Patent Litigation Risk and Innovation Strategy

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Abstract

I examine how patent litigation risk affects corporate innovation strategy. Using a Supreme Court decision that exogenously increased expected litigation risk and costs, I analyze how firms' innovation strategy changes based on their ex-ante patent litigation exposure. I find that firms with higher ex-ante litigation exposure engage in more exploratory innovation and in less exploitative innovation after the decision. High exposure firms focus more on fields with lower litigation risk and reduce innovation in riskier ones. These strategic adjustments occur alongside an increase in overall R&D intensity. This change in innovation strategy comes at the cost of lower patent value and reduced market valuation. My analysis suggests that exploratory innovation serves as a precautionary response to mitigate expected patent litigation risk in one's own industry.

Keywords: Patent Litigation, Innovation Strategy, Exploratory Innovation, Exploitative Innovation

1 Introduction

The strength and effectiveness of intellectual property rights play a crucial role in motivating innovation. However, the exclusive legal rights of patent owners are often challenged or threatened by infringement cases, exposing firms to substantial litigation risks and costs.[1] The expected risk and costs of patent litigation are important factors that firms need to consider when developing innovation. Prior studies have investigated the effect of patent litigation on overall innovation output.[2] However, how firms adjust their future research strategies in response to changes in expected litigation risk remains largely unexplored. In this paper, I examine the effect of increased expected patent litigation risks and costs on firms' future innovation strategy.

Higher expected patent litigation risk and costs may shape firms' innovation strategy, particularly their choice between two distinct types of innovation: exploratory and exploitative. Exploratory innovation is distant from a firm's existing knowledge base, while exploitative innovation builds on it. The effect of higher patent litigation risk and costs on exploratory versus exploitative innovation is ex-ante ambiguous. On one hand, higher expected litigation risk may encourage firms to move innovative activity away from highly litigious technology areas. For firms already operating in litigious areas, exploitative innovation keeps research concentrated in fields with high litigation intensity. In contrast, exploratory innovation allows firms to move into more distant areas that are less exposed to litigation risk, thereby serving as a precautionary strategy to mitigate potential legal risk.

[1] Firms can incur significant financial costs in patent infringement lawsuits, particularly in cases of willful infringement. A notable example is Apple's lawsuit against Samsung in 2011, in which a U.S. jury found Samsung had willfully infringed on multiple Apple patents and awarded $1.049 billion in damages.

[2] For instance, Mezzanotti (2021) suggests that a reduction of patent holders' rights has positive effect on innovation.

As a result, firms may shift their innovation activities toward more exploratory innovation. On the other hand, higher expected litigation risk can impose substantial legal and financial burdens. Facing greater litigation threats, firms may devote considerable resources to legal defense, settlements, and licensing (Cohen et al. (2019); Arena and Julio (2015)), which divert financial resources and managerial attention away from R&D activities. Because exploratory innovation is typically more resource-intensive than exploitative innovation (Levinthal and March (1993)), these resource constraints may instead lead firms to rely more on exploitative innovation.

To test whether and how firms adjust their innovation strategy in response to higher expected litigation risk and cost, I exploit the Supreme Court decision in *Halo Electronics, Inc. v. Pulse Electronics, Inc.* in June 2016. The decision in *Halo* lowered the standard for awarding enhanced damages in cases of willful infringement, increasing the potential penalties associated with patent infringement. The ruling also increased patent holders' incentives to file infringement lawsuits, which increased the likelihood of litigation. Overall, the ruling raised the expected risk and costs of patent litigation.

The main analysis exploits firm-level variation in patent litigation exposure using a difference-in-differences framework. The identification builds on the idea that, while the *Halo* decision generally impacts all innovative firms, those operating in technology areas with higher patent litigation intensity are expected to be more affected by the decision. Following Mezzanotti (2021), the firm-level exposure measure is the weighted average of litigation intensity across the technology classes in which a firm operates, where the weights are the share of each class in the firm's patent portfolio over the ten years prior to the *Halo* decision. This measure captures firms' pre-existing exposure to patent litigation based on the technological areas in which they innovate, rather than firms' own litigation experience.

It is not driven by changes in firms' innovation strategy after the ruling. Following the *Halo* decision, firms with higher pre-determined exposure should experience a larger increase in expected patent litigation risk and costs. The difference-in-differences analysis therefore compares changes in innovation strategy before and after the *Halo* decision across firms with different exposure levels.

Applying this empirical framework, I find that firms more exposed to patent litigation increase exploratory innovation but decrease exploitative innovation following the court ruling. This pattern suggests that high exposure firms respond to increased litigation risk by shifting innovative activity away from their existing technological areas, consistent with the precautionary strategy hypothesis. Further analyses provide more direct evidence for the precautionary strategy interpretation by showing that high exposure firms increase exploratory patenting in low-risk technology classes while reducing filings in riskier areas. This finding indicates that firms reallocate innovative activity toward technological areas with lower litigation risk. These changes are accompanied with higher R&D intensity, suggesting that firms need additional resources when shifting toward exploratory innovation. I next examine the economic consequences of this strategic shift. At the patent level, the economic value of exploratory patents declines significantly for highly exposed firms after the ruling. At the firm level, these high exposure firms experience a deterioration in market valuation. Taken together, these results imply that increased expected litigation risk and costs incentivize firms to shift their innovation strategies toward exploratory activities to mitigate increased litigation risks, but this shift occurs at the cost of lower innovation value and reduced market valuation. Firms facing higher expected litigation risks may be pushed toward second-best innovation choices.

I further investigate the heterogeneous impact of the decision and explore the underly-

ing channels. Consistent with the resource constraint mechanism discussed above, I find that the positive treatment effect on exploratory innovation is attenuated for smaller and younger firms. These firms are typically more constrained in financial and organizational resources and are therefore less able to undertake resource-intensive exploratory innovation. I also find that the treatment effect varies with competitive pressure. The positive treatment effect on exploratory innovation diminishes and eventually reverses for firms facing stronger competitive pressure.This heterogeneity is consistent with prior work showing that exploration involves more uncertain and distant payoffs, whereas exploitative innovation generates greater financial benefits in competitive environments (March (1991), Jansen et al. (2006)). Thus, stronger competitive pressure appears to limit firms' willingness to respond to higher litigation risk through exploratory patents. Overall, the evidence indicates that the positive effect of higher litigation risks on exploratory innovation are more pronounced for firms with greater resource availability and weaker competitive pressure.

My paper contributes to several strands of literature. First, it adds to the literature on the real effects of patent litigation. Previous studies find that firms reduce innovation when involved in patent lawsuits, highlighting the detrimental effects of experiencing patent litigation (Cohen et al. (2019), Huang et al. (2024)). I investigate the effect of expected litigation risk rather than focusing on prior litigation experience. This forward-looking perspective allows me to study how anticipated litigation risk shapes firms' innovation strategies before litigation occurs, particularly how firms allocate effort between exploratory and exploitative innovation.

Second, my paper contributes to the literature on corporate innovation strategy. Prior empirical research shows that exploratory and exploitative innovation are shaped by factors such as independent boards (Balsmeier et al. (2017)), public market listing (Gao et al.

(2018)), capital provision (Almeida et al. (2021), Byun et al. (2023)), technology spillovers (Byun et al. (2021)), shareholder litigation (Lin et al. (2021)), policy in emerging economy (Lee et al. (2024)), among others. Adding to these studies, my paper highlights that ex-ante patent litigation risk is an important determinant of firms' innovation strategy and can induce a precautionary reallocation of innovative effort.

