INTELLECTUAL PROPERTY RIGHTS PROTECTION AND THE VALUE OF CORPORATE CASH EVIDENCE FROM ANTI-TROLL LAWS

YAN SIYUAN

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Intellectual Property Rights Protection and the Value of Corporate Cash

Evidence from Anti-Troll Laws

Yan Siyuan

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CERTIFICATE OF ORIGINALITY

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YAN Siyuan_____(Name of Student)

ABSTRACT

The growing problem of "patent trolling" by non-practicing entities (NPEs) has recently received substantial attention and led to ongoing debates in academia. I examine whether and how anti-troll laws preventing frivolous patent infringement claims from NPEs affect shareholder valuation of corporate cash assets in high-tech industries. My difference-in-differences identification strategy exploits the staggered adoption of anti-troll laws in 34 states as a quasi-natural experiment. I find that the marginal value of cash increases by $0.35 for high-tech firms after the passage of anti-troll laws. I perform multiple identification and robustness tests to ensure the validity of this baseline finding. Moreover, I document considerable heterogeneity of the main finding in the variation of multiple firm characteristics. Cross-sectional tests further reveal that this valuation effect varies depending on firms' growth opportunities, cash needs, access to external financing, and financial condition. Furthermore, anti-troll laws also have real effects in shaping the corporate liquidity policy and encouraging companies to reserve cash resources for precautionary motives. Finally, I find that anti-troll laws are effective in promoting corporate innovation outputs. Specifically, I show that anti-troll laws lead to a higher level of R&D expenses, more number of corporate patent applications, better quality of patents (as measured by patent citations), and a higher market value of patents. Overall, this study highlights that anti-troll laws better protect corporate intellectual property rights, enabling high-tech firms to better exploit cash resources to fund value-increasing R&D investments for upcoming innovation competition. Consequently, shareholders revise their valuation of corporate cash according to their updated assessment of corporate internal financial flexibility.

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From January to May in 2020, I spent the most unforgettable time in my hometown, Wuhan. I am glad that I survived the pandemic so that I can finish my thesis. I wish no such disaster like Covid-19 would ever happen again in any place on the earth.

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1. Introduction

Intellectual capital, which is valued as intangible assets arising from human creative activities, is a significant driving force for innovativeness, productivity, and expansion of the economy (Schumpeter, 1934). In today's knowledge-based economy, intellectual properties (IPs) such as technology licensing programs, trademarks, industrial design, and patent portfolios are more decisive in determining a company's market value than tangible assets based on traditional production factors. Accordingly, society is increasingly recognizing the economic importance of intellectual property rights (IPRs). In addition to their established roles in rewarding inventiveness and deterring counterfeiting, IPRs also enable firms to commercialize their IPs to improve strategic competitiveness and reap returns for stakeholders. A recent study by the European Patent Office and the European Union Intellectual Property Office provides firm-level empirical evidence that, on average, firms that hold at least one IPR generate 20% higher revenues per employee than companies that do not own any intellectual capital.[1]

While the importance of IPRs cannot be overstated, firms are still challenged by various IPR threats that hinder their research and development (R&D) process and undermine the distribution of new and authentic goods and services. Among other growing problems, "patent trolls" have received substantial attention from governments and researchers. Patent trolls are non-practicing entities (NPEs), a new organizational form that is composed of a series of dormant or shell companies with a non-transparent ownership structure. They acquire and accumulate patents from various external sources and exploit

[1] "Intellectual Property Rights and Firm Performance in the European Union, Firm-level Analysis Report" joint EPO/EUIPO study, February 2021. https://www.epo.org/news-events/news/2021/20210208.html

their ownership solely for aggressive patent infringement claims rather than for actual production or invention (Cohen et al., 2016).

The typical profit model based on patent trolling begins with NPEs sending "demand letters" to thousands of companies, asserting their copyrights on certain patents and placing their claims for licensing fees. Targeted firms must accept and pay for the licensing agreement offered by NPEs; otherwise, they may face accusations of patent violations in lawsuits. Since 2005, NPEs have been a major contributor to the nearly 10-fold rise in patent-related litigation (Cohen et al., 2019). At the aggregate level, estimated loss in wealth from NPE lawsuits exceeds half a trillion dollars for listed firms from 1990 to 2010 (Bessen et al., 2011). Moreover, in addition to monetary losses, NPEs' assertions result in non-economic consequences such as disruptions in recruiting, reaching targets, and maintaining business cycles (Chien, 2013). Furthermore, recent studies provide striking empirical evidence showing that patent trolling by NPEs hampers firms' innovation activities (Cohen et al., 2019) and leads to negative spillover effects to industry peers (Chen et al., 2019).

To enhance congressional intervention on the patent troll problem, state legislatures have passed a series of laws limiting NPEs' ability to threaten local firms with frivolous patent litigation. So far, 34 states in the United States have enacted anti-troll legislation to protect local firms' IPRs, starting with Vermont Act 44 in 2013. However, debates about NPEs and anti-troll laws remain ongoing. Proponents of patent trolls view NPEs as important IP investors with significant intermediary functions in the IP market. They contend that the NPEs' pattern of patent licensing and enforcement decreases the economic barrier to entry into the global IP marketplace and provides the opportunity for small or

even individual patent owners to monetize their IPRs. Some practical cases reflect these disagreements on NPEs. Although anti-troll laws spread across the United States steadily and quickly, passage of an analogous bill failed in California, which is commonly viewed as the largest and most innovative state. This failure occurred even with key senators, as well as the Silicon Valley Leadership Group including Google and Facebook, supporting the bill. Similarly, Congress did not pass any related bills, leaving a void in anti-troll legislation at the federal level.

These debates motivate this paper's evaluation of the real impacts of anti-troll laws on corporate operation and market valuation. The extant IPR literature extensively investigates the economic consequences of IPR protection and its effects on innovativeness from the perspective of global IPR regimes and reforms (Sakakibara and Branstetter, 2001; Lerner, 2002; Moser, 2005; Branstetter et al., 2006; Qian, 2007; Bilir, 2014; Galasso and Schankerman, 2015; Fang et al., 2017; Huang et al., 2017). However, viewed from the angle of innovation inputs, very little is known about the valuation effect of IPR protection on other corporate assets, which are essential for financing firms' innovation investments and sustaining continuous R&D spending.

To this end, this study attempts to join the extant literature by examining an unexplored channel through which IPR protection can influence corporate innovation and firm value: corporate cash holdings. The paper focuses on the value of corporate cash holdings because cash resources are of paramount importance in financing innovation activities. First, the "funding gap phenomenon" (Hall and Lerner 2010) indicates that internal resources are especially vital for R&D-intensive and innovative firms owing to external financing being costly. Therefore, cash reserves provide firms with sufficient

internal financial flexibility to support long-term investments in innovative projects. Second, in addition to the growing attention on IPR protection in R&D-intensive industries, another notable phenomenon that has long intrigued researchers is that firms in those industries typically hold a substantial level of cash (e.g., Bates et al., 2009; Riddick and Whited, 2009; He and Wintoki, 2016; Li and Lin, 2019). For instance, the three biggest companies in the United States (i.e., Microsoft, Alphabet, and Apple) accumulated more than US$350 billion of cash by the end of 2019.[2] Interestingly, the marginal value of cash holdings by U.S. manufacturing firms has also massively increased over the last decades (Bates et al., 2018; Chung, Jung, and Park, 2020). Such evidence is surprising because it does not fit the classical view of the agency theory on free cash flows (Jensen, 1986). Since only limited evidence on the variation of the marginal value of cash and its determinants provided by the existing literature (Bates et al., 2018), this paper also seeks to examine whether IPR protection contributes to such secular increase.

My hypotheses are embedded in the framework of trade-off theory in corporate cash studies (e.g., Kim et al., 1998; Opler et al., 1999; Riddick and Whited, 2009), which contend that the optimal cash policy for the firm depends on both their access to external finance and their precautionary motives for future investment opportunities. Specifically, I argue that enhanced IPR protection associated with anti-troll laws leads to a better innovation environment and fewer litigation risks for firms, encouraging companies to allocate cash more towards continuous R&D spending to gain strategic advantages in upcoming innovation competition. In light of this assumption, the value of cash should be

[2] "Here are the 10 companies with the most cash on hand" Pippa Stevens, CNBC, 2019. https://www.cnbc.com/2019/11/07/microsoft-apple-and-alphabet-are-sitting-on-more-than-100-billion-in-cash.html

higher because internal slack allows firms to fund existing R&D projects efficiently, facilitate R&D smoothing for potential adjustment costs, and exploit external technology spillover and knowledge transfer. As a result, shareholders evaluate cash assets as important corporate resources that enhance internal financial flexibility and positively contribute to the firm value.

