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Patent litigation and narrative R&D disclosures: Evidence from the adoption of anti-troll legislation☆

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ABSTRACT

The last two decades have witnessed a sharp increase in patent litigation in the United States (U.S.), mainly driven by patent trolls. By exploiting the staggered adoption of Anti-Troll laws across 34 states as a plausible exogenous shock that reduces the risk of patent litigation by these trolls, we show that firms significantly increase their narrative R&D disclosures following the enactment of Anti-Troll laws. This effect is less pronounced in firms facing higher competitive pressure, and more pronounced in firms that are more exposed to threats from patent trolls. Further analyses alleviate the concern that the impact of Anti-Troll laws on disclosures is attributable to state-level economic or policy changes. Our results highlight the significant role of patent troll litigation in influencing the dissemination of narrative R&D information.

1. Introduction

Patent litigation is integral to the dissemination of R&D information within the economy. In the United States, inventors are granted intellectual property rights for a specified period, along with the ability to enforce these rights through litigation, in exchange for disclosing patent information to the public. This process facilitates broad knowledge dissemination and spurs innovation (Mahoney and Pandian, 1992; Lanjouw and Schankerman, 2001; Somaya, 2003). Despite this, there is a lack of understanding of the impact of patent litigation on other forms of R&D disclosures, such as those that could assist innovators in evaluating how to commercialize their inventions and in assessing the risks and returns of potential projects. This oversight is significant, given the substantial uncertainty inventors confront when allocating resources to innovation (Hall, 2002; Kothari et al., 2002). For inventors to confidently pursue their projects, they need assurance that their efforts will yield adequate value (Leahy and Whited, 1996; Guiso and Parigi, 1999). This confidence is underpinned by access to a comprehensive range of R&D information, which includes understanding the growth and performance implications of the predecessor knowledge that forms the foundation for new technologies. However, the technical details in patent publications do not offer such depth of R&D information (Awate and Makhija, 2021; Kim and Valentine, 2023) and are difficult to gauge accurately even for professionals (e.g., Barron et al., 2002; Chambers et al., 2002). Survey evidence suggests that inventors prioritize "commercial opportunity" over patent disclosures as the primary motivation for innovation (Roin, 2005; Jaffe et al., 2000).

This study examines the impact of patent litigation on a firm's voluntary narrative R&D disclosures, which is considered as a significant source of R&D information for investors, competitors, and intellectual property data specialists (e.g., Entwistle, 1999; Merkley, 2014; Koh and Reeb, 2015; Lu, 2020; Glaeser et al., 2023; Kim and Valentine, 2023). Prior studies suggest that although voluntary, narrative R&D disclosures cover a wide range of topics including R&D strategies, technological development, collaboration, patenting, licensing, product market progress, current and future use of patents, and expected returns,

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thereby providing business and financial context to a firm's innovation (e.g., Merkley, 2014; Koh and Reeb, 2015; Kim and Valentine, 2023).[1] Specifically, we utilize the staggered adoption of Anti-Troll legislation in 34 U.S. states as a plausible exogenous shock that limits the risk of patent litigation by patent trolls following prior research (e.g., Appel et al., 2019; Huang et al., 2022; Chen et al., 2023a; Dayani, 2023) to examine the impact of patent litigation on firms' narrative R&D disclosures.[2]

We focus on patent litigation by patent trolls for two reasons. First, the past two decades have witnessed a significant increase in patent litigation in the U.S., largely driven by patent trolls (Kiebzak et al., 2016; Cohen et al., 2019; Chen et al., 2023a). However, there is a widespread belief among scholars, practitioners, and policymakers that patent trolls have imposed significant costs on U.S. firms.[3] Patent trolls acquire patents from third parties and sue potential licensees for quick settlements, although most of their claims are believed to be meritless (Schwartz and Kesan, 2013; Cohen et al., 2016, 2019).[4] They can do this because they do not produce anything, so they face much lower litigation costs than practicing entities (e.g., discovery costs). They use vague demand letters to threaten legal action and strategically set royalty demands below litigation costs, making the decision to settle an obvious one (Lemley and Melamed, 2013). According to an estimate, for the period of 2007–2011, the direct legal (and settlement) costs associated with formal patent infringement litigation lawsuits initiated by patent trolls exceeded $87 billion for listed companies, accounting for more than 25 % of the annual U.S. industrial R&D investment (Bessen and Meurer, 2013). Consistent with this, existing studies document the detrimental effects of patent trolls on firms' access to finance, employment, innovation, and market value (e.g., Kiebzak et al., 2016; Appel et al., 2019; Chen et al., 2023a). However, little is known about their effect on firms' narrative R&D disclosures.

Second, patent trolls tend to place great emphasis on the economic value of patents and their utilization, information that is likely to be found in a firm's narrative disclosures. This includes assessing a firm's entrenchment level in the patented knowledge and their ability to pay (Mann, 2004; Merges, 2009; Love, 2012; Morton and Shapiro, 2013; Rogers and Jeon, 2014; Cohen et al., 2019). For example, Acacia Research Corporation, a publicly listed patent troll, openly states that their patent licensing process involve "working with experts to evaluate the use of the patented invention" and determining the economic value of a particular patent by assessing the "past, present, and future revenue of infringing products or services".[5]

Beginning with Vermont in 2013, U.S. state legislatures have progressively passed laws targeting "bad faith assertions of patent infringement" by patent trolls (hereafter, Anti-Troll laws). The Vermont law has become a model for other states, inspiring similar legislation in other states. It specifies criteria to determine whether a patent infringement claim is "baseless" without assessing the patent's merits. These criteria consider the details in the demand letter and the reasonableness of licensing fees and timelines (9 V.S.A. § 4197). The law also takes into account the claimant's status, giving preference to original inventors and those who have invested in and successfully enforced their patents in court. Importantly, it offers victims of bad-faith patent infringement assertions a range of remedies and imposes significant penalties on patent trolls (9 V.S.A. § 4199 (b)). Additionally, the law enables the state's Attorney General to take action against patent trolls. Although detailed public data on patent troll litigation is limited, primarily because such actions often involve informal patent assertions, there is a widespread belief that these assertions are decreasing with the implementation of state Anti-Troll laws (DeSisto, 2015; Lee, 2015; Appel et al., 2019; Cohen et al., 2019).

Voluntary disclosure theory suggests that managers trade off benefits and costs when deciding the level of information to disclose. Disclosures can reduce information asymmetry, leading to improved stock price informativeness, lower capital costs, and increased liquidity (e.g., Diamond and Verrecchia, 1991; Easley and O'Hara, 2004; Lambert et al., 2007). However, the proprietary information revealed through disclosures can be observed and utilized by others, potentially damaging a firm's prospects (Bhattacharya and Ritter, 1983; Verrecchia, 1983; Darrough and Stoughton, 1990). We argue that the adoption of state Anti-Troll laws could influence the cost-benefit tradeoff firms face in disclosing proprietary information, thereby affecting the equilibrium level of narrative R&D disclosure. Providing such disclosures can help firms reduce information asymmetry and uncertainty, and enjoy capital market benefits, particularly regarding their R&D activities (e.g., Jones, 2007; Merkley, 2014). Before the adoption of Anti-Troll laws, patent trolls incurred fewer costs to target firms, making it costly for firms to publicly share narrative R&D information since it contains detailed contextual information on firms' R&D activities, useful for patent trolls in valuing the asserted patents and choosing a target. With Anti-Troll laws significantly increasing the costs for patent trolls to pursue claims, the cost of disclosure decreases, leading to an increase in firms' narrative information disclosure post-law adoption.[6] Consequently, we predict that the adoption of Anti-Troll laws increases firms' narrative R&D disclosures. Such an increase in narrative R&D disclosures aligns with prior empirical and survey evidence that identifies litigation risk as a major barrier to disclosures (Francis et al., 1994; Graham et al., 2005; Bourveau et al., 2018).

However, it is possible our prediction may not be borne out. Prior studies suggest that patent litigation is a major instrument for firms to protect their inventions (Choi, 1998; Lanjouw and Schankerman, 2001; Crampes and Langinier, 2002). If Anti-Troll laws weaken patent enforcement, firms may worry about their inventions being misused without sufficient legal protection. This concern could deter firms from sharing information or push them towards trade secrecy, ultimately reducing narrative R&D disclosures (e.g., Fromer, 2008; Graham and Hegde, 2012).

To test our prediction, we follow prior research (Appel et al., 2019; Huang et al., 2022; Chen et al., 2023a; Dayani, 2023) and identify instances of the passage of state-level Anti-Troll laws. Our treatment group consists of firms headquartered in states that have adopted Anti-Troll laws, while our control group includes firms in states that do not

[1] See Appendix A for examples.

[2] Using the staggered adoption of state Anti-Troll legislation as a research setting offers advantages. The primary goal of these legislations is to encourage efficient resolution of patent infringement claims, meaning any effects on firms' narrative R&D disclosure decisions are likely unintended consequences. This aligns with recent studies on the political economy of state Anti-Troll laws, which show that their adoptions were driven by lobbying efforts from either a single firm or financial institutions (Appel et al., 2019; Dayani, 2023). This suggests that the relationship between Anti-Troll legislation and changes in firms' disclosure behaviors is unlikely to be affected by reverse causality.

[3] A recent survey also suggests that over 65 % of the 406 publicly listed companies surveyed believed that patent trolls' demands were a "problem" for them as well as for the industries they belong to (Feldman and Frondorf, 2015). In the words of former President Obama, patent trolls "don't actually produce anything themselves… They are essentially trying to leverage and hijack somebody else's idea and see if they can extort some money out of them".

[4] For example, while most patent infringement cases are settled well before reaching the stage of formal patent litigation and thus remain unobservable to the public (Cohen et al., 2019), for those cases that do ultimately get decided in court, patent trolls lose over 90 % of the time (Chandler, 2013).

[5] See How We Work: Patent Licensing Primer, Acacia Res. Corp., archived at http://perma.cc/5WLE-9G2V (discussing the process of patent-licensing).

[6] Such an increase in narrative R&D disclosures aligns with prior empirical and survey evidence that identifies litigation risk as a major barrier to disclosures (Francis et al., 1994; Graham et al., 2005; Bourveau et al., 2018).

adopt such laws.[7] Following Merkley (2014), we measure narrative R&D disclosure by counting the number of sentences in the 10-K reports that contain R&D-related phrases. First, we demonstrate the significance of a firm's narrative R&D disclosures. We show that an increase in these disclosures is positively correlated with future innovative outcomes, such as higher R&D investments, increased patent applications, and more citations. However, this increase in transparency also corresponds to a higher patent litigation risk for the firm.

Next, we employ a difference-in-differences (DiD) analysis and find that firms headquartered in states that adopt Anti-Troll laws significantly increase their level of narrative R&D disclosures by approximately 3.7 %, conditional on actual contemporaneous R&D spending, after the adoption of Anti-Troll laws, relative to firms headquartered in states without such laws.[8] Placebo experiments with fictitious Anti-Troll events confirm that this relation is unlikely driven by random chance. Our multi-period dynamic analysis shows no significant difference in R&D disclosures between treated and control firms before the laws' adoption, providing comfort that the control states serve as valid counterfactuals for how R&D disclosures would have evolved in the treated firms without Anti-Troll laws.

One may be concerned that confounding factors (e.g., a regional economic shock or policy) could affect both the adoption of Anti-Troll laws and narrative R&D disclosures. While we believe that the staggered nature of law adoption could mitigate these concerns,[9] we conduct several additional tests. First, we find that our results are robust to controlling for various state-level legislative changes and economic variables or excluding states that underwent coinciding policy changes. Second, we find that state-level average R&D disclosure measures do not predict the passage of Anti-Troll laws. Although a state's income per capita and its unemployment rate are negatively correlated with the likelihood of adopting Anti-Troll legislation, this correlation is not robust once state fixed effects are included. This suggests that the passage of Anti-Troll laws is likely to be driven by persistent characteristics of the states rather than changes in their economic conditions. Finally, we observe a significant decline in patent litigations initiated by patent trolls following the adoption of Anti-Troll laws. This result provides supporting evidence that Anti-Troll laws limit the activities of patent trolls.