Third, my findings contribute to the literature on patent policy and innovation outcomes. Prior studies typically examine how patent law affects aggregate innovation output without distinguishing across different types of innovation. For instance, existing research shows that weakening patent protections through defendant-friendly reforms (Antill et al. (2023)), patent invalidation (Galasso and Schankerman (2015)), and reduced patent holder rights (Mezzanotti (2021)) can stimulate innovation and knowledge diffusion, while stronger protection may hinder domestic innovation (Lerner (2009)). Exploiting a novel empirical setting, I provide new causal evidence on how patent litigation risk shapes the composition of innovation output. More specifically, I show that firms respond to increased patent litigation risk by expanding exploratory innovation and scaling back exploitative innovation, rather than moving all types of innovation in the same way.

This paper proceeds as follows. Section 2 provides the hypothesis development and institutional background. Section 3 presents the empirical design. The empirical results are provided in Section 4. Section 5 reports cross sectional analysis and Section 6 concludes the paper.

2 Hypothesis Development and Institutional Background

2.1 Related Literature and Hypothesis Development

The increase in expected litigation risk and costs incentivize innovative firms to adjust their innovation activities to mitigate potential legal threats (Lerner (1995)). One possible response is a shift toward exploitative innovation. When facing increased expected litigation costs, firms with greater litigation exposure may allocate more resources toward potential legal defense and compliance, thereby reducing resources available for R&D in subsequent periods. Exploratory innovation typically requires long-term commitments and substantial investment, along with uncertain payoffs. In contrast, exploitative innovation demonstrates lower costs and realizes payoff in a shorter time through incremental improvements (March (1991), Manso (2011) and Deng et al. (2025)). As a result, firms with high litigation exposure may allocate their constrained R&D budgets to less costly exploitative innovation. This leads to the resource constraint hypothesis:

Hypothesis 1 *Firms with higher litigation exposure shift toward filing more exploitative innovation after the Halo decision.*

However, firms face a tension between exploratory and exploitative innovation (Manso (2011)). Greater litigation risk may also push firms in the opposite direction. For firms operating in highly litigious technology areas, continuing innovation within existing areas may make them more vulnerable to potential legal disputes. Because exploitative innovation build on firm's existing knowledge base, it may keep the firm concentrated in areas where patent disputes are already frequent. By contrast, exploratory innovation allows firms to move into new or more distant technological areas that are less exposed to litigation risk. In

this case, firms with high litigation exposure are more likely to strategically shift innovative effort toward exploratory activities in less litigious areas. This precautionary strategy can reduce the firm's concentration in highly litigious areas by diversifying their innovation efforts across different technological domains. Thus, although exploratory innovation remains technologically uncertain, it can help firms mitigate expected litigation risk. This argument further implies that firms with greater patent litigation exposure should allocate a larger share of exploratory patents to technology areas with lower litigation intensity after the ruling. The above discussions lead to the precautionaty strategy hypothesis:

Hypothesis 2 *Firms with higher litigation exposure shift toward filing more exploratory innovation after the Halo decision.*

2.2 The *Halo Electronics, Inc. v. Pulse Electronics, Inc.* Case

A patent grants the patent holder the exclusive right to exclude others from making, using, importing, and selling the patented innovation for a limited period.[3] Patent holders can enforce their patents through patent infringement lawsuits. In a patent infringement lawsuit, the court determines whether the defendant infringed the patent and decides the damages to be awarded. Under 35 U.S.C §284, a court may increase damages up to three times the amount found or assessed if the defendant willfully infringed the invention. Because of this provision, plaintiffs often alleges willful infringement and seek enhanced damages. (Means (2013)). The legal standard for determining whether the infringement was willful evolved several times (Serbest (2019)). The most recent changes came from the Supreme Court's decision in *Halo Electronics, Inc. v. Pulse Electronics, Inc.* (I simply refer to this as *Halo* deivision).

[3] See https://www.law.cornell.edu/wex/patent

Before *Halo*, the decision on willful infringement was based on the standard set forth in *In re Seagate Technology, LLC*. Under the *Seagate* test, a patent owner had to satisfy a two-part standard to obtain enhanced damages. The plaintiffs had to demonstrate that the defendant acted with subjective intent to infringe and that the infringement was objectively reckless. The patent owners also had to show clear and convincing evidence to establish willful infringement. Even when infringement was found, defendants could often avoid enhanced damages, because the Seagate standard allowed them to rely on defenses raised during litigation. This framework made willfulness difficult to establish and enhanced damages were rare (Serbest (2019)). Many of the most serious offenders were not penalized under the *Seagate* standard. As a result, innovative firms faced litigation risk, but the expected downside from severe penalties was limited.

In June 2016, the United States Supreme Court issued a decision in *Halo Electronics, Inc. v. Pulse Electronics, Inc.* and overturned the existing rule required to prove willful infringement. The case involved allegations that Pulse infringed Halo's patents on electronic components. The Court found that the *Seagate* test was "unduly rigid" and overturned the *Seagate* "objectively reckless" requirement. Under the new standard, district courts have the discretion to award enhanced damages in "egregious cases typified by willful misconduct". The new standard is more flexible and open-ended than before.

This change has direct implications for expected litigation risk and costs. First, *Halo* decision increases the expected rewards of patent owners conditional on winning the willful infringement lawsuits. Second, the *Halo* decision may also strengthen plaintiffs' incentives to pursue willfulness claim. The more flexible standard for enhanced damages lowers the burden of proof for willful infringement and makes it easier for patent owners to seek enhanced damages. This may encourage patent owners to file infringement lawsuits.

Evidence from the post-Halo period is consistent with this interpretation. Since *Halo*, the willfulness findings have increased by 27.8% and enhanced damages findings have increased by 8.7% (Sandrik (2021)).

As an exogenous shock to expected patent litigation risk, the decision was issued by the Supreme Court and was not driven by any individual firm's innovation strategy or operating choices. In addition, the complexity of patent litigation procedures and the associated time lags between filing the lawsuit and the final court decision make it unlikely that firms adjust their innovation strategy in advance of this specific legal change.

As an externally imposed change in the patent enforcement regime, the *Halo* decision was plausibly exogenous to individual firms' innovation strategies and operating choices. The proceedings leading to the decision were publicly observable: Halo filed its petition for certiorari in June 2015, the Supreme Court granted the petition in October 2015, oral arguments were held in February 2016, and the Court issued its decision in June 2016. Thus, firms may have anticipated that the Court could reconsider the existing willfulness standard. However, the decision to hear the case did not reveal the ultimate outcome, the scope of the Court's ruling, or its practical consequences for enhanced damages. Firms could therefore anticipate the possibility of a legal change, but not its precise nature or magnitude. These features make the *Halo* decision a useful setting for studying how firms respond to increased expected patent litigation risk and costs.

