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Abstract

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JEL Classification: N/A

Keywords: corporate governance, law and economics, Innovation, patents, Shareholder Litigation, Class Action Lawsuit

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1 Introduction

A vast body of academic work, from Adam Smith's pin factory to Schumpeter's creative destruction, emphasizes the importance of corporate innovation for economic growth. Consistent with this favorable view of innovation, fostering and promoting corporate innovation has become a policy objective in governments around the world. If promoting innovation is a societal goal, identifying obstacles to the creation and implementation of valuable new ideas is important.

This paper presents novel evidence suggesting that securities class action lawsuits, a central pillar of the U.S. litigation and corporate governance system, can constitute such an obstacle. Our main results are as follows. First, higher innovation output increases the probability of subsequent class action lawsuits. Second, most of the increase in subsequent class action lawsuits is driven by low-quality class action lawsuits.[1] As we discuss in greater detail below, we use case dismissal as a proxy for case quality in our empirical tests. Third, there is no relationship between innovation input and subsequent low-quality class action lawsuits. Fourth, an increase in shareholder class action litigation risk leads firms to patent less and decreases the value of innovation output. Combined, our findings suggest that the class action litigation system imposes disproportionate costs on firms with valuable innovation output, by making these successful innovators vulnerable to low-quality class action litigation.

The idea that lawyers can abuse the class action system by bringing low-quality cases against innovative firms is widespread and influential. The standard narrative is as follows: because innovation is inherently risky, innovative firms have more volatile stock prices and experience more large stock drops. And since large stock drops are attractive for lawyers who want to claim that a stock has traded at inflated prices because relevant information was withheld from investors, we see more low-quality litigation for innovative firms. This view – which we label the "risky innovation hypothesis" – that large stock drops associated with failed innovation make innovative firms more susceptible to low-quality litigation is influential with lawyers, economists, practitioners, and policy-makers.[2]

Despite being influential and intuitively appealing, there are two empirical facts which challenge the risky innovation hypothesis. First, the empirical case for a causal relation between

[1]We use the term *low-quality lawsuit* to denote lawsuits with low legal merit and an elevated probability of dismissal. Law firms may file low-quality cases in an effort to extract a settlement from firms wishing to avoid a costly legal dispute. For our purposes, and unless otherwise indicated, the closely related terms "meritless lawsuits" and "frivolous lawsuits" can be used interchangeably. See below for further details on securities class action lawsuits and the motivations of law firms to file low-quality suits.

[2]See, for example, Alexander (1991) and Seligman (1994) for evidence from the law literature; Lin, Liu, and Manso (2019) for evidence from the economics literature; and U.S. Chamber Institute for Legal Reform (2014), p. 20–21, for evidence from the practitioner and policy-oriented literature. Notably, the risky innovation hypothesis was an important motivation behind the Private Securities Litigation Reform Act (PSLRA) of 1995, which was enacted by U.S. Congress in an attempt to reduce abuses of the class action litigation system via low-quality litigation (e.g., Seligman (2004)).

innovation and the probability of being target of a low-quality lawsuit in the existing literature is weak. It mostly rests on observing higher litigation rates in some sectors, like the technology sector (e.g., Francis, Philbrick, and Schipper (1994)). But lawsuits being correlated with industry membership is a far cry from causal evidence that innovation drives litigation. Second, in the average year in our 1996-2011 sample period, 56% of all Compustat firms experience a daily stock drop of at least 10%, but only 2% of those firms are sued in a class action lawsuit.[3] Given that there are many more large stock drops than class action lawsuits, stock drops *per se*—the focal object of the risky innovation hypothesis—provide at best a partial explanation for litigation. Why firms are sued *among those that experience stock drops* is a key question, necessary to understand the underlying economics, necessary for sound policy recommendations, and largely unanswered by the risky innovation hypothesis. Overall, our understanding of the relation between corporate innovation and litigation is more limited than casual observation of the topic may suggest.

The purpose of this paper is to make progress by suggesting a new perspective on the link between innovation and litigation, which we label the "valuable innovation hypothesis." The valuable innovation hypothesis holds that low-quality lawsuits specifically target successful innovators, i.e., firms that have recently received economically valuable patents and are about to embark on implementing their valuable ideas, because such successful firms are attractive targets for low-quality litigation. Several not mutually exclusive reasons can explain why successful innovators are attractive targets, including that managers who are busy growing their firms have high opportunity costs on time and other resources, that growing firms are particularly sensitive to bad publicity, and that successful innovators use more positive and forward-looking communication with investors, which is potentially easier for lawyers to attack. In this study, we provide empirical support for the valuable innovation hypothesis and show it fits the data better than the risky innovation hypothesis.

A conceptual contribution of the valuable innovation hypothesis is to emphasize the distinction between innovation inputs, such as R&D expenditures, and innovation outputs, which we measure as the economic value of granted patents in a given firm-year as described in detail below. This distinction allows us to reconcile the fact that practitioners and policy makers perceive innovation to be an important driver of low-quality litigation with the paucity of evidence for a link between innovation and meritless litigation in the existing literature. We show that, once we focus on innovation output, there is a significant empirical link between innovation and subsequent low-quality class action litigation. Specifically, a one-standard-deviation increase in innovation output increases the likelihood of a low-quality shareholder lawsuit by 0.34 percentage points. This is a sizable effect relative to the unconditional probability of a low-quality lawsuit

[3] The 10% threshold has been argued in Senate hearings to be a common trigger point for class action litigation. See, for example, Seligman (1994) and the references therein.

filing of 1.0%. By contrast, if we follow prior work and focus on innovation input, we find no relation between innovation and low-quality litigation.

To measure a firm's innovation output, we rely on an approach proposed by Kogan, Papanikolaou, Seru, and Stoffman (2017) (KPSS), who exploit stock-market reactions to patent grants to determine the private economic value of innovations. The KPSS measure of valuable innovation output is ideal for our purpose because it is a strong predictor of subsequent growth in employment, capital, output, profits, and revenue-based total factor productivity. As shown by KPSS, this sets their measure apart from various other measures of innovation output and innovation input used in the prior literature. Hence, if innovation-induced firm growth makes innovative firms more attractive litigation targets, as predicted by the valuable innovation hypothesis, then the KPSS measure should allow us to pick up this relationship.

We address potential endogeneity concerns using a range of different approaches. First, we show that the probability of a subsequent low-quality class action lawsuit increases in current innovation value also when controlling for variables which have been shown by Kim and Skinner (2012) to predict shareholder litigation, including firm size, sales growth, stock returns, volatility, skewness, and turnover. In particular, we also control for innovation input using R&D expenditures and find that, while innovation output links strongly with subsequent lawsuits, innovation inputs do not. Second, we exploit information about how innovation affects not only low-quality lawsuits, but also high-quality lawsuits, and all lawsuits. While the valuable innovation hypothesis is consistent with the broader set of patterns, several alternative stories are not. For example, the hypothesis that innovative firms may simply have better lawyers is inconsistent with our finding that the probability of high-quality lawsuits does not decrease in innovation, and the finding that the overall probability of any lawsuit (i.e., both high and low-quality) increases. Third, we can include firm fixed effects in our regressions, which rule out that time-invariant characteristics of the firm, such as firm culture, are driving the documented relationship. Fourth, we show that the results are robust to using ex-ante proxies for lawsuit quality, as well as to alternative measures of innovation output. Fifth, we show that our results also obtain when we consider instruments for valuable innovation output. Finally, we estimate a dynamic version of our model, which shows that the timing of the effects supports a direct link between valuable innovation and subsequent low-quality litigation.

On top of making a lawsuit more likely, we find that valuable innovation is associated with greater losses to shareholders conditional on a low-quality class action lawsuit being filed. A one-standard-deviation increase in valuable innovation is associated with an additional 1.4 percentage-point decrease in the targeted firm's market capitalization in the seven days around a low-quality class action lawsuit filing. Combined, these findings imply that more valuable innovation output is associated with both, a greater probability of being subject to a low-quality class action lawsuit, and a greater loss conditional on receiving such a lawsuit. The expected costs of low-quality class action lawsuits are thus particularly high for firms with the highest innovation output. This finding is significant, because it implies that low-quality litigation systematically drains resources from those firms with the most valuable ideas.

In the second part of the paper, we ask whether the threat of innovation-induced class action litigation, as established in the first part of our paper, also affects firms' innovation choices *ex ante*. Even though litigation costs are economically sizable ex post, this is ultimately an empirical question. To tackle it, we follow an approach by Huang, Hui, and Li (2019) and exploit changes in the expected business-friendliness of judge panels in federal circuit courts as exogenous determinants of class action litigation risk. We find that an increase in shareholder class action litigation risk leads firms to patent less and decreases the value of firms' innovation output.

In sum, we advance a novel perspective on understanding the economic link between corporate innovation and class action lawsuits. Our findings suggest that low-quality lawsuits are targeted at, lead to economically sizeable losses for, and affect the innovation decisions of highly innovative firms. To understand the link between innovation and low-quality class action litigation, we need to think beyond innovation risk and innovation failure, which were emphasized in prior work. It is innovation output, not innovation input, which drives subsequent low-quality litigation.

More broadly, by providing new, large-scale evidence on the innovation-litigation link, our findings contribute to the ongoing debate on whether securities class action lawsuits have adverse effects on the competitiveness of the U.S. economy. While, all else equal, minimizing the amount of meritless class action litigation may be desirable, designing optimal policy to discourage meritless suits is difficult. A case in point is the Private Securities Litigation Reform Act (PSLRA) of 1995, which did not prevent a large number of low-quality class actions being filed after its passage. A more recent illustration is the Lawsuit Abuse Reduction Act (LARA) of 2017, which aimed at curbing meritless litigation by holding plaintiff lawyers accountable for the cases they bring.[4] A remarkable, and perhaps surprising, fact about the discussion surrounding LARA, which echoes a similar state of affairs surrounding the introduction of PSLRA, is that there seems to be substantial disagreement on a central object: just how costly are meritless class action lawsuits? For example, on one end of the spectrum, the U.S. Chamber of Commerce argues that: "*Every year, potentially billions of dollars are wasted on frivolous lawsuits, hurting job growth and slowing the economy*" (U.S. Chamber of Commerce (2017)). On the other end of the spectrum, the American Bar Association argues that the costs associated with meritless litigation are, at best, small, and that claims of high costs are mostly based on anecdotes rather than large-scale empirical research (American Bar Association (2017)). The divergence of opin-

[4]The bill was passed by the U.S. House of Representatives, but was so far not passed by the Senate.

ion on such a central issue underscores the need for systematic empirical evidence on the cost of meritless litigation and the channels which induce these costs.

2 Relation to the Existing Literature

Our paper contributes to the literature on the economic consequences of the U.S. class action litigation system. One strand of this literature focuses on the incidence, discovery, and cost of true frauds, i.e., high-quality, meritorious, class action lawsuits.[5] Because we focus on low-quality class action lawsuits, i.e., lawsuits with little or no legal merit, our paper is different and complements the previous findings for meritorious lawsuits. A second strand of this literature focuses on low-quality class actions and their impact on the economy. Zingales (2006) argues that the class action litigation system in the U.S. leads to a loss of competitiveness of U.S. public equity markets. Spiess and Tkac (1997) and Johnson, Kasznik, and Nelson (2000) study selected industries to show that market valuations of firms that are more likely to be target of meritless class action lawsuits increase around the introduction of the Private Securities Litigation Reform Act (PSLRA), which is consistent with meritless suits being costly to shareholders.[6] These papers do not investigate how innovation affects the incidence and shareholder wealth losses associated with low-quality litigation, which is what we analyze in our paper.

Our findings on the link between innovation output and class action litigation risk accord well with the observation in prior work that some industries, most notably the technology sector, have particularly high class action litigation rates (e.g., Francis, Philbrick, and Schipper (1994), Kasznik and Lev (1995), Field, Lowry, and Shu (2005), Crane and Koch (2018)). However, it is important to note that we are making a new point, not subsumed by this prior literature. Conceptually, the reason is that many factors could drive an observed relation between industry membership and litigation rates, and, as a result, it is not possible to conclude from observing higher litigation rates in, for example, the technology industry, that corporate innovation drives litigation. Correlation is not causation and therefore none of the above papers makes the claim that innovation causes higher litigation rates. Empirically, we go beyond this work above in three important ways. First, we identify the effect of corporate innovation using variation within industry-dates, which implies that our findings are orthogonal to industry membership. Second, we show that distinguishing between innovation input and output is crucial for understanding the relation between innovation and class action litigation—a point which, to the best of our

[5]Papers in this literature include Karpoff, Lee, and Martin (2008), Gande and Lewis (2009), Wang, Winton, and Yu (2010), Dyck, Morse, and Zingales (2010), and Dyck, Morse, and Zingales (2017).

[6]Ali and Kallapur (2001) challenge some of the conclusions in these two studies. Whether or not PSLRA was successful in its stated aims remains a topic of scientific debate (e.g., Klock (2016), Choi (2007)). A summary of work on low-quality litigation before the introduction of PSLRA in 1995 can be found in Choi, Pritchard, and Fisch (2005).

knowledge, is new to this literature. Third, we show that class action litigation risk affects firms' innovation decisions.

Our paper is related to, and builds upon, the work of Kim and Skinner (2012), who emphasize that industry indicators tell us little about why firms become targets of class action lawsuits. They propose a range of firm-specific variables to augment industry membership in standard firm-level regressions used to predict class action lawsuits. We derive our results from regressions that include their proposed variables as controls.