I perform a battery of empirical analyses to investigate whether and how anti-troll laws affect investors' valuation of cash assets for firms in high-tech industries. To conduct analyses, I exploit the staggered adoption of anti-troll laws in 34 states as a quasi-natural experiment, following Appel et al. (2019). The difference-in-differences (DID) identification strategy can enable making causal inferences from comparing the value of cash for firms in states with anti-troll laws with that for firms located in states without such laws. Consistent with the prediction, I document a substantial increase in the value of cash for firms located in states with anti-troll laws. The baseline result suggests that the marginal value of cash increases by $0.35 after anti-troll laws pass. This increase accounts for about a 24% rise in the value of cash compared with firms in states without anti-troll laws.

Although the staggered adoption of anti-troll laws is a relatively clean empirical setting, I confirm the validity of DID models by implementing three additional identification/ falsification tests. First, showing that the difference in the value of cash is not statistically significant for two groups in years before anti-troll laws are adopted, I ensure that the treatment and control groups satisfy the parallel trend assumption. Next, I perform a placebo test where I falsely change the timing of the passage of the anti-troll laws. Lastly, I find the baseline result hold in a propensity score matched sample, alleviating concerns of biased estimation due to confounding and unobservable variables. I also conduct several robustness tests by using

alternative samples and different industry definitions and I find quantitatively consistent results with equivalent statistical significance to the baseline finding.

Moreover, I document considerable heterogeneity of the main result in the variation of multiple firm characteristics. A series of cross-sectional analyses further reveal different mechanisms through which anti-troll laws influence the marginal value of cash. Consistent with the argument that IPR protection enables firms to rely on having more cash to sustain innovation investments and exploit technology spillover and knowledge transfer, I find that the relation between anti-troll laws and the value of cash is stronger for R&D-intensive firms. In addition, the effect of anti-troll laws on the value of cash is more pronounced for firms with higher growth opportunities, indicating that cash is more valuable because it allows firms to undertake valuable projects that they might otherwise bypass due to limited financing options. Young and small firms are more likely to become targets for NPEs and to suffer from costly external financing. I find that the positive relationship between anti-troll laws and the value of cash is more pronounced for smaller and younger companies. These results suggest that the market value of internal cash reserves is higher for firms with costly external financing and for firms that are more likely to be financially constrained. Directly, I also find that this positive relation is stronger for firms with a higher probability of having financial constraints and being financially distressed. These cross-sectional results suggest that the valuation effects of IPR protection on corporate cash assets depend on firms' cash needs, corporate access to external financing, and whether firms have value-increasing investment opportunities. In addressing the real effects of anti-troll laws, I find that firms accumulate more cash after their IPRs receive protection through reduced patent litigation by NPEs. This result further provides evidence that managers of firms

dynamically alter their liquidation policy according to the evolution of the IPR institutional environment and with the investors' valuation of corporate cash assets. Lastly, I investigate how anti-troll laws influence corporate innovation outputs. The prior literature shows that anti-troll laws increase startups' innovative activities (Appel et al., 2019). I further show that anti-troll laws are also effective to promote innovation outputs for listed corporations. Specifically, I find anti-troll laws lead to a higher number of patent applications, the better quality of patents (as measured by patent citations), and a higher market value of patents.

This paper makes several contributions to the existing literature. First, to the best of my knowledge, it presents the first study to show that IPR protection can affect shareholder valuation of corporate cash holding. Exploiting the staggered adoption of anti-troll laws, this study provides causal inferences that well-protected IPRs enhance investors' evaluation of cash resources when IPR legislation creates a better environment for firms to innovate with effective financing from corporate own internal cash assets. Such results provide evidence that IPR protection laws not only directly reinforce corporate IP but also have a valuation effect on other corporate assets (i.e., the cash resource shown in this study). In this regard, this paper documents an unexplored channel through which IPR protection can influence the market value of the firm. Second, the paper complements studies on the value of cash. Bates et al. (2018) suggest that the extant literature offers only limited evidence on the variation of the marginal value of cash and its determinants. Although several studies document the secular increase in the value of cash in the United States (e.g., Chung et al, 2020), none of them attributes such increase to enhanced IPR protection. Therefore, this paper provides empirical evidence that IPR protection is a significant driving factor for the marginal value of cash, especially for high-tech firms. Third, this

study also adds to the growing studies on the issue of patent trolling. The results in this paper indicate that NPEs' bad-faith patent infringement claims impede corporate internal flexibility and market valuation of a firm's liquid assets.

More broadly, the findings in this study contribute to the literature on corporate litigation risks. This paper is related to but distinct from previous studies investigating the effect of shareholder litigation on corporate cash policy in several aspects. First, shareholder litigation, commonly consisting of securities class action lawsuits and derivative lawsuits, is brought by a subgroup of shareholders of firms against corporate managers for governance reasons. Besides, any settlement in shareholder litigation is transferred within the firm and its stakeholders. In this respect, shareholder litigation only represents internal agent-principle conflicts without any involvement of outside parties. By contrast, NPEs-related litigation results in out-of-pocket expenses and imposes potential wealth losses on the firm and its shareholders simultaneously. Therefore, patent trolls lead to innovation uncertainty and external legal risks, which essentially differ from internal legal risks from shareholder litigation. As such, different types of litigation risks should have different implications for corporate cash policies. Second, prior studies on shareholder rights protection emphasize more on the disciplining function of shareholder litigation on managers' misuse of corporate cash resources (e.g., Nguyen et al., 2018). In contrast, this paper highlights how enhanced intellectual property rights protection and reduced innovation risks enhance shareholder valuation on cash assets, which are paramount corporate resources in sustaining firms' R&D investment. Moreover, this paper observes different empirical patterns from the prior literature on how litigation risk shapes corporate liquidity policy. Arena and Julio (2015) find that firms accumulate more cash with ex-ante

shareholder litigation risk. Consistently, Nguyen et al. (2018) show that reduced litigation risks from derivative lawsuits by universal demand laws lead to a lower level of corporate cash. Differently, this paper documents that reduced litigation risks from anti-troll laws result in a higher level of cash holdings, largely consistent with the argument that managers optimally adjust cash balances to fund R&D investment when the innovation environment is enhanced.

The rest of the paper proceeds as follows: Section 2 discusses the institutional background and related literature; Section 3 presents the development of hypotheses; Section 4 introduces the data and sample as well as the descriptive statistics; and Section 5 exhibits the empirical results. In Section 6, I conclude the paper.

2. Research background and related literature

Massive patent litigation by NPEs has recently been expanding on a global scale (Cohen et al., 2016). While controversies exist over the impact of NPEs in the IP marketplace, both practitioners and scholars currently perceive patent trolling by NPEs as a growing threat to IPRs. In the United States, nearly half of the infringement actions in 2017 are from NPEs (Sterzi et al., 2020). Thus, NPEs-related litigations become the most common litigation risk faced by U.S. firms in the high-tech industries comparing to other types of legal risks.

In characteristics and economic consequences, NPEs-related litigations are significantly distinct from shareholder litigation, which has been extensively examined by previous studies (e.g., Arena and Julio, 2015; Nguyen et al., 2018). In common cases, securities class action and derivative lawsuits are initiated by internal shareholders of the firm against corporate managers. Specifically, the prior literature suggests that litigation is an important channel for shareholders to exert corporate governance, discipline managers, and mitigate agency conflicts (e.g., Appel, 2019). On the contrary, it is noteworthy that both the firm and its shareholders share the potential wealth losses resulted from litigation risks by patent trolls. In this regard, the interests of managers and shareholders are predominantly aligned regarding the threat of patent trolls. More importantly, while shareholder litigation aims to accuse managers' self-dealing and misconduct, patent trolls mainly focus on software and other technology-based patents (Bessen et al., 2011). As such, the growing prevalence of patent trolls concentrated in high-tech industries should have greater impeding effects on corporate innovation than that from shareholder litigation.

Substantial social costs, reputational damage, and monetary loss represent the typical negative impacts of patent trolling on firms. For direct costs, such as out-of-pocket legal expenses and licensing fees in response to patent ligation by NPEs, Bessen and Meurer (2013) show that the aggregate direct costs incurred due to NPEs rise rapidly from about $7 billion in 2005 to $29 billion in 2011. The indirect costs of NPEs' patent assentation on social welfare are even more striking. Bessen et al. (2011) estimate that NPE lawsuits account for over $500 billion in lost wealth for listed firms from 1990 to 2010 at the aggregate level. On an annual basis, NPEs' patent litigations are responsible for over $83 billion lost shareholder wealth from 2007 to 2010, equivalent to more than a quarter of contemporaneous industrial R&D expenditure in the United States. Moreover, NPEs' litigation not only creates a negative market reaction toward the accused defendant, but it also has a spillover effect on the defendant firm's industry peers with close technological connections (Chen et al., 2019).

