation whenever the stock price falls by approximately 10%, even if there's absolutely no violation of security laws or fiduciary responsibility."

[7] From Richard J. Egan, Chairman of EMC Corp. Also see the statement from Thomas Dunlap, Jr., General Counsel of Intel Corp: "Companies will not take sound risks, but will manage their operations so as to maintain steady performance and avoid stock fluctuations."(Seligman 1994)

[8] Agency problems arise in the process of shareholder litigation because the shareholder is acting as the principal and the attorney as the agent. Attorneys might urge shareholders to file lawsuits to maximize their own interests instead of the shareholders'. The problem results in "frivolous" shareholder lawsuits that waste corporate resources.

that managers have strong incentives to engage in policies that lower their legal exposure, such as disclosing more information (Wynn 2008).

To establish the relationship between shareholder litigation and corporate innovation is empirically challenging. On the one hand, the threat of being sued by shareholders affects the internal managerial incentives for innovation activities. On the other hand, innovation failures due to firm's innovation strategy may also trigger shareholder litigation. Our empirical investigation relies on a plausible exogenous reduction in litigation risk at the incorporation state level generated by the staggered adoption of the universal demand (UD) laws. Between 1989 and 2005, 23 states passed UD laws that raise the difficulty of filing shareholder derivative lawsuits against a company's top management, thereby substantially reducing the threat of shareholder litigation (Davis Jr 2008; Appel 2015). A firm's individual shareholders retain the right to initiate a derivative lawsuit against corporate insiders on behalf of the firm to address a breach of fiduciary duty. However, the universal demand laws require that for each derivative lawsuit the plaintiff shareholder must first make a demand on the board of directors to take remedial action. As one finds in the usual case, if the plaintiff shareholders allege the wrongdoing of the board members in the claim, the board would rarely accept such a demand and proceed with litigation (Swanson 1992). In this way, the "universal demand requirement" has significantly increased the hurdle for shareholders to overcome to file a derivative lawsuit seeking remedies, and it has created variation among the states over the risk of litigation. As shown in prior studies (Appel 2015), enforcement of the UD laws has effectively reduced the incidence of derivative lawsuits filed by shareholders. The staggered adoption of the UD laws therefore enables us to apply a difference-in-differences approach and establish the causal relationship between shareholder litigation and corporate innovation.

Using a sample that contains 57,310 firm-year observations of public firms in the U.S. between 1976 and 2006, we find evidence consistent with "pressure hypothesis". First, following the adoption of the UD laws, the treated firms invest more in innovation in terms of R&D expenditures. Second, the UD laws lead to greater engagement with explorative innovation. Specifically, firms are producing more patents based on new knowledge instead of existing knowledge and filing more patents in unfamiliar technological classes. Finally, following the passage of UD law, the treated firms generate more patents with a large number of citations and achieve higher patent value. The results imply that limiting managerial discretion through shareholder litigation impedes explorative innovation activities. As shown in the dynamic analyses, the effects of the UD laws tend to be long-term.

Building on our basic findings, we further conduct a subsample analysis to provide additional evidence that the passage of UD laws stimulate innovation resulting from a reduction of the shareholder litigation threat. We rely on an industry-level proxy for litigation risk. As documented in prior studies, firms operating in industries with higher stock return volatility bear a higher risk of shareholder suit and thus are likely to be subject to the effect of UD laws to a larger extent. Consistent with this notion, we find that the effects of lowered litigation risk on explorative innovation owing to UD laws are stronger for firms in industries with high return volatility.

We conduct a battery of empirical tests to alleviate endogeneity concerns related to reverse causality and omitted factors. First, we find no evidence that a firm's innovative measures reversely trigger the adoption of UD laws. Second, we include state-by-year and industry-by-year fixed effects to control for trends at the state and industry levels. Third, our main findings are insensitive to changes in the sample's composition. In particular, the negative effects of the UD laws on innovation are quantitatively similar if we use a sample that excludes the Internet bubble

of 2000-2001, or excludes IPO firms. Third, some studies imply that shareholder litigation alters corporate governance (Ferris *et al.* 2007). Following the adoption of the UD laws, the affected firms are more likely to use corporate provisions that entrench managers and are also less likely to be held accountable by institutional investors (Appel 2015). These contemporaneous changes provide more managerial discretion and might encourage innovative activities. To explicitly control for this possibility, we add two proxies for corporate governance, the G-index as in Gompers, Ishii and Metrick (2003) and institutional ownership and our results remain unaffected. Our results are also robust if additional board characteristics are controlled. Finally, we demonstrate the adoption of takeover laws do not confound our results.

This study provides the first evidence of the influence of shareholder litigation on innovation and makes several contributions to the literature. First, this study adds to the research on law and finance. A large amount of literature has stressed the relevance of the securities laws and shareholder protection for capital market development. Much of this research, however, highlights the positive effect of the laws protecting the rights of shareholders (La Porta *et al.* 1998; La Porta *et al.* 2000; La Porta *et al.* 2006; Djankov *et al.* 2008). Particularly, Brown, Martinsson and Peterson (2013) document that markets with strong shareholder protection achieve higher R&D investment and innovation. Instead of focusing on the general rules of law, in this study we consider a key shareholder protection mechanism: the right to shareholder litigation. In contrast to the traditional wisdom, our evidence uncovers the circumstances under which shareholder protection rights restrict managerial discretion and stifle corporate innovation.

Second, our study contributes to the debate on the role of the capital market in motivating innovation. Recent empirical studies document a number of determinants for corporate innovation both in positive and negative ways (see He and Tian 2017 for a review). Those factors include

CEO compensation (Ederer and Manso 2013), analyst coverage (He and Tian 2013), stock market liquidity (Fang, Tian and Tice 2014), labor union (Bradley, Kim and Tian 2016), and board monitoring (Balsmeier, Fleming and Manso 2017). Shareholder litigation is mainly undertaken when other governance mechanisms fail in their monitoring roles (Romano 1991). Therefore, it is interesting to examine whether one important type of shareholder protection rights, shareholder litigation, impedes or incentivizes innovation. Our findings also highlight the underlying reasons why corporate governance might hinder the process of explorative innovation.

Finally, our paper corresponds to the growing literature on shareholder litigation. Prior studies suggest that shareholder litigation influences value-relevant corporate policies in various dimensions. For example, shareholder lawsuits impose heighted financing costs and stricter financing terms on the firms involved (Deng, Willis and Li 2014). Firms are more likely to make value-destroying acquisitions and face higher external financing costs if the management is protected by D&O insurance (Lin, Officer and Zou 2011; Lin *et al.* 2013). Distinguished from previous studies, this study probes another critical and value-relevant investment decision, corporate innovation. By doing so, we connect the effects of shareholder litigation to the real economy.

Our evidence sheds new light on the compelling debate over shareholder litigation. Some studies highlight the deterrence effect (Reinert 2014). In contrast, there is an ongoing concern over the potential "dark side" of shareholder litigation. The agency costs rooted in the shareholder litigation process might generate a large number of lawsuits with little legal merit (Fulop 2007). These lawsuits are not usually in the best interest of the shareholders because they distract the managers and influence normal business. According to William R. McLucas, Director of SEC Division of Enforcement, "the SEC has acknowledged the detrimental impact of meritless

securities cases. To the extent that these claims are settled to avoid litigation, they impose a tax on capital formation" (Seligman 1994). With the purpose of mitigating this concern, the past two decades have witnessed a nationwide trend aimed at controlling meritless lawsuits. Both the UD laws and the Private Securities Litigation Reform Act (PSLRA) are intended to partially act as a barrier to abusive lawsuits brought by shareholders (Buxbaum 1980; Swanson 1992). In academia, however, researchers still hold different opinions on these policies. Some believe they have fulfilled their purpose, whereas others argue the unintended consequences such as the deterioration of corporate governance (Johnson *et al.* 2007; Appel 2015). In this study, we offer the first evidence suggesting that a regulation restricting the rights of shareholders to litigate against their corporation, on average, incentivizes innovation.

This study proceeds as follows. Section II discusses the institutional details and identification strategy. Section III discusses the sample construction and the definitions of the variables. Section IV discusses the empirical results. We conclude in Section V.

II. Institutional Background and Empirical Design

2.1 Shareholder Derivative Suits

Managers and directors owe fiduciary duties to their shareholders, meaning that legally those managing a corporation should do so in such a way that the best interests of the shareholders are served. In reality, however, agency problems arise due to the separation of ownership and control, inducing managers to maximize their own interests at the shareholders' expense (Jensen 1986). In the United States, shareholders may file lawsuits against their management for such wrongdoing. Litigation imposes personal liability on the officers and directors if they are found to have breached

their fiduciary duties (either duty of care or duty of loyalty). This helps to align the managers' incentives with the shareholders' interests (Romano 1991).

Shareholder judicial proceedings are mainly divided into two categories, direct suits and derivative suits. In a direct suit, the lawsuit is brought up to remedy one shareholder or a subset of shareholders (Ferris *et al.* 2007). For example, multiple shareholders in a defined "class" could commence a class action against firm's management seeking compensation for common damages in a particular period. The other type of claims from shareholders, derivative suit, is the focus of this paper.