While our paper focuses on shareholder class action lawsuits, our work is related to a set of studies which establish adverse effects of the litigation system on innovative firms in other settings. Lin, Liu, and Manso (2019) use a natural experiment to show that innovative activity increases when the threat of shareholder derivative lawsuits in state-courts decreases. Our study differs from theirs in several respects. First, they study a different type of lawsuit, state-level derivative suits, so their results do not imply ours and vice versa. Prior research argues that, relative to federal class action lawsuits, derivative lawsuits in state courts (i) "generally cover a narrow range of misbehavior, that is, almost entirely limited to two contexts–acquisitions and self-dealing transactions"; (ii) "carry less severe penalties and are of diminishing importance"; and (iii) "typically follow the filing of a federal securities class action suit" (see Huang, Hui, and Li (2019), footnote 1 and the references therein). Second, they use state-level changes in universal demand laws to obtain variation in the risk of being sued in a derivative suit. As they show, those law-changes affect derivative suits, but not class actions. By contrast, for the last set of tests in our paper, we obtain identification from judge turnover in federal circuit courts, which affects class actions but not derivative suits. Third, while their results show that changes in derivative-litigation risk affects innovation, they do not show (and their results do not imply) that innovation causes litigation, which is the focus of our study (in our different legal context). Other studies have focused on patent litigation. Cohen, Gurun, and Kominers (2016) document a sharp rise in patent litigation by nonpracticing entities in the United States between 2005 and 2015. In addition, Cohen, Gurun, and Kominers (2019) provide evidence that non-practicing entities appear to act as "patent trolls," targeting cash-rich firms irrespective of actual patent infringement, and subsequently reduce innovative activity at targeted firms. Mezzanotti (2020) shows that stronger patent enforcement can reduce the negative effects of patent litigation on corporate innovation.

Combined, these studies and ours highlight the adverse effects of the litigation system on innovative activity across a broad spectrum of important, but distinct, subspaces of the litigation universe. Jointly, they provide some empirical support for a concern raised by a number of CEOs in a survey conducted by McKinsey for the city of New York in 2007. These CEOs felt that "*the legal environment is detrimental to America's spirit of entrepreneurialism and innovation*"

(McKinsey & Company (2007)).

3 Theoretical Framework

3.1 Basic Framework

To fix ideas, this section presents a simple, highly stylized, framework. The goal is to provide intuition as to why lawyers may file meritless lawsuits in the first place, and why higher innovation output may lead to more low-quality litigation.

Suppose that there are K firms and K law firms. There are three periods. At the beginning of period $t = 0$, each law firm is randomly matched with a firm, which yields K law firm-firm pairs. The sequence of events is then as follows. In $t = 0$, a law firm can costlessly perform a pre-scan on the firm for opportunities to bring a suit. If a law firm decides to file a suit, it has to incur a cost $0 < c < 1$. In $t = 1$, after a suit is filed, the defendant files a motion to dismiss. A judge then decides on whether or not to dismiss the case. If the case is dismissed, both parties have a payoff of zero. If the case is not dismissed, the case is either settled, or else goes into the discovery phase. If there is no settlement, the court issues a verdict in $t = 2$. If the court rules against the defendant, the defendant has to pay the plaintiff an amount that we normalize to 1. Discount rates are zero, and all firms and law firms are risk-neutral.

The K firms are indexed by $k = 1, \ldots, K$. We refer to k as "case quality" and think of it as follows. For high levels of k, i.e., when k_i for a given firm i exceeds an exogenous threshold $\overline{k}$, we assume that the firm has violated securities law. A lawsuit against the firm is then of "high quality" and has legal merit. Intuitively, Enron or Worldcom have very high values of k. Of particular interest in our context is the set of cases in which $k_i < \overline{k}$. For that set, firms have not actually violated securities law, and case quality k can then be thought of as measuring how close a firm came to violating the law. We refer to cases with $k_i < \overline{k}$ as "low-quality cases," or, interchangeably, as cases with little or no legal merit. We assume that k is privately observable by the plaintiff and the defendant.

In our framework, judges do not directly observe k, but have to infer k from the information provided by both sides in the legal process. Judicial decisions are therefore not perfect. In particular, not every case in which $k_i < \overline{k}$ is dismissed, and vice versa. However, we assume that judicial decisions are "informative" in the sense that the probability of a judge dismissing the case is negatively correlated with case quality.[7] We denote the probability of dismissal by $p_d(k)$, which is strictly decreasing in k. The negative slope implies that higher quality cases are associated with a higher chance of not being dismissed.

[7]This assumption is weak in the sense that it remains largely agnostic about how well the judicial process works, which would be governed by the degree of correlation.

If a case survives the motion to dismiss, and if it is not settled, there is a positive probability that the defendant loses in a trial. For simplicity, and to save on notation, we assume the conditional probability of the defendant winning the trial is the same probability as the probability of dismissal upon the motion to dismiss, $p_d(k)$.

A subset of firms are firms with high innovation output ("innovators"), and the remaining firms are firms with low innovation output ("non-innovators"). The innovation type of a given firm is fixed ahead of $t = 0$ and independent of k.

Our key assumption is that lawsuits entail reputation and opportunity costs for the defendant. Examples of such costs would be losses due to worse terms of trade and financing, lost business, impaired hiring opportunities, higher employee turnover, and a general drain on corporate resources related to dealing with the accusations. We argue that these costs are likely higher for innovators than for non-innovators. This assumption is directly motivated by the findings of KPSS, who show that firms with valuable innovation output grow more, in terms of sales, employees, and investment, than other firms. (We show in the Internet Appendix that the results from KPSS also obtain for our sample.) Successful innovators are about to bring a new product to the market, which means they are particularly vulnerable to bad publicity due to a lawsuit; successful innovators want to hire new employees, so a disruption in the hiring process due to potential new hires whose view of the firm is negatively influenced by a pending lawsuit may be particularly costly; and successful innovators have particularly high investment needs, which means that an increase in financing costs due to a lawsuit may be particularly costly. Directly in line with the latter argument, Deng, Willis, and Xu (2014) report a deterioration in loan terms after a securities class action lawsuit is filed against a firm. More generally, the evidence in KPSS suggests that successful innovators are firms in which managerial time and corporate resources are particularly valuable, which is why lawsuits, which place an additional burden on time and resources, may hurt them more than other firms.

To incorporate this in the simplest manner for our purposes, we assume that reputation and opportunity costs are normalized to zero for non-innovators, and $C_I > 0$ for innovators. We assume that a fraction $(1 - \phi)C_I$ of the total costs C_I are incurred at the filing of the lawsuit, where $0 < \phi < 1$. That fraction is sunk and not recoverable by lawyers. An example could be the deterioration in loan conditions documented in Deng, Willis, and Xu (2014), who also show that these costs do not revert even after case dismissal, or other types of permanent stigma associated with being accused of wrongdoing. The remainder of the costs ϕC_I are incurred once the lawsuit has not been dismissed by a judge and the case enters the discovery phase.

To analyze the model, start at time $t = 1$, after a decision on the motion to dismiss was made. Conditional on a non-dismissed case (which happens with probability $1 - p_d(k)$), an innovator stands to lose $1 - p_d(k) + \phi C_I$ if it does not settle and goes on to the discovery phase. Without settlement, and conditional on having filed a non-dismissed case, the expected payoff to the law firm is $1 - p_d(k)$. Hence, both the firm and the law firm would find it profitable to settle after the judge has ruled on the motion to dismiss. Specifically, for any $0 < \gamma < 1$, both the firm and the law firm would be better off with a settlement amount of $1 - p_d(k) + \gamma\phi C_I$, where γ depends on the relative bargaining power. While γ could potentially vary across firms, we do not analyze this here, and simply assume that γ is exogenous and the same for all firms.

From the law firm's perspective, the decision to file a suit depends on the expected payoff from a case relative to the cost of bringing the suit. As of time $t = 0$, the law firm will file a suit if

$$(1 - p_d(k))(1 - p_d(k) + \gamma\phi C_I) > c, \tag{1}$$

where the left hand side represents the expected payoff and the right hand side represents the cost of bringing the suit. Cases are filed if the above inequality is satisfied. Equation (1) illustrates that lawyers can have a rational incentive to file meritless suits (i.e., lawsuits with $k_i < \overline{k}$) because such lawsuits can be positive expected value bets.

We can derive a number of testable predictions from this stylized framework. The intuition is simple and we present it below. We relegate proofs to Appendix A.2. C_I represents both, a cost to the sued firm, as well as a benefit to the law firm. *Ceteris paribus*, equation (1) shows that more innovation, i.e., an increase in C_I, increases the benefit of suing. As the costs of filing a lawsuit are unchanged, this implies a higher number of lawsuits brought. This is our first prediction.

Prediction 1: *Across all K firms, increasing innovation output makes it more likely that a lawsuit is filed.*

A main goal of our paper is to make progress on understanding the relation between innovation and low-quality lawsuits. A core problem is that case quality k is not observable to the econometrician. Because dismissals are correlated with case quality, and because dismissals are observable, we analyze case dismissals in our empirical analysis below. This approach is in line with the one adopted in the literature on corporate fraud, which also uses dismissals to proxy for lawsuit merit (see, e.g., Dyck, Morse, and Zingales (2010), Wang and Winton (2014), and our discussion in the robustness section below). The framework delivers the following predictions on dismissed and non-dismissed cases, respectively.

Prediction 2: *Across all K firms, the chance of being subject to a lawsuit that is dismissed increases as innovation output increases.*

Prediction 3: *Across all K firms, the chance of being subject to a lawsuit that is not dismissed increases as innovation output increases.*

The intuition for Predictions 2 and 3 is straightforward: if innovation output increases, there are N additional lawsuits (Prediction 1). As the dismissal probability for each case is between zero and one, some of these new cases will be dismissed, and some will not. Despite their simplicity, Predictions 2 and 3 are not devoid of content. They are testably different from a number of alternative frameworks that may come to mind. For example, if innovative firms had better lawyers, or if judges were more lenient on innovative firms, we would expect, *all else equal*, fewer non-dismissed cases, and fewer cases overall, as innovation increases.

The previous predictions are qualitative. The size of these effects, as well as the relative size, are empirical matters, and their main determinant is the average dismissal probability of the incremental cases, $\overline{p_d^{new}}$. Intuitively, if more of the incremental cases are dismissed than not dismissed, which is the case if $\overline{p_d^{new}} > 0.5$, then the effect of an increase in innovation on dismissed cases will be larger than on non-dismissed cases. Based on our data, $\overline{p_d^{new}} > 0.5$ is a reasonable assumption, as we argue in Appendix A.2. We summarize this discussion in the following prediction.

Prediction 4: *Across all K firms, as innovation output increases, the chance of being subject to a lawsuit that is dismissed increases more than the chance of being subject to a lawsuit that is not dismissed.*

The above model works via the costs to the firm/benefit to the law firm. An alternative (not mutually exclusive) channel through which the valuable innovation hypothesis could operate are the filing costs c. Filing costs for the plaintiff (understood here as the total cost of crafting a case) could be lower when the target is a successful innovator, for example, because such firms use more forward-looking language, which is easier to attack ex post. In Appendix A.2, we show that such a filing cost channel can generate the same predictions as above. We further show in the Internet Appendix there exists empirical evidence in line with the more specific channel of forward-looking language as a driver of lawsuits.

Finally, the model allows us to think about the expected losses to the firm's shareholders conditional on being sued. If we make the additional assumption that $p_d(k)$ is either linear or convex in k, then we can prove in the Appendix:

Prediction 5: *The average losses to the firm's shareholders around the filing of a lawsuit are higher as innovation output increases.*

Note that, unlike Prediction 5, Predictions 1 to 4 are independent of the functional form of $p_d(k)$.

We will test Predictions 1 to 5 in our empirical sections below.

3.2 Relation to the Risky Innovation Hypothesis

The risky innovation hypothesis posits that companies with large investments in research and development, i.e., innovation input, are more likely to experience large stock drops, and therefore low-quality lawsuits, because investments in innovation projects have an elevated failure propensity. The risky innovation hypothesis represents a view on the link between innovation and litigation, which is influential with practitioners, politicians and academics.

The above framework is useful for understanding how the valuable innovation hypothesis relates to the risky innovation hypothesis. In essence, the risky innovation hypothesis is a theory about stock drops. Stock drops are central to how lawyers compute damages, which is why almost all lawsuits filed are cases in which the firm has sustained a large stock price drop. A simple way to capture this idea in our model is to assume that (i) stock drops are uncorrelated with case quality k; (ii) the likelihood of a stock drop is higher for innovative firms, and (iii) damages awarded by the court are an increasing function of the size of the stock drop. With those assumptions, and shutting down our opportunity cost channel by setting $C_I = 0$, one can derive the analogue to equation (1): $(1 - p_d(k))^2 B(SD) > c$, where B is the function that determine the size of the damages, and SD is the stock drop. Predictions 1 to 4 then also obtain for the risky innovation hypothesis.

The above discussion makes clear that the risky innovation hypothesis and the valuable innovation hypothesis are not mutually exclusive and yield similar predictions. Both hypotheses are consistent with stock drops being a necessary condition for a subsequent lawsuit. How, then, can one distinguish between the two? An important difference between the risky innovation hypothesis and the valuable innovation hypothesis we exploit in this paper is that the former focuses on innovation input (in particular, innovative activity that fails and leads to stock drops), while the latter focuses on innovation output (i.e., instances in which a firm has been granted valuable new patents). Whether one theory describes the data better than the other is an empirical question, which we address in our empirical section below.

4 Data

4.1 Class Action Lawsuits

Private securities class action lawsuits are a central pillar of the U.S. litigation and corporate governance system. According to data from the Stanford Securities Class Action Clearinghouse (SCAC), about 5,000 class actions were filed between 1996 and 2017, and close to 40% of all companies listed on major U.S. stock exchanges have been targeted by a securities class action lawsuit at least once during that period. The upper graph in Figure 1 shows the annual number of securities class action lawsuits from 1996.

The core of our data are securities class action lawsuit filings obtained from the SCAC database. The SCAC covers essentially all securities class action lawsuits filed in a federal court in the United States since the adoption of the Private Securities Litigation Reform Act

(PSLRA), starting in 1996. The database provides filing dates for each lawsuit as well as all associated court filings. We exclude cases related to IPO underwriter allocation, analyst coverage, and mutual funds, because we want to eliminate cases where agents and not the firm itself allegedly engaged in wrongdoing.