The extant literature also highlights that patent trolling has real negative effects on corporate innovation and operation. Cohen et al. (2019) document that NPEs' patent infringement claims are purely profit-driven behavior. Distinguished from lawsuits initiated by practicing entities, NPEs intensively target cash-rich firms and companies that have low capabilities to defend themselves against litigation. Furthermore, the authors find a systemic reduction in defendant firms' innovation productivity after they experience lawsuits pursued by NPEs. The timing of the litigation further reflects that NPEs exploit patent trolling as an opportunistic strategy. NPEs increase the frequency of patent infringement claims when the patent is close to expiration (Cohen et al., 2019). In the primary market, Caskurlu (2020) provides evidence that patent lawsuits from NPEs

increasingly attack firms before their IPO completion, indicating that going public exposes firms to the threat of NPE litigation.

Consequently, an increasing number of academics and public commentators are calling on policymakers to take steps to restrict NPEs. The America Invents Act passed by Congress in 2011 set a provision aimed at curbing NPEs' abusive patent litigation by making it less possible and more costly to initiate litigation against multiple defendants in the same patent infringement suit. However, later evidence shows that the America Invents Act only provides a marginal effect in monitoring NPEs' patent trolling (Appel et al., 2019). Although federal-level anti-troll legislation has not been enacted, 34 states in the United States, starting with Vermont in 2013, have passed patent reforms to protect local firms' IPRs from bad-faith patent infringement claims.[3] These laws increase the costs incurred by NPEs in sending abusive bad-faith demand letters, and they provide firms involved in the assertion of patent infringement with judicial remedies. These remedies include nonmonetary relief, monetary compensation for actual losses, attorney's fees, and compensation on the excess of the actual damages, up to $500,000 or three times the total of actual damages.[4]

The staggered adoption of anti-troll laws provides an effective research setting to investigate the real effect of frivolous claims of patent infringement. The seminal work by Appel et al. (2019) shows that anti-troll laws increase the employment for high-tech start-ups by 4.4% and stimulate venture capital to participate in start-up investments. They conclude that anti-troll laws reduce the risk of firms facing frivolous patent demands and

[3] See Appendix I for details on the dates that specific state laws were signed.

[4] For example, see SB-258, File No. 118, Connecticut. https://www.cga.ct.gov/2014/FC/2014SB-00258-R000118-FC.htm

increase firms' access to external financing. Similarly, Duan (2020) finds that high-tech firms increase their leverage ratio after their states pass anti-troll laws. Examining the effect of anti-troll laws in the acquisition market, Dayani (2020) documents that anti-troll laws increase the acquisition value for small businesses.

3. Hypothesis development

In this section, I develop testable hypotheses on the effect of IPR protection on the value of corporate cash holdings. Specifically, I contend that IPR protection from anti-troll laws affects the value of cash holdings by reducing litigation risk and improving corporate innovation efficiency.

Recent evidence shows that patent trolling by NPEs deteriorates corporate innovativeness and R&D productivity (Cohen et al., 2019). Targeting cash-rich firms, NPEs issue frivolous patent infringement claims to extort early settlements, imposing potential legal threats and substantial settlement costs on targeted firms (Scoot Morten and Shapiro, 2014; Chien 2014). Moreover, NPE patent litigations create negative externalities and pressure on stock prices from the capital market, distracting firms from their core business (Chen et al., 2019).

In practice, IRP protection afforded by anti-troll laws prevents such opportunistic patent litigation by NPEs and reduces corporate innovation uncertainty. Intuitively, an enhanced R&D environment will improve corporate innovation efficiency and increase the probability of patent success. Such assertion is also consistent with contemporary theoretical frameworks and empirical findings that firms have more incentives to increase innovation inputs and R&D expenditure on the condition of higher innovation productivity with better-protected IP rights (Spulber, 2013; Appel et al., 2019; Dayani, 2020). Subsequently, firms have a higher demand for additional capital to sustain their R&D investments and projects in the long run. In this regard, corporate internal funding from the cash reserve is especially valuable to support innovation for firms with stronger IPR protection for multiple reasons.

First, the accumulated internal cash reserve is a more effective funding source for innovation when external financing frictions exist. The extant literature suggests the existence of a "funding gap" for innovation investment (Hall and Lerner 2010). Because R&D projects typically require time, their payoff involves high risk and uncertainty. Moreover, firms have proprietary concerns about their ongoing innovation projects, which exacerbates the information asymmetry with outside capital providers. Thus, cash reserves are especially important for firms to finance their innovative activities, due to the costly external funding from equity and debt (Hall et al., 2016). In addition, even when sufficient funding is already in place, R&D-intensive firms still face refinancing risk on the long-term horizon (Harford et al., 2014). Therefore, internal cash stocks allow firms to support continuous R&D spending in the absence of sufficient external funding.

Second, corporate cash holdings can facilitate R&D smoothing. Appel et al. (2019) show that anti-troll laws increase employment in high-tech divisions. Although expansion in R&D human capital contributes to innovation outputs, it is also associated with substantial training costs and wages paid to highly skilled technology inventors and specialists (Brown and Peterson, 2011). In other words, the firm's knowledge and technology accumulation are tightly embedded in its human capital in R&D teams (Gao and Zhao, 2021). As a result, firms' persistence in R&D inputs leads to high R&D adjustment costs if skilled worker turnover occurs. Accordingly, cash should be more valuable to the extent that it enhances corporate internal flexibility and liquidity to smooth R&D spending and mitigate adjustment expenses in a way that improves innovation productivity.

Third, in addition to the direct improvement on corporate internal efficiency, IPR

protection from anti-troll laws should also positively contribute to the innovation environment at the industrial level. Thus, anti-troll laws may affect the firm's research policy through two extra channels: knowledge spillover and competition. On the one hand, increasing the marginal product of R&D that results from IPR protection could lead to innovation competition and further innovation investments (Spulber, 2013). On the other hand, more chances for technology spillovers provide companies with greater incentives to apply external knowledge and conduct innovative activities, resulting in a higher demand for cash (Qiu and Wan, 2015). Therefore, cash reserves enable companies to better exploit knowledge spillover and gain technological advantages for market competition.

In addition, the reduced litigation risk should also play an important role in shaping the relation between IPR protection and the value of cash. Previous studies highlight that the probability of litigation ex ante leads to reputational loss and aggravates managers' myopia as well as career concerns, resulting in underinvestment in innovation (Lin et al., 2020). Arena and Julio (2015) provide direct evidence that the market value of cash decreases when firms are exposed to litigation risk. Therefore, reduced litigation risk can increase the value of cash by encouraging managers to catch risky but valuable growth opportunities that would be bypassed under greater legal pressure (Nguyen et al., 2018).

Nevertheless, the logical intuition of agency theory supports other reasons to believe that anti-troll laws could have an opposite effect on the value of cash. Anti-troll laws decrease legal expenses and cash flow volatility from NPEs' patent infringement demands, resulting in higher expected free cash flow and agency costs (Jensen, 1986). In light of the higher probability of misused cash assets for the manager's private benefits, the market would evaluate the firm's cash holdings less favorably. However, Harford et al.

(2008) find that, instead of accumulating cash, firms subject to the agency problem in the United States are more likely to quickly spend it for acquisitions and capital expenditure. Moreover, recent accounting literature suggests that innovative firms can alleviate information asymmetry by conducting strategic disclosures (Huang et al., 2021). Reduced information asymmetry improves shareholder valuation of corporate cash assets (Drobetz et al., 2010). Thus, the negative effect of the free cash flows problem on the value of cash is less likely to manifest compared with the innovation mechanisms discussed previously.

Collectively, although tension exists in the research question, the primary hypothesis is stated in alternative form as follows:

H1: *IPR protection resulting from anti-troll laws increases shareholder valuation of corporate internal cash for high-tech companies.*

Furthermore, I expect that considerable heterogeneity exists in how anti-troll laws alter the incremental value of cash based on different firm characteristics. Thus, I develop several cross-sectional hypotheses.

