Innovating on a Legal Minefield: How Litigation Risks Shape Firms' Patent Strategies

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Abstract

Firms build new technological capabilities through internal development and external acquisitions. This paper explores how patent litigation risks influence these innovation strategies, offering new insights into how firms respond to uncertainty regarding intellectual property rights (IPR). Leveraging the enactment of the America Invents Act (AIA) in 2012, especially its creation of the Patent Trial and Appeals Board, and using a sample of IT-related firms, we find that a reduced patent infringement litigation risk prompted firms to reduce patenting, especially in exploitative areas, and increase patent acquisitions, particularly in explorative domains. In addition, firms shifted their focus from software patents to hardware patents. The findings underscore that the IPR regime not only shapes firms' patent development and acquisition strategies but also influences the direction of their invention efforts. By revealing firms' strategic responses to the new legislation, this study deepens our understanding of how the evolving benefits and costs of patenting influence how firms pursue innovation.

Keywords: Patent; patent litigation; intellectual property rights; market for technology; the America Invents Act

INTRODUCTION

Patents strengthen the economic incentives to innovate, thereby stimulating innovation and economic growth (Mazzoleni and Nelson, 1998; Lamoreaux and Sokoloff, 2002; Moser, 2005; Hu and Png, 2013). However, as inventions are often difficult to describe and delineate precisely, patents can be ambiguous and create uncertainty about the boundaries of their coverage (Lemley and Shapiro, 2005; Mansfield *et al.*, 1981). Moreover, despite the availability of digitized databases, identifying relevant patents and prior art can be challenging because of idiosyncratic descriptions and variable (or strategic) use of prior art citations. As a result, inventors face the risk of patent infringement litigation (Hagiu and Yoffie, 2013; Moser, 2013). This risk is compounded by the evolving standards of patentability, particularly in emerging technology areas such as software, which increases the likelihood of patents being invalidated or litigated (Feng and Williams, 2024). Indeed, the majority of patent litigation cases occur in Information Technology-related (IT) industries. The fuzzy boundaries and uncertain enforceability of patents also make it difficult for firms to accurately assess their value.

In this study, we explore how firms respond to changes in the risk of patent litigation by adjusting their strategies to develop and acquire patents. Litigation is an integral part of the IPR regime, granting patent holders rights to enforce their patents (Teece, 1986). These rights enable patent holders to pursue legal remedies, such as demanding royalties, to protect against infringement (Lanjouw and Schankerman, 2001). Nonetheless, the inherent complexity of modern inventions and the often ambiguous boundaries of patents can make enforcement challenging (Bessen and Meurer, 2006). This vagueness not only complicates the detection of infringement, leading to potential unintentional infringement, but also affords patent holders considerable discretion in their enforcement actions (Linden and Somaya, 2003). As a result, patent holders may litigate to expropriate rents from alleged infringers, exploiting the legal system to appropriate rents from other firms as opposed to enforcing patents to protect their products and services (Lanjouw and Schankerman, 2001; Somaya, 2003; Reitzig *et al.*, 2007).

A litigious patent environment may increase the costs associated with technology development and commercialization and depress the incentives to invest in R&D (Lanjouw and Schankerman, 2001). In addition, litigation may influence firms' allocation of investments in internal technology development versus external technology acquisitions (Arora *et al.*, 2001; Ziedonis, 2004). When the risk of litigation is high, patents are valuable strategic tools, and firms may develop and acquire defensive patents to protect their product revenues against litigation threats (Cappelli *et al.*, 2023). In contrast, when the risk of litigation decreases, the defensive value of patents is reduced, and firms may refocus their patent strategies on new product development and technology exploration, as opposed to defending existing products and technologies. As the value of different types of patents in the market evolves based on a lower risk of litigation, and as firms shift patent strategies from exploitation to exploration, they are also likely to change the allocation of investments between internally versus externally sourced patents.

Research on patent litigation provides significant evidence of the detrimental impacts of litigation on targeted firms (Bessen *et al.*, 2011; Cohen *et al.*, 2019; Crampes and Langinier, 2002; Mezzanotti, 2021). Targeted firms often face burdensome settlement and licensing fees, which in turn compel them to reduce research and development (R&D) investments and adopt more defensive innovation strategies (Abrams *et al.*, 2019; Huang *et al.*, 2024; Kiebzak *et al.*, 2016; Cohen *et al.*, 2019). The effects of litigation, however, extend beyond the direct litigants, affecting firms within the same technology domain (Agarwal *et al.*, 2009; Paik and Zhu, 2016). Even those not directly involved in litigation often reorient their innovation strategies to mitigate potential risks (Huang *et al.*, 2024). For instance, firms may strategically reduce citations to previously litigated patents to avoid drawing attention, leading to a chilling effect on industry-wide knowledge sharing (Huang *et al.*, 2024). This widespread defensive posture in response to litigation threats can stymie knowledge diffusion and hinder innovation, even among firms not directly involved in legal disputes (Cockburn and MacGarvie, 2009; Gans and Stern, 2010). Despite these well-documented effects, we do not know how firms adjust their patent development and acquisition strategies in response to changes in litigation risk. A deeper understanding of the effects of litigation risks is crucial, as invention activity can have lasting implications for firms' competitive strategies and market performance, as well as growth and technological change in the broader economy (Ceccagnoli, 2009; Helfat and Peteraf, 2003).

This study investigates how patent litigation risks influence firms' decisions regarding patenting and patent acquisitions, as well as their activities across different technological areas. We focus on IT-related firms and find that as patent litigation risks decrease, firms significantly reduce their patent applications, especially in areas where patents serve primarily defensive purposes, such as exploitative and software-intensive domains. In contrast, firms increase their patent acquisitions, particularly in explorative and hardware domains. This shift from internal development toward external acquisition, and from defensive strategies toward growth-oriented ones, indicates that firms reallocate resources to bolster innovation when legal concerns are reduced. These findings underscore the role of legal risk reduction in fostering technological expansion.

This study makes three main contributions to the patent strategy literature. Firstly, to our knowledge, this study is the first to demonstrate that a decrease in patent litigation risks leads firms to pivot from in-house patenting toward patent acquisitions in the market for technology (Somaya, 2012), thereby illuminating how legal uncertainty shapes the balance between internal development and external sourcing. Second, this study expands our understanding of the broader impact of patent litigation by showing that reduced litigation risks trigger strategic adjustments not only in directly litigated firms but also in those exposed to litigation risks by operating in related technological areas and associated patent markets (Chen *et al.*, 2023; Cohen *et al.*, 2019; Mezzanotti, 2021). Third, we show that reduced litigation risks encourage firms' patent acquisitions, particularly in explorative areas, thereby emphasizing the importance of efficient legal institutions in fostering technology exploration

(Arora and Ceccagnoli, 2006; Gans *et al.*, 2008; Aydin Ozden and Khashabi, 2023). Together, these contributions highlight the interconnected effects of litigation risks on firms' patent strategies and technology market dynamics, offering managerial insights into how innovating firms can adapt to evolving legal landscapes.

THEORY AND HYPOTHESES

2.1 Patent Litigation Risk on Firm Patent Strategy

Patent litigation is a pivotal factor shaping firms' innovation strategies. It influences decisions not only about whether to patent new technologies but also about what innovations to develop for the product market (Awate and Makhija, 2022; Conti *et al.*, 2024). High risks of litigation, characterized by significant legal costs and potential disruptions to R&D or sales, often drive firms to adopt defensive patent strategies (Hegde *et al.*, 2009; Ziedonis, 2004). To deter lawsuits, firms tend to focus on building patent portfolios as a shield against potential legal threats (Hall and Ziedonis, 2001; Clarkson and Toh, 2010). However, as litigation risk decreases, firms' strategic assessments shift, affecting their patenting and patent acquisition behavior.

Opportunities for aggressive patent litigation arise partly from the asymmetrical costs borne by plaintiffs and defendants (Cohen *et al.*, 2016, 2019; Reitzig *et al.*, 2007). While both parties incur direct legal costs, defendants often face additional, substantial indirect expenses (Bessen and Meurer, 2012). Direct costs typically encompass filing fees, attorneys' fees, and charges associated with examining patent scope. Beyond these direct costs, defendants must also contend with potential impacts on their market value and revenue losses that could arise from product or service recalls and damage payments (Bessen *et al.*, 2011). Consequently, to circumvent the burden of prolonged and expensive litigation and mitigate the significant indirect costs associated with the legal process, targeted firms often opt to settle with plaintiffs (Cohen *et al.*, 2016) and change the direction of innovation to avoid future litigation risks (Huang *et al.*, 2024; Lerner, 1995).

While settlement is the outcome of most patent lawsuits, firms' strategies for responding to such lawsuits differ based on the types of plaintiffs. Patent litigation plaintiffs fall into two primary categories: practicing entities (PEs) and patent assertion entities (PAEs). PEs, such as well-known technology companies Apple, Microsoft, and Samsung, typically file lawsuits to curb competition, affecting mainly direct competitors with limited spillover to other firms (Paik and Zhu, 2016). In contrast, PAEs do not produce any goods and focus on amassing patents with the sole intention of monetizing the patents via licensing, which often requires filing infringement lawsuits (Chari *et al.*, 2022; Cohen *et al.*, 2016). As such, traditional defensive strategies employed against PE litigation are frequently ineffective against PAEs. PAE-initiated lawsuits tend to be more opportunistic, targeting cash-rich firms often without regard to actual infringement (Cohen *et al.*, 2019, 2016). The likelihood of litigation of a patent held by a PAE is significantly higher—sixfold greater—than the overall likelihood of litigation (Feng and Jaravel, 2020). Given the increasing prevalence of PAE activities, the risks of PAE litigation has become a significant risk factor for firms' innovation strategy (Kiebzak *et al.*, 2016). PAE litigation is a particularly costly aspect of operating in IT-related industries, draining R&D budgets and diverting innovation efforts to safer domains (Huang *et al.*, 2024).

As the risk of litigation decreases, firms have an opportunity to refine their patent strategies. Firstly, firms may shift away from defensive patenting. Under a high litigation risk, firms often use patents as a defensive mechanism to protect existing technologies and to gain leverage in potential disputes (Cohen *et al.*, 2000). This approach requires significant resource allocation, potentially diverting efforts from innovation activities toward legal risk management (Hall and Ziedonis, 2001). As a result, firms in highly litigious environments may be hesitant to invest aggressively in new technologies, concentrating their innovation strategies on protecting existing stakes in the product market. As concerns about legal disputes weaken, the urgency to maintain defensive patent portfolios diminishes, allowing firms to focus more on technologically valuable patents. This shift reflects a broader strategic adjustment as firms realign their innovation activities to a lower-risk environment, prioritizing technological value and directing efforts toward inventions that offer product market benefits rather than sheer defensive value.

Secondly, firms may shift to external acquisitions when the risk of litigation is reduced. In-house patenting may be more advantageous than acquiring patents under high litigation risks (Ziedonis, 2004). The economic value of a patent is intricately tied to its application within a specific technological or competitive landscape (Teece, 1986). Litigation elevates the risk of technologies becoming blocked or invalidated. In this scenario, developing in-house patents may allow firms to build more comprehensive "patent thickets" that provide the portfolio of complementary patents needed to navigate legal challenges (Earl, 1996). Externally acquired patents may be difficult to identify or acquire for that specific purpose (Chen *et al.*, 2023). Hence, under high litigation risk, the advantages of in-house patenting are more pronounced, while a lower litigation risk reduces the need for in-house patenting, making external patent acquisitions relatively more attractive.