We further obtain information from SCAC on which cases are settled, dismissed, or ongoing.[8] Dismissals include cases dismissed by a judge as well as voluntary dismissals. The latter constitute less than 10% of all dismissals in our sample. In our baseline tests, we treat both types of dismissals equally; i.e., we assume that both voluntary dismissals and dismissals by a judge are negatively correlated with case quality. We show that our results are robust to excluding voluntary dismissals in our robustness section below.

The summary statistics in Table 1 show that our observations are split roughly equally between dismissed and non-dismissed cases. Using dismissals as a proxy for lawsuit quality, Figure 1 suggests that low-quality litigation may be an increasingly important problem. In 2011 (the last year with reasonably complete data on case outcomes in our sample), more than 65% of all cases are subsequently dismissed, which represents a substantial increase over the 35% dismissed cases filed in 1996.

A drawback of the dismissal proxy is measurement error. Inevitably, because the judicial process is not perfect, there will be some lawsuits that we mistakenly define as low-quality even though they are meritorious, and others that we classify as high-quality even though they are meritless. For example, it is possible to think of cases in which the court uses a motion to dismiss to clarify how a law should be interpreted in a good faith dispute, or where the plaintiff decides to drop the complaint voluntarily for reasons unrelated to lawsuit merit. While it is impossible to separate meritless from meritorious cases without error, we view it as indisputable that the average merit, and therefore also the average case quality, is lower among dismissed lawsuits than among non-dismissed lawsuits. It is this feature of our baseline definition that we exploit in our empirical tests. Note that classical measurement error in our proxy for lawsuit quality (i.e., our dependent variable) would reduce the precision of our estimates and therefore work against us. To make sure our main results are not driven by one specific proxy for lawsuit quality, we consider a range of alternative proxies below and show that our main results obtain also for these alternative measures.

[8]The SCAC distinguishes only between dismissed cases and settled cases. Even though not provided by the SCAC, dismissals could be further grouped into cases that are dismissed with and without prejudice following a motion to dismiss.

4.2 Innovation Output

Following the existing economic literature on innovation, we measure innovation output based on patents granted to the firm. For our baseline definition, we obtain the annual firm-level innovation output measure developed in Kogan, Papanikolaou, Seru, and Stoffman (2017) (KPSS) from Noah Stoffman's website. The measure provides an estimate of the private value of the patents granted to a firm by the United States Patent and Trademark Office (USPTO) in a given calendar year, by exploiting movements in stock prices in the three days following the patent grant announcement. As the measure is in dollars, we follow KPSS and scale it by lagged book assets. We call the resulting measure "innovation value."

The KPSS measure of valuable innovation output is ideal for our purpose for a number of reasons. First, the valuable innovation hypothesis posits that successful innovators are more attractive litigation targets because they have valuable growth opportunities and may communicate those to investors. The KPSS measure is ideal to assess this hypothesis, since KPSS show (and we confirm for our dataset) that their measure is a particularly strong predictor of subsequent growth in employment, capital, output, profits, and revenue-based total factor productivity. Substantial growth in these variables provides a reasonable proxy for firms' opportunity costs, since growing firms want to focus resources on growth and not get side-tracked by non-growth related disturbances. Firms with growth opportunities can also be expected to communicate with investors in a positive and forward-looking way in order to raise capital. Second, the KPSS measure of innovation output is based on patent grants, not filings of patent applications. Because the filing date for a patent precedes the patent grant date by, on average, 2.9 years, we can plausibly view the existence of a technological innovation in year t as predetermined, which helps our identification. Third, the measure is constructed assuming that the market forms an expectation about the economic value of an innovation before the patent grant date and that no new information is released by the grant decision itself. KPSS argue this is a reasonable assumption and present supporting evidence. This feature is very useful in our setting, because it mitigates the possibility that new information drives both, the measured return to an innovation, and the propensity to be subject to a lawsuit.[9]

While the KPSS measure has a number of attractive features, some limitations should be noted. First, it is a measure of the *expected* economic value of a patent at the time where the patent is granted by the USPTO; it approximates, but is not the same as, the *actual* economic value of the patent. Second, it may estimate the expected economic value of the patent with some error. In particular, KPSS assume that the probability the market assigns to the likelihood

[9]Patent application filings were not officially publicized by the USPTO prior to the year 2000. However, according to KPSS, firms frequently announced patent applications themselves and, as a result, the market usually had information about the patents prior to the grant date. We show in Table 5 that our main results are robust to restricting our sample to the post-2000 period.

of a patent being granted is uncorrelated with the patent's economic value. Violation of this assumption may give rise to measurement error in the estimated patent value. As KPSS note, aggregating patent values within a firm-year, as we do in this paper, will partly alleviate this concern. We discuss and address measurement error concerns in more detail in Sections 5.5 and 5.7.

4.3 Sample

The innovation value measure is available until 2010, which means that our combined litigation-innovation dataset spans the period from 1995 to 2011, with innovation measures from 1995 to 2010 and class action lawsuit filings from 1996 to 2011. A class action lawsuit in our sample is resolved (i.e., dismissed or settled) on average after 771 days for dismissed cases and 1,403 days for settled cases. Since our sample ends in 2011, we have an essentially complete sample of all filed class action lawsuits, including their resolution, throughout our sample period. Following KPSS, we replace innovation value with zero if a firm is not granted any patent in a given year. We omit firms in industries that never patent in our sample, as well as financial firms (SIC codes 6000 to 6799) and utilities (SIC codes 4900 to 4949). We match our innovation-litigation data with financial information from Compustat, stock return information from CRSP, and institutional holdings data from Thomson Reuters 13-F filings.

Our final sample consists of 40,010 firm-year observations by 6,101 unique firms with non-missing data for our key control variables. Table 1 reports descriptive statistics. Unconditionally, there is a 1.0% chance that a low-quality class action lawsuit is filed against a firm in our sample. Innovation value, i.e., the total economic value of patents granted to a firm scaled by lagged assets, has a mean of 2.4% and a standard deviation of 6.0%, which implies there is substantial variation in the value of innovative output across the firms in our sample.

5 The Effect of Valuable Innovation Output On Shareholder Class Action Lawsuits

This section presents evidence supporting the predictions derived in Section 3. We also present estimates of the costs to shareholders in the targeted firm around the filing of a class action lawsuit.

5.1 Sorting

We begin with a simple sorting exercise. The lower graph in Figure 1 presents the annual probability of a low-quality class action lawsuit filed against two groups of firms over our sample period. Again, we use case dismissal as a proxy for low-quality lawsuits. Low innovation output firms are firms with a zero KPSS measure, i.e., firms without any patent grant, in the previous year. High innovation output firms are those in the top tercile formed according to the KPSS measure of valuable innovation output among the remaining firms in the same industry-year. Industries are defined using 2-digit SIC-industry codes. Low-quality lawsuits are defined using the SCAC dismissal classifier as discussed in Section 4.

The results shown in Figure 1 are striking. In every year during our sample period, the probability of being subject to a low-quality lawsuit filing is substantially larger for firms with valuable innovation output than for firms without valuable innovation output in the same industry and year. On average, the probability of being targeted with a low-quality lawsuit is more than three times as large for successful innovators.

5.2 Regressions

We next examine whether Predictions 1 to 4 from our theoretical framework hold in a multivariate setting. Our baseline regression specification is:

$$y_{ij,t+1} = \lambda_{jt} + \beta \mathcal{I}_{it} + \gamma X_{i,t-1} + \epsilon_{ij,t+1}, \tag{2}$$

where $y_{ij,t+1}$ is an indicator variable equal to one if a class action lawsuit is filed in year $t+1$ against firm i in industry j, $\mathcal{I}_{it}$ refers to the KPSS measure of valuable innovation output, and λ_{jt} are 2-digit SIC-industry $\times$ year fixed effects. We include industry-year fixed effects because we want to rule out that the link between valuable innovation and subsequent litigation is driven by industry-specific business cycles, where more innovation in booms is followed by more litigation in busts for reasons that are unrelated to innovation.[10] $X_{i,t-1}$ is a vector of lagged control variables. Our set of baseline controls follows Kim and Skinner (2012), who empirically investigate the main predictors of shareholder litigation. Specifically, we control for Tobin's Q,[11] the log of assets, cash holdings, sales growth, institutional ownership, stock returns, volatility, skewness, and turnover. All variables are defined in Appendix A.1 and the full list of coefficients is reported in the Internet Appendix. We use a linear probability model to estimate equation (2) and cluster standard errors at the firm level.[12]

Table 2, Panel A, presents our main results for three different dependent variables: an indicator for all lawsuits filed in $t+1$; an indicator for the subset of low-quality lawsuits as defined in

[10] Lerner and Seru (2017) document substantial variation in patenting activity, and Kim and Skinner (2012) document variation in litigation rates, both across industries and over time.

[11] We find very similar results if we use the measure of Tobin's Q by Peters and Taylor (2017), which includes intangible capital.

[12] We have verified that the main results in Table 2 obtain also when we use a probit model instead of OLS.

Section 4; and an indicator for the remaining subset of high-quality lawsuits. Columns (1) to (3) present results using only accounting and ownership-related control variables, whereas columns (4) to (6) add controls related to stock returns and trading volume.

Looking at columns (1) and (4), we find a significant positive link between valuable innovation output and the filing of a class action lawsuit in the following year, consistent with Prediction 1 of the model above.

To determine the source of the overall increase in lawsuit filings, we next reestimate our regressions using dismissed and non-dismissed lawsuits, respectively. We find that the effect is almost exclusively driven by an increase in the filings of low-quality lawsuits against successful innovators. In the full model, reported in columns (5) and (6), the coefficient on the innovation value variable is highly statistically significant for low-quality litigation ($t = 3.50$), but not statistically different from zero for high-quality cases ($t = 0.73$). The point estimate in column (5) implies that a one standard-deviation shift in innovation value increases the probability of a low-quality class action lawsuit filing in year $t + 1$ by 0.34 ($= 0.057 \times 0.060$) percentage points, which is sizable relative to the unconditional probability of a low-quality lawsuit filing of 1.0%. The difference in the relative increases implied by the coefficients in columns (5) and (6) is statistically significant at the 5% level. The same applies to the relative increases implied by the coefficients in columns (2) and (3).

All patterns are consistent with Predictions 1 to 4 of the framework in Section 3. Note that, while Prediction 3 is an increase in high-quality cases, the size of that increase is a function of the average dismissal probability among the incremental cases, i.e., the cases that are only brought if innovation is high. The higher that probability, the more will an increase in innovation affect only dismissed and not non-dismissed lawsuits. As that probability approaches one, our model predicts the increase in non-dismissed cases to approach zero. We can use the coefficients in Table 2, columns (5) and (6) to back out that probability (see equation (A.9) in Appendix A.2 for details). The coefficients imply that incremental cases against successful innovators are of very low quality, with an average dismissal probability of 83%. Hence, while non-dismissed cases do increase, consistent with the model, the magnitude of this increase is so small that we cannot statistically distinguish it from zero.

The results in Table 2, Panel A, are important because they suggest the existence of an implicit "tax" on valuable innovation output, brought about by an increased probability of being subject to low-quality shareholder class action litigation. The controls we include show that our results are not due to innovation output being correlated with general differences in firm size or value and growth attributes, as captured by lagged Tobin's Q, sales growth, cash holdings, trading-volume, and properties of the firm's stock return distribution.[13]

[13]The results in Table 2 show that valuable innovation does not increase *observed* meritorious litigation. An interesting but separate question is whether valuable innovation increases the propensity to engage in actual

To shed some light on the functional form that relates valuable innovation output to shareholder litigation, Figure 2 presents nonparametric binned scatter plots. We compute averages of low-quality class action filing frequencies for 50 innovation value bins, obtained after first residualizing both the class action filing and innovation variables on industry × year dummies and the same set of controls as in Table 2, column (5). Figure 2 shows that the probability of being target of a low-quality lawsuit increases quite steadily in innovation value. In particular, the plot suggests that the positive relation between valuable innovation and subsequent low-quality litigation is not driven by outliers. In contrast, the relationship between valuable innovation and high-quality litigation is much flatter.

Finally, we also consider the dynamics of the relationship between valuable innovation output and low-quality litigation risk. To do that, we estimate regressions of the following form:

$$y_{ij,t+h} = \lambda_{jt} + \sum_{\tau=0}^{\tau=h} \beta_\tau \mathcal{I}_{i,t+\tau} + \epsilon_{ij,t+h}. \tag{3}$$

The dependent variable is an indicator equal to one if a low-quality lawsuit is filed against firm i between (and including) years t and $t+h$, and zero otherwise. The coefficient of interest is $\beta_{\tau=0}$, which measures the incremental effect of innovation in year t on the cumulative probability of a low-quality class action filing between (and including) years t and year $t+h$. The regression does not include any additional controls, because those controls would be endogenous.[14] For each h we consider, we estimate a separate regression.

Figure 3, Panel A, reports the coefficient $\beta_{\tau=0}$ after varying the horizon h of the dependent variable from one to four years (h is plotted on the x-axis of the figure). The leftmost data point, which represents the regression for $h = 0$, shows that there is an elevated probability of being subject to a low-quality lawsuit in year t for firms with valuable innovation output in that same year. The confidence bounds indicate that the effect is statistically significant at the 5% level. The data point at $h = 1$ shows that the largest effect, i.e., the largest incremental change in $\beta_{\tau=0}$ across all values of h on the x-axis, is realized in the year after a firm was granted with valuable patents. In the following years, $h = 2, 3, 4$, the incremental effect of innovation in year t is still positive, but economically much smaller. The pattern that it takes a while for innovation today to attract a lawsuit, but that, at the same time, innovation today does not matter much for lawsuits many years out, appears very plausible.

fraud. We follow a standard approach in the literature on corporate fraud and estimate bivariate probit models (e.g., Wang (2013)) to separate fraud detection from fraud commission. We do not find any evidence to suggest valuable technological innovation would increase the propensity to commit fraud. We provide further details on these results in the Internet Appendix.

[14]While we believe the above specification is the most appropriate one, we have estimated the regression with the set of controls measured in $t-1$, and we have also estimated a specification with firm fixed effects added to equation (3). Both alternatives deliver qualitatively similar results to the specification in equation (3).