We conduct several heterogeneity analyses. First, prior studies suggest the importance of competition in information spillover (e.g., Glaeser and Landsman, 2021). We show that the positive effect of Anti-Troll laws on disclosures is less pronounced for firms facing high technological and local competitive pressures. These results suggest that while Anti-Troll laws could reduce the risk of corporate disclosures being exploited by trolls, firms in highly competitive environments remain cautious about increasing their disclosure. Second, we draw from literature that examines the characteristics of firms more likely to be targeted by patent trolls (e.g., Agarwal et al., 2009; Toh and Kim, 2012; Cohen et al., 2019). We find that the effect of Anti-Troll legislation is more pronounced in firms with larger cash reserves, with limited legal expertise, and without prior patent litigation experience. This indicates that firms which are more exposed to patent troll threats—those with significant financial resources but inadequate legal defences—benefit more from the adoption of Anti-Troll legislations.

Our study contributes to the growing literature on the flow of R&D information in society, which predominantly focuses on downstream patent disclosure (Hegde and Luo, 2017; Chondrakis et al., 2021; Baruffaldi and Simeth, 2020; Dyer et al., 2023; Hegde et al., 2023). In contrast, we investigate the voluntary disclosure of upstream R&D activities. Previous studies have shown that such upstream voluntary narrative R&D disclosures are shaped by firm-specific and managerial traits (e.g., Merkley, 2014; Rawson, 2022; Baruffaldi et al., 2023). Our research shows that firms adjust these disclosures in response to changes in patent litigation risk.

Our paper relates but differs from the work of Appel et al. (2019) who explores the economic consequence of Anti-Troll laws adoptions for a sample of unlisted small ventures at the local level. Appel et al. (2019) suggest that litigation risks from patent trolls create financial strain, hindering access to capital and stifling innovation. In contrast, our study examines a sample of publicly listed corporations and suggests that these firms may adopt proactive disclosure strategies to mitigate such risks. We show that firms increase their R&D disclosures following the passage of Anti-Troll laws that raise the costs for trolls to file frivolous claims. The impact of these laws is more pronounced for firms with limited legal expertise or with no prior patent litigation experience, making them more susceptible to being targeted by patent trolls.

The remainder of this paper proceeds as follows. Section 2 discusses the institutional background. Section 3 presents relevant literature and hypothesis. Section 4 describes data, sample selection, and research design. Section 5 presents the results. Section 6 concludes the paper.

2. Institutional background of state anti-troll legislation

In the U.S., patent law is under federal jurisdiction (Lee, 2015; DeSisto, 2015). Although the Leahy-Smith America Invents Act of 2011 ("AIA") includes several provisions intended to discourage bad faith patent infringement assertions (Bryant, 2012; Executive Office of the President (EOP), 2013; DeSisto, 2015), its impact on patent troll behavior was limited due to the unforeseen tactics of modern patent trolls at the time of its drafting (EOP, 2013; Council of Economic Advisers (CEA), 2016). As a result, despite several congressional proposals, no federal legislation specifically targeting patent trolls has been enacted. In response, states have passed legislation to combat abusive patent assertions and protect local firms from patent trolls. Vermont led the way in May 2013 by enacting legislation against bad faith patent infringement assertions, using consumer protection law to address issues typically reserved for federal patent law (DeSisto, 2015). Specifically, the Vermont Anti-Troll legislation allows for the identification of "baseless" patent assertions (under the State's jurisdiction) without delving into the patent's federal merits (which is under the jurisdiction of federal government), offering a state-level remedy against patent

[7] We focus on a firm's headquarters state for the following reason. Firstly, the headquarters state represents the primary location where a firm conducts most of its crucial business operations. Prior research indicates that firms have strong incentives to operate R&D facilities in their headquarters state (Glaeser et al., 2022) and tend to give greater importance to legislative changes in their headquarters state due to the likelihood of receiving more community support and benefiting from a home-court advantage there compared to other states (Fried, 2004; Bhattacharya et al., 2007). Prior research document that managers actively adapt their disclosures in 10-K filings in response to various legislative changes in their headquarters states, such as unemployment insurance laws, states' adoptions of Universal Demand laws, state Uniform Trade Secrets Act, and states' recognition of Inevitable Disclosure Doctrine (Ji and Tan, 2016; Bourveau et al., 2018; Li et al., 2018; Kim et al., 2021). While these studies focus on different legislative contexts, they provide a basis for believing that managers are more inclined to respond to Anti-Troll legislation in these states by adjusting their disclosure practices. Secondly, an in-depth review of the public hearings on Anti-Troll legislation in the Senate and House of each state reveals that firms typically advocate for this legislation primarily in their headquarters state, providing testimony in support of the Anti-Troll laws there.

[8] Throughout our analysis, we control for contemporaneous R&D activities, ensuring that our documented effect on R&D disclosures is conditional on actual R&D spending. Our results suggest that the legislation's impact on R&D disclosure is not merely a byproduct of changes in R&D activities but is more likely driven by the legislation's direct influence on disclosure practices. Our results also remain robust when we further control for a firm's access to financing and firm employment (Appel et al., 2019).

[9] Since not all states have adopted Anti-Troll laws and there is variation in the timing of adoption among those that have, this means that for an omitted shock or policy to significantly influence the results, such a shock or policy would need to consistently coincide with the adoption of Anti-Troll laws across different states and times.

trolls. This goal of the Vermont Anti-Troll legislation is stated as follows:

> "*Through this narrowly focused act, the General Assembly seeks to facilitate the efficient and prompt resolution of patent infringement assertions, protect Vermont businesses from abusive and bad faith assertions of patent infringement, and build Vermont's economy, while at the same time respecting federal law and being careful to not interfere with legitimate patent enforcement actions.*"
>
> (n.p.)

The Vermont Anti-Troll legislation lists a number of factors that a court may consider in determining whether patent infringement assertions are legitimate or illegitimate. For example, judges may consider whether the alleging party is the original inventor of the asserted patent, whether it has made a substantial investment in commercializing the asserting patent, and whether the demand letters provide specific information about the asserted patents and demand payment in an unreasonably short period of time (9 V.S.A. § 4197). The legislation also provides meaningful remedies for victims of bad faith patent infringement assertions and imposes extra penalties on patent trolls, including "(i) equitable relief; (ii) damages; (iii) costs and fees, including reasonable attorney's fees; and (iv) exemplary damages in an amount equal to $50,000 or three times the total of damages, costs, and fees, whichever is greater" (9 V.S.A. § 4199 (b)). Moreover, the law permits the state Attorney General to take legal actions against patent trolls.

The Vermont Anti-Troll legislation has become a model for other states. Although detailed public data on patent troll litigation are limited, primarily because such actions often involve informal patent assertions, it is widely believed that the state Anti-Troll legislation makes patent trolling a much less lucrative business model (DeSisto, 2015; Lee, 2015; Appel et al., 2019), and patent assertions have largely declined, due to the passage of state Anti-Troll legislation (Cohen et al., 2019). These Anti-Troll legislations significantly alter the cost-benefit calculations of patent trolls and shield local businesses from frivolous patent-infringement claims (DeSisto, 2015).[10]

3. Relevant literature and hypothesis

3.1. Prior studies on patent litigation

Patent litigation is recognized as an essential strategy for firms to protect their innovations from infringement (Choi, 1998; Lanjouw and Schankerman, 2001; Crampes and Langinier, 2002). Over the past thirty years, the incidence of patent-related lawsuits has surged, more than tripling in frequency (Bessen et al., 2018; Mezzanotti, 2021). This increase in litigation has been attributed to the strengthening of patent holders' rights over time (Jaffe and Lerner, 2011). In theory, the bolstering of patent holders' rights encourages innovation and the spread of knowledge. Patent laws grant owners exclusive rights to their inventions, contingent upon public disclosure of these inventions. Nonetheless, the real-world impact of these policies often diverges from their intended purposes. The process of litigating patent infringements comes with substantial costs and time investments, and notable uncertainty (Lemley and Shapiro, 2005). Moreover, the requirement for disclosure can lead to proprietary costs, complicating the protection of intellectual property (Roin, 2005; Fromer, 2008). The legal framework also opens avenues for frivolous litigation (e.g. by patent trolls), placing considerable financial and operational strains on innovative firms. As a result, the increased protection could paradoxically stifle innovation (Boldrin and Levine, 2002; Somaya et al., 2007; Bessen and Meurer, 2008).

A large stream of studies has explored the impacts of patent litigation, revealing both strategic uses and unintended consequences. Focusing on a firm's innovation, Bereskin et al. (2023) show that firms use patent litigation as a strategic tool to deter competitors, often resulting in less industry competition and higher profitability. Mezzanotti (2021) find that easing the process for courts to deny injunctions in patent cases can foster innovation by reducing litigation costs for defendants. Cohen et al. (2019) show that targeted firms significantly cut their R&D investments after losses or settlements with patent trolls. Orsatti and Sterzi (2024) find a notable decline in the forward citations of patents acquired by trolls. Kiebzak et al. (2016) find that patent troll litigation negatively impacts venture capital funding, whereas litigation by regular litigants presents a nuanced, inverted U-shaped effect on funding. Appel et al. (2019) find that the state-level Anti-Troll laws that decreases patent troll litigation risk significantly enhance access to financing for startups, leading to increased employment. Furthermore, Huang et al. (2022) show that litigation by patent trolls can disrupt inter-firm collaboration and technology development, compelling firms to adopt inward-looking innovation strategies. Chen et al. (2023a) show that firms are forced to innovate around technologies entangled in litigation with patent trolls, which adversely affects their operational performance and long-term growth.

In contrast, research on the impact of patent litigation on firms' disclosures remains more limited. Focusing on the proprietary costs of disclosures, Frankel et al. (2018) find that defendants with sealed judicial records have higher R&D and face more competition than defendants without sealed judicial records. Awate and Makhija (2021) and Giebel (2021) find that subsequent innovations by accused firms and competitors increase after the filing of a patent infringement litigation case suggesting an information spillover effect.

3.2. The link between anti-troll legislation and firms' narrative R&D disclosures

Prior research underscores the significance of firms' public disclosures such as 10-K reports, as crucial sources of information for investors and other stakeholders (Bushman and Smith, 2001; Durnev and Mangen, 2009; Beatty et al., 2013; Badertscher et al., 2013; Roychowdhury et al., 2019).[11] Specifically, regarding a firm's R&D activities, studies have shown that narrative R&D disclosures within 10-K reports are essential for assessing a firm's R&D performance; they provide valuable insights into the associated risks and returns for investors, competitors, and intellectual property data specialists (e.g., Entwistle, 1999; Merkley, 2014; Koh and Reeb, 2015; Lu, 2020; Glaeser et al., 2023; Kim and Valentine, 2023). This type of disclosure, which is voluntary, covers a wide range of topics, including R&D strategies, technological development, collaboration, patenting, licensing, product market progress, current and future use of patents, and expected returns. Collectively, these disclosures provide business and financial context to a firm's innovation (e.g., Merkley, 2014; Koh and Reeb, 2015; Kim and Valentine, 2023). For example, disclosures related to product development and pricing may reveal how technology is utilized, while patenting information may indicate the legal strength of the innovation. Additionally, details on licensing, royalty revenues, and the success of specific product lines may indicate the commercial success of the underlying innovation.

Consistent with the usefulness of R&D information contained in a

[10] As a validation, using patent litigation data from the Stanford Non-Practicing Entity (NPE) Litigation Database, we document a significant decline in patent litigations brought by patent trolls to district courts after the adoption of Anti-Troll laws, supporting that Anti-Troll laws effectively limit the activities of patent trolls.