3 Empirical Design

3.1 Identification Strategy

The goal of this study is to examine how increased expected litigation risk affects firms' innovation activities after the ruling. Because the Halo decision applies broadly to firms engaged in patenting activity in the United States, identification does not come from a simple treated versus control comparison. Instead, I leverage the cross-sectional variation in firms' ex-ante exposure to patent litigation. Firms with higher pre-existing exposure to patent litigation are expected to face a larger increase in expected litigation risk and costs after the ruling. In contrast, firms with lower litigation exposure should experience only limited changes in the expected downside of future patent lawsuits after *Halo* decision. This variation allows me to estimate the following difference-in-difference model

$$y_{i,t} = \alpha + \beta_1 Exposure_i \times Post + \gamma Controls_{i,t} + Firm\ FE + Year\ FE + \epsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ measures the outcome of firm *i* in fiscal year *t*. *Post* is a dummy variable that equals one including and after the Supreme Court decision (2016-2019), and zero before the decision year (2012-2015). *Exposure* measures a firm's preexisting exposure to patent litigation risk. The construction of this measure is discussed in section 3.3.1. β_1 is the coefficient of interest, which captures the additional effect of the Supreme Court decision on the innovation strategy of firms with higher ex-ante litigation exposure. $Controls_{i,t}$ is a vector of firm characteristics that could affect a firm's innovation activities. Following the patenting literature, I include a set of firm characteristics that may influence a firm's innovation strategy in the regression analysis. More specifically, I control for profitability

(ROA), leverage, firm size, R&D expense, capital expenditures, asset tangibility (PPE) and sales growth. I also add firm- and year-fixed effects to control for firm-specific time-invariant effects and aggregate time trends. Standard errors are clustered at the firm level across all analyses. All variables used in the regression are defined in Appendix A1.

3.2 Sample Selection

My sample starts with public firms that applied to at least one granted patent over 10 years before the ruling. The estimation window spans 2012 to 2019, considering four years before and after the announcement of the Supreme Court decision. I obtain utility patent grant data (eg., patent number, patent application date, patent classification, backward and forward citations, among others) from U.S. Patent & Trademark Office (USPTO) PatentsView Database.[4] I collect patents' economic value data from Kogan et al. (2017) (KPSS data).[5] The information on patent litigation cases is extracted from USPTO Patent Litigation Docket Reports Data, which contains detailed data such as litigation case number, court filing date and patent number involved in cases. To supplement the patent data with annual firm-level accounting measures, I match the USPTO corporate entities (assignees) with Compustat firm records using a name cleaning and standardization procedure. I apply the same approach to link patent litigation plaintiff and defendant to Compustat firm records. Financial firms (SIC codes 6000–6999) and utilities (SIC codes 4900–4999) are excluded. I drop observations with missing total assets and replace the missing values of R&D expense with zero. To exclude the potential effect of listings and delistings, the sample consists of

[4]USPTO defines that utility patents are issued for the invention of new and useful processes, machines, manufactures, or compositions of matter or new and useful improvements thereof. Approximately 90% of the patent documents issued by the USPTO in recent years have been utility patents.

[5]The dataset is extended until the end of 2023 by the authors. See https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data.

firms with financial information in both pre-period and post-period. Given that the focus of this paper is on corporate innovation strategy, I further require that my sample include only innovative firms. Innovative firms are those that have filed at least one patent in both pre-period and post-period. All continuous variables used in the sample are winsorized at 1% and 99% percentile levels to minimize the impact of outliers. These procedures yield a sample of 6,853 firm-year observations with 944 unique firms.

3.3 Variable Construction

3.3.1 Exposure to Patent Litigation

Following Mezzanotti (2021), I construct a firm-level measure of patent litigation exposure. The basic idea is that the effect of the *Halo* decision should vary across firms depending on the litigation intensity of the technology subclasses in which they operate. A firm is more exposed to patent litigation risk when it operates mainly in technology subclasses with more intensive patent litigation. Accordingly, the exposure measure combines two sources of variation: the distribution of firm i's patents across technology subclasses j, and the level of patent litigation intensity in each subclass j.

This measure is based on two features of the patent system. First, patent litigation is not evenly distributed across technology areas. Some technology areas are much more litigation-intensive than others and Figure 1 illustrates this heterogeneity.[6] Over 10 years before the ruling, litigated patents were mainly concentrated in section G-Physics and H-Electricity. Second, firms usually hold patents in multiple technology areas rather than in a single field.

[6]Given that there are over 600 CPC subclasses in my sample, I use the more aggregated CPC classification, the CPC section, to summarize the distribution of litigated patents in the figure.

Overall, the firm-level exposure measure is a weighted average of litigation intensity across CPC technology subclasses in which a firm operates, where the weights are the share of each subclass j in the firm i's patent portfolio over the ten years prior to the *Halo* decision. This can be denoted by

$$Exposure_i = \sum_{j=1}^{T} \sigma_j^i p_j \tag{2}$$

where σ_j^i is firm i's share of patents across the different technology subclass *j*, and p_j is the distribution of patent litigation across technology fields *j*.

I start by measuring the share of each CPC technology subclass in the patent portfolios of firms (σ_j^i), using PatentsView granted patents application file. I calculate the number of granted patents the firm has applied for in each technology subclass over the 2006-2015 period, divided by the total number of granted patents the firm has produced during the same 10-year period. There are over 600 CPC subclasses in my sample, which provides a detailed definition of the technology field.

Next, I calculate the litigation intensity for each CPC technology subclass period based on USPTO Patent Litigation Docket Reports Data. I extract all patent infringement suits for utility patents and include litigation cases that involve both public and private firms. Since each patent lawsuit can involve multiple defendants and multiple patents, using the lawsuit-case level as the observation unit may lead to significant information loss. Following Mezzanotti (2021), I reshape the patent litigation data at case-defendant–plaintiff–patent level to ensure comparability across lawsuit cases. I then scale the number of litigated patents in each CPC technology subclass by the total number of patents involved in litigation over the 10 years before the ruling.

Finally I estimate the $Exposure_i$ by combining the two quantities mentioned in Equation

(2). For example, if a company has 10 patents in total, with 2 patents filed in technology subclass A and 8 patents filed in subclass B. Regarding the distribution of litigation intensity, it is 0.05 in subclass A and 0.01 in subclass B. This firm's overall exposure to patent litigation would be calculated as follows: $Exposure_i = (\frac{2}{10} \times 0.05) + (\frac{8}{10} \times 0.01) = 0.012$. This measure captures the expected litigation risk based on the technological areas in which a firm innovates, rather than firms' own litigation experience.

3.3.2 Innovation Activities

In terms of dependent variables, I develop several measures to gauge firms' patenting activities and innovation strategies. I use the application year instead of the grant year because the patent application year more accurately reflects the timing of the underlying innovative activity. To further distinguish the composition of firms' innovation output between exploration versus exploitation, I employ the measures used in Brav et al. (2018), Gao et al. (2018) and Lin et al. (2021) to identify the corresponding innovation strategy. A patent is categorized as exploratory if at least 80% of its citations are based on new knowledge outside of the owning firm's existing expertise. A firm's existing expertise is represented by the firm's existing patents and the citations made by these patents. A patent is considered as exploitative if at least 80% of its citations are from firm's existing expertise. *Num_Explore* (*Num_Exploit*) is the number of exploratory (exploitative) patents filed (and eventually granted) in a given year.

However, patent data is associated with truncation issues because of the time lag between application and grant in the patent granting process. It takes two years on average for a patent filing to be eventually granted. Therefore, toward the end of the sample period, many patent applications are still under examined, resulting in a decrease in the number

of granted patents. To address patent-related truncation bias, I follow the time and tech class adjustment documented in the corporate innovation literature (Dass et al. (2017) and Lerner and Seru (2022)). In particular, I scale a patent by the total number of patents applied in the corresponding year and technology class. Moreover, the sample period ends in 2019 and KPSS data used in the patent and citation analysis was updated through 2023, leaving a four-year gap between sample and patent data. This is consistent with the recommendation in Dass et al. (2017) that excluding the last four or more years of patent data to mitigate truncation bias related to patents. I aggregate these truncation-adjusted number of exploratory or exploitative patents to the firm level and apply them to the following regression analysis.