In Panel B, we also study the cumulative lawsuit probability in years prior to innovation in t, and do not find an elevated lawsuit probability for any value of h we consider.[15] The results from these tests, which can be interpreted as a placebo test, show that successful innovators are not simply firms with an elevated litigation risk for other reasons. Before firms are granted valuable patents, they are not at an increased risk of receiving a low-quality lawsuit relative to other firms.

Finally, we provide results on the channel through which innovation output links with lawsuits. To that end, we explicitly test whether successful innovators are more likely to experience negative events, such as large stock price drops or unexpectedly poor accounting performance. We use four different measures: stock return volatility, stock return skewness, large negative stock returns, and large negative earnings surprises. Due to the high persistence in daily stock return volatility and skewness, we estimate dynamic specifications and include on lag of the dependent variable. Controls are otherwise the same as in Table 2, Panel A. Table 3 presents results. Across all four measures, we find no indication that valuable innovation output is associated with a statistically or economically significant increase in the likelihood of experiencing lawsuit-triggering events in the following year. If anything, valuable innovation is associated with *lower*, not higher, subsequent stock return volatility. This is consistent with patent grants reducing uncertainty about the firm's innovation output rather than exacerbating uncertainty. Note that, as a lawsuit filing could mechanically lead to higher volatility, the tests in Table 3 are biased towards finding an increase in volatility.

We conclude from the results in Table 3 that the positive link between valuable innovation output and subsequent litigation is not driven by an elevated probability of successful innovators experience more stock drops or other bad outcomes. This finding is consistent with the theoretical framework in Section 3. There, firms were sued because successful innovation was associated with higher opportunity costs on corporate resources, not because successful innovators had more stock drops.

5.3 Innovation Output vs. Innovation Input and the Risky Innovation Hypothesis

While the risky innovation hypothesis and the valuable innovation hypothesis are not mutually exclusive, we can extend our baseline regression to get additional insights on their relative consis-

[15] Specifically, we report coefficient $\beta_{\tau=0}$ from the following regressions, where h is varied from one to four:

$$y_{ij,t-h} = \lambda_{jt} + \sum_{\tau=-h}^{\tau=0} \beta_\tau \mathcal{I}_{i,t+\tau} + \epsilon_{ij,t-h}. \tag{4}$$

tency with the data. Table 2, Panels B and C, add R&D expenditures as the standard measure of innovation input to our main regression in Panel A.[16] Panel B follows Kim and Skinner (2012) in relating this year's R&D investment to next year's probability to be litigated. Panel C replaces last year's R&D by a three-year moving average. Regressions are otherwise the same as in Panel A. Across all panels and specifications, we find that the coefficients on innovation output are effectively unchanged relative to our baseline, while innovation inputs are always insignificant, irrespective of whether we consider all cases, high-quality cases, or low-quality cases.

These findings address a potential concern with our previous results, which is that we observe a positive and significant relation between innovation output and low-quality lawsuits simply because innovation output is correlated with innovation input. Panels B and C show this is not the case. Moreover, the findings in Panels B and C are informative because they show that the risky innovation hypothesis does not have strong empirical support in the data.[17] To understand the link between innovation and litigation, an alternative theory like the valuable innovation hypothesis may therefore be particularly useful.

5.4 Ex-Ante Proxies for Lawsuit Quality

We believe case dismissal, as defined in the SCAC database, is a good proxy for relative case quality in our setting, because dismissed cases can plausibly be expected to be *on average* of lower-quality, and more likely lacking merit, than cases that are not dismissed. But, as discussed above, the dismissal proxy is not perfect, since the legal merits of a case are unobservable to researchers. We address potential concerns with respect to the measurement of lawsuit quality in two ways.

First, we exploit the fact that the combined set of results – the results for all lawsuits, high-quality lawsuits and low-quality lawsuits – in Table 2 are informative regarding alternative explanations. For example, one may hypothesize that firms with valuable innovation hire better lawyers, or that judges are predisposed to show leniency towards firms that are about to invest and hire new employees, which would predict that innovation success makes it more likely that a case is dismissed, even though, fundamentally, it is meritorious. These hypotheses are inconsistent, however, with the other results in Table 2, Panel A. Specifically, better defense lawyers or more lenient judges would, all else equal, not predict an increase in the overall likelihood of a lawsuit being filed. Specifications (1), (2), (4) and (5) show that these predictions are different from what we observe in the data.

Second, we present results for a range of alternative proxies for lawsuit quality, which are

[16] We replace missing values of R&D by zero, but we find very similar results if we do not replace missing values.

[17] One could argue that, conditional on volatility, innovation input should not load in a regression like ours (we thank an anonymous referee for pointing this out). Specifications (1) to (3) are therefore informative, because they show that R&D does not link to lawsuits even in a regression without volatility controls.

based on ex-ante information when the lawsuit is filed. While, inevitably, none of the alternative proxies we consider is perfect either, finding similar results across a broad range of different proxies strengthens the case for a robust link between valuable innovation output and low-quality class action lawsuits. An attractive feature of the alternative proxies we consider is that they are all based on public information at the time of the case filing, which should help attenuate any remaining concerns that our results are affected by how firms or judges respond to a lawsuit filing.

Our first alternative proxy for class action quality is an indicator for whether the defendant firm was subject to an accounting-related SEC investigation in the filing year or in the two calendar years prior to the filing. This proxy is motivated by the fact, established in prior related research, that material financial misstatements are an indicator of lawsuit merit (e.g., Choi, Pritchard, and Fisch (2005), Karpoff, Koester, Lee, and Martin (2017)). We obtain information on SEC enforcement actions from the Accounting and Auditing Enforcement Releases (AAER) database. We then rerun the baseline results from Table 2, using the SEC-based alternative proxy.

Table 4, Panel A, presents results. We find that using SEC enforcement actions as an alternative proxy for lawsuit quality yields qualitatively identical results to our baseline definition which uses dismissed cases. Specification (2) shows that there is no significant relation between valuable innovation and lawsuit filings for cases in which the SEC has a concurrent enforcement action, i.e., cases that are more likely meritorious given that the SEC tends to investigate only potentially serious cases of financial misconduct. By contrast, the remaining cases, which are more likely meritless, exhibit a significant positive link between valuable innovation and class action filings, as shown in specification (1).

The second alternative proxy we consider is whether the plaintiff alleges a U.S. GAAP violation in the lawsuit filing. The underlying idea is that accounting violations are more tangible than other allegations, such as misleading statements or omissions of material facts in company disclosures. Intuitively, a lawyer who wants to fabricate an allegation despite no wrongdoing would be unlikely to allege an accounting mistake where none is present, because the existence of an accounting mistake is comparatively easy to establish. As for SEC enforcement actions, an alleged GAAP violation is an imperfect, but informative, signal for case quality. We obtain data on whether a U.S. GAAP violation is alleged from the SCAC database. Specifications (3) and (4) in Table 4, Panel A, show that we obtain results very similar to our baseline when we use alleged U.S. GAAP violations to proxy for case quality.

Our third approach is to use a predictive model for lawsuit quality. To that end, we combine a large set of variables available at the time of the lawsuit filing to obtain an ex-ante predicted probability of case dismissal. We estimate a linear probability model where lawsuit dismissal is predicted using information about the violations of the Securities Act of 1933 and the Securities Exchange Act of 1934 alleged in the complaint (we distinguish 8 categories), the nature of the allegations in the complaint (we distinguish 7 categories), variables capturing specific trends in the types of class action suits filed (we distinguish 3 categories), losses around the corrective disclosure event, alleged fraud duration, filing gap, characteristics of the plaintiff and plaintiff lawyer, and the district where the lawsuit is filed. For brevity, we provide the results of this estimation in the Internet Appendix. Based on this model, we classify lawsuits with a predicted dismissal probability above the median in a given filing year as low-quality, and as high-quality otherwise. Specifications (5) and (6) in Table 4, Panel A, present results, which again show that valuable innovation is closely linked to class action filings if the case has a high probability of dismissal, but not otherwise.

Overall, the results in Table 4, Panel A, are consistent across the three alternative proxies for lawsuit quality, and in line with our baseline results in Table 2: valuable innovation output leads to more low-quality securities class action litigation. Panels B and C show that a second important feature of the valuable innovation hypothesis is also preserved for the alternative proxies of lawsuit quality: it is innovation output that matters for low-quality litigation, not innovation input.

5.5 Alternative Measures of Innovation Output

As discussed in Section 4, we use the KPSS measure as our baseline measure of innovation output because the valuable innovation hypothesis posits that successful innovators are more attractive litigation targets due to their valuable growth opportunities. Since KPSS show that their measure is a particularly strong predictor of subsequent growth in employment, capital, output, profits, and revenue-based total factor productivity, it provides an ideal measure for our tests. For completeness, this section explores the relationship between other measures of innovation output and subsequent litigation risk. We report these results in Table 5, Panel A. We report the same specification as in Table 2, Panel A, specification (5), and omit coefficients on control variables for brevity.

We first use the total number of patents granted to the firm. Next, we use citation-weighted patent counts, obtained from Noah Stoffman's website. We also define an indicator equal to one for patents which rank in the top decile of citations among all patents granted in the same technology class and year (we obtain the necessary data from the Patent Examination Research Dataset ("PatEx")). Overall, we obtain qualitatively similar results using these alternative measures of innovation output, although the economic magnitude is lower than for the KPSS measure of innovation output.

These findings are informative about the drivers of our baseline results. The key difference between the KPSS measure and the first three measures of innovation output in Table 5, Panel A, is the KPSS measure's emphasis on the private economic value of a firm's patents. Economic value is plausibly related to, but distinctly different from, the raw number of patents or the scientific value of these patents.[18] If the valuable innovation hypothesis describes the data well, we expect to see stronger results when we use a measure which focuses on the value of innovation output. In that sense, the results in this section provide support for the valuable innovation hypothesis.

Since firms may produce economically valuable innovation output even if they do not patent those innovations, we also use, in a final test, the market value of new product introductions as defined by Mukherjee, Singh, and Žaldokas (2017). Their innovation measure, which we obtain from Alminas Žaldokas' website, is constructed from abnormal stock returns around press releases on new product announcements. Using their measure, we find a positive relationship between economically valuable new products and subsequent litigation risk, consistent with the idea that firms with valuable new products also have valuable growth opportunities. While all alternative measures in Panel A produce similar results, the statistical significance is highest for the number of patents and the economic significance is highest for the economic value of new product introductions.

5.6 Additional Robustness Tests

Next, we perform a series of robustness tests. In Panel B of Table 5, we show that our results are robust to defining low-quality lawsuits as lawsuits that are either dismissed or settled for less than $3 million (e.g., Dyck, Morse, and Zingales (2010)), as well as to excluding voluntary dismissals.[19] Our results are also robust to focusing on a more homogeneous set of cases: all complaints with Section 10(b) or Section 11 claims, which represent the majority of securities class actions.

Panel C considers additional controls. First, we include contemporaneous controls for sales growth, stock return, volatility, skewness, and turnover. These variables are not included in our baseline because they are likely endogenous controls: returns, volatility, and skewness may be higher because of valuable innovation. While excluding these variables is econometrically warranted, the results in Panel C show that our main results obtain also when we include them. Second, we address the possibility that the link between valuable innovation and litigation is

[18]See, e.g., Abrams, Akcigit, and Grennan (2019), who show that the relation between scientific and economic value of patents, while overall positively correlated, follows an inverted U-shape pattern.

[19]Note that the focus of papers like Dyck, Morse, and Zingales (2010), or Wang and Winton (2014), is different from ours. Their goal is to use a conservative measure of true fraud, which is why they exclude cases with low settlements in their definition of meritorious cases. Our goal, by contrast, is to use a conservative measure of low-quality lawsuits, which is why we exclude low settlement amounts in our baseline definition of low-quality cases. We thank Cornerstone Research for providing us with data on settlement amounts.

induced by valuable innovation being a proxy for managerial overconfidence (e.g., Hirshleifer, Low, and Teoh (2012)). To that end, we control for a stock-option based proxy for managerial overconfidence proposed by Malmendier and Tate (2005) and find virtually unchanged results. Third, we use firm fixed effects to attenuate concerns about unobserved firm-level heterogeneity. For example, better-run firms may be both, more likely to generate valuable innovations, and less likely to be sued for securities fraud. Including firm fixed effects leaves the point estimate and the economic significance of our effect virtually unchanged, which suggests our results are not due to omitted time-invariant firm-level factors. While the point estimate remains the same, our estimates become somewhat noisier. A plausible explanation is that, by including firm fixed effects and thus focusing on within-firm variation, identification comes mainly from firms that have at least one meritless lawsuit during our sample period. These firms represent less than 10% of the sample. Finally, by including district court × year fixed effects, we ensure that our results are not driven by innovative firms being located in districts with more business-friendly courts.

In Panel D, we examine alternative sample restrictions. First, in order to ensure our results are not driven by unobserved differences between patenting and non-patenting firms, we estimate our regressions using only firm-years with non-zero innovation. Second, in order to rule out that the technology bubble around the year 2000 drives our result, we exclude the years 2000 and 2001 from our estimation. In both cases, we find essentially unchanged results and the economic magnitude of the effect is, if anything, higher than in our baseline. Since patent application filings were not officially publicized prior to 2000, we further split the same into pre- and post-2000. We find similar effects in both subperiods. This result is consistent with the idea that, although patent filings were not officially publicized prior to 2000, investors had advance knowledge of these applications because firms often publicized patent applications themselves (see also KPSS).

5.7 Instrumental Variable Regression

A potential remaining concern is that unobserved *time-variant* factors at the firm level, which are (i) not captured by our control variables and (ii) correlated with both the value of innovation output and subsequent low-quality litigation, may explain our results. While not impossible, we feel it is nontrivial to think of plausible stories along these lines, since any confounding variation would need to match the dynamic pattern we observed in Figure 3, i.e., the strong increase in litigation risk in the year following the innovation. Moreover, any alternative story needs to explain why innovation output links with low-quality lawsuits much more than it does with high-quality lawsuits.