[11] Anecdotal evidence underscore the significance of 10-K disclosures. For instance, the practice of former Microsoft CEO Steve Ballmer, who meticulously analyzed the 10-K filings of companies like Amazon and Apple to grasp their strategies, exemplifies this point. He remarked, "You know, when I really wanted to understand in depth what a company was doing, I'd get their 10-K and read it. It's wonky, it's this, it's that, but it's the greatest depth you're going to get, and it's accurate."

firm's 10-K reports, Merkley (2014) finds that narrative R&D disclosures reduce information asymmetry around 10-K filings, suggesting that such disclosures help investors interpret financial information by linking R&D activities to financial performance. Bernard et al. (2020) find that firms download rival firms' 10-K filings from the EDGAR database when setting capital and R&D levels and selecting product investments. Cho and Muslu (2021) find that firms determine their capital investment levels based on the changing tone of peer firms' 10-K filings. Survey evidence also confirms that research directors commonly use information about their industry peers to inform investments in their own R&D (Grabowski and Baxter, 1973). Glaeser et al. (2023) show that intellectual property data aggregators submit a significant number of Freedom of Information Act requests to the Securities and Exchange Commission (SEC) for proprietary information.

Voluntary disclosure theory suggests that managers trade off benefits and costs when deciding the level of information to disclose. On the one hand, disclosures can mitigate adverse-selection problems, thereby reducing information asymmetry, enhancing stock price efficiency, and facilitating external financing, and increasing liquidity (e.g., Diamond and Verrecchia, 1991; Easley and O'Hara, 2004; Lambert et al., 2007). Prior literature has consistently demonstrated that firms utilize narrative R&D disclosures as an important communication mechanism and such disclosures are value relevant and informative (Jones, 2007; Merkley, 2014; Rawson, 2022; Chen et al., 2023b). However, the proprietary information revealed through disclosures can be observed and utilized by others, potentially damaging a firm's prospects (Bhattacharya and Ritter, 1983; Verrecchia, 1983; Darrough and Stoughton, 1990). Guo et al. (2004) demonstrate that firms in the early stages of product development disclose less R&D information. Cao et al. (2018) establish a negative relationship between narrative R&D disclosure and firms' technological competition intensity.

We argue that the staggered adoption of state Anti-Troll laws is likely to influence the cost-benefit tradeoff firms face in disclosing proprietary information, thereby affecting the equilibrium level of narrative R&D disclosure. Prior research suggest that R&D disclosures may elevate the risk of firms becoming targets for patent trolls and subsequently facilitate their rent-seeking strategies (Mann, 2004; Merges, 2009; Love, 2012; Morton and Shapiro, 2013; Rogers and Jeon, 2014). Patent trolls strategically exploit firms' R&D disclosures as a means to evaluate the economic value of patents asserted against target firms and determine the appropriate size of the license fee to request (Mann, 2004; Merges, 2009; Love, 2012; CEA, 2016). This suggests that before the adoption of Anti-Troll laws, patent trolls incurred fewer costs to target firms, making it costly for firms to publicly share narrative R&D information since it contains detailed contextual information on firms' R&D activities, useful for patent trolls in valuing the asserted patents and choosing a target. With Anti-Troll laws significantly increasing the costs for patent trolls to pursue frivolous claims, the cost of disclosure decreases, leading to an increase in firms' narrative information disclosure post-law adoption. Consequently, we predict that the adoption of Anti-Troll laws increases firms' narrative R&D disclosures. This leads to our hypothesis below:

Hypothesis. All else equal, the adoption of state Anti-Troll legislation increases firms' narrative R&D disclosures.

However, it is possible our prediction may not be borne out. Prior studies suggest that patent litigation is a major instrument for firms to protect their inventions (Choi, 1998; Lanjouw and Schankerman, 2001; Crampes and Langinier, 2002). Should Anti-Troll legislations diminish the strength of patent enforcement, firms could fear their inventions being exploited without adequate legal safeguards. Such apprehensions may discourage firms from disclosing information or incentivize them to favor trade secrecy, leading to a decrease in narrative R&D disclosures (e.g., Fromer, 2008; Graham and Hegde, 2012).

4. Data, sample selection, and research design

4.1. Data and sample selection

The passage of Anti-Troll laws across the states has been staggered over the period of 2013 to 2017. We start our sample in 2011, which is two years before the adoption of the first Anti-Troll law in 2013 (Vermont), and end our sample in 2019, which is two years after the adoption of the last Anti-Troll law in 2017 (Connecticut and Michigan). Our initial sample consists of 43,735 firm-year observations from Bill McDonald's database.[12] This database provides firms' historical headquarters locations from the 10-K Headers as well as parsed 10-K filing content retrieved from the SEC's EDGAR website. We use this sample to construct the two main variables in our paper, namely the indicator variable identifying the passage of Anti-Troll law (*Anti-Troll*), which requires information on firms' headquarters state location, and narrative R&D disclosure measure (*Ln*(*R&DDisc*)) based on 10-K filings. We drop 5146 firm-years with no data available for control variables and 660 singleton observations when estimating baseline regression.[13] Our final sample comprises 37,929 firm-years. Table 1 Panel A summarizes the sample selection process.

4.2. Empirical model

To identify whether and how Anti-Troll laws affect corporate R&D disclosures, we exploit the staggered adoption of state Anti-Troll laws. We estimate the following DiD regression in a staggered regulatory setting:

$$\begin{aligned} Ln(R\&DDisc)_{i,t} = & \alpha + \beta_1 Anti-Troll_{i,t} + \beta_2 Size_{i,t-1} + \beta_3 Leverage_{i,t-1} \\ & + \beta_4 adjROA_{i,t-1} + \beta_5 StdEarn_{i,t-1} + \beta_6 R\&D_{i,t} \\ & + \beta_7\, Ln(Non-R\&DDisc)_{i,t} + Fixed\ Effects + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where i and t denote firm and year, respectively. The dependent variable *R&DDisc* (before taking log) is our proxy for narrative R&D disclosure; specifically, we search 10-K filings and identify R&D narrative disclosures at the sentence level. We categorize a sentence as a R&D-related sentence if it contains specific R&D keywords or phrases. We employ a dictionary of common R&D keywords and phrases carefully developed by Merkley (2014).[14] *R&DDisc* is defined as the total number of R&D-related sentences in each 10-K filing. Because the narrative R&D disclosure measure is strongly right-skewed, we use the log transformation of one plus *R&DDisc*, as in Merkley (2014).

For each state, we identify the effective date of the passage of state Anti-Troll legislations and define *Anti-Troll* as an indicator variable which equals 1 if Anti-Troll legislation has been signed into law in a firm's headquarters state at any time before t, and 0 otherwise. The coefficient β_1 captures the average difference in changes of narrative R&D disclosures from the pre- to the post-legislation period between (treatment) firms headquartered in states that have adopted Anti-Troll legislation and (control) firms headquartered in unaffected states.

We include a set of controls that have been suggested by prior studies to affect R&D disclosures and are calculated at the end of fiscal year $t-1$. We control for firm size (*Size*) as it has been found that larger firms have a lower cost of disseminating information and a higher incentive to disclose more (Lang and Lundholm, 1993; Clarkson et al., 1999). We

[12] See: https://sraf.nd.edu/data/.

[13] Our main results remain consistent if we do not include any additional controls.

[14] Merkley (2014) developed the dictionary through careful examination of random selection of 150 10-K filings. To ensure that the dictionary is reasonable, he also consulted industry professionals on R&D-related disclosure topics and compared his list to those of Entwistle (1999) and James and Shaver (2009). See Appendix C for details.

Table 1
Sample descriptive statistics.

Panel A: sample selection	
McDonald's 10-K filings data (2011–2019)	43,735
Deleting firms without firm-level financial information	(5146)
Deleting singleton observations when estimating baseline regression	(660)
Total	37,929

Panel B: Firm-year observations in states that adopted anti-troll legislation

	Adoption year	N	% Anti-Troll =1
Alabama	2014	185	0.62
Arizona	2016	534	0.49
Colorado	2015	1049	0.58
Connecticut	2017	766	0.29
Florida	2015	1699	0.57
Georgia	2014	917	0.65
Idaho	2014	108	0.63
Illinois	2014	1523	0.67
Indiana	2015	553	0.52
Kansas	2015	214	0.54
Louisiana	2014	272	0.62
Maryland	2014	701	0.65
Maine	2014	64	0.67
Michigan	2017	686	0.30
Minnesota	2016	808	0.40
Missouri	2014	565	0.62
Mississippi	2015	122	0.52
Montana	2015	57	0.49
North Carolina	2014	802	0.65
North Dakota	2015	46	0.65
New Hampshire	2014	78	0.69
Oklahoma	2014	382	0.68
Oregon	2014	255	0.60
Rhode Island	2016	113	0.41
South Carolina	2016	224	0.39
South Dakota	2014	69	0.67
Tennessee	2014	519	0.65
Texas	2015	3809	0.56
Utah	2014	383	0.66
Virginia	2014	1056	0.66
Vermont	2013	46	0.78
Washington	2015	724	0.54
Wisconsin	2014	572	0.67
Wyoming	2016	25	0.12
Total	19,926		

Panel C: summary statistics

	Mean	Median	S.D.
R&DDisc	18.11	3.00	36.06
Ln(*R&DDisc*)	1.73	1.39	1.53
Anti-Troll	0.30	0.00	0.46
Size	6.29	6.67	2.85
Leverage	0.33	0.20	0.61
adjROA	−0.10	0.05	0.91
StdEarn	0.25	0.03	1.06
R&D	0.06	0.00	0.16
Ln(*Non-R&DDisc*)	7.52	7.53	0.47
N	37,929		

Panel A of this table reports the sample selection procedure; panel B reports the number of firm-year observations by state; and panel C reports descriptive statistics for the regression sample. All continuous variables are winsorized at the top and bottom percentile. See Appendix B for variable definitions.

control for capital structure by including leverage ratio (*Leverage*) in our model. Higher leverage is found to be associated with higher bankruptcy risk (Li, 2010; Rawson, 2022). We control for earnings performance (*adjROA*), because it is known to be negatively correlated with R&D disclosures (Merkley, 2014). We control for earnings uncertainty *StdEarn*, because Waymire (1985) finds that firms with higher uncertainty are less likely to issue voluntary disclosures, and Lu and Wu Tucker (2012) find that these firms are more likely to provide non-earnings forward-looking information. We also include non-R&D narrative disclosures in 10-K (*Ln*(*Non-R&DDisc*)) in our model to control for a firm's overall propensity to disclose, which is measured as natural log of one plus total number of non-R&D-related sentences in the 10-K filing in year *t* (You and Zhang, 2009; Merkley, 2014). We control for contemporaneous R&D spending (*R&D*) to ensure that the effect on R&D

disclosures is conditional on a firm's actual R&D spending (Entwistle, 1999).[15] We include firm fixed effects to control for the time-invariant unobservable firm-specific factors that may affect a firm's disclosure decisions. We include year fixed effects to absorb the aggregate intertemporal economy-wide shocks affecting all states. All standard errors are clustered at the firm level.

We next assess the economic implications of narrative R&D disclosures. First, we empirically examine whether narrative R&D disclosure correlates with real innovative activities at the firm level. Consistent with prior studies (e.g., Zhong, 2018; Chen et al., 2023b), we proxy for a firm's real economic activities using R&D intensity and patent application. *R&D* is calculated as R&D investment scaled by total assets. *Ln* (*Patent_APP*) is the natural log of 1 plus the total number of patents a firm has applied for in a given year. We report the results in Appendix D. As shown in columns (1) and (2), firms disclosing more about R&D are associated with an increase in both future R&D and patenting activities. These results suggest that narrative R&D disclosures can lead to a real change in a firm's innovative activities, aligning with prior research indicating that corporate disclosures have a significant impact on future innovative outcomes (e.g., Zhong, 2018; Brown and Martinsson, 2018; Roychowdhury et al., 2019; Fu et al., 2020; Allen et al., 2021; Chen et al., 2023b; Tseng and Zhong, 2024). We further examine the impact of narrative R&D disclosures on overall innovation through knowledge diffusion. *Ln*(*Citation*), is the natural log of one plus the total number of citations received by the patents applied for in a given year (Zhong, 2018). This measure aims to capture the breadth of a patent's influence (Griliches et al., 1986), where a higher citation count indicates greater knowledge spillovers (Kim and Valentine, 2021; Chen et al., 2023b). We construct *Ln*(*IndPatent*), which is measured as the natural log of one plus the total number of patent applications of for each industry in a given year. The results, as presented in columns (3) and (4), reveal a positive relationship between corporate narrative R&D disclosure and both patent citations and overall innovation activities at the industry level. These results offer evidence in support of the notion that narrative R&D disclosures provide advantages not only to the firms making these disclosures but also to the entire industry (e.g., Merkley, 2014; Koh and Reeb, 2015; Kim and Valentine, 2023).