The second series of variables measures the litigation risk of innovation output. A CPC subclass is classified as either a high-risk or low-risk area, depending on whether it falls within the top 10% of the litigation distribution. *Share_Explore_high* is defined as the number of exploratory patents filed in high-risk technology classes divided by all exploratory patents filed in a given year. *Share_Explore_low*, *Share_Exploit_high* and *Share_Exploit_low* are constructed in the same way.

Finally, I measure the economic value of a firm's long-term investment in innovative activities based on data in Kogan et al. (2017). The patent value variables are defined as the total value of patents applied by a firm scaled by firm market value in the given year.

Table 1 reports the summary statistics of the main variables used in the study. The mean value of $Exposure$ is 0.0299, with a standard deviation of 0.0311. The 25th and 75th percentiles of $Exposure$ are 0.0039 and 0.0503 respectively, suggesting substantial cross-sectional variation in firms' preexisting exposure to patent litigation risk. In terms of main dependent variables, on average, a firm in my sample has about 0.003 (truncation-

adjusted) exploratory patents and 0.007 (truncation-adjusted) exploitative patents. The median values of these two measures are close to zero, indicating that patenting in these categories is concentrated in a subset of firm-years. The average market value of a patent is $0.026 million, and the average economic value of exploratory patents ($0.009 million) is lower than that of exploitative patents ($0.011 million).

4 Main Empirical Results

4.1 Exploratory Patents and Exploitative Patents

I start my empirical investigation by examining whether higher expected litigation costs affect the composition of exploratory and exploitative patents, where the dependent variables is *Num_Explore* or *Num_Exploit*. Table 2 reports the regression results estimating equation(1). Column (1) and (3) present the specification without including any control variables and column (2) and (4) add a battery of control variables to the regression. I find that innovative firms that are more exposed to patent litigation are more likely to file exploratory patents but decrease filing exploitative patents after the Supreme Court decision in *Halo* case. These effects are not only statistically significant but also economically sizable. A one-standard-deviation increase in exposure leads to a 16.96% increase in the number of exploratory patents relative to the unconditional sample mean, while a one-standard-deviation increase implies a 8.82% relative decrease in the number of exploitative patents compared to the unconditional sample mean. This result suggests that higher litigation risks prompt firms to adjust their innovation strategies. In terms of innovation output composition, firms operating in more litigious areas tend to move beyond their existing expertise, filing more exploratory patents.

The validity of the causal interpretation in the difference-in-differences approach depends on the parallel trends assumption. Specifically, the assumption requires that if the exogenous Supreme Court decision did not happen, the responses of low-exposed and high-exposed firms would remain the same. To test the parallel trend assumption, I estimate the following dynamic Difference-in Difference model

$$y_{i,t} = \alpha + \sum_{\tau=-4}^{4} \beta_k Exposure_i \times Year_k + \gamma Controls_{i,t} + Firm\ FE + Year\ FE + \epsilon_{i,t} \quad (3)$$

Year 2015 serves as the reference point for other year coefficients. The results are presented in Figure 2. Before the Supreme Court decision (2012 to 2015), both estimates of β_k stay close to zero, indicating that firms with different litigation exposure have similar trends in innovation strategy. However, after the ruling, β_k increases to significantly positive values for exploration output while declines to significantly negative values for exploitation output. Additionally, Figure 2(a) implies that firms initially increase exploratory patents slightly, followed by a significant increase afterwards. Figure 2(b) highlights the quick reaction to decrease filing exploitative patents. These results validate the parallel trends assumption necessary for the difference-in-difference framework and visually illustrate the effect of higher patent litigation risks on the composition of innovation output over time.

4.2 Patent Riskiness

Having established that firms integrate both exploratory and exploitative patents to manage their expected litigation risk, a natural question is whether these new patents are indeed concentrated ex post in less risky technology classes. To examine this question, I assess patent riskiness based on litigation distribution of technology classes over 10 years (2006-

2015) before the ruling. More specifically, a CPC subclass is classified as a risky area if it belongs to the top 10% of litigation distribution.[7] Then I rerun the DID regression in (1) and present results in Table 3. Column (1) and (2) report results using the share of risky or less risky exploratory patents over all exploratory patents as dependent variables. Both coefficients of $Post \times Exposure$ are significant at 1% level but have different directions. Firms with high litigation exposure increase output in low-risk technology classes while reducing the number of risky exploratory patents. The economic significance is also sizeable. A one-standard-deviation increase in exposure leads to a 20.62% decrease in the share of high risk exploratory patents relative to the unconditional sample mean, while a one-standard-deviation increase results in a 31.96% relative increase in the share of low risk exploratory patents compared to the unconditional sample mean. Employing the same method, I also test the ex-post riskiness of exploitative patents. As shown in column (3) and (4), the upward trend in low-risk innovation output also applies to exploitative patents. Taken together, firms take into account litigation risks in their innovation decisions and increased litigation risk leads firms to focus more on low-risk technology classes. This result provides more direct evidence that exploration innovation could be a precautionary strategy for firms facing high litigation risks.

4.3 Patent Economic Value

So far, the results are consistent with the hypothesis that firms with high litigation exposure adapt a precautionary strategy by developing more exploratory patents in low risk areas. However, it remains unclear whether such a shift affects innovation outcomes. Firms may adjust their research composition in ways that do not maximize economic value. To

[7] The results are similar if risky areas are defined as being in the top 25%.

investigate innovation outcomes after the court decision, I exploit patent economic value measures developed by Kogan et al. (2017). The results are presented in Table 4. I find that the market value of exploratory patents significantly decreases for firms more exposed to litigation after the ruling, while there is no evidence of a significant change in the value of exploitative patents. These results suggest that firms operating in highly litigious areas respond to increased expected litigation costs by shifting toward exploratory innovation, but this shift comes at the expense of innovation value.

4.4 R&D Intensity and Firm Valuation

After identifying the innovation outcome of *Halo* decision at the patent level, I next examine its implications at the firm level. Specifically, I estimate the effect on R&D intensity and firm market valuation. Table 5 reports the regression results. The coefficient on $Post \times Exposure$ is positive and statistically significant in columns (1)–(2), indicating that firms with greater litigation exposure exhibit a significant increase in R&D intensity following the ruling. The increase in R&D expenses is consistent with the documented shift toward more exploratory innovation. Exploratory patents are typically more resource-intensive and require sustained investment. Therefore, firms need additional resources when shifting toward exploratory innovation, leading to higher overall R&D expenses. In columns (3)–(4), I use Tobin's Q to measure a firm's valuation. The coefficient on $Post \times Exposure$ is negative and significant, implying that the market valuation of exposed firms declines after the *Halo* decision. Overall, these results indicate that although firms respond to higher expected litigation risk by increasing R&D investment and adjusting their research composition, such reallocation does not translate into higher market value. This pattern is consistent with investor concerns about higher litigation risk.