A shareholder derivative lawsuit is a legal action instituted by individual shareholders on behalf of the company against their officers and directors for alleged wrongdoing that is harmful to the entire corporate entity. The example of Tesla shareholder derivative suit can be found in Appendix 1. This type of shareholder lawsuit is derivative because the misconduct first harms the corporation and then leads to the welfare deterioration of all shareholders. As a result, shareholders who file derivative lawsuits are on behalf of the corporation instead of themselves. In the case of Tesla, the shareholder, Ross Weintraub, filed the lawsuit derivatively on behalf of the firm. In contrast to class actions, in derivative actions, monetary recovery is paid to the company treasury instead of flows to the plaintiff shareholders. The importance of derivative suit has been recognized in the law and finance literature. For example, La Porta *et al.* (1998) state that "the rights attached to securities become critical when managers of companies act in their own interest…Some countries give minority shareholders legal mechanisms against perceived oppression by directors…These mechanisms may include the right to challenge the directors' decisions in court (as in the American derivative suit)". And in typical cases of US, corporate policies that trigger derivative lawsuits include value-destroying investment decisions, information related activities

and other issues about mismanagement (Ferris *et al.* 2007).[9] Besides US, some emerging economies such as India and China have also set up the law regarding shareholder derivative suits (Scarlett 2011).[10]

Most of large listed companies carry liability insurance for their directors and officers to cover the probable legal settlement costs. It is well documented that D&O insurance protects firm's director and officers from personal liability in the event of litigation and could induce moral hazard problem (Lin, Officer and Zou 2011; Lin *et al.* 2013). In most derivative suits, the settlement is funded or partially funded by D&O insurance. However, D&O insurance typically cannot cover misconducts involving dishonesty or intentional wrongdoings (Ferris *et al.* 2007).[11] Even if firm's managers do not need to personally pay the settlement fees, they will still face severe punishments from the reputation damages in the labor market (Fich and Shivdasani 2007).

Derivative suits publicize the agency problems within the firm and therefore deter directors and officers from engaging with management misconducts in the future. However, these legal actions from shareholders are also accompanied by major concerns among researchers regarding the legal merits of these claims (Fischel and Bradley 1985; Romano 1991).[12] As discussed above, those lawsuits are usually driven by self-interested attorneys (Brandi 1993). And the detrimental impact of those lawsuits without merit is well documented in prior studies. As indicated by the

[9] To increase the probability of winning the suit, shareholders usually allege these misconducts instead of directly accuse firm's innovation-related activities.

[10] Laws regarding shareholder derivative litigation in emerging market typically resemble the derivative actions in US. The India's new Company Bill was introduced by the Ministry of Corporate Affairs and are clear about shareholder's right to filing derivative lawsuits against mismanagement. Shareholder derivative action was first established through regional courts in Shanghai and Jiangsu province and later written in China's 2005 Company Law.

[11] For example, Lawrence J. Ellison, the CEO of Oracle agreed to pay $100 million to charity to settle a derivative lawsuit. He also paid $22 million to plaintiffs' counsel in legal fees and expenses related to the case. See in http://www.nytimes.com/2005/09/12/technology/oracles-chief-in-agreement-to-settle-insider-trading-lawsuit.html?_r=0

[12] Legal researchers commonly believe that most derivative lawsuit is meritless and mainly driven by the settlement fees instead of corporate governance issues. The market does not upgrade the firm when the judicial decisions that allow a derivative suit to continue is announced (see in Fischel and Bradley (1985) and Brandi (1993)).

congress report in 1995, the shareholder litigation system shouldn't "be undermined by those who seek to line their own pockets by bringing abusive and meritless suits". An abusive derivative lawsuit not only wastes a firm's assets but also deter the management from risk taking and experimenting new ideas (Kinney 1994). The prevalence of excessive litigation induces officers and directors to focus more time on legally safe activities rather than on the far-sighted innovation thereby harming the competitiveness of the whole economy (Block, Radin, and Maimone 1993).

2.2 UD Laws

In US, the derivative suit proceeds in several steps. Before bringing a derivative action, the plaintiff shareholders must first demand that their board take action to address the alleged concerns. This process is called the "demand requirement". The board can choose to reject, consider or ignore the request in a reasonable time. But in reality, because the board members are the ones usually targeted by the lawsuit, the directors almost always reject the demand. Shareholders can thus proceed with the derivative suit after the demand is refused or unanswered. But if the demand is rejected, in most of the cases, the court follows the board's decision and dismisses the claim pursuant to the business judgment rule.

Shareholders, however, can circumvent the demand requirement by arguing the futility of demand if they can provide evidence showing the board of directors cannot fairly evaluate it.[13] In practice, shareholders prefer to plead the futility exception, because it is difficult to proceed with a lawsuit if the board refuses the demand. In the case of Tesla, the shareholder argued that making

[13] Shareholders could argue futility if the board is believed to be responsible for the wrongdoing and therefore cannot make unbiased decisions regarding the demand.

demand would be futile because "current members of Tesla's Board are antagonistic to this lawsuit".

Between 1989 and 2005, 23 states in the U.S. implemented the universal demand (UD) laws, which impose the demand requirement on every derivative lawsuit filed in states that have adopted the laws. After the enactment of the laws, shareholders are deprived of the option to plead demand futility. As illustrated in Table 1, the earliest states to adopt the laws were Georgia and Michigan in 1989 and the most recent states to adopt them were Rhode Island and South Dakota in 2005. The idea behind the UD laws comes from the Model Business Corporation Act, a uniform law proposed by the American Bar Association that is voluntarily followed by some states.[14] Because the UD laws require plaintiffs to make a demand as a prerequisite to filing a derivative suit (as discussed above), and the demand would be refused in most cases, the universal demand requirement serves as a significant barrier to filing derivative lawsuits. We document in what follows that the number of shareholder derivative lawsuits has significantly dropped by a range of 17.9% to 21.5% since the UD laws were first adopted, a pattern consistent with the findings in Appel (2015).

2.3 Identification Strategy

Firms incorporated in the states that have passed the UD laws are relatively insulated from shareholder derivative lawsuits for the reasons discussed above. We exploit these incorporation state-level shocks as natural experiments to establish the causal relation between shareholder litigation and innovation. This setting has several appealing empirical features that facilitate a valid

[14] As we will discuss later, we do not find systematic and obvious evidence suggesting the adoption of UD laws is driven by corporate lobbying activities.

difference-in-differences analysis. First, the variation in the litigation threat generated by the staggered adoption of the UD laws is arguably exogenous to firm-level attributes. Second, similar to Bertrand and Mullainathan (2003), who evaluate the effects of the Business Combination Laws, the variation is at the incorporation state level. Empirically, this feature allows us to compare firms that are headquartered in the same state but are subject to different legislation. Firms incorporated in states with UD laws are the treated firms, whereas those incorporated in states without UD laws are the control firms. This empirical design significantly mitigates the confounding effects resulting from regional economic shocks.

Our diff-in-diff specification is as follows:

$$Innovation_{it} = \alpha + \beta UD\ Law_{it} + \theta_i + \delta_{it} + \varepsilon_{it} \qquad (1)$$

where $Innovation_{it}$ is the innovation measure gauged by several proxies. $UD\ Law_{it}$ equals one if the incorporation state of the firm has a UD law.[15] β is the main coefficient of interest to identify the effect of UD law. θ_i denotes the firm fixed effects that capture all of the firm-level time-invariant effects. δ_{it} represents the operating state by year fixed effects that pick up all of the operating state level time-varying trends. In this model, we do not include any endogenous factors as control variables. We estimate an alternative model as follows as a robustness check:

$$Innovation_{it} = \alpha + \beta UD\ Law_{it} + \gamma X_{it} + \theta_i + \delta_{it} + \rho_{it} + \varepsilon_{it} \qquad (2)$$

We include a series of firm-level attributes as control variables, X_{it}. The control variables include firm characteristics such as size, leverage, book-to-market ratio, firm age and capital expenditure.

[15] The treatment variable is assigned zero for the first effective year of UD law throughout this study. The empirical results are robust if we assign the treatment variable as one for the first effective year.

In the robustness check, some proxies for governance, such as the G-index and institutional ownership, or an index of takeover susceptibility are also considered. Further, we consider industry by year fixed effects, ρ_{it}, to account for the effects of industry-level trends.

It is possible that the staggered adoptions of UD laws are not perfectly random. Economic, political or other unobservable factors could contribute to the spread of UD laws. But as we will show in what follows, the passage of UD laws does not appear to be driven by innovation-related reasons. Moreover, UD laws raise the barriers for derivative suits and thus might motivate the shareholders to file more class actions instead. We empirically test this hypothesis and find that UD law does not significantly lead to more class actions for firms incorporated in a state. Lastly, managers may choose a state with UD law in order to alleviate their concerns about shareholder litigation. We also conduct empirical tests to rule out this possibility.

III. Sample and Variables

3.1 Sample Selection

The dataset for our study is determined by the joint availability of data from several sources. First, we collect information on firm characteristics, such as firm size, leverage, book-to-market ratios and R&D expenditures from Compustat. Our patent information is based on NBER database.

Similar to other corporate laws at the state-level (Bertrand & Mullainathan 2003), the effect of the UD law is at the incorporation state level, meaning that firms incorporated in states with effective UD laws will be treated. Firms can however change their state of incorporation in the process of doing business. For a valid inference, it is important to correctly identify a firm's historical state of incorporation. Compustat only provides the latest state of incorporation. Using

this data to construct the treatment variable would create serious measurement error. To mitigate this concern, we rely on the historical state of incorporation provided by Bill McDonald, who compiled each firm's state of incorporation based on its original SEC filing since 1994.[16] We supplement the information on the historical state of incorporation with Compustat records in the years before 1994 in the case of missing values. Table 1 illustrates the timing of the adoption of the UD laws and the firms affected in our sample. Twenty-three out of 50 states have passed the UD laws in different years. We find that 17.7% of our total firm-year observations are firms incorporated in states that have eventually adopted the UD laws. These firms serve as treated firms after the passage of the UD laws.

[Table 1 about here]

Appel (2015) finds that the UD laws possibly lead to the deterioration of corporate governance, through governance provisions and institutional ownership proxies. To isolate the effect of litigation risk and to explicitly control for the contemporaneous effects of corporate governance, we use the governance index (G-index) introduced in Gompers, Ishii and Metrick (2003) and institutional ownership as control variables. The data on the G-index is collected from ISS (formally Riskmetrics). The original data on the G-index starts from 1990. We fill in the firm's G-index with the nearest available data point back to 1981 to take advantage of the variation in shareholder litigation generated from the adoption of the UD laws in the 1980s. The data on institutional ownership comes from the Thompson Reuters Institutional Holding (13F) Database.