Second, we empirically examine whether increased narrative R&D disclosure heightens the risk of patent litigation. To do so, we obtain information on patent litigation case information from the 'Stanford Non-Practicing Entity (NPE) Litigation Database', which is a publicly available dataset that comprehensively tracks patent-related litigation in the United States. The sample period starts in 2000 when the first patent litigation was released in the NPE database and ends in 2012, the year before the first state Anti-Troll legislation was passed in Vermont. We construct *Litigate*, which is an indicator variable equals 1 if the firm is sued for patent infringement within the next three years and 0 otherwise. As shown in column (5), we find that higher narrative R&D disclosure correlates with an increased likelihood of litigation within the following three years, which lends support to our arguments that firms reduce R&D disclosures when facing patent troll threats, as they fear that revealing such information might elevate the risk of becoming a litigation target.

5. Empirical results

5.1. Descriptive statistics

Panel B of Table 1 presents the frequency of firm-year observations for firms headquartered in each of 34 states that adopt Anti-Troll legislation. The total number of firm-year observations for our sample firms headquartered in these 34 states is 19,926, representing about 53 % of the total sample. In addition, the number of firm-years appears to vary widely across these 34 states, suggesting reasonable geographic variation in observations across these states adopting Anti-Troll legislation. Panel C of Table 1 presents summary statistics for our sample. Our measure of corporate R&D disclosure (*R&DDisc*) has a mean (median) value of 18.11 (3) R&D-related sentences in 10-K.[16] Other summary statistics are consistent with prior studies (Merkley, 2014; Cao et al., 2018; Glaeser, 2018). Note that all continuous variables are winsorzied at the top and bottom one percentile in our sample to minimize the impact of outliers.

Table 2
The impact of anti-troll laws on narrative R&D disclosures.

	Dep. = Ln(R&DDisc)
Anti-Troll	0.035***
	(4.88)
Size	0.029***
	(5.37)
Leverage	−0.040***
	(−4.93)
adjROA	−0.027***
	(−3.88)
StdEarn	−0.004
	(−0.70)
R&D	0.327***
	(10.90)
Ln(Non-R&DDisc)	0.336***
	(22.39)
Firm FE	Yes
Year FE	Yes
Adj-R^2	0.954
N	37,929

This table reports the regression results for the impact of the Anti-Troll laws on corporate R&D disclosures. All continuous variables are winsorized at the top and bottom percentile. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. See Appendix B for variable definitions.

5.2. Main regression results

Table 2 reports the results of DiD regression in Eq. (1). Throughout our analysis, we control for contemporaneous R&D spending to alleviate the concern that the observed increases in R&D disclosures are a consequence of changes in actual R&D spending. The coefficient on *Anti-Troll* (β_1) is positive and significant at the 1 % level. In terms of economic significance, firms headquartered in states that adopt Anti-Troll laws disclose 3.7 % more R&D-related sentences in their 10-K filings post-adoption relative to firms in states that do not adopt such legislations.[17] This finding is in line with the view that patent troll threats can

[15] To mitigate the concern that some innovative firms may engage in R&D-type activities without reporting R&D (Koh and Reeb, 2015), in untabulated tests, we use only observations with non-missing R&D figures and for firms which applied and/or received patent applications from the United States Patent and Trademark Office. Our results remain unchanged.

[16] This measure is different from that of Merkley (2014) who excludes firm-year observations with missing R&D figures from his sample. Our measure of *R&DDisc* would have a mean (median) value of 33.93 (19) R&D-related sentences in the 10-K report if we exclude firms with missing R&D from our sample. These figures are consistent with Merkley (2014) and with Cao et al.'s (2018) replication of that study.

[17] Because the dependent variable is in the form $\ln(1+y)$, the first derivative should be $\Delta y \div (1+y)$. Therefore, the economic magnitude is estimated by $\beta_1 \times (1+y) \div y$, which is $[(0.035 \times (1+18.11) \div 18.11)] = 3.7$ %. We benchmark our findings against firm size as a reference point. We find that the economic significance of Anti-Troll legislation is 8.2 times that of firm size (3.7 % / [(coef. *Size* (0.029) × SD. *Size* (2.85)) ÷ mean of *y* (18.11)]), which is comparable to the same ratio calculated in prior research (Bourveau et al., 2018). This comparison helps clarify the meaningfulness of our results.

be a specific cost that impedes firms from voluntarily disclosing R&D information.

5.3. Dynamic analysis

A key identifying assumption for our main tests is parallel trends (Roberts and Whited, 2013). To test the validity of our empirical strategy, we introduce lead-lag terms in our DiD regression. Specifically, we replace *Anti-Troll* in Eq. (1) with six indicator variables: *Anti-Troll* (*3*–) is set to 1 for periods three or more years before the law's adoption and 0 otherwise; *Anti-Troll* (−*2*) is set to 1 for the second year before the law's adoption and 0 otherwise; *Anti-Troll* (*0*) is 1 in the year the law is adopted, 0 otherwise; *Anti-Troll* (+*1*) marks the first year after adoption with a 1, and all other years 0; *Anti-Troll* (+*2*) is 1 for the second year post-adoption, 0 otherwise; and *Anti-Troll* (*3*+) is assigned a 1 for three or more years following the law's adoption, 0 otherwise. We use the year before the adoption of anti-troll laws as benchmark year (*Anti-Troll* (−*1*)). The results are reported in Table 3. We show that the coefficients on *Anti-Troll* (*3*–), *Anti-Troll* (−*2*) and *Anti-Troll* (*0*) are insignificant. This lack of significance suggests that there is no pre-existing trend in R&D disclosure differences between the treatment and the control firms and the parallel trends assumption is not violated. Conversely, the coefficients for *Anti-Troll* (+*1*), *Anti-Troll* (+*2*), and *Anti-Troll* (*3*+) are positive and significant. These results suggest that the effect of the Anti-Troll laws on R&D disclosures becomes evident starting from the first year following the law's adoption. Consistent with the results in Table 3, the graphical analysis in Fig. 1 shows that the R&D disclosure behaviors of firms in treatment and control states exhibit a similar trend prior to the adoption of Anti-Troll laws, and only differs after the adoption of these laws, providing support for the parallel trend assumption.

5.4. Placebo test

We then follow prior studies to conduct a placebo test using fictitious Anti-Troll events (Kogan et al., 2017; Qiu and Wang, 2018; Kim and Valentine, 2021; Miller et al., 2021). Specifically, we randomly assign the Anti-Troll adoption years to states by drawing dates, without replacement, from the actual pool of Anti-Troll adoption years and construct an indicator variable *AntiTroll_Placebo*. By drawing without replacement, we ensure the number of states experiencing adoption in any given year, is the same as it would have occurred had the actual adoptions been in effect. We then re-estimate the effect of these pseudo-Anti-Troll adoptions on firms' R&D disclosures. We repeat this exercise 1000 times and show the distribution of these placebo coefficients in Panel A of Table 4. This exercise allows us to assess the likelihood of observing similar disclosure effects purely by chance. We find our estimation of the effect of Anti-Troll in our main results (0.035 in Table 2) is greater than the 95th percentile of the distributions from the simulations on *AntiTroll_Placebo*. These analyses increase our confidence that that the observed effects are unlikely driven by random chance.

Table 3
Dynamics of anti-troll adoption effect on R&D disclosures.

	Dep. = Ln(R&DDisc)
Anti-Troll (*3*–)	−0.015
	(−1.50)
Anti-Troll (*2*–)	−0.007
	(−0.70)
Anti-Troll (*0*)	0.012
	(1.34)
Anti-Troll (+*1*)	0.025**
	(2.40)
Anti-Troll (+*2*)	0.040***
	(3.70)
Anti-Troll (*3*+)	0.049***
	(4.32)
Controls	Yes
Firm FE	Yes
Year FE	Yes
Adj-R^2	0.954
N	37,929

This table presents the regression results of dynamic analysis. All continuous variables are winsorized at the top and bottom percentile. The t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. See Appendix B for variable definitions.

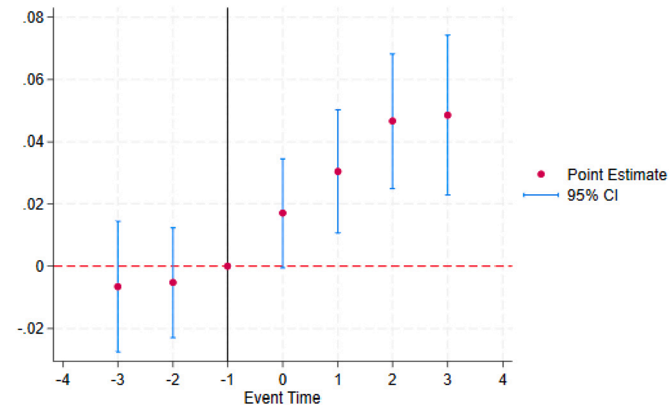

Fig. 1. The straight vertical line (black) corresponds to the year before the adoption of Anti-Troll laws, which serves as benchmark year. The *y* axis presents the magnitude of the effect of Anti-Troll adoption on disclosure of R&D information (together with 95 % confidence interval). The numbers (τ) on the horizontal axis indicate the τth year relative to the adoption year of Anti-Troll laws.

5.5. Alternative estimation

Recent econometrics literature suggests that staggered DiD analyses with varying treatment timing can lead to biased estimation due to treatment effect heterogeneity (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021). Anti-Troll laws were enacted within a relatively short and recent timeframe. Moreover, the presence of 16 states that have never adopted these laws provides us with a clean and effective control group. This setting may reduce the impact of the biases identified in this literature (Dayani, 2023). Nevertheless, to mitigate these concerns, we implement a stacked DiD analysis. Specifically, for each year a state adopts the anti-troll legislation, we identify a cohort of treated firms within that state and pair them with control firms—those from states that have never implemented such laws. We then pool the data across these cohorts to calculate an average effect across all events using the following specification:

$$Ln(R\&DDisc)_{itg} = \beta_1 Anti-Troll_{stg} + Controls_{it-1g} + Fixed\ Effects_g + \varepsilon_{itg} \quad (2)$$

where *s*, i, *t* and *g* denote state, firm, year and cohort, respectively. We include the same set of controls we used in Eq. (1). We report the regression results in Panel B Table 4. We find the coefficient on *Anti-Troll* has the same sign and statistical significance as the estimator shown in our baseline model, which lends further credence to the traditional estimate of the effect reported in Table 2.

5.6. Confounding factors

5.6.1. Controlling for state-level legislations

An important concern related to our DiD method is the potential confounding effect of other state-level legislative changes that coincided with the adoption of the Anti-Troll laws on R&D disclosures. To address this, we identify various legislative changes, including the enforceability

Table 4
Robustness tests.