4.5 Robustness Tests

One concern of my baseline DiD analysis is that firm's prior litigation experience could affect its innovation strategy. Therefore, the positive effect on exploratory and exploitative patents could capture the ex-post response to prior lawsuits rather than the ex-ante expectation of litigation risk. To address this concern, I exclude firms with litigation experience over 10 years before the ruling (2006-2015) and reestimate equation (3). Table 6 Panel A presents the results. The coefficients of $Post \times Exposure$ remain significantly positive, suggesting that the findings are not driven by past lawsuits. Moreover, I perform the difference-in-difference test by including an indicator variable for the existence of a lawsuit last year and report the results in Panel B of Table 6. The baseline results are still robust.

5 Mechanisms

5.1 Firm Resource Constraints

In this section, I extend regression analyses by exploring the heterogeneous effects of higher expected litigation risk. I first examine whether the treatment effect on exploratory innovation differs across firms with varying resource constraints. Following the *Halo* decision, higher expected litigation risk and costs may require firms to allocate more financial resources and managerial attention to legal defense and compliance, thereby reducing the resources available for innovation. For firms that are more resource constrained, limited R&D budgets may restrict their ability to undertake costly exploratory innovation. Therefore, I predict that the positive treatment effect on exploratory innovation will be attenuated in firms with resource constraints. I classify firms as resource constrained based on whether

their firm size in 2015 is below the sample median. I rerun the main DID analysis in (1) with the triple interaction term of $Exposure \times Post \times SmallFirm$. Table 7 Panel A reports the results. The coefficient estimates on $Exposure \times Post \times SmallFirm$ are negative and significant while the coefficients on $Exposure \times Post$ are still significantly positive at the 1% level. These results indicate that the increase in exploratory innovation following the decision is weaker for smaller firms.

I next use firm age as an alternative proxy for resource constraints. Younger firms often face more limited organizational and human capital despite their growth potential. I construct the dummy variable $Youngfirm$ that is equal to one if firm age in 2015 is below the sample median. As shown in Table 7 Panel B, the coefficient estimates on $Exposure \times Post \times Youngfirm$ are negative and significant at a 5% level, confirming that the positive treatment effect on exploration is driven by firms with less resource constraints.

5.2 Product Market Competition

Finally, I examine the role of ex-ante product market competition. Market competition can either encourage or discourage innovation depending on the relative rents from innovation (Aghion et al. (2005)). More directly, persuing exploitative innovation generates greater financial benefits in more competitive environments (Jansen et al. (2006)). Accordingly, firms facing stronger competitive pressure may find exploratory patents less attractive bacause explotatory innovation involves more uncertain and distant payoffs. In contrast, firms in less competitive markets face fewer threats from rivals and have greater flexibility to pursue exploratory innovation.

To test this prediction, I use product market fluidity developed in Hoberg et al. (2014) to measure market competition. The market fluidity measures the extent to which other firms

in related markets are changing their product offerings in the current year relative to last year. I use this measure instead of the traditional Herfindahl–Hirschman index because the product market dynamically changes over time and firms update their focused industries as well (Hoberg and Phillips (2016)). The regression results are reported in Table 8. Consistent with the proposition, I find that the positive treatment effect on exploration is diminished and eventually reverses to negative for firms facing stronger competitive pressure. In contrast, the effect on exploitative innovation turns positive in highly competitive markets. These findings suggest that competitive pressure further limits firms' willingness to shift toward exploratory innovation following the increase in expected litigation risk.

6 Conclusion

In this paper, I examine how an increase in expected patent litigation risk affects corporate innovation strategy. Exploiting the 2016 Supreme Court decision in *Halo Electronics v. Pulse Electronics* as an exogenous shock, I find that firms with higher litigation exposure shift away from exploitative innovation toward exploratory innovation, particularly in technology areas with lower litigation intensity. Further analysis shows that this effect is concentrated among firms facing fewer resource constraints and less competitive pressure.

This pattern is consistent with a precautionary response to higher expected litigation risk. However, this adjustment is not frictionless and costless. The economic value of exploratory patents declines significantly for highly exposed firms after the ruling, ans these firms experience lower market valuation despite increasing R&D intensity.

Taken together, the results suggest that changes in the patent litigation environment can affect not only the level but also the direction of innovation. Such changes may have

unintended consequences for the composition and efficiency of innovation. In particular, higher litigation risk may discourage firms from building on existing knowledge and instead push them toward less risky but potentially less productive innovation paths. When driven by legal risk rather than technological opportunities, such shifts may distort the allocation of innovative effort across technological areas. These findings extend our understanding of how changes in the patent litigation environment shape firms' innovation choices and contributes to the broader policy discussions on the costs and efficiency of the patent system.

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Figure 1: Litigation distribution across CPC sections

This figure shows the distribution of case-patent observations across CPC technology sections over the ten-year period preceding the ruling (2006–2015). Each bar reports a section's share of all case-patent observations in the sample; sections are ordered by this share. Section Y (Emerging Cross-Sectional Technologies) is omitted because it contains no observations in my sample.

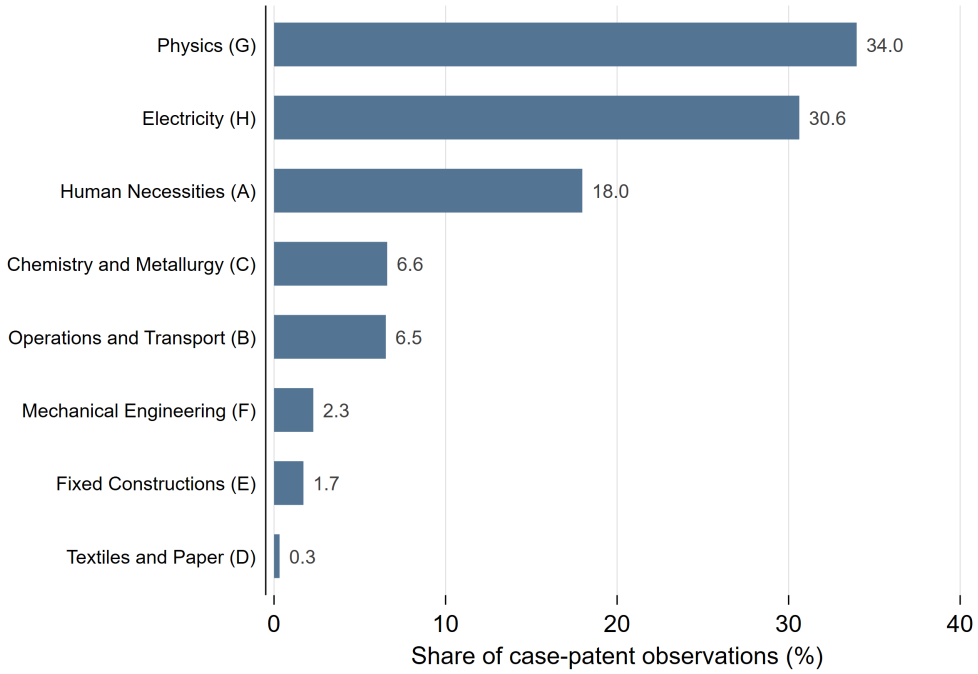
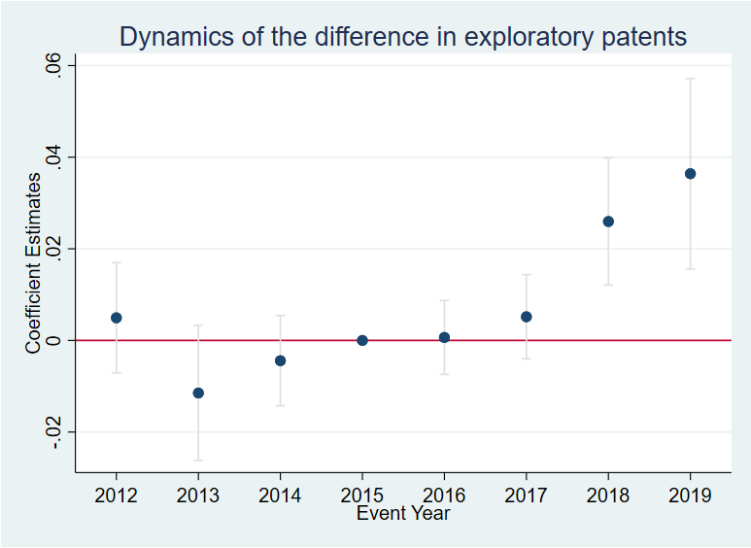
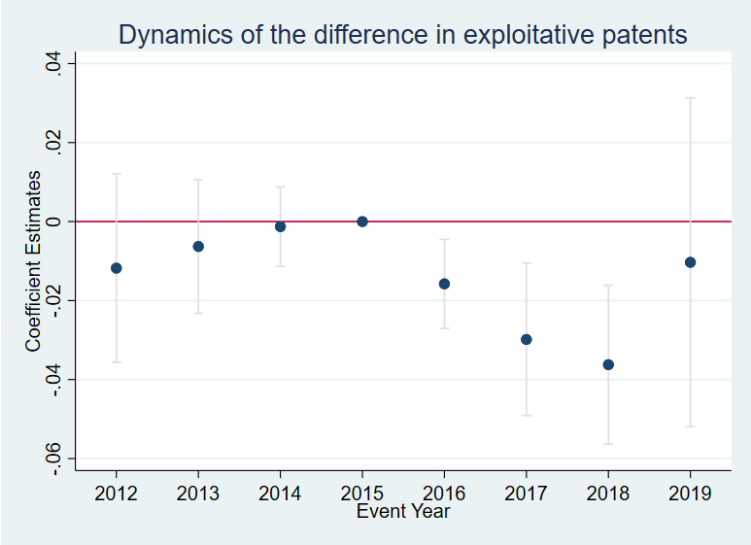