First, I expect that the valuation effect of anti-troll laws on corporate cash assets is stronger for R&D-intensive firms and companies with more growth opportunities. Previous studies conclude that corporate cash assets are extremely important as a funding resource for investment, especially for R&D and innovation, due to external financing being costly. For instance, He and Wintoki (2016) show that the cash-hoarding phenomenon of U.S. firms in the past three decades can be explained by their increase in R&D investment. In addition, Bates et al. (2018) further document that the marginal value of cash is higher for R&D-intensive firms. These empirical results suggest that cash is important for firms to

make R&D investments to enable competing in intensified knowledge-based global market (e.g., Lyandres and Palazzo, 2016; He and Wintoki, 2016).

As previously mentioned, anti-troll laws enhance the innovation environment, improve innovation efficiency, and enable firms to exploit external technology spillover. Therefore, cash assets should be valued higher for firms with existing growth options compared with firms without R&D expenditure and innovation projects since improved internal financial flexibility can directly facilitate those value-increasing opportunities. Thus, firms with investment opportunities should benefit more from shareholder valuation of cash hoarding after the passage of anti-troll laws.

H2: *The relation between anti-troll laws and the value of cash is stronger for R&D-intensive firms and companies with higher growth opportunities.*

The second variation focuses on the firm age and size. Appel et al. (2019) highlight that patent infringement claims by NPEs have significant negative economic effects on employment and financing for young and small start-ups. Similarly, Caskurlu (2020) suggests that firms experience excessive patent trolling shortly before the IPO and the intensity of this litigation persists for a few years. Typically, young and small firms have weaker legal teams than large and mature companies. Thus, they have higher costs to protect their IPRs against bad-faith demand letters. In this regard, anti-troll laws should reduce litigation risks for such firms to a greater extent. Moreover, cash assets are thought to be more valuable for young and small firms because they have less access to financing sources in capital markets (e.g., Faulkender and Wang, 2006; Bates et al., 2018; Li and Lin; 2019). Therefore, the valuation effect from enhanced IPR protection from anti-troll laws on cash assets should be stronger for firms that are smaller and younger.

H3: *The relation between anti-troll laws and the value of cash is more pronounced for smaller and younger firms.*

My third cross-sectional hypothesis builds on the heterogeneity of whether firms ex ante have available financial resources. The prior literature documents that cash is valued more in financially constrained firms than in unconstrained firms. For example, Denis and Sibilkov (2010) find that constrained firms depend on their internal cash flows to sustain a value-increasing investment and subsequently improve their financial conditions. In the context of this paper, anti-troll laws reduce the probability of firms being sued by NPEs, which decreases the volatility of expected cash flows and the occurrence of adverse shocks. Therefore, anti-troll laws should have more prominent effects on financially constrained firms. Based on this rationale, I argue that IPR protection from anti-troll laws increases shareholder valuation on corporate liquidity by improving financial flexibility and facilitating corporate investment.

H4: *The relation between anti-troll laws and the value of cash is stronger for firms with a higher probability of having financial constraints and being financially distressed.*

4. Data and methodology

4.1 Data

My initial sample includes firm-year observations from 2011 (two years before the adoption of the first anti-troll law in 2013) to 2019 (two years after the adoption of the last anti-troll law in 2017). I only include firms from high-tech industries because NPEs extensively target those companies (e.g., Appel et al., 2019; Cohen et al., 2019). The high-tech industry is defined following the American Electronic Association as two-digit SIC codes of 28, 35, 36, 38, 48, and 73 (e.g., Eckbo et al., 2018). I obtain accounting data from Compustat and stock return data from CRSP. I require firms to have positive cash, total assets, sales, book equity, and market equity during the year. After excluding observations with missing data for the baseline regression, the final sample contains 12,835 firm-year observations from 2,192 distinct companies (264 firms operate in states that eventually pass anti-troll laws by the end of my sample period). I winsorize all continuous variables at the 1% and 99% levels to minimize the effect of outliers.

4.2 Research design

Following the prior studies evaluating the economic consequence of anti-troll laws (e.g., Appel et al., 2019; Dayani, 2020), my DID identification strategy exploits the staggered adoption of anti-troll laws in 34 states as a quasi-natural experiment. The variation arising from states passing or not passing anti-troll legislation and from states passing anti-troll laws at different times enables distinguishing the effects of policy changes from other confounding factors. Moreover, lobbying for the laws is initiated either

by non-high-tech industry groups or by a single firm.[5] Thus, the DID research design is unlikely to be subject to endogeneity concerns.

Building on the framework established by Faulkender and Wang (2006), I use the following equation to measure whether the adoption of anti-troll laws affects the marginal value of cash holding. More specifically, I further include the anti-troll law dummy (*Anti-Troll Law*) as well as the interaction with change in cash level (ΔC) in the model of Faulkender and Wang (2006).

$$ABRET_{it} = \beta_0 + \beta_1 \Delta C_{it} * Anti\text{-}Troll\ Law_{it} + \beta_2\ Anti\text{-}Troll\ Law_{it} + \beta_3\ \Delta C_{it} + \beta_4 \Delta E_{it} + \beta_5 \Delta NA_{it} + \beta_6\ \Delta RD_{it} + \beta_7\ \Delta I_{it} + \beta_8\ \Delta D_{it} + \beta_9\ C_{it-1} + \beta_{10}\ L_{it} + \beta_{11}\ NF_{it} + \beta_{12}\ \Delta C_{it} * C_{it-1} + \beta_{13}\ L_{it} * \Delta C_{it} + Firm/Year\ Fixed\ Effects + u_{it} \quad [1]$$

where

$ABRET_{it}$ is the abnormal stock return over year t (raw return minus the Fama and French 1993 size and book-to-market matched portfolio return).

Anti-Troll Law $_{it}$ is a dummy variable that equals one if the state passes the anti-troll law by year t, and zero otherwise.

ΔC_{it} is the change in cash over the year divided by the market value of equity at the beginning of the year;

ΔE_{it} is the change in earnings before extraordinary items over the year divided by market value of equity at the beginning of the year;

[5]See Appel et al. (2019) for details of the political economy of anti-patent laws.

ΔNA_{it} is the change in net assets over the year divided by the market value of equity at the beginning of the year;

ΔRD_{it} is the change in R&D expenses over the year divided by the market value of equity at the beginning of the year;

ΔI_{it} is the change in interest expenses over the year divided by the market value of equity at the beginning of the year;

ΔD_{it} is the change in common dividends (21) over the year divided by the market value of equity at the beginning of the year;

C_{it-1} is cash level at the beginning of the year divided by market value of equity at the beginning of the year;

L_{it} is leverage [total debt at the end of the year over the sum of total debt and beginning market value of equity];

NF_{it} is net financing [total equity issuance minus repurchase plus debt issuance minus debt redemption] for the year divided by the market value of equity at the beginning of the year.

I include firm and year fixed effects to control for the time-invariant and firm-specific factors. Standard errors are clustered at the firm level. Following my hypothesis 1, I expect β_1 to be positive and statistically significant.

4.3 Descriptive statistics

Table 1 shows the descriptive statistics. The mean (median) for the abnormal return during the fiscal year (*AbRet*) is −1.3% (−5.4%), indicating that the returns are right-

skewed (e.g., Faulkender and Wang, 2006; Louis et al., 2012). Similar to the findings of Faulkender and Wang (2006), the mean and median of change in cash (ΔC) are close to zero, which is symmetric. Meanwhile, the distribution of cash level (C) is right-skewed, with a mean (median) of 0.218 (0.147). The statistics of other variables are also consistent with the previous studies (e.g. Faulkender and Wang, 2006).

In untabulated analyses, I analyze the short-term market reactions to the passage of anti-troll laws for firms in all industries. Using portfolio adjusted returns, I find that firms experience a slightly positive market reaction (0.430%) in the 7-days window when their operating states pass the related laws. And the t-tests further shows that the mean of returns is significantly different from zero (t-value = 2.38).

Besides, I further investigate the long-term stock performance for firms in all industries after the anti-troll laws. The results show that firms typically have a positive positive stock performance within three years after the passage of anti-troll laws in their operating states. Specifically, the mean of 1-year portfolio adjusted returns is 1.329% with marginal significance (t-value = 1.43). However, the mean of 2-year and 3-year portfolio adjusted returns are much larger and with a higher degree of statistical significance. Specifically, the mean of 2-year portfolio adjusted returns is 4.151% (t-value = 2.98) and the mean of 3-year portfolio adjusted returns is 3.103% (t-value = 1.80). These results may indicate that anti-troll laws result in a better innovation environment for firms and the effect is more pronounced in the long run.