[16] The data on incorporation states from 10K filings are extracted from the SEC's EDGAR website and compiled by Bill McDonald, available at http://www3.nd.edu/~mcdonald/10-K_Headers/10-K_Headers.html

Our sample only includes companies that appear in the NBER database. Specifically, only firms that are researched by the NBER team are considered. This process is distinguished from other studies that consider a large sample and assign zero patents to firms that have not been tested by NBER. Utilizing this small sample, in contrast, mitigates the concerns arising from measurement errors (Balsmeier, Fleming and Manso 2017). The resulting sample includes 4,526 unique U.S. public firms and 57,310 firm-year observations from 1976 to 2006.

3.2 Variables

Following the practices in the literature, we mainly use patent-based measures to gauge the quantity and quality of innovations. The patent information is extracted from NBER database[17], which provides patent and citation information from 1976 to 2006 and the links to match the patent assignee to the identifier in Compustat.

Our innovation measures fall into three categories: innovation inputs, explorative innovation and high-impact innovation. First, we use R&D expenditure to measure a firm's investment in innovation. The variable *R&D/Assets* is the amount of R&D expenses scaled by total assets.[18] Second, we utilize patent information to gauge explorative innovation. *Patent* is the total number of patents. It is worthwhile to note that these patents include both high quality and low quality patents. Following Manso (2011) and Balsmeier, Fleming and Manso (2017), we construct variables measuring the extent of explorative innovations to answer the question of whether shareholder litigation stifles the explorative innovation process. We first construct a variable taking the firm's current patent knowledge into consideration. A patent is considered as an explorative

[17] Details can be found in Hall *et al.* (2001).
[18] Missing values in R&D are treated as zero. In what follows, we will show that the results are robust when the observations with missing R&D are dropped.

one if at least a certain percentage of the citations it refers are ***not*** from existing knowledge. Here existing knowledge includes all the patents produced by the firm or patents cited by firm's patents filed over past five years (Brav *et al.* 2016). We consider three cutoffs, namely, 70%, 80% and 90%. We define *Explorative Patent, 70%/80%/90%* as the number of these explorative patents filed in a given year. Similarly, we define *Exploitive Patent, 80%* as the number of patents that at least 80% of their knowledge they refer to are from existing knowledge. These firm-level aggregated variables indicate whether the firm focus on explorative search or exploit existing knowledge.

We further construct two variables considering firm's existing knowledge in certain technological classes. *New-class Patent* is the number of patents filed in technology classes previously unknown to the firm in a fiscal year. *Known-class Patent* is the number of patents filed in a technology class previously known to the firm in a fiscal year. Intuitively, the phenomenon that a firm must produce more patents that are distinct from its patent portfolio in terms of technological classes indicates the presence of more explorative innovative activities. In contrast, firms that file more patents within familiar technological classes might suggest that they are more likely to exploit their existing patent knowledge and avoid explorative innovation search.

Last, we further differentiate the patents according to their position in the distribution of citations in a given 3-digit class and application year. *Top10% Patent* is a firm's total number of patents that fall into the top 10% of the most cited patents within a given 3-digit class and application year. *Top10% Patent* measures the high quality innovations that a firm produces. We also quantify the quality of a patent according to the market reactions to the announcement of patent grants following Kogan *et al.* (2016). *Patent Value* denotes the total value of patents applied by a firm scaled by market capitalization.

Consistent with prior studies on corporate innovation (Hsu, Tian, and Xu 2014), we address the two types of well-documented truncation problems regarding NBER patent database. The first truncation problem is due to the application-grant lag in the patent granting process. We only observe patents granted through 2006 and it takes on average two years for a patent to be eventually granted. As many patent applications might still be under review, we observe a decrease in the number of granted patents in the last few years of our sample period (2005 and 2006). We follow Hall, Jaffe, and Trajtenberg (2001, 2005) to address this truncation problem in counting number of granted patents. We obtain a series of weight factors using the empirical distribution of application-grant gap. Our measures regarding the number of patents are adjusted by these weight factors. Second, NBER database also suffers from truncation problems regarding patent citations. Patents continue to receive citations over long periods and NBER database only allows us to observe citations up to 2006. We address this type of truncation by estimating the shape of the citation-lag distribution following Hall, Jaffe, and Trajtenberg (2001).

Following the practices in the literature, we take the natural logarithm of these patent-based variables in the regression analysis to mitigate the concern for skewness and to facilitate a reasonable econometric interpretation. We also add one to the actual number in calculating the logarithm value in order to include the firm-year observations with zero patents in our analysis.

For other firm attributes, we consider firm size (*Size*) and market-to-book ratio (*MTB*) because the size of a firm and its growth opportunities are likely to correlate with innovative activities. We use leverage (*Leverage*) and capital expenditure (*Capex*) to account for the extent of financial constraints, because financial distress might affect a firm's propensity to innovate. In addition, we control for firm age (*Ln(Age)*)*:* the logarithm of the number of years since the initial public offering date, because older firms may search in older technological areas. In the robustness check, we

include the governance index (*G-index*) and institutional ownership (*IO*) as proxies for corporate governance. Throughout this study, the industry is based on the two-digit standard industry classification code.

3.3 Summary Statistics

Table 2 presents the descriptive statistics of the main variables. There are 57,310 observations spanning from 1976 to 2006. On average, the sample firms invest 7.9% of their total assets in R&D in a fiscal year. Consistent with the literature, the patent-based measures in our sample show a typical skewness pattern. Sample firms file on average 10.8 patents in a given year that are eventually granted. A large number of patents however are filed by a small number of innovative firms. There are 1.5 explorative patents measured using 80% cutoff accounting for 13.8% of total patents. About 0.87 newly filed patents (accounting for 8% of the total number of patents) are filed in technological classes unfamiliar to their firm. The majority of patents (92%) are filed in technological classes in which their firms have previously been granted patents. About 0.96 patents are classified as top 10% patents according to citations. Total value of patents over market value of equity is about 2.4%. Appendix 3 displays a correlation table of all of the innovation measures.

The summary statistics of the other control variables are quite close to what is found in the literature. On average, firms are 11.9 years old, have total assets of $124.8 million, a leverage ratio of 51.9%, capital expenditures over total assets of 6.3%, and a market-to-book ratio of 2.6. The average G-index is about 8.9. Institutional investors own 21% of the shares.

[Table 2 about here]

IV. Results

In this section, we discuss the empirical findings in detail. We first present evidence that supports the validity of our identification strategy. We then show the results concerning the relationship between shareholder litigation and corporate innovation along several dimensions, in particular explorative innovation search. We examine the heterogeneous relationship between shareholder litigation and corporate innovation among firms operating in industries with various levels of return volatility. Finally, we provide evidence on the robustness of our results at the end of this section.

4.1 Setting Validity

We conduct empirical tests to confirm the validity of the natural experiment. It is theoretically possible that firms troubled by frivolous derivative lawsuits engage less in the innovation process and use their political connections to lobby for the adoption of UD laws. To mitigate this concern, we rely on the database of the Center for Responsive Politics (CRP), which contains the information about the specific issues that US firms and organizations lobby from 1998 to the presents.[19] In the database, we do not find any corporate lobbying activity associated with UD laws. [20] To further alleviate the endogeneity concern arising from reverse causality and simultaneity, we implement formal tests in the following.

[Table 3 about here]

Panel A of Table 3 suggests that the pre-existing innovation measures do not affect the timing of a state's enactment of UD laws. Specifically, we apply a Weibul hazard model (Beck *et al.* 2010)

[19] The Lobbying Disclosure Act of 1995 mandated that corporate lobbying activities should be reported to the Secretary of Senate's Office of Public Records.
[20] We conduct a comprehensive search with the keywords including "Model Business Corporation", "universal demand", "derivative action", "derivative suit", "derivative litigation", "derivative lawsuit", "shareholder lawsuit", and "shareholder litigation" and no related lobbying issues are found.

where the dependent variable is the log of the time expected to the passing of UD laws, and the explanatory variable corresponds to the contemporaneous measures of innovation aggregated at the state level. We estimate the duration model using all of the innovation measures and present the results in each of the columns in Panel A of Table 3. We control for several time-varying state-level characteristics to pick up the contemporaneous effects related to the regional economy and the trends related to the listed firms incorporated in a state. Specifically, we include state-level real GDP, GDP per capita and the number of firms incorporated in a state. We use the natural logarithm of these variables in the analysis. The results in Panel A of Table 3 suggest that the coefficients of all 7 state-level innovation measures are insignificant. Thus, we cannot reject the null hypothesis that firm-level corporate innovation does not affect the timing of adopting UD laws. As shown in Appendix 4, we obtain similar results if we use the growth of the innovation related measures as independent variable.

The second concern is that whether the adoption of UD laws actually leads to fewer shareholder derivative lawsuits. We rely on the legal cases collected from Audit Analytics for a formal empirical test. We identify shareholder derivative lawsuits as ones classified as "shareholder suits" and "derivative". The resulting sample contains about 500 derivative cases between 2000 and 2013 as Audit Analytics only contains lawsuits filed after 2000. During the sample period, there are five states that adopted UD laws. And we run the difference-in-differences regression at incorporation state level to demonstrate the impact of UD laws on shareholder derivative litigation activities. As shown in Model (1) of Panel B in Table 3, the number of derivative suits drops by 21.5% following the adoption of UD laws. When controlling for GDP and number of incorporated firms, the coefficient is still significantly negative. The findings are

consistent with the evidence documented in Appel (2015) that UD laws indeed raise the barrier for derivative litigation and reduce the litigation threat associated.