Figure 2: Dynamic Effects for Innovation Strategy

This figure plots the dynamic effects of *Halo* decision on innovation strategy. The coefficients and the 95% confidence intervals are based on regression model (3). The dependent variable of Panel a is *Num Explore*, the truncation-adjusted number of exploratory patents filed (and eventually granted) in a given year. The dependent variable of Panel b is *Num Exploit*, the truncation-adjusted number of exploitative patents filed (and eventually granted) in a given year. The X-axis represents the year relative to the *Halo* decision. The Y-axis represents the coefficient estimates on the time indicator variables surrounding the ruling.



(a) Dynamics of the difference in exploratory patents



(b) Dynamics of the difference in exploitative patents

Table 1: Summary Statistics

This table presents descriptive statistics for the key variables used in my analysis, including mean, standard deviation, and percentile values. All variables used in the regression are defined in Appendix A1. All continuous variables are winsorized at 1%.

	Mean	SD	Min	P25	P50	P75	Max	N
Exposure	0.0299	0.0311	0.0003	0.0039	0.0161	0.0503	0.1066	6853
Num Explore	0.0033	0.0114	0.0000	0.0000	0.0000	0.0011	0.0826	6853
Num Exploit	0.0067	0.0263	0.0000	0.0000	0.0001	0.0018	0.2016	6853
Share_Explore_high	0.3334	0.4206	0.0000	0.0000	0.0000	0.8000	1.0000	6853
Share_Explore_low	0.2378	0.3687	0.0000	0.0000	0.0000	0.4348	1.0000	6853
Share_Exploit_high	0.3719	0.4424	0.0000	0.0000	0.0000	0.9545	1.0000	6853
Share_Exploit_low	0.2255	0.3699	0.0000	0.0000	0.0000	0.3333	1.0000	6853
Total Value	0.0257	0.0444	0.0000	0.0000	0.0071	0.0309	0.2586	6850
Explore Value	0.0089	0.0181	0.0000	0.0000	0.0002	0.0092	0.1068	6850
Exploit Value	0.0113	0.0241	0.0000	0.0000	0.0013	0.0114	0.1551	6850
Tobin's Q	2.7235	2.0150	0.7535	1.4333	2.0524	3.2244	11.7440	6850
ROA	-0.1039	0.3342	-1.7540	-0.1556	0.0257	0.0744	0.2947	6853
Leverage	0.2052	0.2049	0.0000	0.0044	0.1737	0.3228	0.9785	6853
Size	7.0194	2.4281	2.1557	5.1999	6.8389	8.7397	12.3107	6853
R&D expense	0.1341	0.1822	0.0000	0.0188	0.0674	0.1704	0.9874	6853
CAPEX	0.0336	0.0320	0.0000	0.0118	0.0244	0.0442	0.1660	6853
PPE	0.1619	0.1623	0.0008	0.0511	0.1085	0.2136	0.7819	6853
Sales Growth	0.1670	0.7994	-0.9250	-0.0269	0.0383	0.1509	6.4757	6853
Lawsuit	0.2203	0.4145	0.0000	0.0000	0.0000	0.0000	1.0000	6853
Litigation Experience	0.5279	0.4993	0.0000	0.0000	1.0000	1.0000	1.0000	6853

Table 2: Innovation Strategies and Litigation Exposure

This table presents the effect of *Halo* decision on innovation strategy using the difference-in-differences estimation. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. *Num Explore* is the truncation-adjusted number of exploratory patents filed (and eventually granted) in a given year. *Num Exploit* is the truncation-adjusted number of exploitative patents filed (and eventually granted) in a given year. *ROA* is the ratio of income before extraordinary items to total assets in year t. *Leverage* is the ratio of a firm's total debt to its total assets in year t. *Size* is the natural logarithm of a firm's total assets in year t. Observations with missing assets are dropped. *R&D expenses* is the ratio of a firm's R&D expense to total assets in year t. Observations with missing R&D expenses are replaced with zero. *CAPEX* is the ratio of a firm's capital expenditure to total assets in year t. *PPE* is the ratio of net property, plant, and equipment to total assets in year t. *Sales Growth* is a firm's growth in total sales from previous year. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

	Num Explore		Num Exploit	
	(1)	(2)	(3)	(4)
Post× Exposure	0.022***	0.018***	-0.018**	-0.019**
	(0.005)	(0.005)	(0.009)	(0.009)
ROA		-0.000		0.001
		(0.000)		(0.001)
Leverage		0.001		-0.002
		(0.001)		(0.001)
Size		0.001***		0.001***
		(0.000)		(0.000)
R&D expense		0.001**		0.002*
		(0.001)		(0.001)
CAPEX		-0.001		0.002
		(0.004)		(0.009)
PPE		0.003		-0.001
		(0.002)		(0.004)
Sales Growth		-0.000		0.000**
		(0.000)		(0.000)
Observations	6853	6853	6853	6853
Adjusted R^2	0.682	0.683	0.801	0.801
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Patents Riskiness and Litigation Exposure

This table presents the effect of *Halo* decision on patent riskiness using the difference-in-differences estimation. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. *Share_Explore_high* (*Share_Exploit_high*) is the number of exploratory (exploitative) patents filed in high-risk technology classes divided by all exploratory (exploitative) patents filed in a given year. A CPC subclass is classified as high risk area if it falls within the top 10% of litigation distribution. *Share_Explore_low* (*Share_Exploit_low*) is the number of exploratory (exploitative) patents filed in low-risk technology classes divided by all exploratory (exploitative) patents filed in a given year. A CPC subclass is classified as low risk area if it does not fall within the top 10% of litigation distribution. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