A related concern could be measurement error in the KPSS innovation measure. To derive the economic value of a patent, KPSS use the observed share price appreciation when the patent is granted as a main input. One specific alternative hypothesis related to measurement error is that those patents with the highest observed announcement returns, and therefore the highest KPSS measures of innovation value, are those for which managers are most successful in making investors believe, potentially falsely, that the patent is very valuable. This could explain why those firms with the highest KPSS measures are subsequently facing more lawsuits. However, it does not necessarily explain why low-quality lawsuits increase more with innovation than high-quality lawsuits. To obtain this prediction, one would have to assume that managers are successfully inducing excessive optimism among investors, but not using truly fraudulent means, and that more managerial effort to raise false expectations increases the likelihood that some disappointed investor files a low-quality lawsuit later.[20] We feel this alternative story is sufficiently complicated to raise some skepticism. At the same time, it is still perfectly consistent with our main hypothesis: it is innovation output, not innovation input, that drives low-quality litigation. What would change is the interpretation of this empirical fact. Under the alternative story, low-quality litigation is driven by "erroneously perceived-to-be valuable innovation," rather than "fundamentally valuable innovation," but the fact remains that, in both cases, there is an elevated risk that firms that have not violated the law are targeted by class action lawsuits.

To alleviate remaining concerns about omitted variables and measurement error, we consider two instruments for innovation value. We provide a condensed discussion here, for brevity, and relegate details to the Internet Appendix. The first instrument for valuable innovation we use is tax-induced changes in the user cost of R&D capital, a strategy motivated by previous studies in the literature (e.g., KPSS, Matray and Hombert (2018), Bloom, Schankerman, and Van Reenen (2013)). The underlying idea is that R&D tax credits motivate investment in R&D, and that more investment in R&D will tend to increase the total value of innovation output in the following years. The instrument exploits the fact that different firms within the same industry and year face different changes in state-level R&D tax credits depending on the geographical distribution of their R&D activity. State-level tax credits can be considerably more generous than federal tax credits and are therefore a relevant concern for firms when deciding about R&D investments.

The second instrument we use follows Sampat and Williams (2019) and exploits the leniency of the USPTO patent examiner assigned to outstanding patent applications. New patent applications at the USPTO are categorized based on the type of technology, and directed to a specialized group of examiners called art unit. Within an art unit, a supervisor then allocates new patent applications to examiners in a process that is quasi-random (Lemley and Sampat (2012)). Variation in patent examiner leniency therefore induces exogenous variation in the total

[20]This hypothesis may sound more straightforward than it actually is. In particular, one needs to also assume that managers do not raise the market's expectation of the likelihood of patent application success prior to the patent grant. If that probability were to go up at the same time, which is quite plausible if managers try to make investors bullish about the innovation to begin with, the overall effect on *observed* share price appreciation around the grant date would be ambiguous.

value of innovation output for a given firm.

As reported in the Internet Appendix, the first-stage estimates reveal a significant positive relation between R&D tax credits and subsequent innovation output, as well as between patent examiner leniency and innovation output. The coefficient estimates in the second-stage regression are larger but qualitatively similar to our baseline results, for both instruments. These results further attenuate concerns about measurement error and omitted variables.

5.8 Quantifying the Costs of Shareholder Litigation

Valuable innovation output leads to more low-quality class action lawsuits. But how costly is low-quality litigation against successful innovators? The purpose of this section is twofold. First, we gauge the economic magnitude of the costs of low-quality shareholder litigation against innovative firms. We focus on the cost conditional on being sued (the "ex-post" effect) here, and analyze potential ex-ante implications in later sections. Second, we test Prediction 5 from Section 3, by comparing the magnitude of the shareholder litigation costs to firms with high versus low innovation output.

5.8.1 Shareholder Losses Around Filing Dates

We start with an event study around the filings of low-quality and high-quality class action lawsuits without conditioning on innovation output. We use an event window from three trading days before the filing date to up to ten trading days after the filing, and compute abnormal returns relative to a Fama and French (1993) and Carhart (1997) four-factor model estimated over days $t = -300$ to $t = -50$. To be conservative, we only study filing events where the first trading day after the end of the class action period does not fall inside the event window (-3,+10). This ensures that the large stock drops, which usually mark the end of a class period and which are often driven by negative information the market receives about a firm, are not affecting our estimates. This, in turn, should give us a cleaner estimate of the impact of the lawsuit itself. In case of multiple lawsuits filed against the same company which are later consolidated, we only retain the filing of the first lawsuit.

The top panel in Figure 4 presents results separately for low-quality and high-quality cases, respectively. The filing of a low-quality class action lawsuit is associated with a significant drop of about 2.1% in market value for the targeted firm in the (-3,+3) window around the filing date, with no further change afterwards. Turning to high-quality lawsuits, we find, as expected, even bigger effects. Over the seven days around the filing, the market value of affected stocks drop by 3.6%, with cumulative losses approaching 5.0% by day ten. While samples and methodologies differ, the magnitude of these drops is in the same ballpark as those reported in earlier studies on stock market reactions in response to class action filings. In particular, finding substantial shareholder value losses around low-quality lawsuit filings is consistent with work by the U.S. Chamber Institute for Legal Reform (2017), Klock (2016), Griffin, Grundfest, and Perino (2004), and Pritchard and Ferris (2001).[21]

There are reasons to believe the above effects understate the true cost of low-quality class action lawsuits to shareholders. In particular, Gande and Lewis (2009) argue and show that lawsuits are partially anticipated by the market and that focusing on filing dates thus understates the magnitude of shareholder losses. In addition, Karpoff, Koester, Lee, and Martin (2017) show that the filing date is only one event, albeit an important one, in a string of events that occur when a company gets into legal trouble. By design, we are not capturing any additional value lost in these other events. In our setting, longer event windows produce larger effects, but, to minimize the potential impact of confounding events, we restrict ourselves to the short event windows above.

In the bottom panel in Figure 4, we plot the cumulative abnormal returns around the filing of a low-quality lawsuit separately for innovative and non-innovative firms. High-innovation firms are defined as firms which rank in the top tercile of firms within the same industry and year, respectively, based on their KPSS innovation measure in the calendar year prior to the filing, conditional on the KPSS measure being non-zero. No-innovation firms are those with zero patents granted in the previous calendar year. Consistent with the idea that litigation is costlier for firms with attractive growth opportunities, we see a larger drop for high-innovation firms. Over days (-3,+3), the drop in market value is 2.8% for innovative firms and thus about 1.0 percentage points higher than for non-innovative firms. This is consistent with Prediction 5 from our framework in Section 3.

Table 6 confirms the result that abnormal stock returns around lawsuit filings are lower for innovative firms in an OLS regression with the same set of control variables and fixed effects as in Table 2, specifications (2) and (5). If anything, the difference grows larger once we control for potentially confounding variables. The point estimates in specification (2) suggest that a one-standard-deviation increase in innovation value leads to a 1.4 ($= 0.241 \times 0.060$) percentage points lower abnormal stock return.

If firms with valuable innovations were smaller than their peers, higher percentage losses would not necessarily translate into higher dollar losses. In the data, however, we find the opposite. Among targeted firms, successful innovators have an average market capitalization of around $14.0 billion, which is much larger than the $2.2 billion average market capitalization for non-innovators. The larger percentage losses that we document above thus fall on larger firms.

[21] Our approach above may underestimate the difference between low-quality and high-quality cases if anticipation effects are greater for truly fraudulent behavior. Consistent with the latter possibility, we find, in unreported results, much larger declines in market value around the class action period end date for high-quality than for low-quality cases. This has no bearing on our central point: being target of a low-quality class action lawsuit is very costly in terms of shareholder value.

One question about those losses is whether they revert after the filing date. We do not observe such reversals when we extend the event study window further (results unreported for brevity). In the Internet Appendix, we also use a calendar-time portfolio approach to examine long-run returns after a filing. We find no evidence of a reversal in the first eight months following the initial lawsuit filing. This suggests that the shareholder-value losses documented above are long-lasting.

Another question is whether stock prices revert as the market learns about lawsuit merit. To investigate this, we examine abnormal returns around the dismissal date, which on average occurs more than two years after the filing date. As shown in Table 6, columns (3) and (4), firms with high innovation output in the year prior to the lawsuit filing tend to have more positive abnormal returns around the dismissal date. While the estimates are noisy, the point estimates suggest that up to one third of the effect around the filing date is recovered once the market learns that a lawsuit is dismissed. This is consistent with the framework in Section 3.

5.8.2 Potential Sources of Shareholder Value Losses around Lawsuit Filings

The above results establish that the losses to shareholders around the filing of a low-quality lawsuit are economically substantial. For the average firm in our sample of targeted firms, the 2.1% loss in market value in the (-3,+3) window around the filing date of a low-quality lawsuit translates into a dollar-value loss of $109M. What are the exact sources behind these losses, and what is their relative contribution? While fully answering this question is beyond the scope of our study, and left for future research, we consider three potential sources in this section.

A first source of value reduction are direct legal costs associated with the lawsuit. Unfortunately, large-scale data on defense counsel costs are scarce. Survey evidence suggests a median range for direct legal costs for outside lawyers working on class action lawsuits of around $1M for more routine cases, and up to $30M for very complex cases (Carleton Fields (2016), p. 17). We conclude that direct legal costs are non trivial and may explain a considerable fraction of the shareholder value loss associated with class action filings for smaller firms. But, for larger firms, direct legal costs are unlikely to explain the bulk of the shareholder value loss associated with class action filings.

A second potential source of firm-value reduction are expected settlement costs. One way to derive an upper bound estimate of the impact of expected settlement costs is as follows: if the market had no information regarding the outcome of a specific lawsuit, the average settlement amount ($27M) multiplied with the average probability that the lawsuit is not dismissed (56%) would yield a shareholder value loss of around $15M. This represents only about 14% of the market value loss of the average firm ($109M), which would suggest expected settlement costs are not a major driver of observed losses around filings of low-quality lawsuits. This estimate is an upper bound in the following sense: the better the market is able to predict dismissals, the lower are the expected settlement costs for cases which ultimately end up being dismissed. In the limiting case in which markets can perfectly predict which cases will end up being dismissed, expected settlement costs for these cases are zero, and can therefore not contribute to the loss in market value for low-quality cases we observe in the data. On the other hand, if the market cannot perfectly predict dismissals, and if expected settlement costs would be substantial, then we would expect to see large positive returns around the lawsuit dismissal date. Since this is not the case, the combined evidence in this paragraph argues against expected settlement costs being a major driver of the observed shareholder value losses around lawsuit filing dates.

We note that Directors & Officers (D&O) Insurance may cover some or all of the direct legal fees and settlement costs for many cases. This would suggest that shareholder value losses must be driven by other factors, over and above direct legal costs, settlement costs, and other costs covered by D&O insurance.

The evidence above is consistent with the non-recoverable losses to the defendant upon lawsuit filing, captured by $(1-\phi)C_I$ in our framework, being large. This resonates well with existing research, which suggests that reputation costs may be an important driver of shareholder value losses around shareholder lawsuits. A widely held view is that, for cases of actual wrongdoing, reputation costs are of central importance. For example, Karpoff, Lee, and Martin (2008) estimate that reputation costs alone make up on average two thirds of the decline in shareholder value associated with financial misconduct. Consistent with this idea, survey evidence based on 385 U.S. firms documents that reputation concerns and potential business implications rank among the most important risk factors firms cite in connection with class action lawsuits (e.g., Carleton Fields (2018), p. 23). The results above indicate that, just like for high-quality lawsuits, reputation (and opportunity) costs are an important driver of the observed value losses also for low-quality class action lawsuits.

6 Does Class Action Litigation Risk Affect Firms' Innovation Decisions?

The results so far indicate that valuable innovation output increases the risk of being subject to costly low-quality class action lawsuits. In this section, we ask whether firms take into account litigation risk in their innovation decisions. In particular, we are interested in whether changes in litigation risk affect the quantity and economic value of corporate innovation output.

To overcome pertinent endogeneity issues in analyzing these channels, we explore how firms respond to exogenous changes in federal class action litigation risk. To that end, we follow Huang, Hui, and Li (2019) and look at the composition of judicial benches to elicit a measure of litigation risk. Specifically, we exploit changes in judge ideology of the federal circuit court whose jurisdiction covers the firms' headquarters.[22] We measure a circuit court's judge ideology as the probability that a panel consisting of three randomly chosen federal judges is dominated by appointees of Democratic presidents. The underlying motivation is that political views have been shown in prior work to possess significant predictive power for a judge's tendency to be business-friendly in their rulings. We conjecture that, all else equal, firms in a circuit with a less business-friendly court would be more attractive litigation targets. Identification comes from two features. First, changes in judge ideology are driven by death or voluntary retirement decisions of federal judges, since federal judges cannot be fired or otherwise forced out of office. This means the timing of changes should be unrelated to economic fundamentals that might affect corporate innovation patters. Second, we compare corporate innovation patterns across circuits at the same point in time, which implies that general changes in innovation patterns across time (which may coincide with changes in government) cannot affect our results.

We can think about the ex-ante effects of a change in low-quality litigation risk due to judge turnover as follows in the context of our model. For any given level of case quality k, less business-friendly judges imply a lower dismissal probability $p_d(k)$. Hence, by equation (1) in the model, less business-friendly judges will make it, all else equal, more likely that a firm becomes subject to a lawsuit upon successfully innovating. All firms that did not find it worthwhile to innovate before would continue to not innovate when the threat of lawsuits increases. By contrast, and on the margin, some firms that chose to innovate before the change in judges will now choose to reduce their innovation activity. Hence, we expect that firms have an incentive to reduce their innovative activities. This should lead to a decrease in the aggregate expected economic value of a firm's patents, as well as to a decrease in the number of patents it applies for.