Thirdly, firms often use patenting as a strategic tool to signal technological capability and market leadership, particularly in highly competitive environments (Hoenig and Henkel, 2015; Levitas and McFadyen, 2009; Hsu and Ziedonis, 2013). When the risk of litigation is high, intensive patenting signals the focal firms' deep technological capability in the domain, deterring competitors or legal challenges. However, as the litigation risk declines, the signaling function of internal patenting becomes less critical, reducing firms' motivation to file patents for signaling purposes. This shift further contributes to the decline in overall patenting activity, as firms no longer feel the need to patent aggressively to maintain market perceptions of strength.

Consequently, as the risk of litigation decreases, firms reduce defensive patenting, reallocate resources toward technological innovations that have commercial value, and lower their patenting expenditures. This strategic shift leads to a decrease in overall patenting, reflecting a more efficient and innovation-driven allocation of resources.

Hypothesis 1a. *Firms reduce their patenting as patent litigation risk decreases.*

As mentioned above, in-house development has several advantages when the risk of patent litigation is high. Litigation is common when patents are highly enforceable and, therefore, very valuable. Strong enforceability encourages patenting (Hall, 2007). However, as the risk of litigation is reduced and the need for defensive patenting decreases, patents become strategically less valuable. As the overall value of patents decreases, the market valuations of traded patents are also likely to decrease, allowing firms to acquire a larger number of patents within the same R&D bugdet. This makes patent acquisition relatively more cost-efficient compared to patenting. Furthermore, the reduced risk of litigation may allow firms to spend a larger share of the R&D budget on technology expansion instead of legal risk mitigation.

With a reduced litigation risk, firms may view patent acquisitions as an efficient means to expand their technological portfolios and competitive advantages. Patent acquisitions allow firms to quickly integrate new technologies without the delays associated with developing, filing, and enforcing patents internally. Acquired patents are often already legally validated, meaning their claims are less likely to be contested. These patents come with established legal rights, providing firms with clearer protection and reducing the burden of legal due diligence. The increased speed of integration becomes even more appealing in a low-risk legal environment, where firms can focus on the product market benefits of acqured technologies rather than devising defensive strategies. In such an environment, firms are also more likely to pursue patent acquisitions in emerging and strategic areas with high growth potential. Acquisitions enable firms to diversify their technological bases and explore new markets with fewer legal barriers to entry (Demsetz, 1982). As a result, firms can allocate more resources toward acquiring technologies that align with future growth opportunities, capitalizing on a legal landscape that poses fewer legal challenges to patent innovation.

In summary, a lower litigation risk shifts firms' strategic priorities toward patent acquisition as an efficient means of expanding technological assets. The reduced legal exposure and lower patent values make acquisitions relatively more feasible within the R&D budget, enabling firms to enhance their innovation capabilities while maintaining IP protection.

Hypothesis 1b. *Firms increase the number of patent acquisitions as patent litigation risk decreases.*

2.2 Explorative vs. Exploitative Areas

While a reduced litigation risk prompts firms to decrease patenting and increase patent acquisitions, it also shifts the focus between technology exploration and exploitation. Prior literature on innovation highlights differences between explorative and exploitative innovation, each with its own set of benefits and associated risks (Gupta *et al.*, 2006; Katila and Ahuja, 2002; March, 1991; Uotila *et al.*, 2009). Specifically, explorative innovation, characterized by the pursuit of new knowledge and technologies, typically entails higher risks and costs, but offers the potential for significant future revenues (Levinthal and March, 1993; March, 1991). In contrast, exploitative innovation typically focuses on improving and refining existing technologies within well-established technology domains (Fleming, 2001; Gupta *et al.*, 2006; He and Wong, 2004). While exploitative areas generally have clearer patent boundaries, they are also highly competitive (Stagni *et al.*, 2021) and more prone to patent disputes. Firms focused on exploitative innovation are more likely to engage in defensive patenting to protect their existing market positions and prevent competitors from gaining legal advantages (Reitzig, 2004). However, as litigation risks diminish, defensive patenting in exploitative areas becomes less critical.

Explorative areas involve pursuing novel, uncertain, and emerging technologies, where the innovation outcomes are less predictable (Levinthal and March, 1993; March, 1991). These areas are often less well-defined, making them less conducive to defensive patenting and more aligned with growth opportunities. Hence, even with lower litigation risks, firms continue to patent in explorative areas to secure footholds in new markets, attract partnerships, or gain early competitive advantages (Katila and Ahuja, 2002). Patents in these areas, representing substantial technological shifts, are valuable for their potential to launch new products or open new markets and create significant competitive differentiation.

In contrast, exploitative patenting is often driven by strategic considerations such as reinforcing existing market shares, extending product life cycles, maintaining competitive barriers, and enhancing negotiation leverage in defense against potential infringement claims (Ziedonis, 2004). In a high-risk environment, firms actively patent in these areas to deter litigation by competitors who might seek to challenge their market dominance (Conti *et al.*, 2024). For instance, firms are likely to be sued right before the release of a new product (Hagiu and Yoffie, 2013). Therefore, firms may consider it essential to patent incremental improvements in their core technologies to protect against potential legal challenges. However, in a low-risk environment, firms perceive less need to secure patents for minor enhancements, as the threat of lawsuits over these technologies weakened whereas the internal cost of patenting has remained the same.

Firms in low-risk environments thus become more selective about filing new patents in exploitative domains, focusing on more significant advancements with clear strategic benefits. As exploitative patenting tends to involve more frequent and incremental filings that require continuous resource investment, firms will seek to optimize their resource allocation by reducing the frequency of such filings. Conversely, explorative patents typically involve more significant technological advances and represent larger investments with higher potential returns. Thus, firms are more likely to sustain patenting efforts in explorative areas even as a lower litigation risk dampens the overall value of patenting.

In summary, as the risk of litigation decreases, firms shift away from exploitative patenting, which is likely to generate defensive benefits. At the same time, firms maintain or even increase their efforts in explorative patenting, as these areas align with long-term strategic growth and innovation potential, unaffected by the lower threat of legal disputes.

Hypothesis 2a. *Firms reduce their patenting in exploitative areas relative to their patenting in explorative areas as patent litigation risk decreases.*

Patent acquisitions in explorative technologies typically involve emerging technologies that offer access to new markets and significant growth opportunities. However, patenting in a new domain can entail risks of inadvertently infringing on unknown patents. Therefore, explorative acquisitions can become relatively more attractive than in-house patenting when the overall risk of patent litigation is reduced. This shift enables firms to pursue patents that can drive substantial technological advancements without the burden of managing the challenges of patenting. Explorative patent acquisitions can offer higher growth potential and greater opportunities for breakthroughs, aligning well with firms' innovation goals in a lower-risk environment. As a result, firms can accelerate technological diversification and respond rapidly to new market opportunities (Boldrin and Levine, 2013). With fewer legal barriers, firms are more confident in pursuing explorative technologies when the benefits of pioneering in new areas outweigh the risks of legal disputes.

In contrast, as litigation risk diminishes, the defensive motivation for patent acquisitions declines, and firms no longer need to expand their portfolios solely to defend existing technological strongholds (Rudy and Black, 2018). The strategic value of exploitative patents decreases accordingly. Even though the cost of acquiring exploitative patents may be reduced in a low-risk environment, their strategic appeal may not increase.

Overall, as litigation risk decreases, firms shift their acquisition focus toward explorative patents, driven by the opportunity to capitalize on high-impact technologies with fewer legal concerns and lower market values. This proactive pursuit of explorative technologies enables firms to seize growth opportunities in emerging domains, aligning their patent acquisition strategies with the potential for long-term innovation and competitive advantage.

Hypothesis 2b. *Firms increase their patent acquisitions in explorative areas relative to their acquisitions in exploitative areas as patent litigation risk decreases.*

2.3 Software-related and Hardware-related Domains

Software patents are disproportionately involved in infringement lawsuits. These patents often have broader and more ambiguous claims, making them frequent targets of disputes and legal challenges. In a high-risk environment, firms patent in software domains as a defensive strategy, aiming to establish broad claims that deter litigation or provide leverage in negotiations. The low barriers to entry and the high imitability of software inventions further drive firms to build extensive patent portfolios, focusing more on legal protection than on strategic differentiation. In such litigious settings, firms rely on software patents to safeguard proprietary algorithms, interfaces, or processes from infringement, and to create freedom to operate without being sued for infringement by others.

However, as the patent litigation risk decreases, the urgency for extensive defensive patenting in software diminishes. With lower legal threats, firms may no longer feel compelled to maintain large software portfolios solely for defense. Instead, they become more selective, choosing to patent only those software inventions that offer clear strategic or commercial value. As a result, firms allocate resources more efficiently, reducing their patenting efforts in software and focusing instead on innovations with substantial strategic potential.

In contrast, hardware patents are likely to have relatively clearer technological boundaries and standards for patentability. This makes hardware patents less prone to litigation challenges and gives firms greater confidence in filing them. The more well-defined nature of hardware patents reduces the risk of unintentional infringement, making them more stable forms of IP protection, relative to software patents. As litigation risks decrease, the strategic benefits of hardware patents remain largely unaffected. Though the reduction in transaction costs may generally reduce the attractiveness of any type of patenting, firms may not reduce hardware patenting as much as software patenting.

Overall, as patent litigation risk decreases, firms reassess the strategic necessity of software patents and shift their focus toward hardware patents, where protection is longer-lasting and offers clearer strategic leverage. This adaptation results in a relative decline in software patenting, reflecting firms' efforts to optimize innovation protection in a more stable legal environment.

Hypothesis 3a. *Firms reduce their patenting in software domains relative to their patenting in hardware domains as patent litigation risk decreases.*

The relative clarity of hardware patents makes them more attractive for acquisition in a low-risk legal environment. In a lower-risk environment, hardware patent acquisitions provide firms with faster access to market-ready innovations. This makes hardware patent acquisitions increasingly attractive, especially as firms shift from defensive to proactive strategies. Hardware patents offer tangible opportunities for securing technological advancements and future value appropriation, particularly when complemented by other assets the firm already holds. In contrast, while low litigation risks may encourage patent acquisitions in general, firms are less motivated to acquire software patents. These patents often come with less certain protection and less predictable strategic value compared to the more clearly defined hardware patents.

Hypothesis 3b. *Firms increase their patent acquisitions in hardware domains relative to their acquisitions in software domains as patent litigation risk decreases.*

METHODS

3.1 Research Context and Design

We exploit the enactment of the America Invents Act (AIA) of 2012 as a quasi-experiment to empirically test our hypotheses. The AIA has been characterized as the most significant legislative change to the United States patent system since 1952. The AIA introduced several major changes to the U.S. patent system, significantly restricting strategic patent litigation activities (Bryant, 2012). The AIA was passed by Congress and signed into law by President Barack Obama in September 2011, and it was implemented in September 2012.

The AIA implemented various provisions aimed at curtailing opportunistic patent litigation activities. Notably, the AIA strengthened defendants' power to challenge patent validity by broadening channels and simplifying procedures. Firstly, the AIA introduced the Inter Partes Review and revised the procedures for post-grant review to remove poor-quality patents from the system. The Inter Partes Review, conducted at the Patent Trial and Appeal Board (PTAB), scrutinizes the patentability of claims in a patent. Complementing this, the post-grant review process permits challenges to the validity of a patent within the first nine months of its issuance. Given that some patents depend on claims with questionable validity and excessive breadth, these provisions enhance the defendants' ability to contest patents outside conventional court proceedings. PTAB proceedings are quicker and less expensive than court proceedings, making it less demanding to challenge poor-quality patents.