	Share_Explore_high	Share_Explore_low	Share_Exploit_high	Share_Exploit_low
	(1)	(2)	(3)	(4)
Post× Exposure	-2.210***	2.444***	-1.054***	1.659***
	(0.279)	(0.192)	(0.324)	(0.193)
ROA	-0.019	-0.038*	-0.047	0.026
	(0.035)	(0.021)	(0.039)	(0.025)
Leverage	0.020	0.003	-0.030	-0.031
	(0.040)	(0.026)	(0.045)	(0.028)
Size	0.025*	0.018*	0.047***	0.009
	(0.013)	(0.010)	(0.014)	(0.010)
R&D expense	0.073	-0.044	0.013	-0.007
	(0.069)	(0.040)	(0.087)	(0.045)
CAPEX	0.274	0.004	-0.031	-0.107
	(0.233)	(0.202)	(0.236)	(0.220)
PPE	0.166*	0.077	0.020	0.109
	(0.090)	(0.082)	(0.105)	(0.110)
Sales Growth	0.003	-0.006**	0.008	0.000
	(0.006)	(0.003)	(0.008)	(0.004)
Observations	6853	6853	6853	6853
Adjusted R^2	0.468	0.465	0.521	0.527
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Patent Economic Value

This table presents the effect of *Halo* decision on patent economic value using the difference-in-differences estimation. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). See Section 3.3.1 for a detailed definition. *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. *Total Value* is total value of patents applied by a firm scaled by firm market value in the given year. Patent value data is from Kogan et al. (2017). *Explore Value* is total value of exploratory patents applied by a firm scaled by firm market value in the given year. *Exploit Value* is total value of exploitative patents applied by a firm scaled by firm market value in the given year. Appendix A1 provides the detailed definitions of the variables used in the table. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

	Total Value	Explore Value	Exploit Value
	(1)	(2)	(3)
Post× Exposure	-0.013	-0.044***	0.008
	(0.031)	(0.014)	(0.017)
ROA	-0.002	-0.000	0.000
	(0.004)	(0.002)	(0.002)
Leverage	0.021***	0.003*	0.014***
	(0.006)	(0.002)	(0.003)
Size	-0.011***	-0.003***	-0.006***
	(0.002)	(0.001)	(0.001)
R&D expense	0.020**	0.006*	0.012**
	(0.009)	(0.003)	(0.006)
CAPEX	-0.053	-0.021	-0.014
	(0.033)	(0.014)	(0.016)
PPE	0.029**	0.020***	-0.003
	(0.014)	(0.006)	(0.008)
Sales Growth	-0.000	-0.000	0.000
	(0.001)	(0.000)	(0.000)
Observations	6850	6850	6850
Adjusted R^2	0.552	0.494	0.533
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: R&D Intensity and Firm's Valuation

This table presents the effect of *Halo* decision on R&D intensity and Tobins'q using the difference-in-differences estimation. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). See Section 3.3.1 for a detailed definition. *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. *R&D intensity* is the ratio of a firm's R&D expense to total assets in year t. *Tobin's Q* is the ratio of market value of assets to book value total assets. Appendix A1 provides the detailed definitions of the variables used in the table. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

	R&D intensity		Tobin's Q	
	(1)	(2)	(3)	(4)
Post× Exposure	0.321***	0.280***	-4.963***	-4.645***
	(0.117)	(0.086)	(1.526)	(1.484)
ROA		-0.297***		0.221
		(0.018)		(0.241)
Leverage		-0.027		-0.238
		(0.018)		(0.299)
Size		-0.035***		-0.536***
		(0.005)		(0.083)
CAPEX		0.254***		6.265***
		(0.059)		(1.161)
PPE		0.094**		-1.874***
		(0.044)		(0.546)
Sales Growth		0.005**		0.056*
		(0.002)		(0.033)
R&D expense				1.713***
				(0.407)
Observations	6853	6853	6850	6850
Adjusted R^2	0.782	0.882	0.648	0.668
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Robustness Tests

This table presents the robust test for *Halo* effect on innovation strategy and patent riskiness. Panel A reports the results when excluding firms with any litigation experience before the ruling. *Litigation experience* is a dummy variable that equals one if a firm experienced lawsuit either as plaintiff or defendant over 10 years (2006-2015) before the ruling. Panel B presents the results controlling the lawsuit case in the prior year. *Lawsuit* is a dummy variable that equals one if a firm experienced lawsuits last year (year t-1). *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). See Section 3.3.1 for a detailed definition. Appendix A1 provides the detailed definitions of the variables used in the table. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

Panel A. Firms without litigation experience before the ruling

	Num Explore	Num Exploit	Share_Explore_high	Share_Explore_low	Share_Exploit_high	Share_Exploit_low
	(1)	(2)	(3)	(4)	(5)	(6)
Post× Exposure	0.013***	-0.013**	-1.951***	2.143***	-0.324	1.434***
	(0.003)	(0.007)	(0.384)	(0.268)	(0.451)	(0.273)
Observations	3235	3235	3235	3235	3235	3235
Adjusted R^2	0.339	0.285	0.336	0.406	0.442	0.451
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Baseline DiD test controlling for lawsuit in the prior year

	Num Explore	Num Exploit	Share_Explore_high	Share_Explore_low	Share_Exploit_high	Share_Exploit_low
	(1)	(2)	(3)	(4)	(5)	(6)
Post × Exposure	0.018***	-0.019**	-2.212***	2.443***	-1.059***	1.662***
	(0.005)	(0.009)	(0.279)	(0.192)	(0.324)	(0.193)
Lawsuit	-0.000	-0.000	0.009	0.003	0.021	-0.015
	(0.000)	(0.001)	(0.012)	(0.011)	(0.013)	(0.010)
Observations	6853	6853	6853	6853	6853	6853
Adjusted R^2	0.683	0.801	0.468	0.465	0.521	0.527
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Innovation, Firm Size and Firm Age

This table presents heterogeneous effects of the increase in expected patent litigation costs on innovation strategy by firm size and age. *Small Firm* is a dummy variable that equals one if firm size in 2015 is below median in 2015 and zero if otherwise. *Young Firm* is a dummy variable that equals one if firm age in 2015 is below median and zero if otherwise. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). See Section 3.3.1 for a detailed definition. *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. Appendix A1 provides the detailed definitions of the variables used in the table. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

Panel A. Cross-sectional tests based on firm size

	Num Explore	Num Exploit
	(1)	(2)
Post× Exposure	0.025**	-0.030*
	(0.011)	(0.016)
Post× Small Firm	0.003***	-0.002*
	(0.001)	(0.001)
Post× Small Firm× Exposure	-0.024**	0.024
	(0.011)	(0.017)
Observations	6845	6845
Adjusted R^2	0.687	0.801
Firm FE	Yes	Yes
Year FE	Yes	Yes

Panel B. Cross-sectional tests based on firm age

	Num Explore	Num Exploit
	(1)	(2)
Post× Exposure	0.023**	-0.021
	(0.010)	(0.017)
Post× Young Firms	0.002***	-0.001
	(0.001)	(0.001)
Post× Young Firms× Exposure	-0.022*	0.008
	(0.012)	(0.018)
Observations	6845	6845
Adjusted R^2	0.685	0.801
Firm FE	Yes	Yes
Year FE	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Innovation and Product Market Competition

This table presents the heterogeneous effect of enhanced litigation risks and costs on innovation strategy based on product market competition. I use product market fluidity constructed by Hoberg et al. (2014) to measure market competition. *Fluidity* is a dummy variable that equals one if a firm's product market fluidity measure in 2015 is above median and zero if otherwise. *Exposure* capture the exposure of firm *i* to patent litigation over 10 years before the ruling (2006-2015). *Post* is an indicator variable that equals one after *Halo* decision (2016–2019) and zero otherwise. All continuous variables are winsorized at 1%. Standard errors are clustered at the firm level across all analyses.