Panel A: placebo test								
Variable	No. of replications	Mean	SD	p25	Median	p75	p95	Documented effect
AntiTroll_Placebo	1000	−0.000	0.017	−0.012	−0.001	0.010	0.028	0.035

Panel B: stacked DiD analysis	
	Dep. = *Ln*(*R&DDisc*)
Anti-Troll	0.041***
	(3.38)
Controls	Yes
Cohort FE	Yes
Firm FE	Yes
Year FE	Yes
Adj-R2	0.963
N	79,373

This table reports the robustness results of the impact of Anti-Troll laws on R&D disclosures. All continuous variables are winsorized at the top and bottom percentile. *, **, and *** indicate that the estimated coefficient is statistically significant at the 10 %, 5 % and 1 % levels, respectively. See Appendix B for detailed variable definitions.

of state-level non-compete agreement and trade secrets protection laws, such as the Uniform Trade Secret Act (UTSA) and the recognition or rejection of the Inevitable Disclosure Doctrine (IDD). These laws could alter firms' incentives to disclose proprietary information publicly, as they limit visibility into competitors' activities, potentially increasing the value of any disclosed proprietary information (Aobdia, 2018; Li et al., 2018; Chen et al., 2018; Glaeser, 2018; Kim et al., 2021; Wang, 2023). Additionally, following Appel et al. (2019), we examine various state-level policies aimed at promoting local innovation, such as the initiation of innovation funds and tax incentives. These policies may motivate firms to disclose their R&D activities to demonstrate their commitment to local innovation ecosystems and to become eligible for additional support.

For each of the above legislative changes and state-level policies, we note down their corresponding enactment dates and states. As the Anti-Troll laws focused in our paper were adopted at different times across states, for any omitted legislative or policy changes to confound our results, they need to coincide with the staggered adoption of Anti-Troll laws across multiple states and time periods to significantly impact our results. We find that although overlaps occurred, they do not overlap in systematic way. For example, North Carolina both rejected the IDD and adopted Anti-Troll legislation in 2014; Maryland initiated Cyber Security Investment Fund and Anti-Troll legislation in 2014; and Washington initiated Data Center Tax Exemption and Anti-Troll legislation in 2015.

We next examine whether our main results are consistent if we control for these legislative changes in our main test. Specifically, we construct *UTSA*, which equals 1 if the firm's headquarters state has enacted the UTSA, and 0 otherwise. *IDD* is set to 1 if the IDD is in effect in the state where the firm is headquartered, and 0 otherwise. To capture the effect of non-compete agreements, we adopt the enforceability index (*Non-Compete*) developed by Garmaise (2011) and later extended by Ertimur et al. (2018). This enforcement index is based on detailed evaluation of statutes and case law for each state in terms of each policy's effective time (e.g., court ruling dates), extent of enforcement, and the role of state courts in enforcement, and is widely used in various literature (Aobdia, 2018; Chen et al., 2018; Ertimur et al., 2018; Gao et al., 2023). *Other-State-Initiatives* is set to 1 if the firm's headquarters state has adopted the initiatives aimed at promoting local innovation, and 0 otherwise. We report the results in Panel A Table 5. As shown in column (1), we find that the effects of the Anti-Troll laws on R&D disclosures, remain significant, after controlling for the effect of the IDD, UTSA, the state-level enforceability index of non-compete agreements, and other state initiatives.

To further address the concern of potential confounding effects from other state-level legislative changes, we refine our analysis by excluding states that experienced coinciding policy changes during our sample period (i.e. North Carolina, Maryland, and Washington). After re-estimating our main regressions without these states, we find that the results (untabulated), remain qualitatively similar.

5.6.2. Controlling for state-level economic variables

To address the concern that correlated omitted variables at the state level might drive our results, we regress the passage of Anti-Troll laws (*Anti-Troll Adoption*) (1 if the Anti-Troll law is in effect in the state-year, and 0 otherwise) on several R&D disclosure measures averaged at the state level (*Average_RnDDISC*, *Average_RnDDISCFor* and *Average_RnDDISCNum*), and state-level characteristics, such as GDP growth (*GDPGrowth*), income per capita (*Ln*(*Income* per capita)), and unemployment rate (*Unemployment rate*).

The results reported in Panel B of Table 5. As shown in column (1), R&D disclosure variables aggregated at the state level do not have predictive power for the passage of Anti-Troll laws. This evidence supports that states' Anti-Troll adoption is unlikely to be driven by firms' preexisting disclosure incentives. We also show that while both a state's income per capita and its unemployment rate are negatively correlated with the likelihood that the state adopts Anti-Troll legislation, this finding is not robust once state fixed effects are included (column (2)), which suggests that the passage of Anti-Troll laws is driven by persistent characteristics of the states rather than changes in their economic conditions. This is consistent with Appel et al. (2019) who documents similar findings. In column (2) of Panel A Table 5, we also show that our main analysis is robust to controlling for these geographic variables and state fixed effects, suggesting our results are unlikely driven by regional shocks.

5.6.3. Patent troll activities

Next, we provide further evidence supporting the view that the adoptions of Anti-Troll laws have a significant effect on patent troll activities. We obtain the patent litigation data from the NPE database to analyze the effects of Anti-Troll laws on the incidence of patent infringement claims by patent trolls. However, one limitation of this test is that these litigation cases only represent a fraction of the overall picture, as many disputes do not make it to court (Righi, 2022; Chen et al., 2023a). Data on demand letters sent by patent trolls are pre-lawsuit communications and are almost always confidential. Specifically, we use the NPE database's categorization to determine whether the lawsuit was filed by a patent troll or a practicing entity. We use the location of the district court where the case is brought and the filing date

Table 5
Confounding factors.

Panel A: controlling for state-level legislations and economic variables

	Dep. = Ln(R&DDisc)	
	(1)	(2)
Anti-Troll	0.035***	0.030***
	(4.90)	(3.82)
Non-Compete	0.003	
	(0.38)	
UTSA	−0.005	
	(−0.43)	
IDD	−0.000	
	(−0.02)	
Other-State-Initiatives	−0.007	
	(−0.76)	
Ln(Income per capita)		−0.219***
		(−3.23)
Unemployment rate		−0.006**
		(−1.99)
GDPGrowth		0.105
		(0.81)
Controls	Yes	Yes
Firm FE	Yes	Yes
State FE	No	Yes
Year FE	Yes	Yes
Adj-R^2	0.954	0.955
N	37,929	37,929

Panel B: determinants of anti-troll laws

	Dep. = Anti-Troll Adoption	
	(1)	(2)
Ln(Income per capita)	−0.225**	0.300
	(−2.44)	(1.63)
Unemployment rate	−0.037***	−0.029
	(−2.97)	(−1.33)
GDPGrowth	0.966	−0.508
	(1.04)	(−0.81)
Average_RnDDISC	0.023	0.016
	(0.13)	(0.08)
Average_RnDDISCFor	−0.114	−0.136
	(−0.64)	(−0.61)
Average_RnDDISCNum	−0.002	−0.281
	(−0.01)	(−1.53)
State FE	No	Yes
Year FE	Yes	Yes
Adj-R^2	0.289	0.712
N	449	449

This table presents the regression results controlling for potential confounding factors. All continuous variables are winsorized at the top and bottom percentile. The t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. See Appendix B for variable definitions.

to aggregate litigation data at the state-year level. We construct the dependent variable, *Ln*(*LitigationTroll*), as the natural log of one plus the number of patent litigations initiated by patent trolls in a specific state during a given year.

Our untabulated results indicate a significant decline in patent litigation brought by patent trolls to district courts after the adoption of Anti-Troll laws. These results provide evidence supporting the view that Anti-Troll laws effectively limit the activities of patent trolls and protect local businesses from frivolous patent-infringement claims. Together, these findings help alleviate identification concerns and thus further support the properly identified effect of state Anti-Troll laws on corporate R&D disclosures.

5.7. Heterogeneity analyses

5.7.1. High versus low competition pressure

Previous literature suggests that competition is especially important to R&D disclosures (Cao et al., 2018; Glaeser and Landsman, 2021). When technological competition is intense, innovative disclosure is costly because doing so creates knowledge spillover that can allow technological competitors to use disclosed information to compete against the disclosing firms (Grossman and Helpman, 1991; Anton and Yao, 2004; Bloomfield and Tuijn, 2019). Therefore, we expect firms experiencing greater technological competition are less likely to disclose R&D information after the passage of Anti-Troll laws. Following prior literature, we construct the first technological competition *Tech_Comp1* as an indicator variable that equals 1 if the number of patent citations the firm receives is above sample median, and 0 otherwise. Following Arts et al. (2021), we employ another measure of technological competition, *Tech_Comp2*, which is an indicator variable that equals 1 if a firm's average patent similarity score with all succeeding patents is above sample median, and 0 otherwise. We re-estimate the main model and interact *Tech_Comp1* and *Tech_Comp2* with *Anti_Troll*, respectively, as reported in Panel A of Table 6. As shown in columns (1) and (2), the

Table 6
Heterogeneity analyses.

Panel A: high versus low competition pressure

	Dep. = Ln(R&DDisc)		
	(1)	(2)	(3)
Tech_Comp1 × Anti-Troll	−0.103***		
	(−8.44)		
Tech_Comp1	0.055***		
	(5.81)		
Tech_Comp2 × Anti-Troll		−0.071***	
		(−5.94)	
Tech_Comp2		−0.012	
		(−0.75)	
LocalComp × Anti-Troll			−0.038***
			(−3.43)
LocalComp			−0.007
			(−0.71)
Anti-Troll	0.051***	0.055***	0.048***
	(6.72)	(6.82)	(5.86)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.954	0.954	0.954
N	37,929	37,929	37,929

Panel B: high versus low patent troll threats

	Dep. = Ln(R&DDisc)		
	(1)	(2)	(3)
CashRich × Anti-Troll	0.023**		
	(2.16)		
CashRich	0.028***		
	(3.24)		
LegalExpertise × Anti-Troll		−0.043**	
		(−2.50)	
LegalExpertise		−0.009	
		(−0.80)	
Litigiousness × Anti-Troll			−0.109***
			(−6.11)
Litigiousness			−0.048
			(−1.50)
Anti-Troll	0.041***	0.024***	0.046***
	(5.57)	(2.61)	(5.07)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.954	0.959	0.954
N	37,915	24,355	37,929

This table reports the results of heterogeneity analyses. All continuous variables are winsorized at the top and bottom percentile. *, **, and *** indicate that the estimated coefficient is statistically significant at the 10 %, 5 % and 1 % levels, respectively. See Appendix B for detailed variable definitions.

coefficient for *Tech_Comp1* × *Anti-Troll* and *Tech_Comp2* × *Anti-Troll* are significantly negative, suggesting that the effect of Anti-Troll laws and R&D disclosures is weaker for firms facing more intense technological competition.

Additionally, acknowledging the significance of localized knowledge spillovers and competitive dynamics, we examine the effects of Anti-Troll legislation as a function of the geography of competitors (Jaffe et al., 1993; Peri, 2005; Feldman and Kogler, 2010; Baruffaldi and Simeth, 2020). We posit that a firm's disclosure costs are likely to be higher in the presence of heightened local competitive pressures because local rivals are more inclined to exploit the knowledge spillovers to damage the competitive position of the disclosing firms. To identify a firm's local competitors, we leverage the Hoberg-Phillips Text-based Network Industry Classification to identify competitors headquartered in the same state as the focal firm.[18] We construct *LocalComp*, which is an indicator variable that equals 1 if the firm's ratio of local competitors to total competitors is above sample median, and 0 otherwise. As shown in column (3), we find the effect of Anti-Troll laws and R&D disclosures is weaker for firms facing higher degree of local competitive pressure.

5.7.2. High versus low patent troll threats

Research indicates that firms with substantial cash reserves are more attractive targets for patent trolls (Cohen et al., 2019; Bereskin et al., 2023). We thus expect that the protective effects of Anti-Troll laws would be more pronounced for these cash-rich firms. To test our prediction, we condition our main analysis on *CashRich*, which is an indicator variable that equals 1 if the firm's cash holding is above sample median, and 0 otherwise. As reported in column (1) of Panel B of Table 6, we find that the effect of Anti-Troll laws is stronger for cash-richer firms.