In addition, the AIA changed the rules regarding the joinder of defendants in patent infringement cases, thereby preventing patent holders from targeting multiple unrelated defendants in a single lawsuit. Before the AIA, it was common for opportunistic patent holders to bundle numerous defendants into one lawsuit, a tactic used to maximize potential licensing fee extractions from alleged infringers while minimizing the cost of enforcement. However, section 19(d) of the AIA made it more challenging to join unrelated defendants in the same lawsuit. Defendants can now only be joined in a case if they are involved in the same transaction or occurrence relating to the infringement. This modification was intended to curb opportunistic patent litigation by increasing the financial burden of initiating lawsuits.

Finally, the AIA expanded the scope of the prior user rights defense. This defense safeguards defendants who had commercially utilized the patented method or product for over a year before the patent application was filed. Such a provision offers a defense against unintended infringement claims. Together, these provisions made some aspects of patent litigation most costly for plaintiffs and patent challenges less costly for defendants and third parties, reducing the likelihood of patent validity and making patent enforcement more demanding. As a result, the enactment of the AIA significantly curtailed opportunistic patent litigation and consequently reduced patent litigation risks faced by firms.

Though the AIA applied to all firms patenting in the U.S., its impact was not uniform across all firms. Firms more susceptible to patent litigation, particularly those operating in high-technology sectors, were more likely to be affected by the act. In contrast, firms innovating in less complex and slower-evolving technology fields likely experienced negligible changes due to the AIA (Mezzanotti, 2021). This differential effect enabled us to construct an indicator for the intensity of treatment – litigation exposure – to capture the effect of reduced patent litigation risk. This unique context allowed us to exploit the variation in the intensity of treatment and employ a differences-in-differences (DID) research design to test our hypotheses.

3.2 Data and Sample

To test our hypotheses, we use a panel dataset of publicly listed firms in the U.S., spanning the years 2009 to 2015. The time window placed the implementation of the AIA at its midpoint, with 14 quarters before (2009Q1 - 2012Q2) and 14 quarters after the enactment of the AIA (2012Q3 - 2015Q4). Our dataset was constructed from multiple sources: firm financial and accounting data from COMPUSTAT, patent litigation data from LexMachina, patent transaction data from the United States Patent and Trademark Office (USPTO) reassignment register, and patent information from USPTO and the Patent Statistical Dataset (PATSTAT). As firms operating in high-technology sectors and complex technological landscapes are more likely to struggle with opportunistic patent litigation, we focused on IT-related firms. Specifically, we examined firms in software (SIC 737), computer hardware (SIC 357), semiconductors (SIC 367), telecommunications (SIC 481 and 484), communications equipment (SIC 366), and electronic instruments (SIC 381 and 382) (Benson and Ziedonis, 2009). Furthermore, we limited our sample to innovative firms with at least one patent filing between 2000 and 2015.

We utilized LexMachina to extract patent lawsuit records, which provided detailed information about patent lawsuits, including case title (plaintiff vs. defendant), involved patents, filing dates, courts, and outcomes. From this data, we identified 2,495 public firms subjected to patent litigation during 2009 - 2015.

We collected patent transaction data from the USPTO reassignment register and merged it with firm-specific data from COMPUSTAT using company names. Patent information was sourced from the UVA Darden Global Corporate Patent Dataset, which includes patents registered with the USPTO by publicly listed firms worldwide between 1980 and 2017. We utilized the global company key (GVKEY), a unique company identifier for publicly listed firms in COMPUSTAT, to merge the patent information with COMPUSTAT. Patent technology class information was obtained from the OECD Patent Quality Indicators database, which covers USPTO patents.

Combining data from various sources, our final sample for analysis consists of 817 firms and 20,725 firm-quarter observations from 2009 to 2015.

3.3 Dependent variables

Patenting is the logarithm of one plus the total number of patents applied for by firm i in quarter t. Similarly, *Patent acquisition* is the logarithmic transformation of one plus the total number of patents acquired by firm i in quarter t. Since firms are not required to publicly disclose their patent acquisitions, our patent acquisition data is limited to voluntarily disclosed information (Aydin Ozden and Khashabi, 2023).

To examine the impact of patent litigation risk on the direction of firms' technological innovation, we differentiate between patenting in explorative and exploitative technology areas. For each patent, we focus on its primary technology class and calculate our key variables. Exploitative technology areas are identified by the top three 3-digit Cooperative Patent Classification (CPC) technology classes where a firm's patent applications were concentrated over the previous five years. Conversely, any areas outside these top three are considered as explorative technology areas for the firm (Stagni *et al.*, 2021). Thus, *Explorative (Exploitative) patenting* is the logarithmic transformation of one plus the number of patent applications in explorative (exploitative) technology areas for firm i in quarter t. Likewise, *Explorative (Exploitative) patent acquisition* is the logarithmic transformation of one plus the number of patent acquisitions in explorative (exploitative) technology areas for firm i in quarter t.

Following previous literature (Chung *et al.*, 2019), we identified software patents as patents in the 3-digit CPC technology areas of G06F, G06K, and H04L. Patents in other technology areas were considered as hardware-related. We then constructed *Software (Hardware) patenting* and *Software (Hardware) patent acquisition* for firm i in quarter t.

3.4 Explanatory variable

Post×Risk is our key independent variable for the DID analysis. To measure our independent variable, we created a composite indicator, *Litigation risk*, to quantify the litigation risk to which a focal firm is exposed. *Litigation risk* is a weighted average of patent lawsuits across all technology classes in which the focal firm operates (Mezzanotti, 2021). *Litigation risk* is calculated as follows:

$$\text{Litigation risk}_{i,t} = \sum_{j=1}^{J} (\text{Exposure}_{i,j,t} \times \text{Proportion}_{i,j,t})$$

where $\text{Exposure}_{i,j,t}$ is the number of patent infringement lawsuits in technology class j in the last five years at time t, normalized by the total number of patents involved in patent litigation during the same period. $\text{Proportion}_{i,j,t}$ refers to the percentage of all patents filed by the focal firm in the technology class j relative to all patents the focal firm had filed since 2000. A higher value of *Litigation risk* indicates a greater exposure to the impact of the AIA. As the AIA was implemented in 2012, we calculated *Litigation risk* based on data from 2000 to 2011.

Then, we created a binary time indicator variable, *Post*, which equals 1 for quarters after the implementation of the AIA (2012Q3 - 2015Q4) and 0 for quarters before the AIA (2009Q1 - 2012Q2). We constructed an interaction term of *Post*, and *Litigation risk*, *Post×Risk*, to capture the differential impact of the reduced litigation risk on firms' patent strategies in our DID analysis.

3.5 Control variables

We included a set of firm-level variables to account for alternative explanations of a firm's patent strategy. We use the natural logarithm of gross sales of firm i in year t as the proxy for *Firm size* since larger firms may possess greater resources to invest in patents. To control for the effect of a firm's patent stock, we included *Patent stock* (measured as the logarithmic transformation of one plus the number of patent applications filed in the last three years) when exploring the effect on patent acquisitions. Moreover, we considered firms' litigation experience. Firms with experience in patent disputes are less likely to be influenced by litigation risks. *Litigation experience* is measured by the number of lawsuits initiated by firm i in quarter t. Detailed variable definitions are in Table A1.

3.6 Empirical Strategy

To examine the impact of litigation risk on firms' patent strategies, we conduct firm fixed-effects ordinary least squares (OLS) regressions to test our hypotheses.

As litigation risks vary among firms, the impact of the AIA is unlikely to be uniform across all firms. Specifically, the extent to which a firm is exposed to litigation risk should influence whether and how significantly it adjusts its patent strategies. In general, firms facing higher litigation risk are expected to be more influenced by the AIA compared to those with minimal exposure (Gupta et al., 2021). By leveraging variation in treatment intensity, we aim to identify the impacts of litigation risk. We estimate the following regression model:

$$Y_{i,t} = \alpha_1(\text{Post} \times \text{Risk}_i) + \alpha_2 X_{i,t} + \text{Firm FE} + \text{Year FE} \times \text{Industry FE} + \varepsilon_{it}$$

where $Y_{i,t}$ is the dependent variable for firm i at time t; *Post* is a dummy variable equal to 1 for the period from 2012Q3 onward; Risk_i captures the litigation risk faced by firm i, calculated based on patent litigation over the five years prior to the AIA and patent applications filed during 2000 to 2011; $X_{i,t}$ includes a vector of firm-level control variables; and ε_{it} denotes the error term. The coefficient α_1 captures the impact of reduced litigation risk on firms' patent strategies. Our model includes firm fixed effects to control for unobserved, time-invariant firm heterogeneity, as well as year and industry fixed effects to control for industry-specific trends over time. Robust *SEs* are clustered at the firm level.

Descriptive statistics and correlations for all variables included in the analysis are shown in Table 1. All continuous variables are winsorized at the 2.5th percentile on both tails to mitigate the potential influence of outliers.[1] We calculated variance inflation factors (VIFs) for all variables included in the models. The mean VIFs across all models are all below 5, indicating that multicollinearity is not a concern.

[Insert Table 1 about here]

[1] Results without winsorization are in Appendix Table A2.

RESULTS

4.1 Empirical Results on Patent Strategy

We present results of OLS and Linear Probability Models (LPMs) in Table 2. Models 1 and 2 examine the effect of reduced litigation risk on firm patenting. The coefficients of the interaction term *Post×Risk* are significant and negative (β=-0.511, p<.05; β=-0.463, p<.01), indicating that after the implementation of the AIA, firms reduced their patent filings at both the intensive and extensive margins. Specifically, a one-standard-deviation decrease in patent litigation risk is associated with a relative decrease of approximately 3% in patent applications and a 2.73% reduction in the likelihood of patenting after the AIA. Models 3 and 4 examine the impact of reduced litigation risk on patent acquisitions. The coefficients for the interaction term *Post×Risk* are significant and positive (β=0.278, p<.01; β=0.147, p<.05), indicating that after the AIA, firms increased their investments in patent acquisitions at both the intensive and extensive margins. A one-standard-deviation decrease in exposure to litigation risk is associated with a relative increase of approximately 1.68% in the number of patents acquired and a 0.88% increase in the likelihood of acquiring patents. The contrast between the results in Models 1 and 3 suggests that firms exposed to reduced litigation risks shifted their patent strategies, decreasing their patent applications while increasing their patent acquisitions. These findings lend empirical support for Hypotheses 1a and 1b.

[Insert Table 2 about here]

4.2 Direction of Patent Strategy

Table 3 presents the tests of Hypotheses 2a and 2b examining the influence of reduced litigation risk on firms' patenting and patent acquisition in explorative and exploitative technology areas. We show results of OLS and LPM specifications. Models 1 to 4 examine changes in firm patenting, while Models 5 to 8 focus on firm patent acquisition.