5. Empirical results

5.1 Baseline results

I start by replicating Faulkender and Wang (2006) and report the results in Column (1) of Table 2. A one-dollar increase in the cash level corresponds to a 1.125-dollar increase in the market value (1.504-0.454*0.218 − 1.986*0.141) in the sample. This finding is in line with Bates et al. (2018) that the value of cash holding increases significantly in recent years. Notably, the fact that a one-dollar increase in cash results in more than a one-dollar increase in the market value of the firm reflects the increasing importance of cash assets to corporate R&D and innovation needs during recent decades (e.g., Lyandres and Palazzo, 2016; He and Wintoki, 2016; Bates et al., 2018). In terms of other controls, I find the marginal value of cash decreases with leverage and the level of cash, and the magnitude is also comparable to Faulkender and Wang (2006).

Column (2) of Table 2 shows my baseline regression of whether the passage of an anti-troll law increases the marginal value of cash. The interaction term of an anti-troll law and a change in cash (*ΔC*Anti-Troll Law*) is positive and significant at the 5% level. The magnitude of 0.353 shows that investors increase their valuation of an additional dollar of cash by 35.3 cents when state laws come into effect. Such an increase represents a 24% rise compared with the marginal value of cash, 1.474 dollars, on average for firms before anti-troll laws. This finding is consistent with my hypothesis that anti-troll laws lead to higher market valuation of corporate cash assets by the shareholder in the market.

5.2 Identification

To validate my difference in differences analysis, I conduct three identification tests shown in Table 3. First, I conduct the parallel trend test to verify the DID model, i.e., I want to make sure the difference of the marginal value of cash between the treatment and control groups is insignificant in the absence of anti-troll laws. Following Fich et al. (2018), I define *Parallel Trends* as a dummy that equals one if the observation is within three years before the law adoption. The coefficient on *ΔC*Parallel Trends* in Column (1) is insignificant with the p-value of 0.416, suggesting that the parallel trends assumption is satisfied. While *ΔC*Anti-Troll Law* is still positive and significant, meaning that the marginal value of cash for firms operating in the treatment states only increases after the passage of the laws.

Column (2) reports the placebo test based on changing the timing of the anti-troll law. I follow Appel et al. (2019) and falsely assume that each state that passed the law did so three years before the actual passage time. Correspondingly, *Anti-Troll Law* in this test is defined as a placebo indicator that equals one starting three years before a state passing the legislation. The placebo sample goes from 2008 to 2016. Consistent with the assumption, the coefficient on *ΔC*Anti-Troll Law* is insignificant with a p-value of 0.315. In untabulated results, I also replace the placebo timing using t-2 to t+3 and get similar inferences.

Lastly, I use propensity score matching (PSM) to match a control firm to each treatment firm. To be more specific, I conduct the 1:1 matching without replacement for each year with the initiation of anti-troll laws. I obtain the characteristics for PSM one year ahead of the event year to mitigate the potential effect of the laws on firm characteristics.

I estimate the probit regression to predict the probability of being treated during the given year with all the variables in the baseline except for *ΔC * Anti-Troll Law* and *Anti-Troll Law*. I further include *Size* (nature logarithm of the market value of equity) and *MTB* (ratio of market equity to book equity) and industry fixed effects (defined as two-digit SIC codes).[6] By identifying one control firm with the closest PSM score for each treatment firm in the same industry, I obtain 184 pairs. All the variables used in PSM are not different significantly after matching. Results in Column (4) confirm my baseline results. Although the number of observations drops to 2,718, the coefficient on *ΔC*Anti-Troll Law* is still significant with an even larger magnitude.

5.3 Robustness tests

To further ensure the robustness of my baseline results, I conduct four additional tests, and the results are shown in Table 4. Column (1) uses the raw return instead of the adjusted return as the dependent variable. Similar to the results in Table (2), *ΔC*Anti-Troll Law* is positive and significant with the magnitude of 0.404. Previous studies suggest that firms take cognizance of tax costs when determining corporate cash policies (Foley et al., 2007; Faulkender et al., 2019). In the second column, I exclude the sample after 2017 to mitigate the confounding effect of the Tax Cuts and Jobs Act of 2017 (TCJA). TCJA, which went into effect in 2018, encourages multinational companies to bring the money back to the U.S, thus possibly changing the optimal level and marginal value of cash in those firms. To alleviate the concern, I exclude the post-TCJA period, i.e., 2018 and 2019. The results

[6] Results are robust if I exclude Size and MTB variables or use four digit SIC to define industry.

remain similar to the baseline. In Column (3), I exclude firms operating in California. Although the anti-troll law was introduced in California in 2015, it was ultimately rejected in 2017 (Dayani, 2020)[7]. My results remain quantitatively similar after excluding those firms. In the last column, I redefine the HighTech industry following Appel et al. (2019) as firms in the four-digit NAICS industries 2211, 3341, 3342, 3344, 3353, 4234, 5112, 5161, 5171,5172, 5173, 5174, 5179, 5181, 5182, 5415, and 5416. The coefficient is still positive and significant.

5.4 Cross-sectional analyses

I conduct several cross-sectional tests to deepen the understanding of the effect of anti-troll laws on the value of cash holding. Firstly, I test whether the effect of the laws is more pronounced in firms with higher investment spending. I measure *Investment* with R&D expense as well as capital expenditure during $t-1$, deflated by the beginning market equity. The positive coefficient on *ΔC*Anti-Troll Law* Investment* in Table 5 is in line with my hypothesis that anti-troll laws encourage companies to allocate cash more towards continuous R&D and capital spending to gain strategic advantages in upcoming innovation competition, thus leading to higher market value for the cash.

The second sets of analyses examine whether the effects are stronger for firms that are more vulnerable to patent trolls. Prior studies find that NPEs are more likely to target smaller and younger firms, leading to worse economic consequences in comparison with large and mature companies with strong legal representation. I define the firm size (*Size*)

[7] In the untabulated tests, I also exclude Delaware, which account for 70% of the whole sample, and get robust results.

as the natural logarithm of market equity in $t-1$. Large companies tend to have better legal teams and more cash reserves. Thus, I predict that the anti-troll laws have limited effects on those companies because patent trolls are less detrimental to them. Consistent with my prediction, *ΔC*Anti-Troll Law*Size* is negative and significant in Table 6. The second test focuses on firm age. *Young* is a dummy that equals one if the firm age is ranked in the bottom decile. Age is the number of years the firm has been in Compustat. Results in Table 7 show that the triple interaction term is positive and significant, indicating that the value of cash increases more for early-stage firms after the passage of the law. This set of cross-sectional results suggest that anti-troll laws induce stronger valuation effects on corporate cash assets for firms that are more likely to suffer from patent trolling and for firms with greater needs in internal financial flexibility.

My third set of tests focus on the effects of financial constraints or distress. I argue that more financially constrained or distressed firms benefit from anti-troll laws because of their higher demand for cash to invest in value-enhancing projects in the presence of costly external financing options. I define *Constraint* with *KZ index* and *WW index* in year $t-1$. KZ = −1.001909 * (Cash Flow) + 3.139193 * (Leverage) − 39.36780 * (Dividend) − 1.314759 * (Cash Holdings) + 0.2826389 * (Q Ratio). My calculations follow Lamont et al. (2001). WW = − 0.091 * (Cash Flow) − 0.062 * (Dividend Payer Indicator) + 0.021 * (Leverage) − 0.044 * log (Book Value of Assets) + 0.102 * (Industry Sales Growth) - 0.035 * (Firm Sales Growth). Calculations follow Whited and Wu (2006). *Distress* is defined with Z-Score. Z = 0.012*(Working Capital / Total Assets) + 0.014*(Retained Earnings /Total Assets) + 0.033*(EBIT /Total Assets) + 0.999*(Sales / Total Assets) + 0.006*(Market Value Equity / Book Value of Total Liabilities). My calculations follow

Altman (2013). Table 8 shows the results. The coefficient on the interaction term is positive in Columns (1) and (2) and negative in Column (3), suggesting that the valuation effect of IPR protection from anti-troll laws varies according to the firm's financial condition and liquidity needs.