Cohen et al. (2019) documents that in-house legal expertise of firms may deter patent troll threats. We thus expect that such firms should be less likely affected by the adoption of anti-troll laws that limit the troll activities. We use corporate executives and directors' legal background as a proxy for firms' legal expertise. We extract data on executives and directors' legal background from Boardex and construct *LegalExpertise*, which equals 1 is a firm has at least one executive or director has a law degree or a legal background (i.e., LLB, BCL, LLM, LLD, or JD) and 0 otherwise (Jiang et al., 2021; Henderson et al., 2023). As shown in column (2), we find that the effect of Anti-Troll laws is weaker for firms with in-house legal expertise, which is consistent with our expectation.

Prior research also indicates that firms can cultivate a reputation for being tough through engaging in costly and visible litigious actions (Agarwal et al., 2009; Toh and Kim, 2012). This is particularly relevant in the context of patent trolls, who typically target firms by exploiting asymmetric costs in litigation, favor settlements over going to court (Cohen et al., 2019) and make claims with little chance of winning in court (Bessen and Meurer, 2013). We thus expect that trolls are less likely to sue firms known for their toughness. Consequently, we expect the impact of Anti-Troll laws on narrative R&D disclosures to be less pronounced for these firms. We construct *Litigiousness*, which is an indicator variable that equals 1 if the firm has prior patent litigation experience and 0 otherwise. We re-estimate the main model and interact *Litigiousness* with *Anti_Troll*. As shown in column (3), the results are consistent with our expectation.

In combination, our results suggest that the effect of Anti-Troll laws adoptions on corporate R&D disclosures is more pronounced for firms which are more exposed to patent troll threats—those with significant financial resources but inadequate legal defences—benefit more from the adoption of Anti-Troll legislations.

[18] See: https://hobergphillips.tuck.dartmouth.edu/.

5.8. Supplementary tests

5.8.1. Other aspects of corporate R&D disclosures

We further explore the effect of Anti-Troll laws on other aspects of corporate R&D disclosures following Merkley (2014): (i) the amount of numerical information in R&D narrative disclosures (*Ln* (*R&DDisc_Num*)); and (ii) the amount of forward-looking narrative R&D disclosures (*Ln*(*R&DDisc_For*)). In particular, *Ln*(*R&DDisc_Num*) is the natural log of one plus total number of R&D-related sentences which also contain numerical information that is not in the form of a date, and *Ln*(*R&DDisc_For*) is the natural log of one plus total number of R&D-related sentences which also contain a set of future tense words (Li, 2010; Merkley, 2014). Untabulated results suggest that firms also modify the numerical and forward-looking information on R&D in response to patent troll threats.

5.8.2. Multiple operating states

Firms may have operations across many states, thereby adding noise to the effect of Anti-Troll adoptions at the headquarters state. To address this concern, we control for the firms' exposure to Anti-Troll legislation in all firms' non-headquarter states by estimating a weighted measure of Anti-Troll legislation exposure that takes into account the sales figure for multistate firms in each state. Firms always have the option to reduce the chance of being targeted by strategically seizing their operation in the state.[19] However, these firms are more likely to forgo their market shares in a state that contributes smaller portion to their overall sales. As such, firms are more likely to be targeted in states with more sales. We follow Li et al. (2018) and Bourveau et al. (2020) to calculate a firm's weighted average of Anti-Troll legislation exposures based on non-headquarter states in terms of sales as follows[20]:

$$Weighted\_AntiTroll\_Nonhq = \sum_{s=1}^{s} \frac{sales_{i,s,t} \times AntiTroll_{s,t}}{\sum_{s=1}^{s} sales_{i,s,t}} \tag{3}$$

where $sales_{i,s,t}$ represents firm *i*'s sales in the non-headquarter state *s* in year *t*, $AntiTroll_{s,t}$ is the Anti-Troll legislation indicator for state *s* in year *t*. We then re-estimate Eq. (1) after controlling for *Weighted_AntiTroll_Nonhq*. Untabulated results show that the coefficients on *Anti-Troll* continue to be significant. These results suggest that our main tests are robust even after controlling for firms' exposure to the Anti-Troll legislation in firms' non-headquarter states.

6. Conclusion

Exploiting the staggered rollout of Anti-Troll laws across 34 states as a plausible exogenous event that diminishes the risk of patent litigation from trolls, we document a significant increase in narrative R&D disclosures by firms post-legislation. This increase is less pronounced in firms facing higher competitive pressure and is more pronounced for firms that are more exposed to patent troll threats and thus most affected by the Anti-Troll legislations (i.e., cash rich firms; firms with less in-house legal expertise; and firms with no prior litigation experience). Further analyses alleviate concerns that the impact of Anti-Troll legislation on disclosures could be attributed to state-specific economic or policy changes. These findings support our argument that patent litigation by trolls constrains the dissemination of narrative R&D

[19] One similar example is that Apple Inc. closed two stores in the Eastern District of Texas in 2019 and it is widely believed that they did so to avoid patent troll litigation cases in patent troll-friendly courts in the Eastern District of Texas. See: https://arstechnica.com/tech-policy/2019/02/apple-closes-two-dallas-stores-in-apparent-bid-to-ward-off-patent-trolls/.

[20] Firm-level sales by state data is obtained from Lexis-Nexis Corporate Affiliations database. This dataset provides detailed establishment-level operational information for U.S. firms that have more than 300 employees and $10 million in revenue.

information by firms.

Our study adds to the literature on R&D information flow. Prior studies mainly focus on downstream patent disclosures (Hegde and Luo, 2017; Chondrakis et al., 2021; Baruffaldi and Simeth, 2020; Dyer et al., 2023; Hegde et al., 2023). We focus on the voluntary disclosure of upstream R&D activities. Previous studies have shown that such disclosures are influenced by firm-specific and managerial traits (e.g., Merkley, 2014; Rawson, 2022; Baruffaldi et al., 2023). Our findings suggest that such disclosures could be hindered by patent litigation risk. Additionally, we build upon research on the negative impacts of patent trolls on firms (e.g., Cohen et al., 2019) by showing that such effects also affect R&D disclosures, crucial for knowledge diffusion and innovation (Murray and O'Mahony, 2007; Romer, 1986).

Finally, we acknowledge several caveats in our study. First, unanticipated economic changes could still impact judicial decisions and firms' disclosure behaviors, despite our efforts to address these concerns. Second, given R&D disclosure's unique, long-term nature, we caution against broadly generalizing our findings to other dimensions of voluntary disclosures. Nonetheless, our research represents a meaningful step forward in understanding how patent litigation influences knowledge dissemination, a crucial factor in fostering aggregate economic growth.

CRediT authorship contribution statement

Rui Huang: Writing – original draft, Formal analysis, Data curation. **Jeong-Bon Kim:** Writing – original draft, Project administration, Conceptualization. **Louise Yi Lu:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization. **Dongyue Wang:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Yangxin Yu:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. R&D disclosures in 10K

For example, the R&D disclosures in Motorola's 2018 10k show that the focus areas for their R&D programs include developing new public safety devices, infrastructure, software, solutions, command center software applications featuring voice, data, and video integrations, public safety broadband solutions utilizing LTE technology, and video devices along with software applications. Financially, R&D expenditures have shown a year-over-year increase: $553 million in 2016, $568 million in 2017, and $637 million in 2018. By the end of 2018, the company employed around 5,000 staff in R&D roles. Moreover, to complement its internal R&D efforts, the company collaborates with joint development and manufacturing partners and outsources certain R&D activities to engineering firms.

The R&D disclosures in Emcore's 2018 10K highlight that to stay competitive, the company believes in the necessity of substantial investment in developing new product features, enhancements, and maintaining global customer satisfaction. R&D expenses have increased over the past three fiscal years, totalling $15.4 million in 2018, $12.5 million in 2017, and $9.9 million in 2016, reflecting a rising percentage of revenue year over year. The R&D budget primarily covers compensation, including stock-based compensation, engineering and prototype costs, depreciation, and other overheads related to product design, development, and testing, with these expenses being recognized as they occur.

Appendix B. Variable definitions

Anti-Troll	An indicator variable which equals 1 if Anti-Troll legislation has been signed into law in a firm's headquarters state before the firm's fiscal year, and 0 otherwise.
Anti-Troll (*3–*)	Equal to 1 for periods three or more years before the law's adoption and 0 otherwise.
Anti-Troll (−*2*)	Equal to 1 for the second year before adoption, and 0 otherwise.
Anti-Troll (−*1*)	Equal to 1 for the year before adoption, and 0 otherwise.
Anti-Troll (*0*)	Equal to 1 in the year the law is adopted, and 0 otherwise.
Anti-Troll (+*1*)	Equal to 1 for the first year after adoption, and 0 otherwise.
Anti-Troll (+*2*)	Equal to 1 for the second year post-adoption, and 0 otherwise
Anti-Troll (*3*+)	Equal to 1 for three or more years following the law's adoption, and 0 otherwise.
R&DDis	The total quantity of R&D narrative disclosures, based on the total number of R&D-related sentences in each 10-K filing.
Ln(*R&DDisc*)	The natural log of 1 plus *R&DDisc*.
Ln(*Non-R&DDisc*)	The natural log of 1 plus number of non-R&D sentences in the 10-K filing.
Size	The natural log of the market value of equity.
R&D	The total value of R&D expenditure divided by total operating expenditure.
adjROA	The value of operating income before R&D and advertising expenses, divided by total assets.
StdEarn	The standard deviation of adjusted return on assets.
Leverage	The ratio of total debt to total assets.
Ln(*Patent_APP*)	The natural log of 1 plus the total number of patents a firm has applied for in a given year.
Ln(*Citation*)	The natural log of one plus the total number of citations received by the patents applied for in a given year.
Ln(*IndPatent*)	The total number of patent applications of for each industry in a given year.
Litigate	Equal to 1 if the firm is sued for patent infringement within the next three years and 0 otherwise.
IDD	Equal to 1 if the IDD is in effect in the state where the firm is headquartered, and 0 otherwise.
UTSA	Equal to 1 if the firm's headquarters state has enacted the UTSA, and 0 otherwise.
Non-Compete	The enforceability index of state-level non-compete agreements developed by Garmaise (2011) and later extended by Ertimur et al. (2018).
Other-State-Initiatives	Equal to 1 if the firm's headquarters state has adopted the initiatives aimed at promoting local innovation, and 0 otherwise.
AntiTroll_Placebo	Equal to 1 if pseudo Anti-Troll legislation is in effect in a firm's headquarters state, and 0 otherwise.
Anti-Troll Adoption	Equal to 1 if the Anti-Troll law is in effect in the state-year, and 0 otherwise.
GDPGrowth	GDP growth rate at the state level.
Ln(*Income per capita*)	The natural log of income per capita at the state level.