Models 1 and 2 show the results of the impact of reduced litigation risk on firm patenting in explorative technology domains. The coefficients of *Post×Risk* are negative and statistically insignificant (β=0.038, p =.767 β=0.083, p=.282), suggesting that a decrease in litigation risk has no significant effect on firms' patenting in explorative areas. In contrast, Models 3 and 4 report the impact on firm patenting in exploitative technology domains, with both models showing negative and statistically significant coefficients for *Post×Risk* (β=-0.546, p=.014, β=-0.483, p<.001). The results show that after the AIA, firms tended to reduce their patenting in exploitative areas. Specifically, a one-standard-deviation decrease in litigation risk is associated with a relative decrease of approximately 3.22% in the number of exploitative patent applications and about a 2.86% reduction in the likelihood of exploitative patenting. Collectively, the regression coefficients in Models 1-4 show that firms when faced with diminished litigation risks decreased their patenting in exploitative areas compared to explorative areas, lending support to H2a.

In addition, the coefficients for the interaction term *Post×Risk* in Models 5 and 6 are statistically significant and positive (β=0.196, p<.01, β=0.196, p<.01), indicating that reduced litigation risk encouraged firms to increase patent acquisitions in explorative technology areas. In contrast, Models 7 and 8 report statistically insignificant coefficients of *Post×Risk* (β=0.111, p>.05, β=0.069, p>.1). The results show that reduced litigation risk did not significantly affect patent acquisitions in exploitative areas. Specifically, a one-standard-deviation decrease in litigation risk is associated with a relative increase of approximately 1.18% in both the number of patents acquired and the likelihood of acquiring patents in explorative technology classes after the AIA implementation. These results support H2b. Overall, these findings are in line with our expectations that after the AIA, with a reduction in being involved in patent litigation, firms became more inclined to invest in explorative instead of exploitative technology domains, but primarily through patent acquisitions rather than patent applications.

[Insert Table 3 about here]

Table 4 presents the results of testing the effects of reduced litigation risk on firms' patenting in software and hardware domains. The coefficients of Models 1 and 2 for the interaction term *Post×Risk* are significantly negative in both models (β=-0.702, p<0.01,

β=-0.466, p<.01), suggesting that firms facing reduced litigation risks reduce their patenting activities in software-related domains. Specifically, a one-standard-deviation decrease in patent litigation risk will lead to a relative decrease of approximately 4.13% in the number of software-related patent applications and a 2.76% decrease in the likelihood of filing software-related patents after the AIA implementation. However, Model 4 shows a statistically significant negative coefficient for *Post×Risk* in hardware-related domains (β=-0.244, p<0.05), while the coefficient in Model 3 is negative but not significant (β=-0.140, p>0.1).

Additionally, Models 5 and 6 examine the effects on firms' acquisitions of software-related patents. The coefficients for *Post×Risk* are marginally significant in both models (β=0.061, p<.1, β=0.088, p<.1), suggesting a slight tendency for firms to increase patent acquisitions in software-related areas. In contrast, Models 7 and 8 present statistically significant positive coefficients for *Post×Risk* in hardware-related domains (β=0.215, p<.01, β=0.164, p<.01). A one-standard-deviation decrease in patent litigation risk is related to a relative increase of approximately 1.30% in the number of hardware-related patents acquired and a 0.99% increase in the likelihood of acquiring hardware-related patents after the AIA implementation. These findings provide support for Hypotheses 3a and 3b and suggest that firms with reduced litigation risks are likely to decrease patenting in software domains but increase their acquisitions of hardware-related patents.

[Insert Table 4 about here]

4.3 Dynamic Effects

To evaluate dynamic effects and conduct a pre-trend test, we estimate the following specification that includes separate coefficients for each period before and after the implementation of the AIA. Specifically, we run the following regression:

$$Y_{i,t} = \alpha_1 + \sum_{s=-3}^{-1} \beta_s \mathrm{Risk}_i \times \mathrm{Pre}_s + \sum_{k=1}^{4} \gamma_k \mathrm{Risk}_i \times \mathrm{Post}_k + \mathrm{FirmFE} + \mathrm{YearFE} \times \text{ Industry FE} + \varepsilon_{it}$$

where s and k represent the periods before and after 2012, the year when the AIA was implemented. For instance, s = -2 indicates observations taken 2 years before the AIA (i.e., 2010), and $k = 2$ represents observations taken 2 years after (i.e., 2014). The coefficients β_s and γ_k capture dynamic effects for each year. 2012 is excluded and serves as the reference period. Given that firms may need time to adjust their strategies, we expect the treatment impact on patent strategies to strengthen in the years following the AIA implementation.

Figures 1 and 2 display the binned coefficient plots of firm patenting and patent acquisition activities over time, along with the estimated coefficients and 95% confidence intervals. Notably, the pre-treatment coefficients for patenting and patent acquisition are insignificant, indicating that firms with varying levels of litigation risk did not exhibit significantly different trends before the AIA. These temporal patterns are consistent with the assumption of parallel trends. However, the effects of reduced litigation risk on firm patenting and patent acquisition become pronounced after the AIA implementation. The negative effects on patenting are significant for exploitative and software-related patents in the post-treatment years, while positive effects on patent acquisition are significant for explorative and hardware-related patents. Overall, these temporal changes in patenting and patent acquisitions align with our hypotheses. Firms facing reduced patent litigation risks tended to reduce their patenting in exploitative and software-related areas. However, their patent acquisitions increased in explorative and hardware-related areas.

[Insert Figures 1 and 2 about here]

ROBUSTNESS CHECKS AND SUPPLEMENTARY ANALYSES

5.1 Alternative operationalization of the patent litigation risk

One potential concern is that we may not detect an impact of the AIA for firms with few patents when the exposure to patent litigation risk measure is based solely on the distribution of patent portfolios across different technology classes. To address this concern, we used an alternative measure of patent litigation risk based on product similarity between a focal firm and its targeted peers. Product similarity is determined by the extent to which the product descriptions in the 10-K filings of two firms are “similar” (Hoberg and Phillips, 2016). Specifically, we calculated a firm’s patent litigation risk using its product similarity score with peer firms that were targeted in patent lawsuits. We then construct the interaction term, *Post×Risk*, to estimate the impact of reduced litigation risk stemming from product market competitors on firms' patent strategies. The results are in Table 5 and are similar to our main findings. Furthermore, in Appendix Table A3, we measured patent litigation risk using an alternative measure based on a firm's patent citation activities. The findings are also consistent with our hypotheses.

[Insert Table 5 about here]

5.2 Alternative models

As a robustness check, we used the raw counts of patents and estimated Poisson pseudo-likelihood fixed-effects models. As firms may engage in bulk acquisitions of large patent portfolios at one time, we excluded these bulk acquisitions to mitigate the influence of outliers. Results in Table A4 from the count models are similar to those in our main tables. Our findings are robust to these alternative models.

5.3 Heterogeneity of Firm Size

Given that firms of different sizes have different resources, an important dimension of firm heterogeneity is their sizes, which shape their response to changes in patent litigation risks. Large firms typically possess greater slack resources and legal capabilities, insulating them from the day-to-day uncertainties of patent litigation. Even when litigation risk is reduced, these firms may still prioritize accumulating patents for strategic reasons—such as blocking competitors, building larger negotiation arsenals, and bolstering their reputations—rather than responding to legal risk variations. As a result, an institutional reduction in patent litigation risk may not significantly affect large firms' patent strategy. In contrast, small firms often lack the legal expertise and resources to engage in patent litigation, making them more sensitive to legal risks. Small firms may rely on patents as defensive tools to protect themselves from potential litigation. Therefore, we expect that, following the reduction in patent litigation risks, small firms will experience a greater reduction in pressure to invest in defensive patenting strategies and, as a result, will reduce patent applications relatively more than large firms.. In terms of patent acquisitions, large firms, with their more substantial resources, are better equipped to engage in patent acquisitions to expand their portfolios. They also view patents as strategic assets for future development. Small firms, on the contrary, often lack the financial resources to pursue patent acquisitions on the same scale. Even though reduced litigation risks decrease the costs associated with patent acquisitions, large firms are in a better position than small firms to cease the opportunity to invest in patent acquisitions.

Appendix Table A5 presents the results of our analysis. We classify firms with total assets exceeding the median as large, while those with assets below the median are considered small. As results in Panel A show, small firms are more sensitive to changes in patent litigation risks and tend to reduce their defensive patenting investments when such risks decrease. Panel B shows the estimated results of reduced litigation risks on patent acquisitions across large and small firms. The positive effects of reduced litigation risks on patent acquisitions are more pronounced for large firms than for small ones. The subsample analysis further confirms the mechanism we propose.

5.4 Placebo Test

We also conducted a placebo test by replicating our analysis during periods when no major changes occurred in patent-enforcement rules. We expect that absent a significant shock to enforcement, such as the AIA, exposure to litigation risk would not lead to differential changes in firms' patent strategies. Following prior literature (Mezzanotti, 2021), we performed the placebo test in a post-period entirely outside the time frame influenced by the AIA. Specifically, we designated 2009Q4 as the placebo shock time and reconstructed the data, using 8 quarters before and after, including both outcome variables and the litigation risk $Risk_i$. Since no actual enforcement changes occurred around the placebo shock, we expect firms' patent strategies to remain stable during this period. The insignificant results in the Appendix Table A6 are consistent with our expectations.

5.5 Mechanism text on the impact of PTAB

The mechanism that led to the decrease in firms' patenting activities and the increase in patent acquisitions may be that AIA weakened the validity of weak patents that can be used in litigations. Hence, firms active in previously highly litigious environments do not need to invest resources as extensively as before in building patent portfolios for defensive purposes. Instead, they can focus on acquiring more technologically valuable patents. To substantiate this argument, it is important to demonstrate how the AIA affected patent validity.

The AIA introduced the PTAB, which revised post-grant review procedures to allow for easier challenges. If the PTAB indeed reduced expected patent validity, we would expect firms to reduce their patent applications following an increase in firms' use of PTAB. Therefore, we focus on the seven quarters after the establishment of PTAB and before the Alice ruling, from 2012Q3 to 2014Q1, to analyze how the increased number of trials filed at PTAB influenced firms' patenting and acquisition activities within specific technology classes. The results are in Table A7. Models 1 and 2 use Poisson and OLS models to examine the impact of trials filed at PTAB on the total number of patent applications in a given 4-digit CPC technology class. As expected, the results indicate a negative association between the number of trials filed at PTAB and the number of patent applications in the corresponding technology class. These findings suggest that PTAB trials challenged patent validity, leading firms to reduce their patenting investments in those technology classes. However, in Models 3 and 4, the coefficients for the number of trials filed at PTAB on patent acquisitions are statistically insignificant, indicating that the increase in the number of trials filed at PTAB had no significant effect on patent acquisitions. This suggests that while the AIA's PTAB trials influence patent validity in certain technology classes, they do not significantly affect firms' acquisitions of patents. Instead, firms appear to acquire patents regardless of challenges to patent validity. The motivations for patent acquisitions may be broader than just litigation defense, and acquisitions may target patents that have already been validated and, hence, are not at risk of PTAB challenges.

To further examine changes in patent validity caused by PTAB trials, we analyzed the number of PTAB trials filed within our time window. As shown in the Appendix Figure A1, there is an upward trend in PTAB trials filed each quarter from 2012Q3 to 2014Q1, which can be attributed primarily to the AIA, rather than to the impact of the United States Supreme Court's "Alice" decision. This increase continued until 2014Q2, which is the date when the Alice decision provided further clarity and reinforced the role of PTAB, resulting in the number of trials to stabilize. This trend is consistent with our dynamic trend plots, which show that the effects of reduced litigation risk on firms' patent strategies unfolded gradually over time.