5.5 The effect of anti-troll laws on the level of cash

The previous analyses show that the market value of cash holding increases after the anti-troll laws. Fich et al. (2018) suggest that when firms experience an increase in their market valuation of cash, their managers may optimally accumulate more cash resources correspondingly. I further explore how the laws affect the level of cash holding. NPEs tend to target firms with higher cash reserves (Cohen et al., 2019). Thus, I expect that the laws not only boost the market value of cash but also increase the firm's willingness to hold cash. I follow the specification of Opler et al. (1999) and test the effect of anti-troll laws on the level of cash. More specifically, I regress the level of cash on the law dummy as well as a set of controls. The control variables include *MTB* (market value of assets over total assets), *Size* (natural logarithm of book assets minus cash), *CFO* (cash flow from operation over total assets), *NWC* (net working capital over total assets), *CAPEX* (capital expenditure over total assets), *Leverage* (total debt over total assets), *R&D* (R&D expense over total assets), *Acquisition* (acquisition spending over total assets), *Dividend* (a dummy for dividend payout), and *CF Volatility* (cash flow volatility over the past 10 years), as well as firm and year fixed effects. Table 8 shows the regression results: the anti-troll laws increase the ratio of cash over assets by 0.167. The coefficient is significant at the 5% level. This empirical result suggests that anti-troll laws not only have capital market effects on

shareholder valuation of corporate cash assets but also have a real effect in shaping the corporate liquidity policy.

5.6 The effect of anti-troll laws on corporate innovation inputs & outputs

The core argument in my hypotheses is that anti-troll laws reduce innovation uncertainty and increase patenting success for firms in high-tech industries. In this section, I directly whether firms adjust their innovation inputs and outputs after the passage of the anti-troll laws. Firstly, I measure firms' innovation inputs by corporate R&D expenses. The regression results are presented in Table 10. The coefficient of the anti-troll indicator is positive and significant at the 5% level. This empirical result suggests that anti-troll laws not only have real effects in shaping the corporate liquidity policy but also have a real effect in shaping the research policy.

To further explore the effectiveness of anti-troll laws, I continue to examine whether firms have better innovation outputs after the passage of the anti-troll laws. In Column (1) to (3) of Table 11, I use three variables to measure innovation outputs: *Ln (1+Patent Application)* is the nature logarithm of one plus the number of patent applications during the year[8]. *Ln (1+ Patent Cites)* is the natural logarithm of one plus the number of forward citations of all the patents granted to a firm in a year[9]. *Ln (1+Patent Value/MCA)* is the natural logarithm of one plus the scaled patent value of all the patents granted to a firm in the year. *Patent Value* is the total market value of newly granted patents,

[8] Since Kogan et al. (2017) data ends in 2019 and it only covers the patent application that is eventally granted, I do a robustness check with observations on or before 2017 (assuming two year gap between the patent application and grant date) and get similar inferences.

[9] To mitigate the truncation problems of patent citation, I also do a robustness check using the natural logarithm of one plus the annual number of citations (the number of total citation divided by the number of years from patent grants to 2019) of all the patents granted to a firm in the year

calculated using abnormal stock market responses to the patents' approval. I scale the variable by the market equity of the company at the beginning of the year following Dai et al. (2021). All the patent data is taken from Kogan et al. (2017). When there are no patents during the year, I set *Patent Cites* and *Patent Value* to zero[10]. The positive and significant coefficients on *Anti-Troll Law* suggest that firms increase patent applications after the passage of the law. Moreover, the future citation and market reaction to the patents approved during the post-law period increase. This set of results is consistent with my hypothesis that anti-troll laws have a positive role in creating a better innovation enviroment and raising patenting success. This result complements the findings in Appel et al. (2019) by showing that anti-troll laws are also effective to promote innovation outputs for listed corporations.

[10] Results are robust if I set the two variables to missing when there are no patents.

6. Conclusion

Increasingly, corporate IPRs are thought to be an essential driver for innovation and economic growth. The growing problem of NPEs has become the predominant threat hindering corporate IPRs in recent years. Exploiting flaws in the patent system, patent trolls result in distinctive litigation risks that target firms with established technology and undermine innovation activities (Bessen et al., 2011). While debates on patent trolls remain ongoing, anti-troll laws restricting NPEs' bad faith infringement claims spread quickly across 34 states in the United States.

In this study, I adopt a DID identification strategy to examine whether and how the staggered adoption of anti-troll laws affects shareholder valuation of corporate cash assets. This choice is motivated by the growing literature unceasingly taking cognizance of the paramount role of cash resources in financing corporate R&D investment (e.g., Hall 2010; Lyandres and Palazzo, 2016). I find that the marginal value of cash increases by $0.35 for high-tech firms after the passage of anti-troll laws, equivalent to a 24% rise in the value of cash compared with firms in states without such laws. This result indicates that improved IPR protection from anti-troll laws leads to enhanced shareholder valuation on corporate cash assets. I further implement a battery of identification and robustness tests to ensure the validity of the baseline finding.

Cross-sectional analyses continue to reveal the heterogeneity in the main findings. I show that the valuation effect of anti-troll laws on the marginal value of cash is more pronounced for firms with intensive R&D spending and growth opportunities, for younger and small firms, and for financially constrained and distressed firms. In this regard, this paper provides evidence that anti-troll laws improve the innovation environment for

companies and result in an updated shareholder evaluation on corporate internal financial flexibility based on the firm's growth opportunities, the demand for cash, corporate access to external financing, and financial condition.

I further document that anti-troll laws have real effects on increasing firms' propensity to save cash resources. This empirical association indicates that enhanced IPR protection by anti-troll laws shapes corporate strategic motives to accumulate internal slack for precautionary reasons. Moreover, in contrast to contenders' concerns that anti-troll laws would hamper NPEs intermediary function in the IP market; I document an effective role of anti-trolls in promoting corporate innovation outputs for listed corporations in the high-tech industries. I find that anti-troll laws increase the number of corporate patent applications, the patent quality (as measured by patent citations), and the market value of patents. This result complements the finding in Appel et al. (2019), where they find anti-troll laws increase startups' innovative activities.

Overall, the findings in this study speak to the ongoing debate on the validity of patent trolls. By documenting the causal effect of anti-troll laws on the value of corporate cash assets, this paper highlights the valuation effect of IPR protection on the firm's market value. Regarding the practical and policy implications, the suggestive results showing the effectiveness of anti-troll laws caution policymakers in the intellectual property system that regulatory monitoring on NPEs' patent trolling activity is essential and necessary.

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Table 1 Descriptive Statistics

Variable	Mean	S.D.	P10	P25	P50	P75	P90
AbRet	-0.013	0.474	-0.541	-0.299	-0.054	0.180	0.513
Anti-Troll Law	0.071	0.257	0.000	0.000	0.000	0.000	0.000
ΔC	0.006	0.137	-0.111	-0.036	0.002	0.040	0.115
ΔE	0.004	0.154	-0.099	-0.029	0.002	0.026	0.096
ΔNA	0.044	0.257	-0.116	-0.023	0.015	0.074	0.218
ΔRD	0.002	0.032	-0.012	0.000	0.001	0.007	0.023
ΔI	0.001	0.011	-0.003	0.000	0.000	0.001	0.007
ΔD	0.000	0.009	0.000	0.000	0.000	0.000	0.002
C	0.218	0.231	0.032	0.072	0.147	0.278	0.476
L	0.141	0.178	0.000	0.000	0.077	0.213	0.392
NF	0.063	0.216	-0.066	-0.023	0.001	0.070	0.253

This table reports the descriptive statistics. All the contentious variables are winsorized at 1% and 99% levels. Detailed definition of all the variables are listed in Appendix II

Table 2 The effect of anti-troll law on the value of corporate cash

VARIABLES	*AbRet*	
	(1)	(2)
*ΔC*Anti-Troll Law*		0.353**
		(0.042)
Anti-Troll Law		-0.005
		(0.830)
ΔC	1.504***	1.474***
	(0.000)	(0.000)
ΔE	0.423***	0.425***
	(0.000)	(0.000)
ΔNA	0.199***	0.198***
	(0.000)	(0.000)
ΔRD	1.139***	1.149***
	(0.000)	(0.000)
ΔI	0.094	0.095
	(0.877)	(0.876)
ΔD	1.177***	1.184***
	(0.009)	(0.009)
C	0.914***	0.915***
	(0.000)	(0.000)
L	-1.425***	-1.426***
	(0.000)	(0.000)
NF	0.018	0.023
	(0.718)	(0.647)
*ΔC*C*	-0.454***	-0.431***
	(0.003)	(0.004)
*L*ΔC*	-1.986***	-1.994***
	(0.000)	(0.000)
Constant	-0.038***	-0.038***
	(0.006)	(0.006)
Firm FEs / Year FEs	Yes	
Observations	11,216	11,216
Adjusted R-squared	0.277	0.277

This table reports the results of regressing the excess stock return on the interaction term between change in cash level and anti-troll law dummy. See Appendix II for variable definitions. The regressions include firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 3 Identification Tests