We test these hypotheses by estimating the following regression:

$$\mathcal{I}_{ijk,t+h} = \lambda_{jt} + \lambda_k + \beta LibCourt_{kt} + \gamma X_{it} + \epsilon_{ijk,t+h}, \tag{5}$$

where $\mathcal{I}_{ijkt}$ refers to the KPSS measure of innovation output (and alternative measures below) of firm i in industry j located in circuit court k in year $t+h$, scaled by lagged total assets. We vary h from one to five years. λ_{jt} are industry $\times$ year fixed effects, and $LibCourt_{kt}$ refers to the probability that a panel composed of three randomly drawn judges from circuit court k in year t is dominated by appointees of Democratic presidents. We follow Huang, Hui, and Li (2019) and include circuit court fixed effects (λ_k) to control for potential circuit-level omitted variables that are correlated with $LibCourt$. Effectively, we are thus focusing on changes in $LibCourt$ within

[22]We are grateful to Reeyarn Zhiyang Li for sharing the measure of federal judge ideology. We refer the reader to Huang, Hui, and Li (2019) for details on the construction of the judge ideology variable, as well as detailed explanation on the measure's motivation and grounding in prior research.

circuit court. X_{it} is the same vector of control variables included in column (5), Panel A, of Table 2.[23]

Table 7 presents results. Each coefficient in Table 7 represents a separate regression and we omit results on the control variables for brevity. Panel A shows that an increase in litigation risk brought about by more liberal federal judges leads to a decrease in the private economic value of patents granted. As shown in Panel A, this effect becomes stronger over time. By year five, our estimates imply that replacing a judge appointed during a Republican presidency by a judge appointed during a Democratic presidency on a three-judge panel (i.e., an increase in $LibCourt$ of 1/3) would reduce the scaled KPSS measure by 0.7 (=–0.021 × 1/3) percentage points, which is large relative to its mean of 2.4 percent. The effect on the aggregate economic value of the firm's patents is even larger and more immediate when we align patents by when they were filed, not by when they were granted (Panel B). Here, we observe a decrease in the scaled KPSS measure by 1.2 (=–0.037 × 1/3) percentage points in year five.

Several not mutually exclusive factors may contribute to explaining the results in Panels A and B. First, higher litigation risk and associated litigation costs should decrease the aggregate economic value of a firms' patents. Second, firms may file fewer patents. Third, learning about judges' investor friendliness by firms and investors may contribute to the more pronounced effects in later years.

In Panel C, we directly test whether firms patent less following an increase in $LibCourt$. The results show that fewer granted patents after an increase in litigation risk can help explain the drop in innovation value from Panel A in the later years, but not in the earlier years. The fact that we do not observe any significant effect on the number of patents granted in the early years provides a useful placebo test, because with an average application-to-grant duration of about three years, patents granted in those years were most likely filed before the change in $LibCourt$. Panel D also looks at the number of patents, but, in contrast to Panel C, it aligns patents by when they were filed, not by when they were granted. The results show that an increase in litigation risk indeed leads firms to patent substantially less, an effect that is partly obscured by the time-lag between patent application and patent grant in Panel C. Increasing $LibCourt$ by 1/3, as above, leads to a decrease in the number of patents filed of 14% (=–0.428 × 1/3) by year five. This result shows that firms actively alter their innovation patterns in response to a change in securities class action risk, consistent with prior studies that find corporate innovation responds to changes in other sources of litigation risk (e.g., Lin, Liu, and Manso (2019) and Mezzanotti (2020)).

[23]The maintained assumption underlying our tests, in line with Huang, Hui, and Li (2019) and the substantial body of evidence cited in their paper, is that an increase in $LibCourt$ increases *ex-ante* litigation risk, i.e., the risk of being subject to a lawsuit if firms did not change their behavior in response to the change in $LibCourt$. Whether, *ex post*, the observed number of lawsuits increases when $LibCourt$ increases is a different question, theoretically ambiguous, and inconsequential for our analysis.

Finally, we also explore the effect on the average economic value per patent granted or filed. Note that the sign of the effect of an increase in litigation risk, as proxied by *LibCourt*, on the average economic value per patent is theoretically ambiguous. On the one hand, for any hypothetical patent, higher litigation costs should reduce the economic value of the patent. On the other hand, selection effects may increase the average economic value per patent filed. If firms no longer file patents with low expected economic value, because these are precisely the patents which may become negative NPV after the increase in litigation costs, then this would lead to an increase in the average value per patent.

We find that the first effect dominates. In Panel E, we see that the average economic value per patent granted decreases substantially – by 44% ($=-1.320 \times 1/3$) – by year five. We obtain a very similar point estimate when we look at the average economic value per patent filed, except that the effect shows up even faster.

The above tests have advantages, but they also have limitations. A noteworthy limitation is that we cannot distinguish between meritless and meritorious lawsuits in this section. While we would expect judges' political views not to matter in cases that are obviously frivolous or obviously meritorious, more business friendly judges may, on the margin, have an increased tendency to not dismiss harder to judge cases, both meritorious and meritless. The tests therefore do not *directly* show the effects of an increase in the risk of a meritless lawsuit, which would be the ideal experiment in our setting. We nevertheless argue that, combined with the other evidence in our paper, the most plausible interpretation of the above results is that an increase in the risk of being subject to a low-quality lawsuit, which is captured by *LibCourt*, leads firms to alter their innovation patterns. Two facts in particular support this view. First, we have shown earlier in our paper that firms with more valuable innovation are more likely to become targets of low-quality class actions, but we have found no such evidence for high-quality cases. The valuable innovation hypothesis thus offers a common framework to understanding the results in this and earlier sections: if firms with valuable innovation are more likely subject to low-quality class actions (as seen in Table 2), then an increase in the risk of such litigation should disincentivize producing valuable innovation (as seen in Table 7). By contrast, it is not clear why firms would alter their innovation patterns in response to an increase in the risk of meritorious litigation if more innovation is not associated with more meritorious lawsuits in the first place. Second, we examine directly in the Internet Appendix whether firms with higher innovation values are more likely to commit fraud. The evidence indicates they do not.

7 Conclusion

It has long been suspected by academics, practitioners, and lawmakers, that corporate innovation and low-quality shareholder litigation, i.e., litigation that has an elevated likelihood of being without legal merit, may be intrinsically linked. A common narrative is that innovation projects have high uncertainty and may, in the case of project failure, increase the likelihood of a large stock drop. A large stock drop, in turn, may trigger a lawsuit filing – irrespective of actual wrongdoing. This view stands in contrast with existing empirical studies that have so far not been able to document a causal link between innovation inputs and subsequent meritless litigation, as well as with new evidence on the absence of such a link we provide in this paper. Moreover, the empirical fact that large "litigable" stock drops occur much more frequently than class action lawsuits (56% vs. 2% for the average firm-year in our sample) suggests that stock drops can only provide a partial explanation for why firms become targets of class action lawsuits.

In this paper, we propose and test a new perspective on the link between innovation and class action litigation, which we label the "valuable innovation hypothesis." The valuable innovation hypothesis holds that low-quality class action lawsuits specifically target successful innovators, because such firms are attractive targets for low-quality class action litigation. The core conceptual contribution of the valuable innovation hypothesis is to emphasize the distinction between innovation inputs, like R&D expenditures, and innovation outputs, which we measure as the economic value of granted patents in a given firm-year following Kogan, Papanikolaou, Seru, and Stoffman (2017). This distinction allows us to reconcile the fact that practitioners and policy makers perceive innovation to be an important driver of low-quality litigation with the lack of evidence for an innovation-litigation link in the existing literature. We show that once we focus on innovation output, there is a significant empirical link between innovation and subsequent low-quality class action litigation, consistent with a theoretical model we also develop in this paper. By contrast, if we follow prior work and focus on innovation input, we find essentially no relation between innovation and low-quality litigation. Exploiting judge turnover in federal courts, we also show that changes in class action litigation risk affect the value and number of patents filed, suggesting that firms take into account class action litigation risk in their innovation decisions.

Our study focuses on innovation output due to its documented importance for economic growth as well as empirical advantages, such as measurement and identification.[24] However, it is

[24]We observe patent grants perfectly, and we can estimate the value of an innovation with some accuracy using the KPSS approach. We can thus attribute our findings directly to a firm's innovation success. The fact that patent grants occur on average years after the firm conducted the research and filed the patent, allows us to decouple corporate actions relating to the investment in innovation, i.e., innovation input, and investors' learning about the innovation, from innovation output as measured by patent grants. Those advantages set innovation apart from other potential variables of growth opportunities such as, for example, Tobin's Q or investment, which may reflect many things over and above growth opportunities that could give an incentive for lawyers to target

plausible that a more general systematic link exists between corporate success and low-quality litigation. Specifically, we argue that firms with valuable innovation output may be more attractive litigation targets because they (i) face high opportunity costs, and (ii) use more forward-looking and optimistic language in their communication with investors. Since most positive shocks to future cash flows, e.g., in the form of a new positive NPV project, are likely to change a firm's characteristics along these dimensions, the U.S. litigation system may systematically punish firms with the most attractive growth opportunities. If the tax on valuable innovation output we identify in this paper is reflective of a broader "tax on valuable growth opportunities," the overall economic costs of low-quality class actions are potentially even larger than we estimate them to be. Of course, some of our arguments may also apply to other types of litigation, which would further increase the possible economic costs associated with low-quality litigation against innovative firms. We leave exploring the link between low-quality litigation and growth opportunities more broadly to future research.

Our results contribute new evidence to the important ongoing debate on the efficiency of the U.S. securities class action litigation system. Overall, the findings support the view that certain features of the system may be an impediment to corporate innovation and, ultimately, economic growth. To avoid misunderstandings, a word of caution is in order: of course our results do not imply that all securities class action litigation is meritless. Nor do our results imply that class action litigation should generally be discouraged. Securities class action lawsuits can be socially beneficial; for example, if they deter wrongdoing, curb managerial rent extraction, and compensate injured shareholders. Designing a well-functioning securities class action system requires carefully balancing the benefits and costs of the system and its features. Our paper contributes to this policy goal by providing new evidence on the potential costs of securities class actions.

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the firm via low-quality class action litigation, and for which it seems harder to find reasonable instruments.

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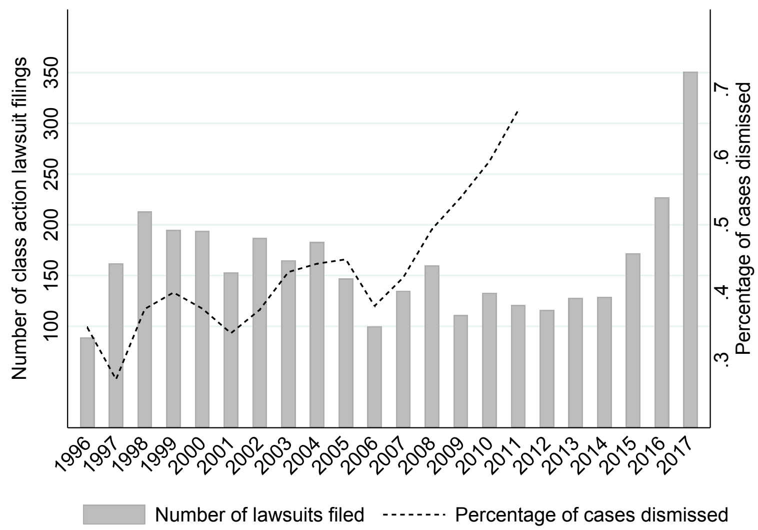
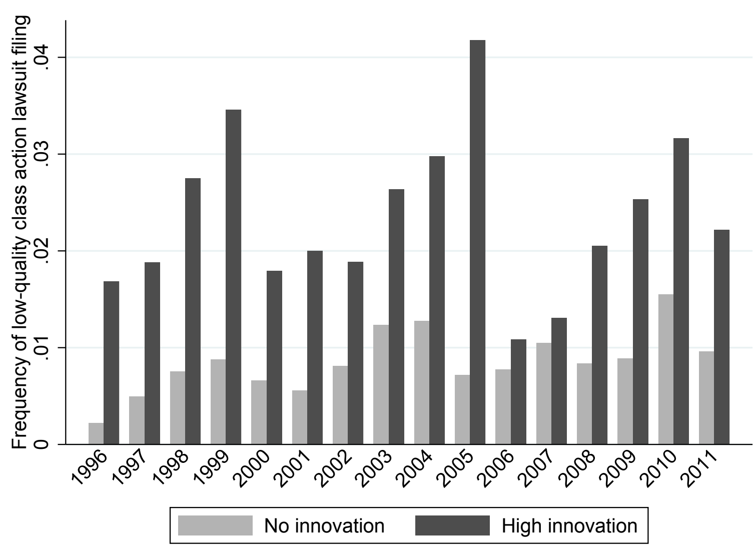
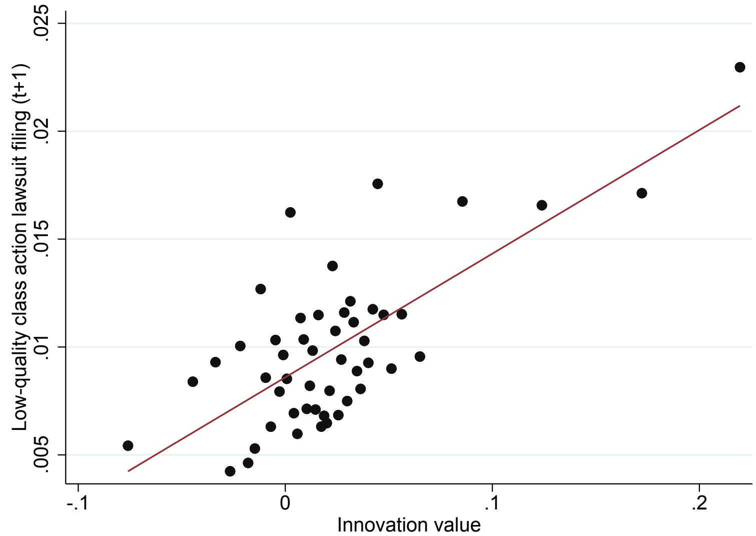


(A) Number of Lawsuits Filed and Frequency of Dismissal

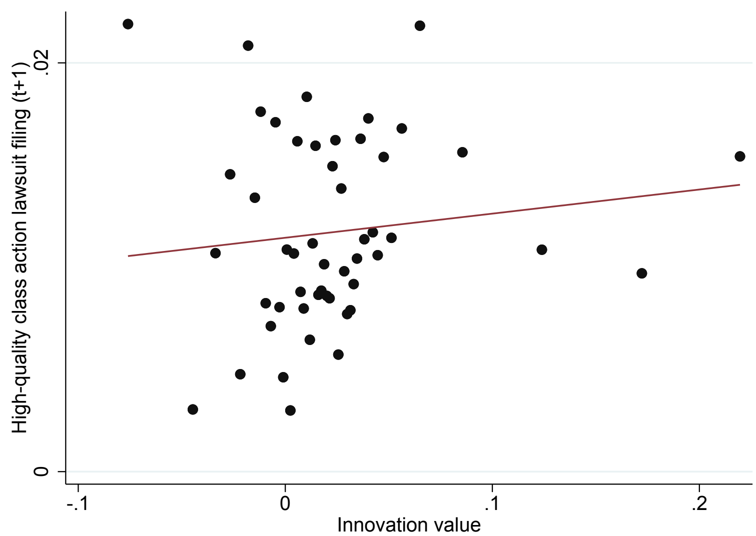


(B) Frequency of Low-Quality Lawsuits by Innovation

Figure 1: Securities class action filings over time.
Panel A presents the total number of securities class action lawsuit filed in a given calendar year, and the fraction of these cases which are subsequently dismissed. Panel B presents the frequency of dismissed (i.e., low-quality) class action lawsuit filings over time for two groups of firms: high innovators and non-innovators. We sort all firms with positive innovation value in the previous calendar year into terciles within the same SIC 2-digit industry and year. High innovation are firms which rank in the top tercile. Low innovation firms are those with zero innovation in the previous calendar year. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017).