Additionally, we examined the distribution of PTAB trials across different technology classes between 2012Q3 and 2014Q1. As shown in the Appendix Figure A2, the top three technology classes with the highest number of PTAB trials were G06Q, H04L, and G06F — fields primarily associated with software-related patents. These findings further support the notion that PTAB trials were especially concentrated in technology areas where patent validity challenges were more frequent, particularly in software-related technologies.

5.6 Timing of the Effects

Since the AIA's passage in September 2011, it garnered considerable media attention and sparked widespread discussion in the industry (Bryant, 2012). To examine the potential chilling effect on firms' patenting activities during the legislative process, we excluded the years 2011 and 2012 from our analysis and employed a restricted sample as a robustness check. The results of the restricted sample are presented in the Appendix Table A8.

In the dynamic trend tests, Figures 1 and 2 show that the effects of reduced patent litigation risk on firm patenting and patent acquisitions began to unfold at the beginning of 2014. We expect that there are two key reasons for this gradual trend: 1) The impact of the AIA itself unfolded gradually, as shown in the Appendix Figure A1, and 2) While firms can adjust their patent acquisitions relatively quickly, they may require more time to modify their patent application strategies. To further explore this lagged effect, we lagged firm patenting for four quarters in the analysis presented in Appendix Table A9. This allows us to examine how patent litigation risks affect patenting strategies over time. However, we did not lag patent acquisitions, as firms are likely able to adjust those more immediately. To mitigate any potential bias from the Alice decision, which could still influence patent litigation during the period under consideration, we limited our analysis to observations between 2010Q4 and 2014Q1, covering seven quarters both before and after the AIA. The results suggest that the impacts of reduced litigation risks on firm patenting unfolded gradually over four quarters, whereas firms appeared to adjust their patent acquisitions more instantaneously.

5.7 Alternative explanation: The Alice Decision

During our time window, the U.S. Supreme Court ruling in Alice Corp. v. CLS Bank International (2014), known as the Alice decision, was issued in 2014Q2, and it had a similar impact on firms' exposure to patent litigation risks as the AIA. Alice established a framework to determine whether an abstract idea could be eligible for patent protection. Specifically, the ruling held that abstract ideas are not patentable unless they include an "inventive concept" that transforms the idea into something more than just the abstract idea itself. This decision had a particularly significant impact on software-related patents.

To explore the effect of patent litigation risks resulting from Alice, we re-ran our analysis covering the period from 2013Q1 to 2015Q4, which spans five quarters before and after Alice. We calculated each firm's exposure to patent litigation risks based on its patent applications from 2000 to 2013 and patent lawsuits filed in the five years before Alice. The results in Appendix Table A10 align closely with our main findings. Specifically, as patent litigation risks decreased due to Alice, firms reduced their patenting activities, especially in exploitative areas and software-related patents. However, because Alice primarily addresses the patentability of abstract ideas, which particularly affects the validity of software patents, its impact on patent acquisitions was limited. These findings provide further evidence that the reduction in patent litigation risks, driven by both the AIA and Alice, has a significant effect on firms' patent application strategies.

Since the AIA and Alice were issued in quick succession, it is challenging to isolate their individual impacts. We expect that both changes in patent law had similar effects on firms' patent litigation risks, with Alice being more closely related to software-related patents. To distinguish the impact of these two rulings, we reran the analyses considering both at the same time. The results are shown in Appendix Table A11. We calculated firms' exposure to patent litigation risks prior to the implementation of the AIA and created two time indicators: *Post* and *Post-Alice*. *Post* equals 1 for periods after the AIA implementation (2012Q3) and 0 otherwise, while *Post-Alice* equals 1 for periods after Alice (2014Q2) and 0 otherwise. We then created two interaction terms, $Post \times Risk$ and $Post\text{-}Alice \times Risk$, to capture the impacts of the AIA and the Alice decision, respectively. As discussed previously, firms may need time to adjust their patenting activities, so we lagged patenting by four quarters. The results show that the reduction in patenting in response to reduced patent litigation risks was more pronounced after Alice, while the increase in patent acquisitions was more pronounced after the AIA, with the exception of hardware-related acquisitions.

DISCUSSION

6.1 Theoretical Implications

This study makes the following contributions to literature on patent strategies and IPRs. Firstly, it provides evidence on how patent litigation influences firms' decisions to develop and acquire patents. By demonstrating that reduced litigation risks lead firms to decrease their patent filings while increasing patent acquisitions, particularly in areas with clearer legal boundaries such as hardware technologies, this research contributes to understanding how legal uncertainties shape firms' innovation strategies. This finding aligns with prior observations that unclear IPR regimes can depress R&D incentives by increasing the costs of managing legal risks (Lemley and Shapiro, 2005; Moser, 2013). The study extends this line of inquiry by showing that legal risks not only deter innovation but also prompt strategic shifts in how firms balance internal development and external sourcing.

Secondly, this study broadens the scope of research on patent litigation by investigating its wider impact beyond the immediate defendant firms and their associated technology areas. Prior studies have largely focused on the direct adverse effects of patent litigation on the firms involved and the specific technological sectors they operate in (Awate and Makhija, 2022; Cumming *et al.*, 2017; Schliessler, 2015). However, there is a lack of insight into how these negative impacts extend to the broader technology domains. Evidence has shown that litigation affects non-litigated firms, leading to indirect losses (Chen *et al.*, 2023) and evolving cooperative strategies, even for those not directly involved in legal disputes (Jones *et al.*, 2021). By examining the effects of a significant reduction in litigation risks, our research uncovers the strategic adjustments of at-risk firms within litigated technology fields, irrespective of their direct involvement in legal cases. The findings suggest that firms strategically realign their innovation strategies in response to changes in litigation risks, highlighting a broader effect of patent litigation that reaches beyond those immediately concerned. Consequently, our paper contributes to the patent litigation literature by highlighting the broader influence on the strategic decisions of firms navigating high-risk technology landscapes.

Thirdly, the study enhances our knowledge of the patent market by illustrating how litigation risks shape firms' engagement in technology acquisition. Prior research has indicated that high search and transaction costs in the patent market can discourage firms from engaging in external technology sourcing (Gans and Stern, 2010). This study advances that line of inquiry by showing that reduced litigation risks increase firms' willingness to engage in technology acquisitions, especially in explorative areas that typically involve higher transaction costs and uncertainty. This finding suggests that legal clarity not only lowers the barriers to acquiring patents but also plays a crucial role in facilitating the commercialization of innovations, improving market efficiency. By linking litigation risk reduction with increased patent acquisitions, particularly in high-potential but risky technology areas, the study offers fresh insights into how firms optimize their innovation strategies in response to changes in the legal environment.

Overall, this study provides a comprehensive analysis of how legal uncertainty influences firms' patent strategy, highlighting the implications of patent litigation risks on firms' defensive patenting and participation in the market for technology. The research offers insights into how firms manage innovation in response to evolving legal landscapes, contributing to ongoing discussions of patent litigation in the strategy literature (Chari *et al.*, 2022; Huang *et al.*, 2024; Hou *et al.*, 2023).

6.2 Practical Implications

Our research also has significant practical implications for policymakers and managers operating in environments with significant litigation risks. Firstly, our study underscores the social costs of litigation on firms' innovation activities (Ganglmair *et al.*, 2021). By demonstrating that firms highly exposed to litigation decrease their reliance on external search and narrow their search scope, we provide empirical evidence on the spillover effect of patent litigation. Policymakers can utilize these findings to guide regulatory reforms and design policies aimed at mitigating the negative consequences of litigation on innovation. AIA appears to have been a step in the right direction.

In addition, our findings may be of interest to managers of firms confronted with litigation risks. Our study emphasizes the importance of monitoring the broader patent landscape in which a firm operates. By understanding the effects of litigation risks, managers can develop flexible strategies that balance the benefits of developing and acquiring patents. This awareness can help firms better anticipate and respond to the challenges posed by patent litigation.

6.3 Limitations and Future Directions

Our study has several limitations that can provide avenues for future research. Firstly, from a theoretical perspective, we focused on the impact of appropriation risks stemming from patent litigation. However, appropriation risks associated with patent litigation may also affect other aspects of firms' innovation strategies, such as their internal search activities or collaboration with other firms. Future research could expand the theoretical scope to investigate the broader implications of appropriation risks associated with patent litigation on firms' innovation processes.

Secondly, while we exploited AIA as an exogenous shock that reduced litigation risk for firms and computed each firm's exposure to the reduction of litigation risk, we did not directly measure the threats perceived by firms (Cohen *et al.*, 2016). To overcome this limitation, future research may employ survey instruments to capture changes in perceived threats when firms face litigation risks.

Thirdly, our study focuses on firms' patent strategy, which may not capture all aspects of firms' innovation strategies. Other forms of external search, such as collaboration with universities or research institutions or informal knowledge exchange, might not be fully reflected in patent data. Patents are intermediate inputs into innovation, and changes in patent strategy may not have a very direct or immediate impact on innovation outcomes. Hence, we are not able to conclusively infer the long-term impact on innovation. Future studies could employ alternative measures of external search or use mixed-method approaches to provide a more comprehensive understanding of how appropriation risks affect firms' innovation activities and outputs.

Fourthly, though firms' choices of developing and acquiring technologies depend on the relative costs of the two options, we do not have direct measures of the costs, especially the price of the patent acquisitions. In addition, licensing could be another method of acquiring technology but not the patent, which we have not discussed. However, we believe our theoretical insights also apply to the licensing scenario in that reduced litigation risk lowers the threat to the validity of licensed patents and may encourage licensing. Future studies may also study how firms decide between licensing and acquiring patents in response to changes in litigation risk.

Lastly, there are aspects of firm heterogeneity that we have not explored, future scholarship can investigate how firms with different litigation experiences and varying technical capabilities may respond to changing litigation risks differently compared to firms that are less experienced or technically capable. This line of inquiry can help provide a more nuanced understanding of the diverse ways in which firms adapt their innovation strategies facing uncertainties in the legal institutions.

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Table 1: Summary Statistics

	Variable	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)
1	Patenting	0.96	1.34	0.00	4.98					
2	Explorative patenting	0.33	0.80	0.00	3.43	0.81				
3	Exploitative patenting	0.90	1.27	0.00	4.70	0.99	0.77			
4	Software patenting	0.48	0.96	0.00	3.85	0.83	0.66	0.84		
5	Hardware patenting	0.76	1.21	0.00	4.60	0.94	0.86	0.93	0.66	
6	Patent acquisition	0.09	0.35	0.00	1.79	0.32	0.30	0.31	0.31	0.29
7	Explorative acquisition	0.05	0.20	0.00	1.10	0.29	0.30	0.28	0.27	0.28
8	Exploitative acquisition	0.06	0.25	0.00	1.39	0.27	0.24	0.26	0.27	0.24
9	Software acquisition	0.02	0.12	0.00	0.69	0.22	0.19	0.22	0.27	0.18
10	Hardware acquisition	0.07	0.27	0.00	1.39	0.31	0.31	0.30	0.28	0.30
11	Risk	0.09	0.06	0.00	0.18	-0.02	-0.12	0.00	0.19	-0.12
12	Firm size	5.70	2.47	0.14	10.73	0.59	0.49	0.58	0.50	0.56
13	Patent stock	2.50	2.14	0.00	7.60	0.90	0.70	0.89	0.72	0.84
14	Litigation experience	0.03	0.24	0.00	4.75	0.11	0.12	0.11	0.12	0.11
	Variable	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	
7	Explorative acquisition	0.83								
8	Exploitative acquisition	0.89	0.58							
9	Software acquisition	0.70	0.51	0.75						
10	Hardware acquisition	0.94	0.85	0.80	0.51					
11	Risk	0.02	-0.01	0.03	0.07	-0.01				
12	Firm size	0.21	0.19	0.18	0.15	0.20	0.07			
13	Patent stock	0.31	0.27	0.26	0.21	0.30	0.01	0.62		
14	Litigation experience	0.09	0.09	0.08	0.08	0.08	0.01	0.06	0.11	

Notes: N=20,725. All continuous variables are *winsorized* at the 2.5^{th} and 97.5^{th} percentiles.