VARIABLES	*AbRet*		
	Parallel Trends	Placebo Timing	PSM
	(1)	(2)	(3)
*ΔC*Parallel Trends*	0.197		
	(0.416)		
Parallel Trends	-0.015		
	(0.639)		
*ΔC*Anti-Troll Law*	0.358**	0.151	0.417**
	(0.040)	(0.315)	(0.042)
Anti-Troll Law	-0.015	0.016	-0.029
	(0.646)	(0.491)	(0.326)
ΔC	1.468***	1.639***	1.512***
	(0.000)	(0.000)	(0.000)
ΔE	0.425***	0.378***	0.511***
	(0.000)	(0.000)	(0.000)
ΔNA	0.198***	0.228***	0.235***
	(0.000)	(0.000)	(0.000)
ΔRD	1.150***	0.793***	0.403
	(0.000)	(0.001)	(0.431)
ΔI	0.080	-1.352**	1.065
	(0.895)	(0.030)	(0.394)
ΔD	1.182***	1.049**	1.712*
	(0.009)	(0.020)	(0.054)
C	0.915***	0.976***	0.934***
	(0.000)	(0.000)	(0.000)
L	-1.426***	-1.281***	-1.384***
	(0.000)	(0.000)	(0.000)
NF	0.023	0.107*	0.029
	(0.643)	(0.075)	(0.776)
*ΔC*C*	-0.429***	-0.446***	-0.363
	(0.004)	(0.006)	(0.271)
*L*ΔC*	-1.990***	-1.908***	-1.993***
	(0.000)	(0.000)	(0.001)
Constant	-0.037***	-0.077***	-0.019
	(0.010)	(0.000)	(0.533)
Firm FEs / Year FEs		Yes	
Observations	11,216	11,765	2,718
Adjusted R-squared	0.277	0.295	0.255

This table reports the identification tests. See Appendix II for variable definitions. The regressions include firm and year fixed effects. Column (1) shows the parallel trend test. *Parallel Trends* is a dummy that equals one if the observation is within three years before the passage of the anti-troll laws and zero otherwise. Column (2) uses the placebo timing of anti-troll law as three years before the actual date a state passes the legislation. The placebo sample goes from 2008 to 2016. Column (3) uses the PSM sample. The p-value in parentheses is based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4 Robustness tests

VARIABLES	*Raw Ret*		*AbRet*	
	Raw Return	Exclude post-TCJA Years	Exclude CA	Alternative high-tech industry definition
	(1)	(2)	(3)	(4)
*ΔC*Anti-Troll Law*	0.404**	0.445**	0.373**	0.504**
	(0.019)	(0.020)	(0.033)	(0.023)
Anti-Troll Law	-0.012	-0.008	-0.002	-0.027
	(0.636)	(0.764)	(0.950)	(0.428)
ΔC	1.524***	1.513***	1.449***	1.393***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔE	0.420***	0.461***	0.426***	0.370***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔNA	0.215***	0.210***	0.192***	0.218***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔRD	1.069***	1.448***	1.171***	0.523
	(0.000)	(0.000)	(0.000)	(0.184)
ΔI	0.404	-0.349	0.130	1.369
	(0.515)	(0.644)	(0.832)	(0.150)
ΔD	1.343***	1.011**	1.139**	1.085*
	(0.004)	(0.028)	(0.013)	(0.099)
C	1.006***	1.027***	0.926***	0.948***
	(0.000)	(0.000)	(0.000)	(0.000)
L	-1.513***	-1.537***	-1.431***	-1.167***
	(0.000)	(0.000)	(0.000)	(0.000)
NF	0.018	0.090	0.034	-0.076
	(0.721)	(0.139)	(0.493)	(0.386)
*ΔC*C*	-0.443***	-0.314	-0.395***	-0.265
	(0.004)	(0.110)	(0.009)	(0.443)
*L*ΔC*	-2.010***	-2.340***	-1.987***	-1.279***
	(0.000)	(0.000)	(0.000)	(0.003)
Constant	0.069***	-0.062***	-0.038***	-0.078***
	(0.000)	(0.000)	(0.007)	(0.000)
Firm FEs / Year FEs			Yes	
Observations	11,216	8,779	11,006	4,040
Adjusted R-squared	0.351	0.290	0.275	0.281

This table reports the robustness tests. See Appendix II for variable definitions. The regressions include firm and year fixed effects. Column (1) uses the raw return as the dependent variable. Column (2) use the sample before 2018. Column (3) excludes firms operating in California and Massachusetts. Column (4) includes HighTech firms following the definition of Appel et al. (2019). The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 5 The effect of investment on the relation between anti-troll law and value of corporate cash

VARIABLES	*AbRet*	
	R&D	*CAPEX*
	(1)	(2)
*ΔC*Anti-Troll Law*Investment*	2.885**	2.618**
	(0.012)	(0.049)
Anti-Troll Law Investment*	1.066***	0.789**
	(0.000)	(0.012)
ΔC Investment*	-1.073***	-0.325
	(0.007)	(0.412)
*ΔC*Anti-Troll Law*	0.108	0.250
	(0.615)	(0.194)
Anti-Troll Law	-0.051*	-0.026
	(0.065)	(0.333)
Investment	0.683***	0.482***
	(0.000)	(0.000)
ΔC	1.569***	1.490***
	(0.000)	(0.000)
ΔE	0.410***	0.421***
	(0.000)	(0.000)
ΔNA	0.197***	0.206***
	(0.000)	(0.000)
ΔRD	1.347***	1.090***
	(0.000)	(0.000)
ΔI	0.119	-0.032
	(0.850)	(0.959)
ΔD	1.397***	1.320***
	(0.003)	(0.005)
C	0.943***	0.954***
	(0.000)	(0.000)
L	-1.477***	-1.467***
	(0.000)	(0.000)
NF	0.064	0.048
	(0.225)	(0.359)
*ΔC*C*	-0.363**	-0.443***
	(0.021)	(0.005)
*L*ΔC*	-2.189***	-1.981***
	(0.000)	(0.000)
Constant	-0.077***	-0.054***
	(0.000)	(0.000)
Firm FEs / Year FEs	Yes	
Observations	10,726	10,719
Adjusted R-squared	0.291	0.285

This table reports the cross-section analyses on the corporate investment. *Investment* is measured as R&D expense over beginning market equity in Column (1) and capital expenditure over beginning market equity in Column (2) . See Appendix II for variable definitions. The regressions include firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6 The effect of firm size on the relation between anti-troll law and value of corporate cash

VARIABLES	*AbRet*
*ΔC*Anti-Troll Law*Size*	-0.126**
	(0.044)
Anti-Troll Law Size*	0.003
	(0.754)
ΔC Size*	0.136***
	(0.000)
*ΔC*Anti-Troll Law*	1.004***
	(0.009)
Anti-Troll Law	-0.038
	(0.617)
Size	-0.274***
	(0.000)
ΔC	0.477***
	(0.009)
ΔE	0.317***
	(0.000)
ΔNA	0.254***
	(0.000)
ΔRD	1.296***
	(0.000)
ΔI	0.828
	(0.170)
ΔD	1.827***
	(0.000)
C	0.421***
	(0.000)
L	-1.618***
	(0.000)
NF	-0.096*
	(0.052)
*ΔC*C*	-0.027
	(0.865)
*L*ΔC*	-2.257***
	(0.000)
Constant	1.876***
	(0.000)
Firm FEs / Year FEs	Yes
Observations	11,216
Adjusted R-squared	0.340

This table reports the cross-section analyses on the firm size. *Size* is the logarithm of beginning market equity. See Appendix II for variable definitions. The regressions include firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7 The effect of firm age on the relation between anti-troll law and value of corporate cash

VARIABLES	*AbRet*
*ΔC*Anti-Troll Law*Young*	5.456**
	(0.015)
*Anti-Troll Law*Young*	0.310***
	(0.000)
*ΔC*Young*	0.111
	(0.483)
*ΔC*Anti-Troll Law*	0.322*
	(0.062)
Anti-Troll Law	-0.009
	(0.712)
Young	0.018
	(0.463)
ΔC	1.466***
	(0.000)
ΔE	0.424***
	(0.000)
ΔNA	0.198***
	(0.000)
ΔRD	1.162***
	(0.000)
ΔI	0.078
	(0.898)
ΔD	1.156**
	(0.011)
C	0.918***
	(0.000)
L	-1.426***
	(0.000)
NF	0.015
	(0.762)
*ΔC*C*	-0.425***
	(0.005)
*L*ΔC*	-2.003***
	(0.000)
Constant	-0.040***
	(0.004)
Firm FEs / Year FEs	Yes
Observations	11,216
Adjusted R-squared	0.279