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(*continued*)

Unemployment rate	State-level unemployment rate.
Ln(*LitigationTroll*)	The natural log of one plus the number of patent litigations initiated by patent trolls in a specific state during a given year
Tech_Comp1	Equal to 1 if the number of patent citations the firm receives is above sample median, and 0 otherwise.
Tech_Comp2	Equal to 1 if a firm's average patent similarity score with other patents is above sample median, and 0 otherwise.
LocalComp	Equal to 1 if the firm's ratio of local competitors to total competitors is above sample median, and 0 otherwise. We leverage the Hoberg-Phillips Text-based Network Industry Classification to identify competitors headquartered in the same state as the focal firm's local competitors.
CashRich	An indicator variable that equals 1 if a firm's cash holding is above sample median, and 0 otherwise.
LegalExpertise	An indicator variable that equals 1 if a firm has at least one executive or director has a law degree or a legal background (i.e., LLB, BCL, LLM, LLD, or JD), and 0 otherwise.
Litigiousness	Equal to 1 if the firm has prior patent litigation experience, and 0 otherwise.
Ln(*R&DDisc_Num*)	The natural log of 1 plus the number of R&D-related sentences which also contain numerical information that is not in the form of a date.
Ln(*R&DDisc_For*)	The natural log of 1 plus the number of R&D-related sentences which also contain a set of future tense words.
Average_RnDDISC	Firm-level *Ln*(*R&DDisc*) averaged at the state level in a given year.
Average_RnDDISCNum	Firm-level *Ln*(*R&DDisc_Num*) averaged at the state level in a given year.
Average_RnDDISCFor	Firm-level *Ln*(*R&DDisc_For*) averaged at the state level in a given year.
Weighted_AntiTroll_Nonhq	A firm's weighted average of Anti-Troll legislation exposures based on non-headquarter states in terms of sales

Appendix C. Narrative R&D disclosure key words and phrases

research and development	breakthrough in
R&D	developing new technologies
product development	development of proprietary technology
research, development	established a collaboration
research, engineering, and development	projects in development
research and product development	completion of key milestones
research development	continuing development of
research project	preclinical development
research and evaluation project	preclinical data
research program	evaluating the potential of
research collaboration	clinical data
research facility	clinical development
research facilities	clinical program
research initiative	clinical study
research venture	safety study
research center	pilot study
conduct research	announced a collaboration
new technology	joint venture to develop
joint research	collaborative initiative
develop technology	collaborative research
entering development	research collaborative
developing new products	new patent
development of new products	applied for patent
research operations	claims in this patent
research pipeline	filed patent
product engineering	granted a patent
technology development	issued a patent
technical development	received a patent
technology milestone	patent was awarded
technology breakthrough	key patent
technological breakthrough	important patent
breakthrough innovation	patents pending
clinical candidate	applications pending
product candidate	
drug candidate	

Appendix D. Real effects of narrative R&D disclosures

	Dep. =				
	R&D	*Ln*(*Patent_APP*)	*Ln*(*Citation*)	*Ln*(*IndPatent*)	*Litigate*
	(1)	(2)	(3)	(4)	(5)
Ln(*R&DDisc*)	0.016***	0.034***	0.076***	0.058***	0.002*
	(10.28)	(6.84)	(7.45)	(8.44)	(1.75)
Size	−0.003*	0.026***	0.049***	0.020***	0.002**
	(−1.87)	(5.31)	(5.56)	(4.35)	(2.49)
Leverage	−0.005	−0.008*	−0.013*	−0.010	−0.000
	(−1.18)	(−1.93)	(−1.65)	(−1.56)	(−0.60)
adjROA	−0.009***	−0.008**	−0.018***	−0.008*	−0.000
	(−2.79)	(−2.50)	(−3.12)	(−1.71)	(−0.97)
StdEarn	−0.003	0.005**	0.003	−0.002	−0.000

(continued on next page)

(*continued*)

	Dep. =				
	R&D	*Ln(Patent_APP)*	*Ln(Citation)*	*Ln(IndPatent)*	*Litigate*
	(1)	(2)	(3)	(4)	(5)
	(−1.41)	(2.13)	(0.49)	(−0.46)	(−0.90)
R&D		0.007	0.159***	0.006	−0.011***
		(0.24)	(2.89)	(0.37)	(−2.88)
Ln(Non-R&DDisc)	−0.006***	−0.014	−0.031*	−0.032***	0.001
	(−2.98)	(−1.55)	(−1.82)	(−3.15)	(0.93)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.810	0.921	0.871	0.983	0.580
Observations	37,929	37,929	37,929	37,929	74,756

This table reports the results of validation tests. All continuous variables are winsorized at the top and bottom percentile. *, **, and *** indicate that the estimated coefficient is statistically significant at the 10 %, 5 % and 1 % levels, respectively. See Appendix B for detailed variable definitions.

References

Agarwal, R., Ganco, M., Ziedonis, R.H., 2009. Reputations for toughness in patent enforcement: implications for knowledge spillovers via inventor mobility. Strategic Management Journal 30, 1349–1374.

Allen, A., Lewis-Western, M.F., Valentine, K., 2021. The innovation and reporting consequences of financial regulation for young life-cycle firms. Journal of Accounting Research 00, 1–52.

Anton, J.J., Yao, D.A., 2004. Little patents and big secrets: managing intellectual property. Rand J. Econ. 35, 1–22.

Aobdia, D., 2018. Employee mobility, noncompete agreements, product-market competition, and company disclosure. Review of Accounting Studies 23, 296–346.

Appel, I., Farre-Mensa, J., Simintzi, E., 2019. Patent trolls and startup employment. J. Financ. Econ. 133, 708–725.

Arts, S., Hou, J., Gomez, J.C., 2021. Natural language processing to identify the creation and impact of new technologies in patent text: code, data, and new measures. Research Policy 50, 104144.

Awate, K.S., Makhija, M., 2021. A trojan horse inside the gates? Knowledge spillovers during patent litigation. Acad. Manage. J. 65, 1747–1769.

Badertscher, B., Shroff, N., White, H.D., 2013. Externalities of public firm presence: evidence from private firms' investment decisions. J. Financ. Econ. 109, 682–706.

Barron, O.E., Byard, D., Kile, C., Riedl, E.J., 2002. High-technology intangibles and analysts' forecasts. Journal of Accounting Research 40, 289–312.

Baruffaldi, S.H., Simeth, M., 2020. Patents and knowledge diffusion: the effect of early disclosure. Research Policy 49, 103927.

Baruffaldi, S., Simeth, M., Wehrheim, D., 2023. Asymmetric information and R&D disclosure: evidence from scientific publications. Management Science 70, 1052–1069.

Beatty, A., Liao, S., Yu, J.J., 2013. The spillover effect of fraudulent financial reporting on peer firms' investments. J. Account. Econ. 55, 183–205.

Bereskin, F., Hsu, P.-H., Latham, W., Wang, H., 2023. So sue me! The cross section of stock returns related to patent infringement allegations. J. Bank. Financ. 148, 106740.

Bernard, D., Blackburne, T., Thornock, J., 2020. Information flows among rivals and corporate investment. J. Financ. Econ. 136, 760–779.

Bessen, J., Meurer, M.J., 2008. Do patents perform like property? Acad. Manag. Perspect. 22, 8–20.

Bessen, J., Meurer, M.J., 2013. The direct costs from NPE disputes essay. Cornell Law Rev. 99, 387–424.

Bessen, J., Neuhäusler, P., Turner, J.L., Williams, J., 2018. Trends in private patent costs and rents for publicly-traded United States firms. Int. Rev. Law Econ. 56, 53–69.

Bhattacharya, S., Ritter, J.R., 1983. Innovation and communication: Signalling with partial disclosure. Rev. Econ. Stud. 50, 331–346.

Bhattacharya, U., Galpin, N., Haslem, B., 2007. The home court advantage in international corporate litigation. J. Law Econ. 50, 625–660.

Bloomfield, M.J., Tuijn, M., 2019. Do Firms Strategically Announce Capacity Expansions in Response to Heightened Entry Threats? Available at SSRN 3195932.

Boldrin, M., Levine, D., 2002. The case against intellectual property. Am. Econ. Rev. 92, 209–212.

Bourveau, T., Lou, Y., Wang, R., 2018. Shareholder litigation and corporate disclosure: evidence from derivative lawsuits. Journal of Accounting Research 56, 797–842.

Bourveau, T., She, G., Žaldokas, A., 2020. Corporate disclosure as a tacit coordination mechanism: evidence from cartel enforcement regulations. Journal of Accounting Research 58 (2), 295–332.

Brown, J.R., Martinsson, G., 2018. Does transparency stifle or facilitate innovation? Management Science 65, 1600–1623.

Bryant, T.L., 2012. The America invents act: slaying trolls, limiting joinder. Harvard Journal of Law & Technology 25 (2), 687–710.

Bushman, R.M., Smith, A.J., 2001. Financial accounting information and corporate governance. J. Account. Econ. 32, 237–333.

Callaway, B., Sant'Anna, P.H.C., 2021. Difference-in-differences with multiple time periods. J. Econ. 225, 200–230.

Cao, S.S., Ma, G., Tucker, J.W., Wan, C., 2018. Technological peer pressure and product disclosure. The Accounting Review 93, 95–126.

Chambers, D., Jennings, R., Thompson, R.B., 2002. Excess returns to R&D-intensive firms. Review of Accounting Studies 7, 133–158.

Chandler, M., 2013. Abusive Patent Litigation: The Impact on American Innovation & Jobs, and Potential Solutions. United States House of Representatives Judiciary Subcommittee on Courts, Intellectual Property and the Internet 113th Congress.

Chen, T.-Y., Zhang, G., Zhou, Y., 2018. Enforceability of non-compete covenants, discretionary investments, and financial reporting practices: evidence from a natural experiment. J. Account. Econ. 65, 41–60.

Chen, F., Hou, Y., Qiu, J., Richardson, G., 2023a. Chilling effects of patent trolls. Research Policy 52, 104702.

Chen, J.Z., Kim, Y., Yang, L.L., Zhang, J.H., 2023b. Information transparency and investment in follow-on innovation. Contemp. Account. Res. 40, 1176–1209.

Cho, H., Muslu, V., 2021. How do firms change investments based on MD&A disclosures of peer firms? The Accounting Review 96, 177–204.

Choi, J.P., 1998. Patent litigation as an information-transmission mechanism. Am. Econ. Rev. 88, 1249–1263.

Chondrakis, G., Serrano, C.J., Ziedonis, R.H., 2021. Information disclosure and the market for acquiring technology companies. Strateg. Manag. J. 42, 1024–1053.

Clarkson, P.M., Kao, J.L., Richardson, G.D., 1999. Evidence that management discussion and analysis (MD&A) is a part of a firm's overall disclosure package. Contemp. Account. Res. 16, 111–134.

Cohen, L., Gurun, U.G., Kominers, S.D., 2016. The growing problem of patent trolling. Science 352, 521–522.

Cohen, L., Gurun, U.G., Kominers, S.D., 2019. Patent trolls: evidence from targeted firms. Manag. Sci. 65, 5461–5486.

Council of Economic Advisers (CEA), 2016. The patent litigation landscape: recent research and development. Available at: https://obamawhitehouse.archives.gov/sites/default/files/page/files/201603_patent_litigation_issue_brief_cea.pdf.

Crampes, C., Langinier, C., 2002. Litigation and settlement in patent infringement cases. Rand J. Econ. 33, 258–274.

Darrough, M.N., Stoughton, N.M., 1990. Financial disclosure policy in an entry game. J. Account. Econ. 12, 219–243.

Dayani, A., 2023. Patent trolls and the market for acquisitions. J. Financ. Quant. Anal. 58, 2928–2958.

DeSisto, R., 2015. Vermont vs. the patent troll: is state action a bridge too far notes. Suffolk University Law Review 48, 109–130.

Diamond, D.W., Verrecchia, R.E., 1991. Disclosure, liquidity, and the cost of capital. J. Financ. 46, 1325–1359.

Durnev, A.R.T., Mangen, C., 2009. Corporate investments: learning from restatements. Journal of Accounting Research 47, 679–720.

Dyer, T.A., Glaeser, S., Lang, M.H., Sprecher, C., 2023. The effect of patent disclosure quality on innovation. J. Account. Econ. 77 (2-3), 101647.

Easley, D., O'Hara, M., 2004. Information and the cost of capital. J. Financ. 59, 1553–1583.

Entwistle, G.M., 1999. Exploring the R&D disclosure environment. Account. Horiz. 13, 323–342.

Ertimur, Y., Rawson, C., Rogers, J.L., Zechman, S.L.C., 2018. Bridging the gap: evidence from externally hired CEOs. Journal of Accounting Research 56, 521–579.

Executive Office of the President (EOP), 2013. Patent assertion and U.S. innovation. Available at: https://obamawhitehouse.archives.gov/sites/default/files/docs/patent_report.pdf.

Feldman, R., Frondorf, E., 2015. Patent demands and initial public offerings. Stanford Technology Law Review 19, 52–92.

Feldman, M.P., Kogler, D.F., 2010. Chapter 8 - stylized facts in the geography of innovation. In: Hall, B.H., Rosenberg, N. (Eds.), Handbook of the Economics of Innovation, pp. 381–410. North-Holland.