The third concern is that it is theoretically possible that by raising the procedural hurdles of derivative lawsuit, UD laws encourage shareholders to bring direct actions. If it is the case, we would observe the number of securities class actions for firms incorporated in a state increased following the adoption of UD laws. To test this hypothesis, we collect the data on class actions from Stanford Securities Class Action Clearinghouse. Since the database starts from 1996, we consider a period of 1996 to 2013. The number of class actions is aggregated at incorporation state level. The results reported in Models (3) and (4) of Panel B in Table 3 suggest the number of class actions does not significantly change after the adoption of UD laws. The results remain robust after controlling for state GDP, GDP per capita and the number of incorporated firms. The presented results indicate that we cannot reject the null hypothesis that UD laws do not give rise to the transition to shareholder class actions suggesting UD laws indeed reduce managers' overall exposure to shareholder litigation. There are several possible explanations for this pattern we document. On the one hand, as stated in Federal Rule of Civil Procedure, there are several prerequisites for filing shareholder class actions. One major requirement is that the class should be so numerous that joinder of all members is impracticable.[21] These requirements potentially barrier the transition from derivative actions to class actions. On the other hand, class actions and derivative actions may have different underlying motivations. In derivative actions, only the attorney's fee can be recovered by winning the lawsuit, while any monetary recovery will flow to the firm instead of plaintiff shareholders. Due to this reason, prior studies suggest that derivative

[21] Rule 23 (a) of Federal Rule of Civil Procedure include four requirements for shareholder class actions: 1) the class is so numerous that joinder of all members is impracticable; 2) there are questions of law or fact common to the class; 3) the claims or defenses of the representative parties are typical of the claims or defenses of the class; and 4) the representative parties will fairly and adequately protect the interests of the class. See in https://www.law.cornell.edu/rules/frcp/rule_23

litigation is partially driven by winning attorneys' fees instead of legal merit. If this is the case, the passage of UD laws undermines this motivation by raising the procedural hurdle, but it will not necessarily give rise to more class actions, in which plaintiff shareholders could be recovered directly.

Another possible concern is about "incorporation state shopping". As UD laws raise the barriers of shareholder derivative litigation against management, firm managers might have the incentive to change their incorporation state to states with UD laws in order to mitigate the concerns about litigation threat. We thus conduct empirical analysis to assess this possibility. The results in Models (5) and (6) of Panel B in Table 3 suggest the passage of UD laws does not significantly alter the number of firms incorporated in a state.[22]

4.2 Innovation Input

Based on the validity of the natural experiment discussed in Section 4.1, we now investigate the effect of the exogenous variation in litigation threat on innovation resulting from the UD laws. We first examine the effect of the UD laws on a firm's investment in innovation. In general, we consider three model specifications throughout this study. Specification (a) is a standard OLS model with firm and operating state-by-year fixed effects. In this model specification we do not include any endogenous control variables so that we estimate the effect of the UD laws without any adjustments. This model provides the first clean estimate and provides a stand-alone effect of the UD laws on innovation activities. In (b), we include firm attributes, such as size, market-to-book ratio, leverage ratio, firm age and capital expenditure to control for the contemporaneous

[22] We consider sample periods from 1994 because the historical incorporation variable from SEC filings starts from 1994. Our results remain unchanged if we use the incorporation state variable combined with the variable from Compustat and extend the sample to 1976.

changes in firm fundamentals. Specification (c) further accounts for time-varying industry trends by adding industry-by-year fixed effects into the regression. The industries are based on the two-digit standard industry classification code. Consistent with Bertrand and Mullainathan (2003), the standard error is clustered at the incorporation state level. These conventions apply to Tables 5 to 11.

Following the common practice in the literature,[23] we use R&D expenditure scaled by total assets as a measure of investment in innovation. Table 4 presents the empirical results. The treatment effect is quantified by the coefficient associated with *UD law*. As shown in column (1), compared to firms incorporated in states without UD laws, the treated firms, on average, invest about 1% more in R&D. The increase accounts for about 12.6% of the sample mean for R&D expenditure, indicating an economically meaningful effect. As we include state-by-year fixed effects in the regressions, the increase is measured relative to firms headquartered in the same state. The effect of regional confounding factors tends not to affect our findings. The empirical results are also highly robust with regard to the inclusion of industry-by-year fixed effects, suggesting that the industry time trends do not drive the results. As shown in column (4), the coefficient remains at 1.2% after a full set of controls is included, and it is still significant at the 1% level. Consistent with the "pressure hypothesis," the evidence suggests that when treated firms are less likely to be sued by shareholders through derivative lawsuits, they become more incentivized to invest in innovation.

[Table 4 about here]

[23] For example, Seru (2014) discusses R&D expense measures and costs incurred in both the research and the development phase and quantifies the research intensity of the firm.

4.3 Explorative Innovation

After establishing the relationship between the threat of shareholder litigation and investment in innovation, our next concern is how the enactment of UD laws influences firm's activities in innovation search, especially activities regarding explorative innovation. We build our analysis upon several patent-based variables.

We first claim that we do not have strong theoretical predictions for the effect of the UD laws on the number of patents. On the one hand, the "pressure hypothesis" conjectures that shareholder litigation limits managerial discretion and firms produce fewer patents when they are subject to the threat of litigation. This reasoning leads to the argument that UD laws that reduce litigation risk might increase the number patents produced by the treated firms. On the other hand, the excessive pressure imposed by shareholder litigation could also induce managers to conduct exploitive innovation, thereby generating a number of low quality patents. In this case, the adoption of the UD laws leads to fewer patents. Therefore, either positive or negative effects are consistent with the "pressure hypothesis". It remains an empirical question that which effect dominates the other. The results reported in Table 5 indicate that the UD laws do not have a significant effect on the total number of patents. The evidence is consistent with our reasoning above and suggests that although the treated firms experience intensified research input in terms of increased R&D expenditure, the number of their patents does not show a material increase.

[Table 5 about here]

As discussed above, managers face the choice between exploitive innovation strategies and explorative innovation strategies. The typical managerial myopia contributed by the threat of shareholder litigation might induce a manager to engage in exploitive innovation search. We

formally test this possibility by considering several patent-based measures. First, we examine if the number of explorative patents increases following the enforcement of UD laws. We define a patent as an explorative one if at least 80% of its backward citations are from new knowledge instead of firm's existing knowledge. Firm's existing knowledge includes all the patents filed by the firm and all patents that are cited by patents filed by the firm over past five years (Brav *et al.* 2016). The number of explorative patents filed by a firm directly indicates whether the firm's innovation strategy is heavily depending on the existing knowledge. As the results in Table 6 suggest, comparing with control firms, treated firms experience an increase in the number of explorative patents by a range of 9.7% to 11.7% following the adoption of UD laws. Our results are also robust when the explorative patents are defined using 70% or 90% cutoffs. The effect of UD laws on explorative patents increases to a range of 11.7% to 13.8% when the variable is defined using 90% cutoff. Results in Column 1 of Appendix 5 further suggests the passage of UD laws increase the number of explorative patents but has no significant effect on the number of exploitive patents. The evidence is consistent with the notion that firms tend to explore for new technologies when their managers are relatively less exposed to shareholder litigation.

[Table 6 about here]

We further investigate the number of patents with USPTO technological classes previously unknown to the firm.[24] These new technological classes are ones in which the firm has not filed any patents back to 1976. The behavior of a firm filing a new-class of patent indicates that the manager is entering a new technological realm and is bearing the potential risk of failure. We also define the complement as the number of patents with known classes. The increased number of

[24] There are about 400 major technological classes according to the definition of USPTO.

known class patents therefore indicates a high probability of exploitive innovation search. In the regression, we take the logarithm of these two measures and consider *Ln(New-class Patent)* and *Ln(Known-class Patent)* as dependent variables. Table 7 presents the corresponding regression results. As can be seen, the enactment of UD laws has an insignificant effect on search into previously patented classes, but a strong and significantly positive effect on the exploration of new classes. The number of patents in new classes increases by from 6.6% to 7.4% following the adoption of the UD laws. The evidence suggests that a reduction in shareholder litigation caused by the adoption of the UD laws results in a firm's transition to more explorative innovation search.

[Table 7 about here]

By using several patent-based measures, the evidence in this section supports the argument that the reduced threat of litigation promotes innovation and leads the search for innovation in new and explorative areas. The results are robust to all model specifications and demonstrate an economically meaningful effect. The findings support our "pressure hypothesis".

4.4 High-Impact Patent and Patent Value

In what follows, we explore whether the passage of UD laws leads to more high-impact patents and improves the overall level of patent value. If UD laws encourages the managers to conduct more explorative innovation activities, we should observe more high quality or break-through patents produced following the adoption. We quantify the patent quality (such as break-through patents) according to the citations they receive. As shown in Table 8, the UD laws lead to a significant increase in the range from 3.2% to 3.7% in patents that are in the top 10% category of the distribution of citations in a given 3-digit class and application year.

[Table 8 about here]

We measure the patent value using market reactions to the announcement of patent grants. The market upgrades the firm when a high quality patent is granted to the firm. This market-based measure has several advantages in our context. As discussed in Kogan *et al.* (2016), the stock prices are forward looking and allow us to quantify the private value to the patent holder. Citations, instead, only measure scientific value of the patent. In addition, the fact that the patent value is in terms of dollars facilitates comparison across industry and time. That allows us to construct a variable measuring patent value at firm-level. Following Kogan *et al.* (2016), *Patent Value* is defined as the total value of granted patents applied in a year scaled by market capitalization. The value of a patent is highly skewed. Break-through patents generated due to firm's explorative innovation search are likely to be associated with large market value. As indicated by Table 9, the passage of UD laws leads to about 0.9% increase in patent value accounting for about 37.5% of the sample average. These economically meaningful results suggest that the UD laws significantly change the composition of a firm's patent portfolio, leading treated firms to generate more high quality patents and higher patent value.

[Table 9 about here]

We also examine firm responses in several other dimensions. As shown in Appendix 5, the adoption of UD laws does not lead to higher stock return volatility but the return skewness increases marginally. We also show that UD laws lead to fewer self-citations, which are defined as the number of times a given patent cites other patents owned by the same company scaled by the number of total patents filed in a fiscal year. That is a pattern consistent with explorative innovation activities as firms are less likely to have engaged in explorative innovation if their filed

patents cite patents that the firm currently holds. We further tempt to differentiate the innovation activities into the in-house innovation strategy or acquiring technologies from other firms. We compile a dataset of takeovers from SDC database. As indicated by Columns 5 and 6 of Appendix 5, UD laws do not lead to more innovation-driven acquisitions for treated firms. We thus do not find supportive evidence for firm's strategy of acquiring innovation.