	Num Explore	Num Exploit
	(1)	(2)
Post× Exposure	0.028***	-0.032**
	(0.007)	(0.013)
Post × Fluidity	0.002***	-0.003**
	(0.001)	(0.001)
Post × Fluidity × Exposure	-0.029***	0.039**
	(0.010)	(0.018)
Observations	6055	6055
Adjusted R^2	0.649	0.788
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes

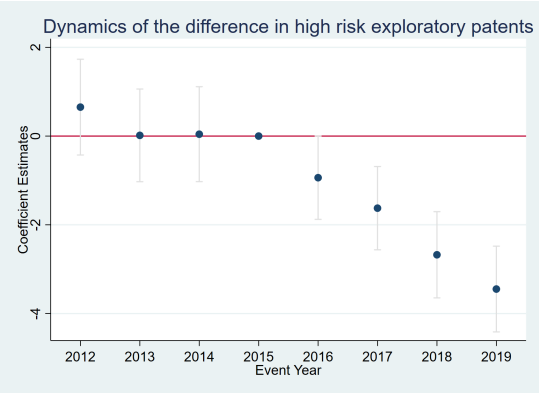
Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

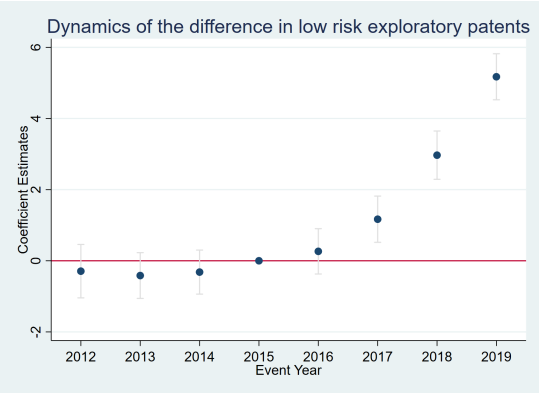
Appendix

Figure A1. Dynamics of the difference in patent riskiness

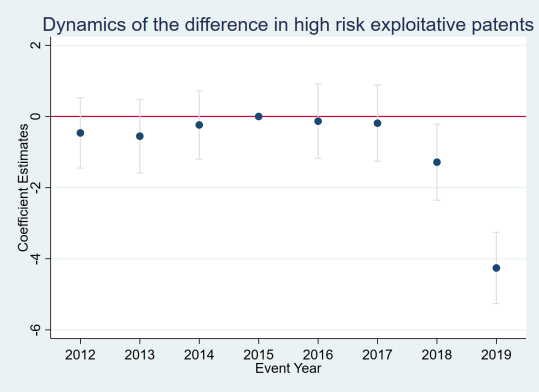
This figure plots the coefficient estimates on the time dummy variables of the dynamic regression that estimate the effect on patent riskiness.



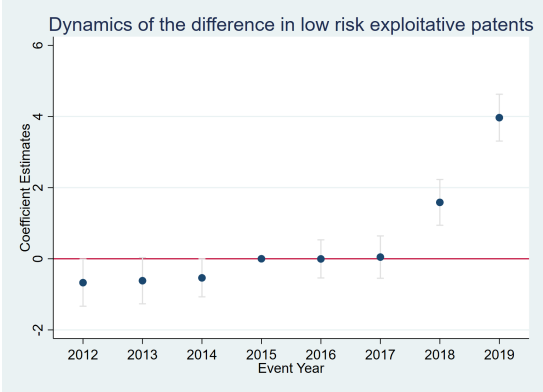
(a) Dynamics of the difference in high risk exploratory patents



(b) Dynamics of the difference in low risk exploratory patents



(c) Dynamics of the difference in high risk exploitative patents



(d) Dynamics of the difference in low risk exploitative patents

Table A1. Definition of Variables

Variable	Definition
Exposure	Exposure of firm i to patent litigation over 10 years before the ruling (2006-2015). See Section 3.3.1 for a detailed definition.
Num Explore	Truncation-adjusted number of exploratory patents filed (and eventually granted) in a given year. A patent is categorized as exploratory if at least 80% of its citations are based on new knowledge outside of the owning firm's existing expertise, where firm's existing expertise includes firm's existing patents and the citations made by these patents over the past 5 years (Gao et al. (2018), Lin et al. (2021)).
Num Exploit	Truncation-adjusted number of exploratory patents filed (and eventually granted) in a given year. A patent is considered as exploitative if at least 80% of its citations are from firm's existing expertise.
Share Explore high	The number of exploratory patents filed in high-risk technology classes divided by all exploratory patents filed in a given year. A CPC subclass is classified as high risk area if it falls within the top 10% of litigation distribution.

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Variable	Definition
Share Explore low	The number of exploratory patents filed in low-risk technology classes divided by all exploratory patents filed in a given year. A CPC subclass is classified as low risk area if it does not fall within the top 10% of litigation distribution.
Share Exploit high	The number of exploitative patents filed in high-risk technology classes divided by all exploitative patents filed in a given year.
Share Exploit low	The number of exploitative patents filed in low-risk technology classes divided by all exploitative patents filed in a given year.
Total Value	Total value of patents applied by a firm scaled by firm market value in the given year. Patent value data is from Kogan et al. (2017)
Explore Value	Total value of exploratory patents applied by a firm scaled by firm market value in the given year.
Exploit Value	Total value of exploitative patents applied by a firm scaled by firm market value in the given year.
R&D intensity	The ratio of a firm's R&D expense to total assets in year t. Observations with missing R&D expenses are replaced with zero.
Tobin's Q	The ratio of market value of assets to book value total assets, which is calcuated as market value of common stock + book value of total assets – bookvalue of common equity, divided by the book value total assets.

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Variable	Definition
ROA	The ratio of income before extraordinary items to total assets in year t.
Leverage	The ratio of a firm's total debt to its total assets in year t.
Size	Natural logarithm of a firm's total assets in year t. Observations with missing assets are dropped.
CAPEX	The ratio of a firm's capital expenditure to total assets in year t
PPE	The ratio of net property, plant, and equipment to total assets in year t
Sale growth	A firm's growth in total sales from previous year
Litigation experience	A dummy variable that equals one if a firm experienced lawsuit either as plaintiff or defendant over 10 years (2006-2015) before the ruling.
Lawsuit	A dummy variable that equals one if a firm experienced lawsuit last year (year $t-1$)
Small firm	A dummy variable that equals one if firm size in 2015 is below median in 2015 and zero if otherwise.
Young firm	A dummy variable that equals one if firm age in 2015 is below median and zero if otherwise

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Variable	Definition
Fluidity	A dummy variable that equals one if a firm's product market fluidity measure in 2015 is above median and zero if otherwise. Product market fluidity measure is developed by Hoberg et al. (2014).