Table 2: The effect of litigation risk on firms' patent strategy (H1)

DV	**Patenting**		**Patent acquisition**	
	(1) OLS	(2) LPM	(3) OLS	(4) LPM
Post×Risk	-0.511	-0.463	0.278	0.147
	(0.026)	(0.000)	(0.004)	(0.038)
Firm size	0.132	0.048	0.001	0.002
	(0.000)	(0.000)	(0.925)	(0.700)
Patent stock	–	–	0.017	0.016
	–	–	(0.000)	(0.000)
Litigation experience	0.003	-0.006	-0.005	-0.004
	(0.719)	(0.195)	(0.661)	(0.692)
Firm FE	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817
Observations	20,725	20,725	20,725	20,725
Adj. R^2	0.886	0.608	0.368	0.328

Notes: DVs of the OLS models are the logarithm of the numbers of patents. DVs of the LPMs are binary variables that equal one if the number of patents is non-zero. Robust standard errors clustered at the firm level; p-values in parentheses.

Table 3: Heterogeneity: Firms' patent strategy in explorative vs. exploitative areas (H2)

	Patenting				**Patent acquisition**			
DV	Explorative (1) OLS	Explorative (2) LPM	Exploitative (3) OLS	Exploitative (4) LPM	Explorative (5) OLS	Explorative (6) LPM	Exploitative (7) OLS	Exploitative (8) LPM
Post×Risk	0.038	0.083	-0.546	-0.483	0.196	0.196	0.111	0.069
	(0.767)	(0.282)	(0.014)	(0.000)	(0.002)	(0.004)	(0.089)	(0.240)
Firm size	0.052	0.024	0.123	0.050	-0.001	-0.000	0.005	0.004
	(0.000)	(0.000)	(0.000)	(0.000)	(0.893)	(0.959)	(0.291)	(0.361)
Patent stock	–	–	–	–	0.009	0.010	0.009	0.009
	–	–	–	–	(0.010)	(0.004)	(0.006)	(0.001)
Litigation experience	0.012	0.000	-0.002	-0.006	-0.001	0.000	-0.002	-0.003
	(0.326)	(0.975)	(0.785)	(0.163)	(0.838)	(0.957)	(0.786)	(0.669)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817	817	817
Obs.	20,725	20,725	20,725	20,725	20,725	20,725	20,725	20,725
Adj. R^2	0.873	0.677	0.873	0.597	0.328	0.305	0.298	0.280

Notes: Columns 1, 3, 5, and 7 report OLS models, while columns 2, 4, 6, and 8 are LPMs. Firms' explorative versus exploitative areas are distinguished based on whether the 3-digit CPC technology classes of the patents filed or acquired by the focal firm i are considered as core areas. Core areas are defined as the top three 3-digit CPC technology classes in which the focal firm most frequently filed patents over the last five years. These top three technology classes represent the focal firm's exploitative areas, while all other peripheral technology classes represent the focal firm's explorative areas. The dependent variables in both the OLS models and LPMs are defined the same as in Table 3. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table 4: Heterogeneity: Firms' patent strategy in software vs. hardware domains (H3)

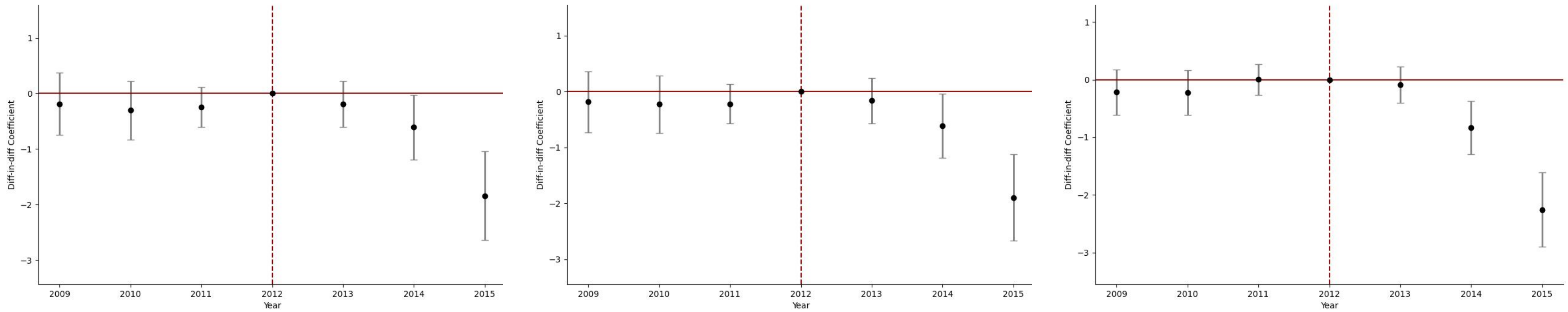
	Patenting				**Patent acquisition**			
DV	Software	Software	Hardware	Hardware	Software	Software	Hardware	Hardware
	(1) OLS	(2) LPM	(3) OLS	(4) LPM	(5) OLS	(6) LPM	(7) OLS	(8) LPM
Post×Risk	-0.702	-0.466	-0.140	-0.244	0.061	0.088	0.215	0.164
	(0.000)	(0.000)	(0.485)	(0.030)	(0.062)	(0.062)	(0.005)	(0.019)
Firm size	0.082	0.035	0.096	0.038	0.002	0.003	-0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.335)	(0.335)	(0.870)	(0.987)
Patent stock	–	–	–	–	0.001	0.002	0.015	0.016
	–	–	–	–	(0.471)	(0.471)	(0.000)	(0.000)
Litigation experience	0.020	-0.002	-0.003	-0.009	-0.001	-0.001	-0.008	-0.005
	(0.178)	(0.684)	(0.639)	(0.053)	(0.885)	(0.885)	(0.380)	(0.507)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817	817	817
Observations	20,725	20,725	20,725	20,725	20,725	20,725	20,725	20,725
Adj. R^2	0.859	0.615	0.884	0.633	0.299	0.299	0.344	0.312

Notes: Columns 1, 3, 5, and 7 are OLS models, while columns 2, 4, 6, and 8 are LPMs. Software-related and hardware-related patents are defined based on the primary 4-digit CPC technology classes of the patents filed or acquired by the focal firm. Patents are classified as software-related if they belong to software-related CPC technology classes (i.e., G06F, G06K, and H04L). Patents in all other technology classes are classified as hardware-related. The dependent variables in both the OLS models and LPMs are defined the same as in Table 3. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table 5: Robustness checks: Alternative measure of litigation risk based on product similarity

	Patenting					**Patent acquisition**				
DV	Overall	Explorative	Exploitative	Software	Hardware	Overall	Explorative	Exploitative	Software	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) OLS
Post $\times$ Risk	-0.005	-0.004	-0.005	-0.007	-0.003	0.004	0.003	0.001	0.001	0.003
	(0.068)	(0.037)	(0.061)	(0.003)	(0.233)	(0.003)	(0.002)	(0.145)	(0.046)	(0.006)
Firm size	0.131	0.052	0.122	0.081	0.096	0.001	-0.000	0.005	0.002	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.878)	(0.940)	(0.267)	(0.322)	(0.914)
Patent stock	–	–	–	–	–	0.017	0.008	0.008	0.001	0.015
	–	–	–	–	–	(0.000)	(0.014)	(0.008)	(0.532)	(0.000)
Litigation experience	0.002	0.012	-0.003	0.019	-0.004	-0.005	-0.001	-0.002	-0.000	-0.008
	(0.789)	(0.346)	(0.701)	(0.209)	(0.597)	(0.697)	(0.885)	(0.808)	(0.914)	(0.406)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE $\times$ Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817	817	817	817	817
Observations	20,725	20,725	20,725	20,725	20,725	20,725	20,725	20,725	20,725	20,725
Adj. R^2	0.886	0.873	0.873	0.860	0.884	0.368	0.329	0.298	0.299	0.344

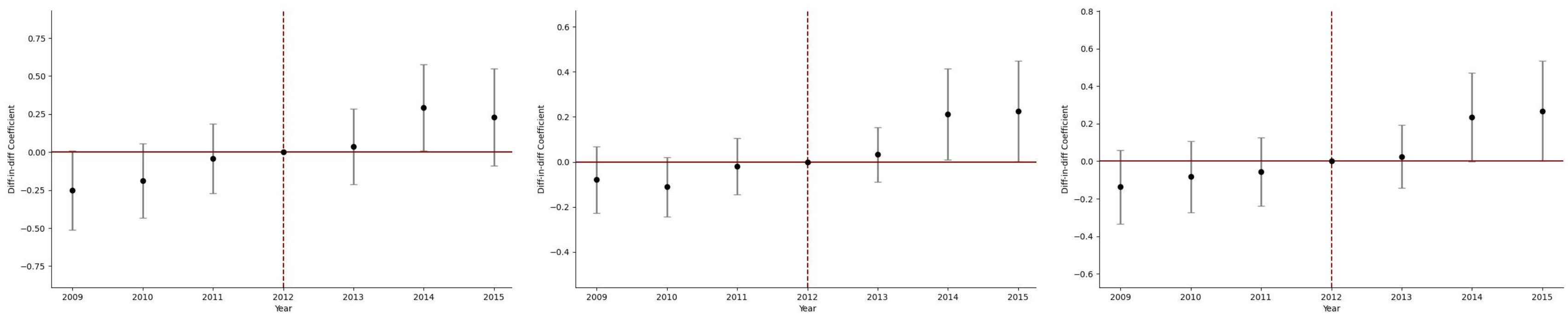
Notes: Columns 1–5 use the logarithmic transformation of the number of patents filed by the focal firm in a given quarter, while columns 6–10 use the logarithmic transformation of the number of patents acquired by the focal firm in a given quarter. The litigation risk in this analysis is calculated based on the product similarity between the focal firm and its peer firms one year prior to the AIA (i.e., 2011) and the number of patent lawsuits experienced by its peer firms during 2007–2011. Product similarity, developed by Hoberg and Phillips (2016), is used to identify the focal firm's peers. Coefficients are based on robust standard errors clustered at the firm level; p-values are in parentheses.



(a) Patenting (b) Exploitative Patenting (c) Software Patenting

Figure 1: Effect of reduced litigation risk on firms' patenting

Notes: The figure plots the coefficients of the interaction terms between a series of year dummies and *litigation risk*. 95% confidence intervals for each point estimate reported. The baseline year is 2012.