4.5 Heterogeneous Effects according to Industry Volatility

In this section, we extend our analyses by exploring whether the effects of the universal demand laws on innovation vary across certain types of industries. These extensions are helpful for identifying the underlying channels through which the UD laws affect innovation. As discussed in the introduction, we conjecture that the increase in innovative search stems from lowering the external pressure imposed by shareholder litigation. If this is the case, we expect the effect of the UD laws to be more pronounced among firms operating in industries with higher return volatility. Ferris et al. (2007) document that firm's return volatility is significantly correlated with being sued in derivative case. Therefore, industry volatility increases the exposure to shareholder litigation and marginally amplifies the effect of litigation risk. We thus propose the industry-level return volatility as a proxy for litigation threat in our study.

We adopt a sub-sample analysis to assess the heterogeneous effects of the UD laws according to industry volatility. The raw sample is divided into two sub-samples according to the median of industry-level return volatility, which is defined as the industry average of the standard deviation of a firm's daily stock returns in a given year. The estimation results are reported in Table 10. We find significant coefficients for firms in industries with high volatility across main innovation dimensions we consider. For example, as indicated in models (1) and (2), the passage of US law

leads to 2.2% more R&D investment accounting for 27.8% of the sample average for firms in industries with high volatility, while its effect is insignificant for firms in industries with low return volatility. Similarly, the effect of UD law on explorative patents for firms in industries with high volatility is about two times larger than firms in other industries. As indicated by p-values reported in Table 10, the differences in coefficients using two subsamples are significant at one-percent level. The findings are consistent with our conjecture that the pressure caused by shareholder litigation is exaggerated by industry volatility.

[Table 10 about here]

4.6 Robustness Checks

In this section, we conduct additional robustness checks to rule out alternative explanations. First, we re-estimate our main regression models using a sample excluding the period of the Internet bubble from 2000 to 2001. The dot-com bubble witnesses an abnormal development of high-tech firms that are considered to be the most innovative. On the one hand, the burst of the Internet bubble creates a systematic effect on the economy. In particular, these high-tech firms may have their innovation strategy altered. On the other hand, when the bubble bursts, the dramatic drops in stock prices possibly generate shareholder litigation. This process might confound our findings. Although we have controlled for industry-wide trends, some potential shocks driven by the Internet bubble within industries and within certain regions cannot be fully captured. To mitigate this concern, we use the sample excluding the internet bubble period and find our empirical results remain unchanged.

[Table 11 about here]

Second, we replicate our results using a sample without IPO firms. Shareholder lawsuits against the managers of IPO firms can be different from other firms because the alleged wrongdoings are likely related to the IPO process (Choi 2007). To rule out the effects of these IPO related lawsuits, we construct a sample by excluding IPO firms. We define IPO firms as observations occurring during the first three-years they appear in Compustat. We obtain quantitatively similar results. The evidence suggests our results are unlikely to be driven by the threat of shareholder litigation related to IPO issues.

Third, following the practice in previous studies, we consider missing values in R&D expenditure as zeros in our main results. Koh and Reeb (2015) however document that some firms with missing R&D in their financial statement have engaged in significant patent activities. This study suggests treating missing R&D as zero in some cases may not be appropriate. To mitigate this possible concern, we first redo our analysis on innovation input by dropping all firm-year observations with missing R&D expenditures in Compustat database. As suggested in Column 1 of Panel C of Table 11, our results are insensitive to this alteration. Second, we investigate whether the adoption of UD laws changes managerial incentives in disclosing R&D expenditures. Column 2 of Panel C indicates the probability of disclosing R&D remains unchanged following UD laws. Lastly, we attempt to predict missing innovation data using economically motivated observable variables. Specifically, we run a regression for each industry using patent count, firm size, market-to-book ratio and leverage to predict the level of R&D. The predicted value of R&D is then used to replace the missing value in the original R&D expenditures. The results again remain robust.[25]

[25] In a table available upon request, we show that our results remain robust to Heckman model for correcting the potential selection problem in missing R&D.

In the following analysis, we further consider several additional controls to strengthen our empirical results. The deterioration of corporate governance due to the passage of UD laws (Appel 2015) might also affect firm's innovation activities and possibly confounds our results. We explicitly control for the contemporaneous effects of corporate governance, we use the governance index (G-index) introduced in Gompers, Ishii and Metrick (2003) and institutional ownership as control variables. As shown in Panel D of Table 11, after controlling for these two governance measure, all dimensions of innovation we consider still demonstrate significant changes following UD laws.

Other incorporating state level legal changes might have a confounding effect on our findings. As well documented in the literature anti-takeover laws (business combination laws, fair price and etc.) alter managerial incentives and innovation activities. To alleviate this concern, we rely on a firm-level index that measures takeover susceptibility. The index is constructed in Cain et al. (2017) who analyze the impact of 17 takeover laws on U.S. firms. The empirical results controlling for this index are reported in Panel E of Table 11. We find little evidence suggesting takeover laws contaminate our estimation. Finally, Panel F reports the results that consider additional board characteristics, such as Percentage of independent directors, Average Age of Board Directors, and Board Size (the number of board members). Again, our results remain unaffected.

4.7 Dynamics

Identification in the difference-in-differences approach builds upon the parallel trend assumption, meaning that treated and control firms do not show a clear trend before the treatment. In this section, we validate this assumption by examining the dynamics of the effect of the UD laws and increase the confidence of our empirical results. Specifically, we visualize the effect of

the UD laws on innovation following the passage year in the figure and address the potential concern about pre-trends.

We consider a 26-year window, spanning from 10 years before the UD laws become enforced until 15 years after they become enforced. The reason why we consider such a long-horizon is that the effects from institutional shocks such as laws are likely to be long-term. Figure 1 plots the dynamic effect of the UD laws on innovation activities within various dimensions. The dashed lines represent 95% confidence intervals. The coefficients estimated are based on the following regression:

$$Innovation_{it} = \alpha + \sum_{k=-10}^{k=15} \beta^k UD\_Law^k + \gamma X_{it} + \theta_i + \delta_t + \varepsilon_{it}, k \neq 0 \qquad (3)$$

UD_Law^k is an indicator equal to one for the k[th] year relative to the UD law enforcement year. $Innovation_{it}$ denotes the two main variables for explorative innovation, *Ln(Explorative Patent, 80%)* and *Ln(New-class Patent)*. X_{it} contains all firm-level control variables in this study. θ_i are firm fixed effects and δ_t represents operating states by year and industry-by-year fixed effects. The standard error is clustered at the incorporation state-level. Panel A, we observe a significant dynamic effect of the UD laws on the number of explorative patents, which is consistent with the results in Table 6. The dynamic effects of the UD laws on the number of new-class patents are shown in Panel B. We find that the coefficients of the treatment dummy are significantly positive in the years following adoption of the UD laws. In general, for the explorative innovation measures, we find no evidence suggesting that the existence of pre-trends and the dynamic pattern shown in the figure reinforces the evidence in the regressions.

[Figure 1 about here]

V. Conclusion

As a legal right under corporate law, shareholder litigation is thought to help reduce agency costs and to improve corporate governance. However, the external pressure imposed by the threat of shareholder litigation might create distorted managerial incentives such as short-termism, thereby impeding innovation. In this study, we evaluate the effect on corporate innovation from exposure to shareholder litigation. By doing so, we attempt to link shareholder protection rights to the real economy.

To facilitate a causal interpretation, we exploit the staggered passage of the universal demand laws across 23 states from 1989 to 2005. The UD laws have raised the hurdle for shareholders to file derivative lawsuits and have thus significantly reduced the litigation risk *ex ante* for treated firms. Using a difference-in-differences approach, we find that firms incorporated in states with UD laws invest more in innovation, engage in more explorative innovation search, produce more high quality patents measured by citations, and generate larger patent value. The findings are robust for the inclusion of stringent control variables as well as state and industrial time-varying fixed effects. Further analyses show the effect of the UD laws is more pronounced for firms operating in industries with higher return volatility.

The evidence is helpful to understanding how shareholder litigation in some circumstances impedes innovation and adds to the discussion on how shareholder intervention shapes corporate policies. We also provide the first evidence showing how a regulation that controls abusive shareholder litigation is beneficial to a firm in terms of encouraging innovation. Our analysis thus corresponds to the general policy debate on the merits of shareholder lawsuits.

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Table 1. Universal Demand Legislation

This table reports the incorporation states with universal demand (UD) laws and the effective year. The third column presents the number of firm-year observations in the sample and the final column shows the percentage of firm-year observations in the full sample. Source: state statutes/session laws.

Effective year	Incorporation State	# of firm-year	% of firm-year
1989	GA	575	1.00
1989	MI	887	1.55
1990	FL	813	1.42
1991	WI	762	1.33
1992	MT	37	0.06
1992	UT	414	0.72
1992	VA	837	1.46
1993	MS	9	0.02
1993	NH	11	0.02
1995	NC	492	0.86
1996	AZ	129	0.23
1996	NE	20	0.03
1997	CT	385	0.67
1997	ME	80	0.14
1997	PA	1,676	2.92
1997	TX	800	1.40
1997	WY	44	0.08
1998	ID	35	0.06
2001	HI	29	0.05
2003	IA	128	0.22
2004	MA	1,827	3.19
2005	RI	114	0.20
2005	SD	31	0.05
Total		10,135	17.68

Table 2. Summary Statistics

This table presents the summary statistics of the main variables used in this study. The sample includes 4,526 unique firms and 57,310 firm-year observations from 1976 to 2006. All variables are defined in Appendix 2. Continuous variables are winsorized at the 0.5% level.