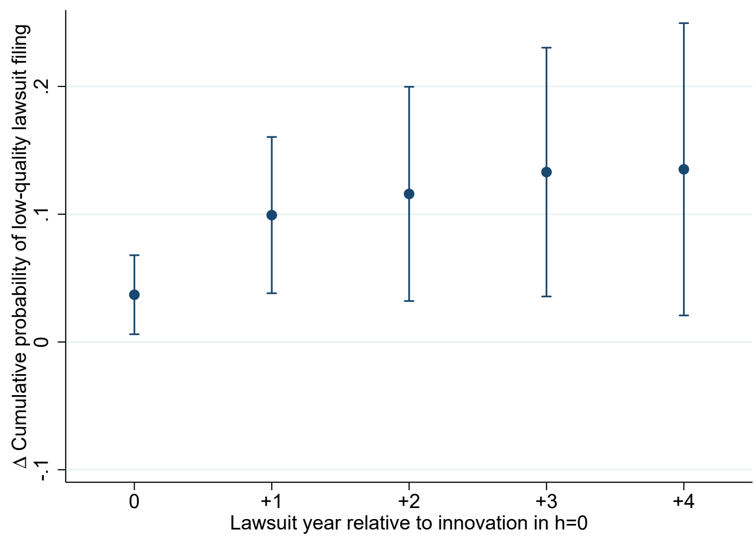


(A) Low-Quality Lawsuits

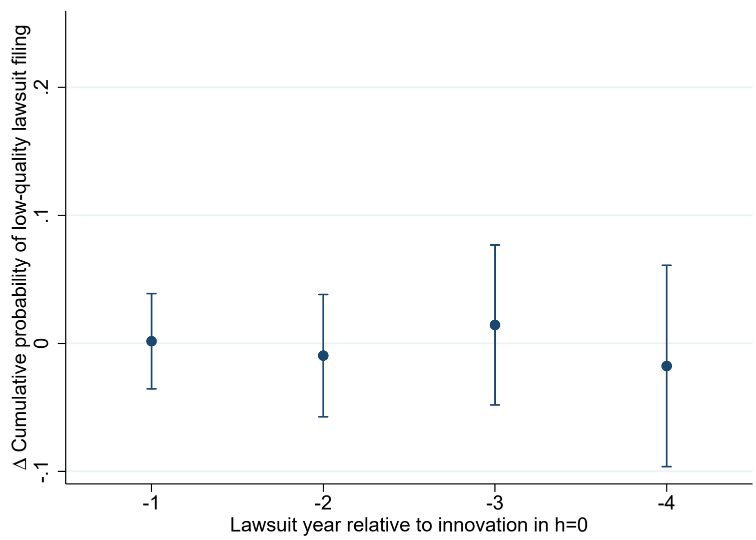


(B) High-Quality Lawsuits

Figure 2: Valuable innovation and next-period class action lawsuit filing.
The figure presents nonparametric binned scatter plots of the relationship between the probability of a class action lawsuit filing in the following year and valuable innovation in the current year. We sort firms' innovation value into 50 equal-sized bins and plot the average frequency of observing a low-quality (Panel A) and high-quality (Panel B) class action lawsuit filing in the following calendar year against the average innovation value measure within each bin. The lawsuit and innovation variables are first residualized on industry × year dummies and the set of control variables presented in Table 2, Panel A, specifications (5) and (6). The best-fit line is estimated with an OLS regression using the underlying micro data. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017). Low-quality lawsuits are identified as lawsuits that are eventually dismissed; all other lawsuits are classified as high-quality.

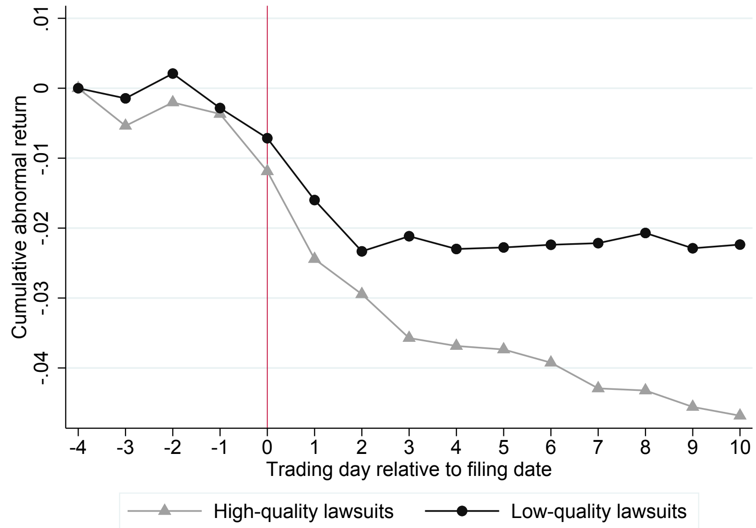


(A) Innovation and Future Lawsuit Propensity

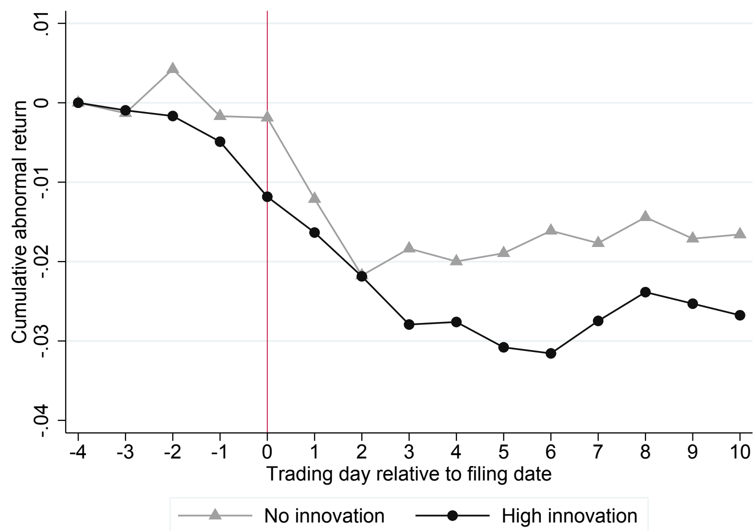


(B) Innovation and Past Lawsuit Propensity (Placebo)

Figure 3: Dynamic effects of valuable innovation on low-quality litigation risk. Panel A plots the coefficients and corresponding 95% confidence intervals from a dynamic analysis of the effect of valuable innovation in t on the cumulative low-quality litigation risk in years t to $t + h$, for each $h = 0, 1, 2, 3, 4$, based on equation (3). Panel B presents the analogous plot for $h = -1, -2, -3, -4$, based on equation (4).



(A) All Lawsuits



(B) Low-Quality Lawsuits Only

Figure 4: Cumulative abnormal returns around class action lawsuit filings.
Panel A shows the cumulative abnormal returns over event days (-3,+10) around the filing of a low-quality versus high-quality lawsuit. Low-quality lawsuits are identified as lawsuits that are eventually dismissed; all other lawsuits are classified as high-quality. Panel B shows the cumulative abnormal returns over event days (-3,+10) around the filing of a low-quality class action lawsuit, separately for high innovators and non-innovators. High innovation refers to firms which rank in the top tercile of all firms in the same industry and year, based on their measure of valuable innovation in the prior calendar year. No innovation refers to firms with zero innovation in the prior calendar year. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017). Abnormal returns are estimated based on the Fama and French (1993) and Carhart (1997) 4-factor model estimated over days $t = -300$ to $t = -50$.

Table 1: Summary Statistics

This table presents summary statistics for key variables. Securities class action lawsuits are retrieved from the Stanford Securities Class Action Clearinghouse database from 1996 to 2011. Low-quality lawsuits are identified as lawsuits that are eventually dismissed; all other lawsuits are classified as high-quality. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017), scaled by lagged book assets.

	N	Mean	Std. Dev.	0.25	Median	0.75
Dependent Variables						
Class action lawsuit filing$_{t+1}$	40,010	0.022	0.146	0.000	0.000	0.000
Low-quality class action lawsuit filing$_{t+1}$	40,010	0.010	0.099	0.000	0.000	0.000
High-quality class action lawsuit filing$_{t+1}$	40,010	0.012	0.108	0.000	0.000	0.000
Key Independent Variables						
Innovation value$_t$	40,010	0.024	0.060	0.000	0.000	0.010
R&D$_t$	39,987	0.057	0.105	0.000	0.003	0.072
R&D$_{(t-2,t)}$	40,010	0.058	0.102	0.000	0.004	0.077
Control variables						
Tobin's Q$_{t-1}$	40,010	2.039	1.651	1.099	1.496	2.283
Log assets$_{t-1}$	40,010	5.478	2.042	3.971	5.340	6.809
Cash$_{t-1}$	40,010	0.189	0.218	0.025	0.096	0.283
Sales growth$_{t-1}$	40,010	0.170	0.513	-0.024	0.087	0.237
Sales growth$_{t-2}$	40,010	0.221	0.577	-0.003	0.105	0.271
IO$_{t-1}$	40,010	0.447	0.294	0.174	0.453	0.703
Stock return$_{t-1}$	40,010	0.191	0.642	-0.162	0.153	0.480
Stock return$_{t-2}$	40,010	0.154	0.628	-0.189	0.121	0.442
Return skewness$_{t-1}$	40,010	0.491	1.112	0.017	0.401	0.866
Return skewness$_{t-2}$	40,010	0.459	1.078	0.013	0.381	0.819
Return volatility$_{t-1}$	40,010	0.639	0.356	0.383	0.557	0.800
Return volatility$_{t-2}$	40,010	0.631	0.351	0.377	0.553	0.792
Turnover$_{t-1}$	40,010	17.573	18.761	5.585	11.552	22.745
Turnover$_{t-2}$	40,010	16.873	18.313	5.387	10.946	21.592

Table 2: Innovation and Class Action Lawsuit Filings

This table regresses indicators for next-period class action lawsuit filings on the value of this period's (t) innovation output. Low-quality lawsuits are identified as lawsuits that are eventually dismissed; all other lawsuits are classified as high-quality. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017), scaled by lagged book assets. Baseline controls include lagged Tobin's Q, log total assets, cash holdings, two lags of annual sales growth, and lagged institutional ownership. Additional controls include two lags of average monthly stock return, return skewness, return volatility, and turnover. In Panel B, we also control for the firm's R&D expenditures in t and, in Panel C, for a moving average of R&D expenditures measured over years $t-2$ to t. R&D expenditures are scaled by lagged assets and replaced by zero if R&D expenditures are missing. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the firm level.

Panel A: Baseline

	Class action lawsuit filing$_{t+1}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Low-quality	High-quality	All	Low-quality	High-quality
Innovation value$_t$	0.084	0.064	0.019	0.070	0.057	0.012
	(3.65)	(3.94)	(1.18)	(3.00)	(3.50)	(0.73)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	No	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.033	0.024	0.040	0.035	0.025
N	40,010	40,010	40,010	40,010	40,010	40,010

Panel B: Innovation output versus innovation input

	Class action lawsuit filing$_{t+1}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Low-quality	High-quality	All	Low-quality	High-quality
Innovation value$_t$	0.080	0.064	0.016	0.067	0.057	0.009
	(3.44)	(3.83)	(0.99)	(2.83)	(3.44)	(0.55)
R&D$_t$	0.009	0.002	0.008	0.009	0.000	0.008
	(0.87)	(0.20)	(0.98)	(0.80)	(0.05)	(1.03)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	No	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.033	0.024	0.040	0.035	0.025
N	39,987	39,987	39,987	39,987	39,987	39,987

Panel C: Innovation output versus 3-year average innovation input

	Class action lawsuit filing$_{t+1}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Low-quality	High-quality	All	Low-quality	High-quality
Innovation value$_t$	0.078	0.063	0.014	0.066	0.058	0.007
	(3.31)	(3.80)	(0.84)	(2.77)	(3.45)	(0.44)
R&D$_{(t-2,t)}$	0.018	0.003	0.015	0.013	-0.001	0.014
	(1.47)	(0.36)	(1.62)	(1.09)	(-0.08)	(1.50)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	No	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.033	0.024	0.040	0.035	0.025
N	40,010	40,010	40,010	40,010	40,010	40,010

Table 3: Valuable Innovation and Lawsuit-Triggering Events

This table regresses next-period stock return volatility, return skewness, an indicator for extreme low returns, and an indicator for extreme negative earnings surprises, on this period's innovation value. Stock return volatility and return skewness are computed based on daily stock returns during any given firm-year. Extreme negative return is an indicator equal to one if the first percentile of daily stock returns of a firm is in the bottom 5% across all firms in the same calendar year. Negative earnings surprise is an indicator equal to one if the firm's most negative quarterly earnings surprise is in the bottom 5% across all firms in the same calendar year. Earnings surprises are computed as the difference between the announced quarterly EPS and the consensus forecast from IBES, scaled by the stock price at the end of the previous calendar quarter. Control variables are the same as in Table 2, as well as one lag of the dependent variable. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the firm level.