(a) Acquisition (b) Explorative Acquisition (c) Hardware Acquisition

Figure 2: Effect of reduced litigation risk on firms' patent acquisition

Notes: The figure plots the coefficients of the interaction terms between a series of year dummies and *litigation risk*. 95% confidence intervals for each point estimate reported.The baseline year is 2012.

Table A1: Variables and Definitions

Variable	**Definition**
Patenting	The logarithm of one plus the total number of patents filed by firm i in quarter t.
Explorative patenting	The logarithm of one plus the number of patents filed by firm i in peripheral CPC technology classes (those outside the firm's top three CPC classes).
Exploitative patenting	The logarithm of one plus the number of patents filed by firm i in the top three CPC technology classes.
Software patenting	The logarithm of one plus the number of patents filed by firm i in software-related CPC technology classes (G06F, G06K, and H04L).
Hardware patenting	The logarithm of one plus the number of patents filed by firm i in non-software-related CPC technology classes.
Patent acquisition	The logarithm of one plus the total number of patents acquired by firm i in quarter t.
Explorative acquisition	The logarithm of one plus the number of patents acquired by firm i in peripheral CPC technology classes (those outside the firm's top three CPC classes) over the past five years.
Exploitative acquisition	The logarithm of one plus the number of patents acquired by firm i in the top three CPC technology classes over the past five years.
Software acquisition	The logarithm of one plus the number of patents acquired by firm i in software-related CPC technology classes (G06F, G06K, and H04L).
Hardware acquisition	The logarithm of one plus the number of patents acquired by firm i in non-software-related CPC technology classes.
Risk	A composite measure of litigation risk based on the weighted average of lawsuits across all technological classes in which the firm i operates.
Firm size	The logarithm of one plus the gross sales of firm i in year t.
Patent stock	The logarithm of one plus the number of patent applications in the last three years.
Litigation experience	The number of patent lawsuits initiated by firm i in quarter t.

Table A2: Robustness checks: All continuous variables without winsorization

	Patenting			**Patent acquisition**		
DV	Overall	Exploitative	Software	Overall	Explorative	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Post × Risk	-0.539	-0.592	-0.777	0.455	0.363	0.369
	(0.021)	(0.009)	(0.000)	(0.003)	(0.005)	(0.007)
Firm size	0.140	0.132	0.092	0.013	0.006	0.008
	(0.000)	(0.000)	(0.000)	(0.406)	(0.645)	(0.566)
Patent stock	–	–	–	0.022	0.014	0.020
	–	–	–	(0.003)	(0.011)	(0.001)
Litigation experience	0.007	0.001	0.023	-0.001	0.002	-0.007
	(0.517)	(0.945)	(0.146)	(0.972)	(0.892)	(0.697)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817
Observations	20,725	20,725	20,725	20,725	20,725	20,725
Adj. R^2	0.892	0.882	0.873	0.347	0.329	0.323

Notes: In this table, no continuous variables in the analysis are winsorized to examine the influence of outliers. All analyses use OLS models. The dependent variable in each model is calculated as the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A3: Backward Citation as an alternative measure of litigation risk

	Patenting			**Patent acquisition**		
DV	Overall	Exploitative	Software	Overall	Explorative	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Post×Risk	-6.055	-5.845	-6.031	3.644	3.500	3.651
	(0.049)	(0.053)	(0.046)	(0.039)	(0.015)	(0.019)
Firm size	0.126	0.118	0.076	0.004	0.002	0.001
	(0.000)	(0.000)	(0.000)	(0.684)	(0.789)	(0.854)
Patent stock	–	–	–	0.018	0.009	0.016
	–	–	–	(0.000)	(0.006)	(0.000)
Litigation experience	0.005	-0.005	0.017	-0.004	0.000	-0.006
	(0.959)	(0.536)	(0.263)	(0.771)	(0.983)	(0.491)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817
Observations	20,725	20,725	20,725	20,725	20,725	20,725
Adjusted R^2	0.886	0.874	0.860	0.369	0.331	0.346

Notes: The table presents the results using an alternative measure of *litigation risk*. Specifically, we reconstruct the focal firm's exposure to litigation risk based on the number of its cumulative backward citations during 2000–2011 that were involved in patent litigation in the five years before the AIA (i.e., 2007–2011), normalized by the total number of litigated patents during 2007–2011. All analyses use OLS models. The dependent variable in each model is calculated as the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A4: Robustness checks: Fixed-effect Poisson model

	Patenting			**Patent acquisition**		
DV	Overall	Exploitative	Software	Overall	Explorative	Hardware
	(1) Poisson	(2) Poisson	(3) Poisson	(4) Poisson	(5) Poisson	(6) Poisson
Post × Risk	-1.455	-1.794	-3.488	3.433	2.826	3.529
	(0.109)	(0.048)	(0.008)	(0.019)	(0.098)	(0.020)
Firm size	0.468	0.440	0.477	-0.002	-0.036	-0.071
	(0.000)	(0.000)	(0.000)	(0.989)	(0.816)	(0.649)
Patent stock	–	–	–	0.232	0.276	0.297
	–	–	–	(0.026)	(0.022)	(0.010)
Litigation experience	0.006	0.006	0.030	-0.000	0.018	-0.017
	(0.611)	(0.684)	(0.329)	(0.999)	(0.678)	(0.716)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	701	701	512	332	270	319
Observations	18,026	18,026	13,223	8,559	6,760	8,224
Adj. R^2	0.936	0.925	0.914	0.265	0.159	0.204

Notes: Columns 1-6 are Poisson pseudo-likelihood fixed effects models. Columns 1–3 use the number of patents filed by the focal firm in a given quarter, while columns 4–6 use the number of patents acquired by the focal firm in a given quarter, excluding bulk acquisitions to mitigate the impact of outliers. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A5: Robustness checks: Heterogeneity of firm size

(a) Panel a: Patenting

	Large firms			**Small firms**		
	Patenting			**Patenting**		
DV	Overall	Exploitative	Software	Overall	Exploitative	Software
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Post × Risk	-0.439	-0.465	-1.152	-0.524	-0.559	-0.428
	(0.372)	(0.329)	(0.001)	(0.017)	(0.010)	(0.004)
Firm size	0.165	0.147	0.113	0.083	0.080	0.033
	(0.007)	(0.008)	(0.009)	(0.000)	(0.000)	(0.007)
Litigation experience	-0.000	-0.006	0.013	-0.005	-0.007	0.023
	(0.986)	(0.429)	(0.437)	(0.795)	(0.700)	(0.200)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	372	372	372	372	372	372
Observations	10,033	10,033	10,033	9,428	9,428	9,428
Adj. R^2	0.897	0.884	0.873	0.606	0.586	0.481

(b) Panel b: Patent Acquisition

	Large firms			**Small firms**		
	Patent acquisition			**Patent acquisition**		
DV	Overall	Explorative	Hardware	Overall	Explorative	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Post × Risk	0.699	0.470	0.555	-0.026	0.010	-0.030
	(0.000)	(0.001)	(0.001)	(0.750)	(0.823)	(0.643)
Firm size	-0.012	-0.005	-0.012	0.005	0.001	0.004
	(0.643)	(0.795)	(0.596)	(0.349)	(0.748)	(0.336)
Patent stock	0.016	0.008	0.017	0.017	0.010	0.014
	(0.084)	(0.259)	(0.033)	(0.000)	(0.001)	(0.000)
Litigation experience	-0.001	0.002	-0.005	-0.022	-0.012	-0.016
	(0.941)	(0.824)	(0.637)	(0.047)	(0.005)	(0.109)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	372	372	372	372	372	372
Observations	10,033	10,033	10,033	9,428	9,428	9,428
Adj. R^2	0.410	0.369	0.385	0.057	0.033	0.057

Notes: Firm size is measured by the total assets of the focal firm in 2012Q2 (one quarter before the implementation of the AIA). Firms with total assets exceeding the median value are categorized as large firms, while those below the median are categorized as small firms. The dependent variable in each model is calculated as the logarithm of the number of patents filed or acquired by the focal firm in a given quarter. Robust standard errors clustered at the firm level; p-values in parentheses.

Table A6: Placebo tests: 2007Q4 - 2011Q3, 2009Q4 as pseudo treatment time

	Patenting			Patent acquisition		
DV	Overall	Exploitative	Software	Overall	Explorative	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Post×Risk	-0.600	-0.546	-0.324	0.103	0.099	0.015
	(0.160)	(0.195)	(0.301)	(0.613)	(0.115)	(0.916)
Firm size	0.108	0.111	0.061	0.016	-0.001	0.014
	(0.002)	(0.001)	(0.002)	(0.213)	(0.906)	(0.153)
Patent stock	–	–	–	0.007	0.001	0.004
	–	–	–	(0.523)	(0.725)	(0.660)
Litigation experience	0.018	0.020	-0.025	0.054	0.028	0.051
	(0.578)	(0.508)	(0.406)	(0.142)	(0.043)	(0.132)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	724	724	724	724	724	724
Observations	10,823	10,823	10,823	10,823	10,823	10,823
Adjusted R^2	0.905	0.893	0.892	0.327	0.248	0.299

Notes: The table presents the results of placebo tests. Specifically, the analysis uses an alternative time window covering 2007Q4 to 2011Q3, with two years before and after a fictional shock (i.e., 2009Q4), which is entirely outside the period following the implementation of the AIA. *Risk* is reconstructed based on the weighted average of patent lawsuits during the previous five years (i.e., 2004–2008) across all technological classes in which the focal firm operated during 2000–2008. *Post* equals 1 if the time is 2009Q4 or later. All analyses use OLS models. The dependent variable in each model is calculated as the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm leve; p-values in parentheses.

Table A7: The impact of PTAB

DV	Patenting		Patent acquisition	
	(1) Poisson	(2) OLS	(3) Poisson	(4) OLS
Num of Trails	-0.006	-0.006	-0.003	-0.019
	(0.000)	(0.012)	(0.731)	(0.168)
Class FE	Yes	Yes	Yes	Yes
Num of technology classes	571	591	301	591
Observations	3,997	4,137	2,107	4,137
Adjusted R	0.968	0.937	0.760	0.701

Notes: The observation units are 4-digit CPC technology class-quarter. Columns 1 and 3 report Poisson pseudo-likelihood fixed effects models, while columns 2 and 4 report OLS models. The dependent variable in column 1 is the total number of patents filed by publicly listed firms within each technology class in a given quarter, while the dependent variable in column 2 is the logarithmic transformation of the total number of patents filed by publicly listed firms within each technology class in a given quarter. The dependent variable in column 3 is the total number of patents acquired by publicly listed firms within each technology class in a given quarter, while the dependent variable in column 4 is the logarithmic transformation of the total number of patents acquired by publicly listed firms within each technology class in a given quarter. The independent variable is the number of PTAB trials at the 4-digit technology class level in each quarter. The analysis covers the time window from 2012Q3 to 2014Q1, capturing the period after the implementation of the AIA and ending one quarter before the Alice decision. Coefficients are based on robust standard errors clustered at the 4-digit CPC technology class level; p-values in parentheses.