Variable	N	Mean	SD	P25	Median	P75
UD Law	57,310	0.062	0.241	0	0	0
R&D/Assets	57,310	0.079	0.165	0	0.022	0.086
Patent	57,310	10.764	72.261	0	0	2.138
Explorative Patent, 70%	57,310	1.812	10.422	0	0	0
Explorative Patent, 80%	57,310	1.518	9.49	0	0	0
Explorative Patent, 90%0	57,310	1.416	9.27	0	0	0
New-class Patent	57,310	0.867	3.237	0	0	1
Known-class Patent	57,310	9.897	71.541	0	0	1
Top10% Patent	57,310	0.964	6.55	0	0	0
Patent Value	56,833	0.024	0.057	0	0	0.017
Size	57,310	4.827	2.296	3.26	4.668	6.313
MTB	57,310	2.587	5.959	1.043	1.428	2.342
Leverage	57,310	0.519	1.002	0.267	0.441	0.594
Ln (age)	57,310	2.478	0.638	2.079	2.485	2.996
Capex	57,310	0.063	0.06	0.025	0.047	0.081
G-index	22,956	8.828	2.751	7	9	11
IO	57,310	0.21	0.262	0	0.071	0.39

Table 3. Validity Tests for the Natural Experiment

This table presents the results of validity tests for the natural experiment in this paper. In panel A, the model is a Weibull hazard model where the dependent variable is the log expected time to the enforcement of UD laws. The independent variables are measures of firms' innovation activities aggregated at the incorporation state level. The sample is at the incorporation state-year level and from 1976 to 2006. GDP and GDP per capital are the current GDP and current GDP over the total population in each state, respectively. Data on GDP and population is from Bureau of Economic Analysis, U.S. Department of Commerce. Number of incorporated firms is the total number of public firms incorporated in each state as identified in Compustat. In Panel B, all variables are at incorporation state-year level. Models (1) and (2) test whether the adoption of UD law leads to fewer shareholder derivative lawsuits. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. Ln(Derivative Actions) is the log value of one plus the number of derivative lawsuits. The information on derivative lawsuits is from Audit Analytics covering the period between 2000 and 2013. We control for log value of GDP, GDP per capita and number of firms incorporated in a state. Model (3) and (4) test whether the adoption of UD laws substitutes for the shareholder's class action litigation activities. The dependent variable, Ln(Class Actions), is the log value of one plus the number of class actions. The sample of shareholder class action is collected from Stanford Securities Class Action Clearinghouse and starts from 1996. Models (5) and (6) test the possibility of incorporation shopping following the adoption of UD laws. The dependent variable, Ln(# of incorporated firms), is log number of firms incorporated in a state. The standard errors are clustered at the incorporation state level and shown in parentheses.

Panel A: Timing of Universal Demand Litigation and Pre-Existing Innovation Activities: The Duration Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
R&D/Assets	2.021						
	(1.92)						
Ln(Patent)		0.051					
		(0.17)					
Ln(Explorative Patent, 80%)			0.624				
			(0.42)				
Ln(New-class Patent)				0.173			
				(0.28)			
Ln(Known-class Patent)					0.026		
					(0.19)		
Ln(Top10% Patent)						0.284	
						(0.70)	
Patent Value							1.680
							(6.73)
Ln(GDP)	0.043	0.032	0.023	0.033	0.034	0.028	0.034
	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)
Ln(GDP per capita)	0.396	0.470	0.497	0.473	0.468	0.471	0.474
	(0.31)	(0.30)	(0.31)	(0.30)	(0.30)	(0.30)	(0.30)
Ln(# of incorporated firms)	-0.053	-0.022	-0.031	-0.024	-0.019	-0.025	-0.022
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
N	770	770	770	770	770	770	770

Table 3. Validity Tests for the Natural Experiment (Continued)

Panel B: Universal Demand Litigation, Derivative litigation, Class Action Litigation and Incorporation State Shopping

	(1)	(2)	(3)	(4)	(5)	(6)
	Period: 2000-2013		Period: 1996-2013		Period: 1994-2013	
	Ln(Derivative Actions)		Ln(Class Actions)		Ln(# of incorporated firms)	
UD Law	-0.215***	-0.179**	0.029	0.013	0.001	-0.010
	(0.06)	(0.07)	(0.09)	(0.08)	(0.10)	(0.10)
Ln(GDP)		0.206		-0.069		0.429
		(0.59)		(0.26)		(0.68)
Ln(GDP per capita)		-1.126		0.416		0.194
		(0.98)		(0.38)		(1.22)
Ln(# of incorporated firms)		0.124		-0.035		
		(0.11)		(0.06)		
Incorp. State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	700	700	900	900	1000	1000
Adj. R-sq	0.668	0.673	0.775	0.775	0.982	0.982

Table 4. The Effect of Universal Demand Law on R&D Expenditures

This table presents the effect of UD laws on a firm's R&D expenditures. R&D/Assets is R&D expenditures scaled by total assets. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)
	R&D/Assets		
UD Law	0.010***	0.010***	0.012***
	(0.00)	(0.00)	(0.00)
Size		-0.013***	-0.015***
		(0.00)	(0.00)
MTB		0.000	0.000
		(0.00)	(0.00)
Leverage		-0.003	-0.003
		(0.00)	(0.00)
Ln(age)		0.008***	0.008***
		(0.00)	(0.00)
Capex		0.052***	0.053***
		(0.01)	(0.01)
Firm FE	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes
Industry-Year FE	No	No	Yes
Observations	57310	57310	57310
Adj. R-sq.	0.669	0.672	0.666

Table 5. The Impact of UD Law on Patent Count

This table presents the effect of UD laws on the number of patents filed in a fiscal year. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. Ln(Patent) is the natural logarithm of one plus the number of eventually granted patents filed by the firm in a fiscal year. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)
		Ln(Patent)	
UD Law	0.006	-0.005	0.003
	(0.03)	(0.03)	(0.03)
Size		0.184***	0.186***
		(0.01)	(0.01)
MTB		0.008***	0.008***
		(0.00)	(0.00)
Leverage		-0.004	-0.000
		(0.01)	(0.00)
Ln(age)		0.110***	0.093***
		(0.02)	(0.02)
Capex		0.107***	0.141***
		(0.03)	(0.03)
Firm FE	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes
Industry-Year FE	No	No	Yes
Observations	57310	57310	57310
Adj. R-sq.	0.763	0.772	0.774

Table 6. The Effect of UD Law on Explorative Patent

This table presents the effect of UD laws on explorative patent production. Ln(Explorative Patent, 70%/80%/90%) is the natural logarithm of one plus the number of explorative patents filed in a fiscal year. A patent is defined as explorative if at least 70%/80%/90% of the citations it refers do not come from existing knowledge, which includes all the patents that the firm produced and all the patents that were cited by the firm's patents filed over the past five years. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln(Explorative Patent, 70%)			Ln(Explorative Patent, 80%)			Ln(Explorative Patent, 90%)		
UD Law	0.088***	0.087***	0.071***	0.116***	0.117***	0.097***	0.136***	0.138***	0.117***
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
Size		0.058***	0.061***		0.048***	0.050***		0.043***	0.045***
		(0.01)	(0.01)		(0.01)	(0.01)		(0.01)	(0.01)
MTB		0.002***	0.002***		0.002***	0.002***		0.002***	0.002***
		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)
Leverage		-0.002	-0.000		-0.002	-0.000		-0.003*	-0.001
		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)
Ln(age)		0.149***	0.147***		0.171***	0.172***		0.189***	0.191***
		(0.02)	(0.02)		(0.02)	(0.02)		(0.02)	(0.02)
Capex		0.118***	0.159***		0.154***	0.202***		0.152***	0.202***
		(0.03)	(0.03)		(0.04)	(0.04)		(0.04)	(0.04)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	Yes	No	No	Yes	No	No	Yes
Observations	57310	57310	57310	57310	57310	57310	57310	57310	57310
Adj. R-sq.	0.717	0.721	0.726	0.703	0.707	0.714	0.695	0.700	0.709

Table 7. The Impact of UD Law on New-class Patent and Known-class Patent

This table presents the effect of UD laws on new-class patents and known-class patents. Ln(New-class Patent) is the natural logarithm of one plus the number of patents filed in technology classes previously unknown to the firm in a fiscal year. Ln(Known-class Patent) is natural logarithm of one plus the number of patents filed in a technology class previously known to the firm in a fiscal year. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(New-class Patent)			Ln(Known-class Patent)		
UD Law	0.074***	0.069***	0.066***	-0.011	-0.020	-0.015
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Size		0.066***	0.066***		0.171***	0.175***
		(0.00)	(0.00)		(0.01)	(0.01)
MTB		0.003***	0.003***		0.007***	0.007***
		(0.00)	(0.00)		(0.00)	(0.00)
Leverage		-0.005***	-0.004**		0.001	0.005
		(0.00)	(0.00)		(0.00)	(0.00)
Ln(age)		0.048***	0.051**		0.160***	0.136***
		(0.02)	(0.02)		(0.02)	(0.02)
Capex		0.178***	0.185***		0.074**	0.111***
		(0.04)	(0.04)		(0.03)	(0.04)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	Yes	No	No	Yes
Observations	57310	57310	57310	57310	57310	57310
Adj. R-sq.	0.382	0.387	0.386	0.781	0.789	0.792

Table 8. The Impact of UD Law on High Impact Patent

This table presents the effect of UD laws on the number of high impact patents filed in a fiscal year. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. Ln(Top10% Patent) is the natural logarithm of one plus a firm's total number of patents that are in the top 10% category of the distribution of citations in a given 3-digit class and application year. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)
	Ln(Top 10% Patent)		
UD Law	0.037**	0.034**	0.032**
	(0.01)	(0.01)	(0.01)
Size		0.056***	0.056***
		(0.00)	(0.00)
MTB		0.003***	0.003***
		(0.00)	(0.00)
Leverage		0.001	0.002
		(0.00)	(0.00)
Ln(age)		0.060***	0.057***
		(0.01)	(0.01)
Capex		0.056***	0.048***
		(0.02)	(0.02)
Firm FE	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes
Industry-Year FE	No	No	Yes
Observations	57310	57310	57310
Adj. R-sq.	0.685	0.689	0.689

Table 9. The Impact of UD Law on Patent Value

This table presents the effect of UD laws on patent value. Patent Value is the total value of patents based on market reactions scaled by market value of equity in a fiscal year. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. All other variables are defined in Appendix 2. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)
	Patent Value		
UD Law	0.009***	0.009***	0.008***
	(0.00)	(0.00)	(0.00)
Size		0.002***	0.001***
		(0.00)	(0.00)
MTB		-0.000***	-0.000***
		(0.00)	(0.00)
Leverage		0.001***	0.001***
		(0.00)	(0.00)
Ln(age)		0.008***	0.009***
		(0.00)	(0.00)
Capex		0.014***	0.017***
		(0.00)	(0.00)
Firm FE	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes
Industry-Year FE	No	No	Yes
Observations	56833	56833	56833
Adj. R-sq.	0.579	0.580	0.583