This table reports the cross-section analyses on the firm age. *Young* is a dummy indicating the firm age ranked lowest decile. See Appendix II for variable definitions. The regression includes firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 8 The effect of financial constraint/distress on the relation between anti-troll law and value of corporate cash

VARIABLES	*AbRet*		
	KX Index	*WW Index*	*Z-Score*
	(1)	(2)	(3)
*ΔC*Anti-Troll Law*Constraint/Distress*	0.011**	0.701***	-0.044***
	(0.018)	(0.004)	(0.004)
*Anti-Troll Law*Constraint/Distress*	-0.000	0.009	-0.005**
	(0.824)	(0.788)	(0.029)
*ΔC*Constraint/Distress*	0.000	-0.284***	0.009
	(0.100)	(0.004)	(0.416)
*ΔC*Anti-Troll Law*	0.396**	0.301*	0.351*
	(0.029)	(0.073)	(0.080)
Anti-Troll Law	-0.009	-0.006	0.013
	(0.731)	(0.809)	(0.693)
Constraint/Distress	0.000	-0.017	-0.003***
	(0.954)	(0.283)	(0.009)
ΔC	1.503***	1.503***	1.343***
	(0.000)	(0.000)	(0.000)
ΔE	0.424***	0.429***	0.394***
	(0.000)	(0.000)	(0.000)
ΔNA	0.200***	0.209***	0.175***
	(0.000)	(0.000)	(0.000)
ΔRD	1.230***	1.185***	1.043***
	(0.000)	(0.000)	(0.001)
ΔI	-0.048	0.268	0.042
	(0.938)	(0.660)	(0.949)
ΔD	1.312***	1.235***	0.625
	(0.006)	(0.007)	(0.304)
C	0.917***	0.948***	1.012***
	(0.000)	(0.000)	(0.000)
L	-1.423***	-1.414***	-1.614***
	(0.000)	(0.000)	(0.000)
NF	0.020	0.017	0.067
	(0.700)	(0.749)	(0.242)
*ΔC*C*	-0.459***	-0.378**	-0.083
	(0.004)	(0.014)	(0.679)
*L*ΔC*	-1.907***	-1.949***	-1.996***
	(0.000)	(0.000)	(0.000)
Constant	-0.036**	-0.038***	0.071***
	(0.018)	(0.006)	(0.000)
Firm FEs / Year FEs		Yes	
Observations	10,288	10,869	7,844
Adjusted R-squared	0.278	0.278	0.309

This table reports the cross-section analyses on financial constraint/distress. *Constraint/Distress* is measured with KZ index, WW index and Z score in year t-1. See Appendix II for variable definitions. The regressions include firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 9 The effect of anti-troll law on the level of cash

VARIABLES	*Cash/Asset*
	(1)
Anti-Troll Law	0.167**
	(0.010)
MTB	0.036
	(0.382)
Size	0.061
	(0.598)
CFO	1.496***
	(0.001)
NWC	-1.958***
	(0.000)
CAPEX	-5.522***
	(0.000)
Leverage	-1.031***
	(0.006)
R&D	0.016
	(0.162)
Acquisition	-1.286***
	(0.000)
Dividend	0.161**
	(0.025)
CF Volatility	-0.318
	(0.494)
Constant	1.207
	(0.122)
Firm FEs / Year FEs	Yes
Observations	9,352
Adjusted R-squared	0.718

This table reports the regression results for the effect of anti-troll law on the level of cash. The regression includes firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10 The effect of anti-troll law on future R&D Expense

VARIABLES	*R&D/Asset*
Anti-Troll Law	0.050**
	(0.050)
MTB	0.040**
	(0.021)
Size	-0.014
	(0.762)
CFO	-1.064***
	(0.000)
NWC	-0.898***
	(0.000)
CAPEX	-1.101***
	(0.000)
Leverage	-0.373***
	(0.006)
Acquisition	-0.248**
	(0.020)
Dividend	-0.029
	(0.163)
CF Volatility	-0.151
	(0.477)
Constant	0.568*
	(0.063)
Firm FEs / Year FEs	Yes
Observations	9,352
Adjusted R-squared	0.783

This table reports the regression results for the effect of anti-troll law on the level of R&D expenses. The regression includes firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 11 The effect of anti-troll law on future innovation

VARIABLES	*Ln (1+Patent Application)*	*Ln (1+Patent Cites)*	*Ln(1+Patent Value/MCAP)*
	(1)	(2)	(3)
Anti-Troll Law	0.130***	0.211**	0.002*
	(0.007)	(0.027)	(0.058)
MTB	-0.023**	-0.059***	0.002***
	(0.013)	(0.000)	(0.000)
Size	0.047	0.038	0.004***
	(0.147)	(0.489)	(0.000)
CFO	-0.074	-0.318***	-0.000
	(0.205)	(0.002)	(0.935)
NWC	-0.042	0.122	-0.004
	(0.705)	(0.512)	(0.246)
CAPEX	0.288	-1.194**	-0.042***
	(0.415)	(0.050)	(0.000)
Leverage	-0.144	-0.261	-0.001
	(0.132)	(0.109)	(0.658)
R&D	-0.000	-0.001	-0.000
	(0.969)	(0.329)	(0.190)
Acquisition	0.190*	0.044	-0.005**
	(0.060)	(0.774)	(0.042)
Dividend	-0.105**	-0.145*	0.000
	(0.015)	(0.059)	(0.876)
CF Volatility	-0.203***	-0.512***	-0.003*
	(0.000)	(0.000)	(0.064)
Constant	0.839***	1.322***	-0.003
	(0.000)	(0.000)	(0.574)
Firm FEs / Year FEs		Yes	
Observations	9,352	9,352	9,352
Adjusted R-squared	0.856	0.791	0.799

This table reports the regression results for the effect of anti-troll law on the future innovation. *Ln (1+Patent Application)* is the nature logarithm of one plus the number of patent applications during the year. *Ln (1+ Patent Cites)* is the natural logarithm of one plus the number of citations of all the patents granted to a firm in the year. *Patent Value/MCAP* is the scaled patent value of all the patents granted to a firm in the year. All the patent data is taken from Kogan et al. (2017). The regressions include firm and year fixed effects. The p-value in parentheses are based on standard errors adjusted for firm-level clustering. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Appendix I Effective dates of state-level anti-troll laws

State	Effective Date
AL	4/2/2014
AZ	3/24/2016
CO	6/5/2015
CT	5/8/2017
FL	6/2/2015
GA	4/15/2014
ID	3/26/2014
IL	8/26/2014
IN	5/5/2015
KS	5/20/2015
LA	5/28/2014
ME	4/14/2014
MD	5/5/2014
MI	1/6/2017
MN	4/29/2016
MS	3/28/2015
MO	7/8/2014
MT	4/2/2015
NH	7/11/2014
NC	8/6/2014
ND	3/26/2015
OK	5/16/2014
OR	3/3/2014
RI	6/4/2016
SC	6/9/2016
SD	3/26/2014
TN	5/1/2014
TX	6/17/2015
UT	4/1/2014
VT	5/22/2013
VA	5/23/2014
WA	4/25/2015
WI	4/24/2014
WY	3/11/2016

Appendix II Variable definition

$ABRET_{it}$	The abnormal stock return over year t (raw return minus the Fama and French 1993 size and book-to-market matched portfolio return).
$Anti\text{-}Troll\ Law_{it}$	A dummy variable that equals one if the state passes the anti-troll law by year t, and zero otherwise.
ΔC_{it}	The change in cash over the year divided by market value of equity at the beginning of the year.
ΔE_{it}	The change in earnings before extraordinary items over the year divided by market value of equity at the beginning of the year.
ΔNA_{it}	The change in net assets over the year divided by market value of equity at the beginning of the year.
ΔRD_{it}	The change in R&D expenses over the year divided by market value of equity at the beginning of the year.
ΔI_{it}	The change in interest expenses over the year divided by market value of equity at the beginning of the year.
ΔD_{it}	The change in common dividends over the year divided by market value of equity at the beginning of the year.
C_{it-1}	Cash at the beginning of the year divided by market value of equity at the beginning of the year.
L_{it}	Leverage [total debt at the end of the year over the sum of total debt and beginning market value of equity].
NF_{it}	Net financing [total equity issuance minus repurchase plus debt issuance minus debt redemption] for the year divided by market value of equity at the beginning of the year