Francis, J., Philbrick, D., Schipper, K., 1994. Shareholder litigation and corporate disclosures. Journal of Accounting Research 32, 137–164.

Frankel, R., Lee, J., Lemayian, Z., 2018. Proprietary costs and sealing documents in patent litigation. Review of Accounting Studies 23, 452–486.

Fried, T.S., 2004. Maintaining the home court advantage: forum shopping and the small business client. Transactions: The Tennessee Journal of Business Law 6, 419–434.

Fromer, J.C., 2008. Patent disclosure. Iowa Law Review 94, 539–606.

Fu, R., Kraft, A., Tian, X., Zhang, H., Zuo, L., 2020. Financial reporting frequency and corporate innovation. J. Law Econ. 63 (3), 501–530.
Gao, B., Guo, F., Lisic, L.L., Omer, T., 2023. Enforcement of non-compete agreements, outside employment opportunities, and insider trading. Contemp. Account. Res. 40, 1250–1279.
Garmaise, M.J., 2011. Ties that truly bind: noncompetition agreements, executive compensation, and firm investment. The Journal of Law, Economics, and Organization 27, 376–425.
Giebel, M., 2021. Patent Enforcement and Subsequent Innovation. Available at SSRN 3992810.
Glaeser, S., 2018. The effects of proprietary information on corporate disclosure and transparency: evidence from trade secrets. J. Account. Econ. 66, 163–193.
Glaeser, S.A., Landsman, W.R., 2021. Deterrent disclosure. Account. Rev. 96, 291–315.
Glaeser, C.K., Glaeser, S., Labro, E., 2022. Proximity and the management of innovation. Management Science 69, 3080–3099.
Glaeser, S., Schonberger, B., Wasley, C.E., Xiao, J.J., 2023. Private information acquisition via freedom of information act requests made to the securities and exchange commission. The Accounting Review 98, 229–255.
Goodman-Bacon, A., 2021. Difference-in-differences with variation in treatment timing. Journal of Econometrics 225, 254–277.
Grabowski, H.G., Baxter, N.D., 1973. Rivalry in industrial research and development: an empirical study. J. Ind. Econ. 21, 209–235.
Graham, S.J.H., Hegde, D., 2012. Do Inventors Value Secrecy in Patenting? Evidence from the American Inventor's Protection Act of 1999. NYU-Stern School of Business Working Paper.
Graham, J.R., Harvey, C.R., Rajgopal, S., 2005. The economic implications of corporate financial reporting. J. Account. Econ. 40, 3–73.
Griliches, Z., Pakes, A., Hall, B.H., 1986. The Value of Patents as Indicators of Inventive Activity. National Bureau of Economic Research.
Grossman, G.M., Helpman, E., 1991. Trade, knowledge spillovers, and growth. Eur. Econ. Rev. 35, 517–526.
Guiso, L., Parigi, G., 1999. Investment and demand uncertainty. The Quarterly Journal of Economics 114, 185–227.
Guo, R.-J., Lev, B., Zhou, N.A.N., 2004. Competitive costs of disclosure by biotech IPOs. Journal of Accounting Research 42, 319–355.
Hall, B.H., 2002. The financing of research and development. Oxf. Rev. Econ. Policy 18, 35–51.
Hegde, D., Luo, H., 2017. Patent publication and the market for ideas. Management Science 64, 652–672.
Hegde, D., Herkenhoff, K., Zhu, C., 2023. Patent publication and innovation. J. Polit. Econ. 131, 1845–1903.
Henderson, M.T., Hutton, I., Jiang, D., Pierson, M., 2023. Lawyer CEOs. Journal of Financial and Quantitative Analysis 1–53.
Huang, K.G.-L., Li, M.-X., Shen, C.H.-H., Wang, Y., 2022. Escaping the patent trolls: impact of non-practicing entity litigation on firm innovation strategies. Academy of Management Proceedings 2022, 16691.
Jaffe, A.B., Lerner, J., 2011. Innovation and Its Discontents: How Our Broken Patent System Is Endangering Innovation and Progress, and What to Do About It. Princeton University Press.
Jaffe, A.B., Trajtenberg, M., Henderson, R., 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. Q. J. Econ. 108, 577–598.
Jaffe, A.B., Trajtenberg, M., Fogarty, M.S., 2000. Knowledge spillovers and patent citations: evidence from a survey of inventors. Am. Econ. Rev. 90, 215–218.
James, S., Shaver, J.M., 2009. Strategic Motivations for Voluntary Public R&D Disclosures. Working paper. University of Minnesota.
Ji, Y., Tan, L., 2016. Labor unemployment concern and corporate discretionary disclosure. J. Bus. Financ. Acc. 43, 1244–1279.
Jiang, C., Wintoki, M.B., Xi, Y., 2021. Insider trading and the legal expertise of corporate executives. J. Bank. Financ. 127, 106114.
Jones, D.A., 2007. Voluntary disclosure in R&D-intensive industries. Contemp. Account. Res. 24, 489–522.
Kiebzak, S., Rafert, G., Tucker, C.E., 2016. The effect of patent litigation and patent assertion entities on entrepreneurial activity. Res. Policy 45 (1), 218–231.
Kim, J., Valentine, K., 2021. The innovation consequences of mandatory patent disclosures. J. Account. Econ. 71, 101381.
Kim, J., Valentine, K., 2023. Public firm disclosures and the market for innovation. J. Account. Econ. 76, 101577.
Kim, Y., Su, L., Wang, Z., Wu, H., 2021. The effect of trade secrets law on stock price synchronicity: evidence from the inevitable disclosure doctrine. The Accounting Review 96, 325–348.
Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. The Quarterly Journal of Economics 132, 665–712.
Koh, P.-S., Reeb, D.M., 2015. Missing R&D. J. Account. Econ. 60, 73–94.
Kothari, S.P., Laguerre, T.E., Leone, A.J., 2002. Capitalization versus expensing: evidence on the uncertainty of future earnings from capital expenditures versus R&D outlays. Rev. Acc. Stud. 7, 355–382.
Lambert, R., Leuz, C., Verrecchia, R.E., 2007. Accounting information, disclosure, and the cost of capital. Journal of Accounting Research 45, 385–420.
Lang, M., Lundholm, R., 1993. Cross-sectional determinants of analyst ratings of corporate disclosures. Journal of Accounting Research 31, 246–271.
Lanjouw, J.O., Schankerman, M., 2001. Characteristics of patent litigation: a window on competition. Rand J. Econ. 32, 129–151.
Leahy, J.V., Whited, T.M., 1996. The effect of uncertainty on investment: some stylized facts. J. Money Credit Bank. 28, 64–83.
Lee, E., 2015. Patent trolls: moral panics, motions in limine, and patent reform. Stanford Technology Law Review 19, 113–149.
Lemley, M.A., Melamed, A.D., 2013. Missing the forest for the trolls. Columbia Law Rev. 113, 2117–2190.
Lemley, M.A., Shapiro, C., 2005. Probabilistic patents. J. Econ. Perspect. 19, 75–98.
Li, X., 2010. The impacts of product market competition on the quantity and quality of voluntary disclosures. Review of Accounting Studies 15, 663–711.
Li, Y., Lin, Y., Zhang, L., 2018. Trade secrets law and corporate disclosure: causal evidence on the proprietary cost hypothesis. J. Account. Res. 56, 265–308.
Love, B.J., 2012. An empirical study of patent litigation timing: could a patent term reduction decimate trolls without harming innovators. Univ. Pa. Law Rev. 161, 1309–1360.
Lu, J., 2020. Patent Valuations across Markets-Patent Price, Royalty Rate, and Damage Award, Part I: Patent Valuations across Transaction and Licensing Markets. Bloomberg Law.
Lu, H.-Y., Wu Tucker, J., 2012. Nonearnings corporate guidance. Financ. Manag. 41, 947–977.
Mahoney, J.T., Pandian, J.R., 1992. The resource-based view within the conversation of strategic management. Strategic Management Journal 13, 363–380.
Mann, R.J., 2004. Do patents facilitate financing in the software industry. Texas Law Review 83, 961–1030.
Merges, R.P., 2009. The trouble with trolls: innovation, rent-seeking, and patent law reform. Berkeley Technology Law Journal 24, 1583–1614.
Merkley, K.J., 2014. Narrative disclosure and earnings performance: evidence from R&D disclosures. The Accounting Review 89, 725–757.
Mezzanotti, F., 2021. Roadblock to innovation: the role of patent litigation in corporate R&D. Management Science 67, 7362–7390.
Miller, S., Johnson, N., Wherry, L.R., 2021. Medicaid and mortality: new evidence from linked survey and administrative data. The Quarterly Journal of Economics 136, 1783–1829.
Morton, F.M.S., Shapiro, C., 2013. Strategic patent acquisitions symposium: patent assertion entities. Antitrust Law Journal 79, 463–500.
Murray, F., O'Mahony, S., 2007. Exploring the foundations of cumulative innovation: implications for organization science. Organ. Sci. 18, 1006–1021.
Orsatti, G., Sterzi, V., 2024. Patent assertion entities and follow-on innovation. Evidence from patent acquisitions at the USPTO. Ind. Innov. 31, 409–443.
Peri, G., 2005. Determinants of knowledge flows and their effect on innovation. Rev. Econ. Stat. 87, 308–322.
Qiu, B., Wang, T., 2018. Does knowledge protection benefit shareholders? Evidence from stock market reaction and firm investment in knowledge assets. Journal of Financial and Quantitative Analysis 53, 1341–1370.
Rawson, C., 2022. Manager perception and proprietary investment disclosure. Review of Accounting Studies 27, 1493–1525.
Righi, C., 2022. Continuation patents and litigation. Acad. Manag. Proc. 2022, 15683.
Roberts, M.R., Whited, T.M., 2013. Chapter 7 - endogeneity in empirical corporate Finance1. In: Constantinides, G.M., Harris, M., Stulz, R.M. (Eds.), Handbook of the Economics of Finance. Elsevier, pp. 493–572.
Rogers, E., Jeon, Y., 2014. Inhibiting patent trolling: a new approach for applying rule 11. Northwest. J. Technol. Intellect. Prop. 12 (4), 291.
Roin, B.N., 2005. The disclosure function of the patent system (or lack thereof). Harv. Law Rev. 118 (6), 2007–2028.
Romer, P.M., 1986. Increasing returns and long-run growth. Journal of Political Economy 94, 1002–1037.
Roychowdhury, S., Shroff, N., Verdi, R.S., 2019. The effects of financial reporting and disclosure on corporate investment: a review. J. Account. Econ. 68, 101246.
Schwartz, D.L., Kesan, J.P., 2013. Analyzing the role of non-practicing entities in the patent system essay. Cornell Law Rev. 99, 425–456.
Somaya, D., 2003. Strategic determinants of decisions not to settle patent litigation. Strategic Management Journal 24, 17–38.
Somaya, D., Williamson, I.O., Zhang, X., 2007. Combining patent law expertise with r&d for patenting performance. Organization Science 18, 922–937.
Toh, P.K., Kim, T., 2012. Why put all your eggs in one basket? A competition-based view of how technological uncertainty affects a firm's technological specialization. Organization Science 24, 1214–1236.
Tseng, K., Zhong, R., 2024. Standing on the shoulders of giants: financial reporting comparability and knowledge accumulation. J. Account. Econ. 78 (1), 101685.
Verrecchia, R.E., 1983. Discretionary disclosure. J. Account. Econ. 5, 179–194.
Wang, Y., 2023. Trade secrets laws and technology spillovers. Research Policy 52, 104794.
Waymire, G., 1985. Earnings volatility and voluntary management forecast disclosure. Journal of Accounting Research 23, 268–295.
You, H., Zhang, X.J., 2009. Financial reporting complexity and investor underreaction to 10-K information. Review of Accounting Studies 14, 559–586.
Zhong, R., 2018. Transparency and firm innovation. J. Account. Econ. 66, 67–93.