Table 10. Heterogeneous Effects of UD Law

This table presents the heterogeneous effects of UD laws according to industry volatility. Industry Volatility is the industry average of standard deviation of firm's stock returns in a year. Industry is based on a two-digit standard industry classification code. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. We split sample into two groups according to the median of industry volatility. All other variables are defined in Appendix 2. Firm and operating state by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Heterogeneous Effect According to Industry Volatility									
	R&D/Assets		Ln(Explorative Patent)		Ln(New-class Patent)		Ln(Top 10% Patent)		Patent Value	
	High	Low	High	Low	High	Low	High	Low	High	Low
UD Law	0.022***	0.001	0.177***	0.058**	0.150***	0.011	0.097***	-0.013	0.012***	0.006***
	(0.01)	0.00	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)	0.00	0.00
p-value: β(High)- β(Low)	0.00		0.00		0.00		0.00		0.00	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28692	28615	28692	28615	28692	28615	28692	28615	28465	28365
Adj. R-sq.	0.623	0.711	0.743	0.679	0.367	0.414	0.708	0.667	0.559	0.61

Table 11. Robustness Checks

This table presents robustness checks on the main results using alternative samples. Panel A presents the results estimated using the sample, excluding the Internet bubble period (2000-2001). The results estimated using the sample excluding IPO firms are reported in Panel B. IPO firms are identified as being in their first three years appearing in Compustat. In Panel C, we deal with the concerns regarding missing values in R&D expenditures. In Column 1, the dependent variable is R&D expenditure scaled by total assets. Here the missing values in R&D are dropped. The dependent variable in Column 2 is a dummy set to one if R&D is not missing in a fiscal year, and zero otherwise. Column 3 reports results using R&D reconstructed through estimates based on other firm characteristics or firm patents. For each industry, we regress R&D/Assets (missing values treated as zero) on firm characteristics (firm size, MTB and leverage) and patent count and retrieve the predicted R&D/Assets to replace the missing values in the original data. Results reported in Panel D considers two corporate governance measures, G-index and institutional ownership (IO). Panel E presents the results controlling for takeover laws. We include the firm-level takeover index from Cain *et al.* (2017). Panel F reports the results that consider additional board characteristics, such as Percentage of independent directors, Average Age of Board Directors, and Board Size (the number of board members). The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Panel A. Alternative samples excluding internet bubble period (2000-2001)

	(1)	(2)	(3)	(4)	(5)	(6)
	Excluding Internet Bubble Period (2000-2001)					
	R&D/Assets	Ln(Patent)	Ln(Explorative Patent, 80%)	Ln(New-class Patent)	Ln(Top 10% Patent)	Patent Value
UD Law	0.009***	-0.009	0.113***	0.066***	0.038**	0.008***
	(0.00)	(0.03)	(0.03)	(0.02)	(0.01)	(0.00)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52632	52632	52632	52632	52632	52179
Adj. R-sq.	0.682	0.772	0.712	0.395	0.690	0.589

Panel B. Alternative samples excluding IPO firms

	(1)	(2)	(3)	(4)	(5)	(6)
	Excluding IPO firms					
	R&D/Assets	Ln(Patent)	Ln(Explorative Patent, 80%)	Ln(New-class Patent)	Ln(Top 10% Patent)	Patent Value
UD Law	0.010***	-0.011	0.122***	0.064***	0.035**	0.009***
	(0.00)	(0.03)	(0.03)	(0.02)	(0.02)	(0.00)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55183	55183	55183	55183	55183	54719
Adj. R-sq.	0.686	0.777	0.710	0.393	0.695	0.588

Table 11. Robustness Checks (Continued)

Panel C. Dealing with missing R&D expenditures

	(1) R&D/Assets without Filling Zero	(2) Dummy (Disclosing R&D)	(3) R&D/Assets predicted using patent count, firm size, MTB and leverage in an industry
UD Law	0.017**	0.013	0.010***
	(0.01)	(0.01)	(0.00)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes
Observations	40605	57310	57310
Adj. R-sq.	0.655	0.818	0.672

Panel D. Controlling for governance measures

	(1)	(2)	(3)	(4)	(5)	(6)
	Control for Governance Measures					
	R&D/Assets	Ln(Patent)	Ln(Explorative Patent, 80%)	Ln(New-class Patent)	Ln(Top 10% Patent)	Patent Value
UD Law	0.005***	-0.015	0.158***	0.079**	0.050**	0.012***
	(0.00)	(0.04)	(0.04)	(0.03)	(0.02)	(0.00)
G-index	0.000	0.039*	0.038***	0.026***	0.031***	0.003***
	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)
IO	0.001	0.049	0.031	0.106***	0.008	0.011***
	(0.00)	(0.07)	(0.04)	(0.03)	(0.02)	(0.00)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22956	22956	22956	22956	22956	22903
Adj. R-sq.	0.702	0.794	0.705	0.393	0.708	0.611

11. Robustness Checks (Continued)

Panel E. Controlling for takeover laws

	(1) R&D/Assets	(2) Ln(Patent)	(3) Ln(Explorative Patent, 80%)	(4) Ln(New-class Patent)	(5) Ln(Top 10% Patent)	(6) Patent Value
UD Law	0.013***	-0.006	0.122***	0.079***	0.032**	0.009***
	(0.00)	(0.03)	(0.03)	(0.02)	(0.02)	(0.00)
Takeover Index	-0.000	0.068	0.323**	0.223**	0.093	0.019*
	(0.01)	(0.14)	(0.15)	(0.10)	(0.08)	(0.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52427	52427	52427	52427	52427	52093
Adj. R-sq.	0.674	0.772	0.711	0.387	0.692	0.578

Panel F. Controlling for additional board characteristics

	(1) R&D/Assets	(2) Ln(Patent)	(3) Ln(Explorative Patent, 80%)	(4) Ln(New-class Patent)	(5) Ln(Top 10% Patent)	(6) Patent Value
UD Law	0.005***	-0.026	0.213***	0.117***	0.060*	0.014***
	(0.00)	(0.04)	(0.04)	(0.03)	(0.03)	(0.00)
Percentage of independent directors	0.004	-0.155	-0.270***	-0.122*	-0.106*	-0.003
	(0.01)	(0.20)	(0.07)	(0.07)	(0.06)	(0.01)
Average Age of Board Directors	-0.000	-0.002	-0.003	-0.011***	-0.003	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Board Size	-0.000	0.013	0.010**	0.009*	0.006	0.000
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	23601	23601	23601	23601	23601	23542
Adj. R-sq	0.713	0.800	0.732	0.424	0.715	0.625

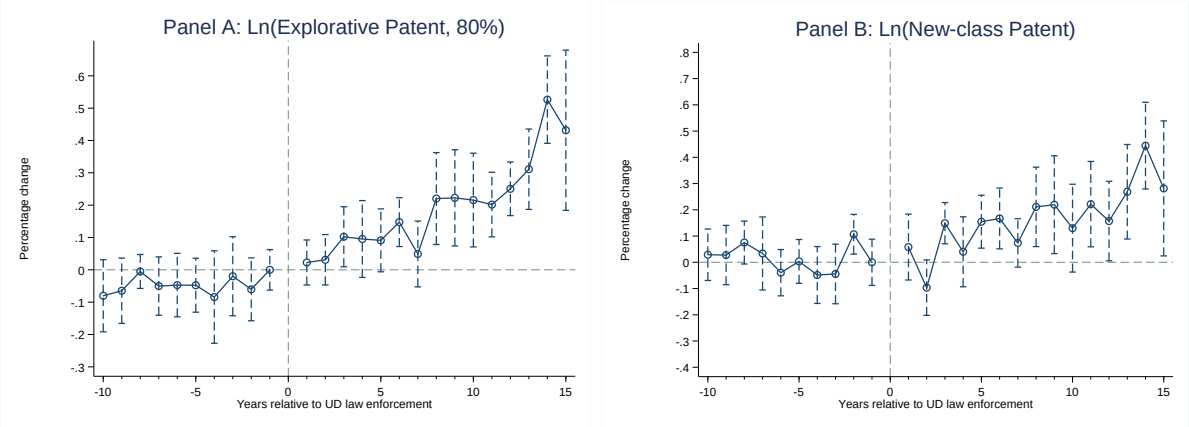

Figure 1. Dynamic Effects of UD Law

The figure plots the impact of the UD laws on explorative innovation activities. We consider a 26-year window, spanning from 10 years before the UD law enforcement year until 15 years after the enforcement year. The dashed lines represent 95% confidence intervals, adjusted for incorporation state-level clustering. The coefficients estimated are based on the following regression:

$$Innovation_{it} = \alpha + \sum_{k=-10}^{k=15} \beta^k UD\_Law^k + \gamma X_{it} + \theta_i + \delta_t + \varepsilon_{it}, k \neq 0$$

UD_Law^k an indicator that equals one for the k[th] year relative to the UD law enforcement year. $Innovation_{it}$ denotes two measures of explorative innovation considered in this study. X_{it} contains all firm-level control variables. θ_i denotes firm fixed effects and δ_t denotes operating state by year and industry by year fixed effects.

Appendix 1. An Example of Shareholder Derivative Lawsuits

Defendants

Elon Musk, Brad W. Buss, Ira Ehrenpreis, Antonio J. Gracias, Steve Jurvetson, Harald Kroeger, Kimbal Musk, and Tesla Motors, Inc.

Plaintiffs

Ross Weintraub, Derivatively on Behalf of Nominal Defendant Tesla

Lawsuit Filing Date

06/18/2014

Summary of the Action

This shareholder's derivative action brought on behalf of nominal defendant Tesla Motors, Inc. ("Tesla" or the "Company"), by one of its shareholders against certain of the Company's officers and members of its Board of Directors (the "Board"), alleging that these officers and directors (collectively, the "Individual Defendants" as defined herein) breached their fiduciary duties by failing to ensure that the Company had adequate internal controls and oversight mechanisms and willfully and/or recklessly causing or allowing the Company to issue false and misleading statements or failing to disclose material adverse facts about Tesla's business, operations and future prospects.