Table A8: Robustness checks: Restricted sample excluded 2011 and 2012

DV	Patenting Overall (1) OLS	Patenting Exploitative (2) OLS	Patenting Software (3) OLS	Patent acquisition Overall (4) OLS	Patent acquisition Explorative (5) OLS	Patent acquisition Hardware (6) OLS
Post × Risk	-0.615	-0.655	-0.803	0.421	0.261	0.294
	(0.044)	(0.026)	(0.000)	(0.002)	(0.003)	(0.006)
Firm size	0.137	0.129	0.084	0.004	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.741)	(0.985)	(0.902)
Patent stock	–	–	–	0.016	0.008	0.013
	–	–	–	(0.005)	(0.053)	(0.003)
Litigation experience	-0.003	-0.004	0.003	0.012	0.006	-0.005
	(0.814)	(0.786)	(0.841)	(0.505)	(0.610)	(0.762)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	816	816	816	816	816	816
Observations	14,393	14,393	14,393	14,393	14,393	14,393
Adj. R^2	0.879	0.865	0.851	0.361	0.328	0.338

Notes: The table presents the results using an alternative time window. Since the beginning of the AIA legislation (i.e., September 2011), there has been significant media coverage, and this case received considerable attention from the industry. To account for the potential chilling effect on firms' patenting activities during the AIA's legislative process, we excluded 2011 and 2012 from the analysis as a robustness check in our restricted sample to retest the main effect on firm patent strategy. All analyses use OLS models. The dependent variable in each model is calculated as the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A9: Robustness checks: Alternative time window

DV	**Patenting$_{t+4}$** Overall	Explorative	Exploitative	Software	Hardware	**Patent acquisition** Overall	Explorative	Exploitative	Software	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) OLS
Post × Risk	-0.475	-0.045	-0.470	-0.795	-0.130	0.074	0.093	0.021	-0.004	0.058
	(0.044)	(0.724)	(0.042)	(0.000)	(0.513)	(0.451)	(0.073)	(0.786)	(0.919)	(0.421)
Firm size	0.081	0.026	0.076	0.051	0.056	-0.005	-0.001	-0.001	0.002	-0.006
	(0.004)	(0.078)	(0.005)	(0.022)	(0.005)	(0.607)	(0.879)	(0.847)	(0.419)	(0.477)
Patent stock	–	–	–	–	–	0.017	0.005	0.014	0.003	0.014
	–	–	–	–	–	(0.009)	(0.308)	(0.005)	(0.192)	(0.004)
Litigation experience	0.006	-0.006	0.012	-0.010	0.009	-0.011	-0.005	-0.006	-0.003	-0.009
	(0.484)	(0.309)	(0.258)	(0.327)	(0.336)	(0.301)	(0.565)	(0.403)	(0.420)	(0.303)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817	817	817	817	817
Observations	10,905	10,905	10,905	10,905	10,905	10,905	10,905	10,905	10,905	10,905
Adj. R^2	0.901	0.885	0.890	0.877	0.899	0.376	0.319	0.336	0.337	0.346

Notes: The table presents the results using an alternative time window. The time window spans from 2010Q4 to 2014Q1, covering seven quarters before and after the AIA Act, and is restricted to the period prior to the Alice decision (i.e., 2014Q2). All analyses use OLS models. The dependent variables in columns 1–5 are the logarithmic transformation of the number of patents filed by the focal firm in *t+4* to capture the lagged effect on firms' patenting. The dependent variables in columns 6–10 are the logarithmic transformation of the number of patents acquired by the focal firm in t , as firms tend to change their patent acquisition behavior instantly. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A10: The impact of the Alice Decision

	Patenting					Patent acquisition				
DV	Overall	Explorative	Exploitative	Software	Hardware	Overall	Explorative	Exploitative	Software	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) OLS
Post × Risk	-1.230	-0.171	-1.354	-2.207	-0.049	0.294	0.231	0.039	0.068	0.279
	(0.005)	(0.536)	(0.002)	(0.000)	(0.899)	(0.210)	(0.097)	(0.798)	(0.383)	(0.117)
Firm size	0.112	0.039	0.114	0.077	0.101	0.009	-0.000	0.019	-0.003	0.007
	(0.037)	(0.186)	(0.029)	(0.074)	(0.021)	(0.632)	(0.997)	(0.132)	(0.735)	(0.634)
Patent stock	–	–	–	–	–	0.007	0.011	-0.003	0.002	0.007
	–	–	–	–	–	(0.485)	(0.104)	(0.677)	(0.609)	(0.404)
Litigation experience	-0.011	-0.008	-0.013	0.016	-0.033	0.019	0.011	0.016	0.014	0.001
	(0.477)	(0.394)	(0.394)	(0.396)	(0.037)	(0.311)	(0.269)	(0.264)	(0.043)	(0.956)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	771	771	771	771	771	771	771	771	771	771
Observations	8,642	8,642	8,642	8,642	8,642	8,642	8,642	8,642	8,642	8,642
Adj. R^2	0.886	0.865	0.873	0.848	0.889	0.432	0.411	0.322	0.329	0.410

Notes: The table presents the results on the impact of the Alice decision. *Litigation risk* is calculated based on the focal firm's patent applications from 2000 to 2013 and patent lawsuits filed in the five years prior to the Alice decision (i.e., 2009–2013). *Post* equals 1 for periods after 2014Q2. The time window spans from 2013Q1 to 2015Q4, covering five quarters before and seven quarters after the Alice decision (i.e., 2014Q2). All analyses use OLS models. The dependent variable in each model is the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

Table A11: Including both the AIA and the Alice Decision

	Patenting$_{t+4}$					**Patent acquisition**				
DV	Overall	Explorative	Exploitative	Software	Hardware	Overall	Explorative	Exploitative	Software	Hardware
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) OLS
Post × Risk	-0.367	0.024	-0.387	-0.748	0.002	0.177	0.120	0.100	0.043	0.115
	(0.119)	(0.856)	(0.089)	(0.000)	(0.991)	(0.070)	(0.027)	(0.179)	(0.238)	(0.111)
Post-Alice × Risk	-1.579	-0.082	-1.671	-1.841	-0.549	0.224	0.168	0.024	0.040	0.222
	(0.000)	(0.594)	(0.000)	(0.000)	(0.022)	(0.099)	(0.054)	(0.743)	(0.318)	(0.038)
Firm size	0.084	0.040	0.078	0.050	0.073	0.001	-0.001	0.005	0.002	-0.001
	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)	(0.937)	(0.881)	(0.293)	(0.340)	(0.858)
Patent stock	–	–	–	–	–	0.018	0.009	0.009	0.001	0.016
	–	–	–	–	–	(0.000)	(0.008)	(0.006)	(0.449)	(0.000)
Litigation experience	0.013	0.002	0.015	0.004	0.014	-0.005	-0.001	-0.002	-0.001	-0.008
	(0.165)	(0.643)	(0.138)	(0.682)	(0.116)	(0.666)	(0.845)	(0.787)	(0.888)	(0.385)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num of firms	817	817	817	817	817	817	817	817	817	817
Observations	17,727	17,727	17,727	17,727	17,727	20,725	20,725	20,725	20,725	20,725
Adj. R^2	0.886	0.870	0.875	0.858	0.885	0.368	0.328	0.297	0.299	0.344

Notes: The table presents the results on the impact of the AIA and the Alice decision. *Litigation risk* is calculated based on the focal firm's patent applications from 2000 to 2011 (one year prior to the AIA) and patent litigation lawsuits filed in the five years prior to the AIA (i.e., 2007–2011). *Post* equals 1 for periods after 2012Q3, and *Post-Alice* equals 1 for periods after 2014Q2. All analyses use OLS models. The dependent variable in each model is the logarithmic transformation of the number of patents filed or acquired by the focal firm in a given quarter. Coefficients are based on robust standard errors clustered at the firm level; p-values in parentheses.

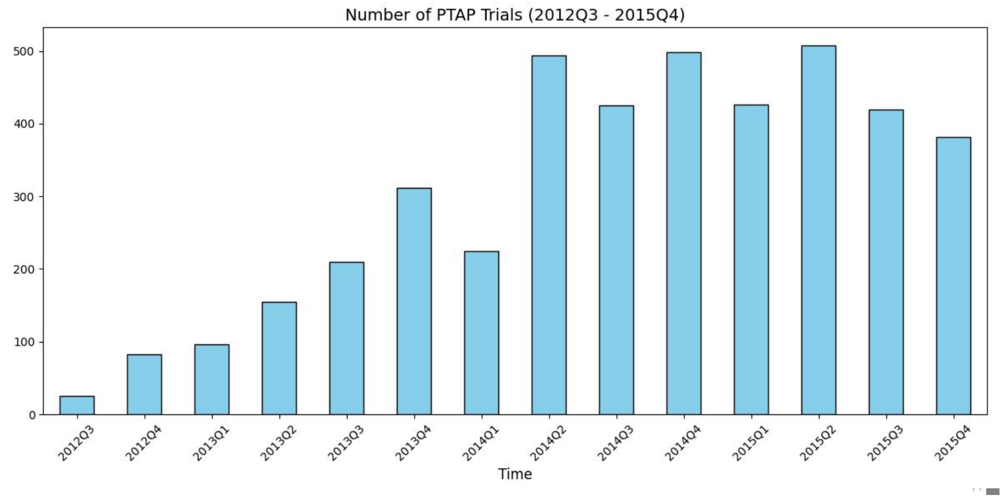


Figure A1: Number of PTAB Trials

Notes: This figure plots the number of PTAB trials filed in each quarter from 2012Q3 to 2015Q4. The Y-axis represents the number of trials filed at PTAB in each quarter, while the X-axis represents the time. From 2012Q3 to 2014Q1, the number of PTAB trials shows a general increase. After 2014Q2, the number of PTAB trials stabilizes at around 400.

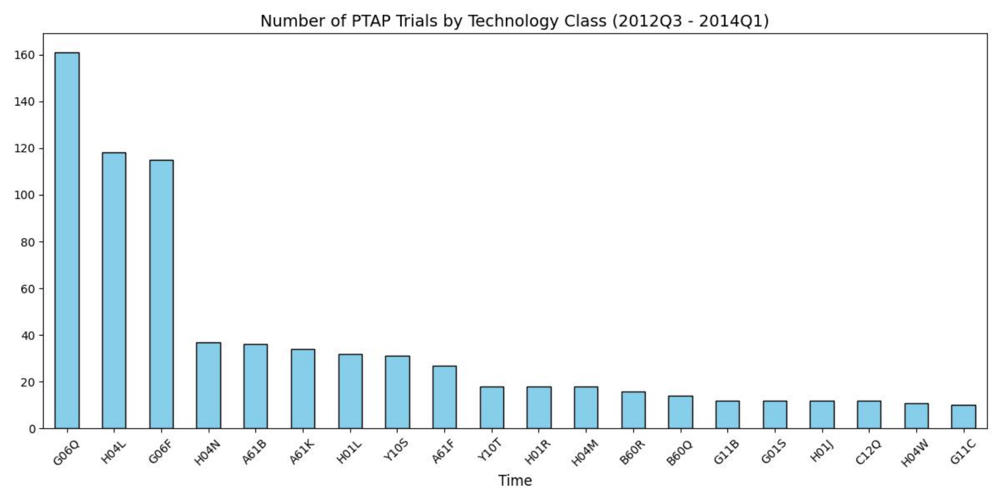


Figure A2: Distribution of PTAB Trials Across Technology Classes

Notes: This figure plots the total number of PTAB trials across the top 20 technology classes during 2012Q3 to 2014Q1. The Y-axis represents the total number of trials filed at PTAB in each technology class, and the X-axis represents the technology classes (i.e., 4-digit CPC classes). During 2012Q3 to 2014Q1, the top three technology classes with the highest number of PTAB trials filed are G06Q, H04L, and G06F.