… investors were shocked when a Model S was completely destroyed on October 2, 2013, due to an undercarriage puncture and high-intensity battery pack fire caused by a collision with road debris in the state of Washington. While Tesla initially denied that the car's battery pack had ignited the fire, it later reversed course and admitted that the battery pack was indeed the source of the blaze after being punctured by road debris encountered during normal driving conditions. On the negative news, Tesla stock declined $12.05 per share or more than 6%, to close at $180.95 per share on October 2, 2013, only to drop another $7.64 per share (or 4.2%) to close at $173.31 per share on October 3, 2013, amid derisive press coverage of the fire and on high volume both days.

In seeking to reassure investors, the Individual Defendants caused the Company to downplay this incident. Indeed, defendant E. Musk gave several interviews during which he downplayed this Model S fire and worse, failed to disclose that another Model S had been consumed by fire in Mexico on October 18, 2013. It has even been alleged in the related federal securities class action lawsuit3 that individuals at Tesla were immediately aware of the fire and sent a team to inspect the vehicle before defendant E. Musk made his foregoing representations to the public. According to allegations in the Federal Securities Action, defendant E. Musk, with knowledge of the fire and inspection, unilaterally determined that the fire was not relevant to investors due to the circumstances under which it arose. However, when the public finally learned of the incident on October 28, 2013, Tesla's shares again plummeted, dropping $7.32 (4.3%) on heavy volume to close at $162.86.

On November 7, 2013, yet another Model S was destroyed by a high-intensity battery fire after road debris punctured its undercarriage under normal driving conditions, this time in Tennessee. Once again, Tesla's stock price fell, closing at $139.77, down $4.42 (3.06%) from its opening price of $144.19, on heavy volume…

Futility of Demand

Plaintiff incorporates by reference and realleges each and every allegation stated above as if fully set forth herein. Presently, the Board consists of the following six individuals: E. Musk, Buss, Ehrenpreis, Gracias, Jurvetson, and K. Musk. Plaintiff did not make a demand on the Board to bring this action because such demand would be futile given the facts as alleged herein and, therefore, such a demand is excused.

As specified herein, demand is excused because this Verified Shareholder Derivative Complaint alleges with particularity that at least half of the members of the current Board breached their fiduciary duties of care, loyalty, reasonable inquiry, oversight, good faith and supervision. Indeed, during the relevant period the Individual Defendants caused or allowed the Company to fail to maintain proper internal controls and oversight mechanisms and to issue false and misleading statements regarding the safety of its only vehicle for sale – the Model S. The Individual Defendants' misconduct has severely damaged the Company. Lawsuits alleging violation of the federal securities laws have been filed against the Company. Further, and more importantly, Tesla's reputation and goodwill have been tainted by the misconduct described herein.

Appendix 2. Variable Definition

Variable	Definition
UD Law	An indicator variable is equal to one if a firm is incorporated in a state that has a UD law in the given year. The first effective year is coded as zero; Source: State statutes/session laws.
R&D/Assets	R&D expenditures (Compustat varaible xrd) scaled by total assets (Compustat variable at); Source: Compustat
Ln(Patent)	Natural logarithm of one plus firm's total number of eventually granted patents filed in a given year; Source: NBER
Ln(Explorative Patent, 70%/80%/90%)	Natural logarithm of one plus firm's total number of explorative patents filed in a given year. A patent is defined as an explorative patent if at least 70%/80%/90% of the citations it refers are not from existing knowledge, which includes all the patents that the firm produced and all the patents that were cited by the firm's patents filed over the past five years; Source: NBER
Ln(Exploitive Patent, 80%)	Natural logarithm of one plus firm's total number of explorative patents filed in a given year. A patent is defined as an explorative patent if at least 80% of the citations it refers are from existing knowledge, which includes all the patents that the firm produced and all the patents that were cited by the firm's patents filed over the past five years; Source: NBER
Ln(New-class Patent)	Natural logarithm of one plus number of patents filed in technology classes previously unknown to the firm in a given year; Source: NBER
Ln(Known-class Patent)	Natural logarithm of one plus number of patents filed in a technology classes previously known to the firm in a given year; Source: NBER
Ln(Top10% Patent)	Natural logarithm of one plus a firm's total number of patents that are in the top 10% category of the distribution of citations in a given 3-digit class and application year; Source: NBER
Patent Value	Total patent value over market value of equity. Patent value is measured using market reactions to the announcement of patent grants following Kogan *et al.* (2016); Source: NBER
Size	Natural logarithm of total assets (Compustat variable at); Source: Compustat
MTB	Market value of assets (Compustat variable csho*prcc_f+lt) over book value of assets (Compustat variable at); Source: Compustat
Leverage	The ratio of long-term liability (Compustat variable lt) net of deferred taxes (Compustat variable txdb) scaled by total assets (Compustat variable at); Source: Compustat
Ln(Age)	Natural logarithm of the number of years since the founding date; Source: Compustat

Capex	Capital expenditures (Compustat variable capx) scaled by total assets (Compustat variable at); Source: Compustat
G-index	Index 24 governance provisions. G-index is back-filled to 1981; Source: Riskmetrics
IO	The average percentage of shares owned by institutional investors of a firm in a given year; Source: Thompson Reuters Institutional Holding (13F) Database
Industry Volatility	Industry-level average of standard deviation of firm's stock returns in a given year. Industry is based on two-digit standard industry classification code; Source: Compustat
Takeover Index	The takeover index from Cain *et al.* (2017). The firm-level index based on 17 takeover laws measures takeover susceptibility.

Appendix 3. Correlation Matrix

This table presents the Pearson correlation matrix of the main variables in this study. * denotes significance at the 5% level.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	R&D/Assets	1								
(2)	Ln(Patent)	0.0066	1							
(3)	Ln(Top10% Patent)	-0.0001	0.8011*	1						
(4)	Ln(Explorative Patent, 70%)	-0.0630*	0.8111*	0.7232*	1					
(5)	Ln(Explorative Patent, 80%)	-0.0613*	0.7720*	0.7021*	0.9758*	1				
(6)	Ln(Explorative Patent, 90%)	-0.0571*	0.7484*	0.6888*	0.9578*	0.9860*	1			
(7)	Patent Value	0.0542*	0.7662*	0.7030*	0.6950*	0.6819*	0.6760*	1		
(8)	Ln(New-class Patent)	-0.0072	0.7422*	0.5692*	0.6705*	0.6475*	0.6328*	0.6139*	1	
(9)	Ln(Known-class Patent)	0.0012	0.9575*	0.8121*	0.7877*	0.7517*	0.7302*	0.7512*	0.5661*	1

Appendix 4. Validity Tests Using Growth of Innovation Variables

This table presents the additional results of validity tests for the natural experiment in this paper. The model is a Weibull hazard model where the dependent variable is the log expected time to the enforcement of UD laws. The independent variables are growth measures of firms' innovation activities aggregated at the incorporation state level. The sample is at the incorporation state-year level and from 1976 to 2006. GDP and GDP per capital are the current GDP and current GDP over the total population in each state, respectively. Data on GDP and population is from Bureau of Economic Analysis, U.S. Department of Commerce. Number of incorporated firms is the total number of public firms incorporated in each state as identified in Compustat.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Growth in R&D/Assets	0.035						
	(0.08)						
Growth in Ln(Patent)		0.086					
		(0.17)					
Growth in Ln(Top10% Patent)			-0.465				
			(0.32)				
Growth in Ln(Explorative Patent, 80%)				-0.266			
				(0.25)			
Growth in Ln(New-class Patent)					0.281		
					(0.18)		
Growth in Ln(Known-class Patent)						-0.430	
						(0.28)	
Growth in Patent Value							0.080
							(0.10)
Ln(GDP)	-0.028	0.062	0.059	0.060	0.061	0.054	-0.038
	(0.11)	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.11)
Ln(GDP per capita)	0.481	0.253	0.236	0.234	0.273	0.250	0.778**
	(0.46)	(0.58)	(0.56)	(0.57)	(0.59)	(0.53)	(0.36)
Ln(# of incorporated firms)	0.039	0.042	0.037	0.042	0.035	0.033	0.054
	(0.09)	(0.10)	(0.09)	(0.10)	(0.10)	(0.09)	(0.11)
N	583	650	650	650	650	650	521

Appendix 5. The Effect of UD Law on Other Firm Responses

This table presents the effect of UD laws on other firm-level responses. Ln(Exploitive Patent, 80%) is the natural logarithm of one plus the number of exploitive patents filed in a fiscal year. A patent is defined as exploitive if at least 80% of the citations it refers come from existing knowledge, which includes all the patents that the firm produced and all the patents that were cited by the firm's patents filed over the past five years. Log(self-cites) is the log of number of average self-citations. Return Volatility is the standard deviation of stock returns in a given year. Return Skewness is the skewness of stock returns in a given year. Ln(M&A deals) is the log of the number of acquisitions. Ln(M&A deals with innovative target) is the log of the number of acquisitions with innovative targets. A target is defined as innovative if it filed at least one patent before the acquisition. M&A deal information is from SDC database from 1979 to 2006. UD Law is an indicator equal to one for firms incorporated in a state in the years after the UD law is adopted. Firm, operating state by year or industry by year fixed effects are included. The standard errors are clustered at the incorporation state level and shown in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Exploitive Patent, 80%)	Log(self-cites)	Return Volatility	Return Skewness	Ln(M&A deals)	Ln(M&A deals with innovative target)
UD Law	-0.026	-0.025*	0.001	0.089*	-0.007	-0.002*
	(0.02)	(0.01)	(0.00)	(0.05)	(0.00)	(0.00)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Op. State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57310	57310	48208	48198	52773	52773
Adj. R-sq.	0.742	0.482	0.616	0.142	0.088	0.035