	Return volatility$_{t+1}$	Return skewness$_{t+1}$	Extreme negative return$_{t+1}$	Negative earnings surprise$_{t+1}$
	(1)	(2)	(3)	(4)
Innovation value$_t$	-0.060	-0.171	0.007	-0.015
	(-2.86)	(-1.43)	(0.43)	(-0.62)
Baseline Controls	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes
R^2	0.670	0.125	0.131	0.103
N	37,721	37,721	37,387	19,047

Table 4: Ex-Ante Proxies for Lawsuit Merit

This table regresses indicators for next-period class action lawsuit filings on valuable innovation output. In specification (1) ((2)), the dependent variable is equal to one if a lawsuit is filed that (does not) coincide or was (not) preceded by an SEC investigation of an accounting restatement by the firm, respectively. In specification (3) ((4)), the dependent variable is equal to one if a lawsuit is filed that alleges (does not allege) a U.S. GAAP violation, respectively. In specification (5) ((6)), the dependent variable is equal to one if a lawsuit is filed that is predicted to have a high (low) chance of dismissal. Dismissal is predicted using the linear probability model presented in Table IA.4, column (2), and lawsuits are classified as having a high (low) chance of dismissal after splitting at the median within a given filing year. Innovation value is measured as the economic value of patents granted to the firm, as provided by Kogan, Papanikolaou, Seru, and Stoffman (2017), scaled by lagged book assets. Control variables are the same as in Table 2, specification (5). t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the firm level.

Panel A: Baseline

	Class action lawsuit filing$_{t+1}$					
	SEC action		GAAP violation		Predicted dismissal	
	No	Yes	No	Yes	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Innovation value$_t$	0.063	0.007	0.061	0.008	0.052	0.005
	(2.94)	(0.79)	(3.13)	(0.60)	(3.66)	(0.44)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.017	0.034	0.026	0.026	0.022
N	40,010	40,010	40,010	40,010	40,010	40,010

Panel B: Innovation output versus innovation input

	Class action lawsuit filing$_{t+1}$					
	SEC action		GAAP violation		Predicted dismissal	
	No	Yes	No	Yes	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Innovation value$_t$	0.061	0.006	0.058	0.009	0.052	0.004
	(2.81)	(0.66)	(2.90)	(0.65)	(3.59)	(0.35)
R&D$_t$	0.006	0.003	0.011	-0.003	-0.002	0.003
	(0.55)	(0.86)	(1.23)	(-0.42)	(-0.36)	(0.54)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.017	0.034	0.026	0.026	0.022
N	39,987	39,987	39,987	39,987	39,987	39,987

Panel C: Innovation output versus 3-year average innovation input

	Class action lawsuit filing$_{t+1}$					
	SEC action		GAAP violation		Predicted dismissal	
	No	Yes	No	Yes	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Innovation value$_t$	0.060	0.005	0.057	0.008	0.052	0.002
	(2.77)	(0.61)	(2.88)	(0.59)	(3.60)	(0.19)
R&D$_{(t-2,t)}$	0.009	0.004	0.014	-0.000	-0.003	0.008
	(0.77)	(1.04)	(1.37)	(-0.04)	(-0.39)	(1.27)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.017	0.034	0.026	0.026	0.022
N	40,010	40,010	40,010	40,010	40,010	40,010

Table 5: Alternative Measures of Innovation Output and Robustness

This table presents results for alternative measures of innovation output as well as robustness tests. The baseline regression refers to specification (5) from Table 2, Panel A. For brevity we only report coefficients of interest and suppress control variables. Economic effects are calculated as the reported coefficient multiplied by the standard deviation of the key independent variable, divided by the mean of the dependent variable. In Panel A, number of patents is defined as the logarithm of one plus the total number of patents granted, citation-weighted patent counts, the number of patents granted which rank in the top decile of patents in the same technology class and year by ex-post citations, and the market value of new product introductions is defined as in Mukherjee, Singh, and Žaldokas (2017). In Panel B, we define low-quality lawsuits as all lawsuits that are either dismissed or settle for less than $3 million (first row); as all dismissed lawsuits that are not based on voluntary dismissal (second row); and as all dismissed lawsuits filed for violation of Section 10(b) or Section 11 of the Securities Acts (third row). In Panel C, we add additional controls. CEO overconfidence is measured as in Malmendier and Tate (2005). In Panel D, we impose sample restrictions. First, we restrict the sample to firms with at least one patent in a given calendar year. Then we estimate the regression for different subperiods.

	Coeff.	*t*-statistic	Econ. Effect	N
Baseline	0.057	(3.50)	33.4%	40,010
Panel A: Alternative Measures of Innovation Output				
Number of patents	0.002	(2.23)	18.2%	40,010
Citation-weighted patent counts	0.001	(2.17)	17.1%	40,010
Patents in top 10% of citations	0.007	(2.06)	16.2%	40,010
New product introductions	0.026	(1.86)	21.0%	40,010
Panel B: Alternative Measures of Low-quality Lawsuit				
Dismissal or settlement <$3m	0.056	(3.10)	24.0%	40,010
Exclude voluntary dismissal	0.054	(3.42)	30.7%	40,010
Only Sec 10b and Sec 11 claims	0.053	(3.34)	31.7%	40,010
Panel C: Additional Controls				
Contemporaneous sales growth and stock return variables	0.042	(2.75)	23.5%	46,868
CEO overconfidence	0.060	(2.33)	34.0%	13,473
Firm fixed effects	0.056	(1.93)	31.6%	39,089
District × year fixed effects	0.056	(3.36)	31.5%	39,800
Panel D: Sample Restrictions				
Non-zero innovation	0.041	(3.20)	46.9%	12,963
Exclude 2000–2001	0.064	(3.27)	36.0%	34,098
Subperiod: 1996–2000	0.068	(2.91)	55.5%	15,625
Subperiod: 2001–2010	0.047	(2.41)	23.8%	24,385

Table 6: Valuable Innovation and Cumulative Abnormal Returns Around Class Action Lawsuit Filing and Dismissal

This table regresses cumulative abnormal returns around the filing and dismissal of low-quality class action lawsuits on valuable innovation measured during the year prior to lawsuit filing. Cumulative abnormal returns are measured over event days (-3,+3), where abnormal returns are estimated based on the Fama and French (1993) and Carhart (1997) 4-factor model estimated over days $t = -300$ to $t = -50$. Low-quality lawsuits are identified as lawsuits that are eventually dismissed. Control variables are the same as in Table 2, specification (5). t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the firm level.

	Cumulative abnormal return (-3,+3)			
	Filing		Dismissal	
	(1)	(2)	(3)	(4)
Innovation value$_t$	-0.235	-0.241	0.044	0.081
	(-1.97)	(-1.81)	(0.53)	(0.99)
Baseline Controls	Yes	Yes	Yes	Yes
Additional Controls	No	Yes	No	Yes
Industry × year f.e.	Yes	Yes	Yes	Yes
R^2	0.432	0.464	0.296	0.359
N	213	206	251	240

Table 7: Federal Judge Ideology and Innovation Output

This table regresses measures of innovation output on federal judge ideology. In Panels A and D, we estimate:

$$\mathcal{I}_{ijk,t+h} = \lambda_{jt} + \lambda_k + \beta LibCourt_{kt} + \gamma X_{it} + \epsilon_{ijk,t+h}, \qquad (6)$$

where h varies between one and five years, $\mathcal{I}$ is innovation value, λ_{jt} are 2-digit-SIC industry × year fixed effects, λ_k are circuit-court fixed effects, and X_{it} is a vector of control variables that includes the same variables as the controls in Table 2, specification (5). *LibCourt* refers to the as the probability that Democratic presidents' appointees dominate a panel of three judges randomly selected from the circuit, obtained from Huang, Hui, and Li (2019). We use the logarithm of one plus the total number of patents as dependent variables in Panels C and D, and the logarithm of the average economic value per patent in Panels E and F. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the firm level.

Innovation horizon				
1	2	3	4	5
Panel A: Innovation value of patents granted				
-0.006	-0.010	-0.015	-0.020	-0.021
(-1.54)	(-2.25)	(-3.05)	(-3.65)	(-3.65)
Panel B: Innovation value of patents filed				
-0.028	-0.031	-0.036	-0.038	-0.037
(-4.46)	(-4.37)	(-4.66)	(-4.78)	(-4.51)
Panel C: Log of (1 + number of patents granted)				
0.089	0.006	-0.042	-0.139	-0.245
(0.99)	(0.07)	(-0.48)	(-1.46)	(-2.30)
Panel D: Log of (1 + number of patents filed)				
-0.077	-0.131	-0.215	-0.317	-0.428
(-1.01)	(-1.61)	(-2.36)	(-2.98)	(-3.47)
Panel E: Log of economic value per patent granted				
-0.373	-0.486	-0.870	-1.241	-1.320
(-3.55)	(-3.43)	(-4.65)	(-5.49)	(-5.21)
Panel F: Log of economic value per patent filed				
-0.843	-1.111	-1.250	-1.138	-1.242
(-4.33)	(-4.84)	(-4.90)	(-4.20)	(-4.56)

Appendix

A.1 Variable Descriptions

Table A.1: Variable descriptions

Variable	Description
Dependent variables	
Class action lawsuit filing_{t+1}	Indicator variable equal to one if a securities class action lawsuit is filed against the firm in the following calendar year, and zero otherwise. Securities class action lawsuits are retrieved from the Stanford Securities Class Action Clearinghouse database.
Low-quality class action lawsuit filing_{t+1}	Indicator variable equal to one if a low-quality securities class action lawsuit is filed against the firm in the following calendar year, and zero otherwise. Class action lawsuits are defined as low-quality if they result in a dismissal of all claims, as indicated in the Stanford Securities Class Action Clearinghouse database.
High-quality class action lawsuit filing_{t+1}	Indicator variable equal to one if a high-quality securities class action lawsuit is filed against the firm in the following calendar year, and zero otherwise. Class action lawsuits are defined as high-quality if they do not result in a dismissal of all claims, as indicated in the Stanford Securities Class Action Clearinghouse database.
Key independent variables	
Innovation value_t	The aggregate economic value of the patents granted to the firm by the USPTO during the calendar year, divided by lagged total assets. The economic value of a patent is calculated as in Kogan, Papanikolaou, Seru, and Stoffman (2017) and the annual aggregated measure is obtained from Professor Stoffman's website.
$\text{R\&D}_t$	Research and development expenditures scaled by total book assets and replaced by zero if research and development expenditures are missing. Balance sheet information is obtained from Compustat Annual, using the most recent fiscal-year-end in a given calendar year t.
$\text{R\&D}_{(t-2,t)}$	Three-year moving average of research and development expenditures scaled by total book assets and replaced by zero if research and development expenditures are missing. Balance sheet information is obtained from Compustat Annual, using the most recent fiscal-year-end in a given calendar year.
Control variables – Firm characteristics	
Tobin's Q_{t-1}	Ratio of the market to the book value of assets as of the most recent fiscal year end in the prior calendar year.
Log assets_{t-1}	Logarithm of total book assets as of the most recent fiscal year end in the prior calendar year.
Cash_{t-1}	Cash plus receivables, normalized by total book assets, as of the most recent fiscal year end in the prior calendar year.

Continued on next page

Table A.1 – continued

Variable	Description
Sales growth$_{t-1}$	Annual growth in total revenue as of the most recent fiscal year end in the prior calendar year.
Sales growth$_{t-2}$	Annual growth in total revenue as of the most recent fiscal year end in the second prior calendar year.
Inst. ownership (IO)$_{t-1}$	Fraction of the firm's stock owned by institutional investors as reported in the Thomson Reuters 13f database, measured at the end of the prior calendar year.
Control variables – Stock characteristics	
Stock return$_{t-1}$	Average monthly stock return during the prior calendar year. Monthly stock returns are obtained from CRSP.
Stock return$_{t-2}$	Average monthly stock return during the second prior calendar year. Monthly stock returns are obtained from CRSP.
Return skewness$_{t-1}$	Skewness of daily stock returns during the prior calendar year. Daily stock returns are obtained from CRSP.
Return skewness$_{t-2}$	Skewness of daily stock returns during the second prior calendar year. Daily stock returns are obtained from CRSP.
Return volatility$_{t-1}$	Volatility of daily stock returns during the prior calendar year. Daily stock returns are obtained from CRSP.
Return volatility$_{t-2}$	Volatility of daily stock returns during the second prior calendar year. Daily stock returns are obtained from CRSP.
Turnover$_{t-1}$	Average monthly stock turnover during the prior calendar year. Monthly stock turnover is computed as total trading volume divided by the average number of shares outstanding. Monthly trading volume and shares outstanding are obtained from CRSP.
Turnover$_{t-2}$	Average monthly stock turnover during the second prior calendar year. Monthly stock turnover is computed as total trading volume divided by the average number of shares outstanding. Monthly trading volume and shares outstanding are obtained from CRSP

A.2 Deriving the Model Predictions in Section 3

A.2.1 Main channel: Higher innovation output increases defendant's opportunity costs

Prediction 1: Across all K firms, increasing innovation output makes it more likely that a lawsuit is filed.

Proof: Denote by k^* the lowest quality level k which satisfies $(1-p_d(k))(1-p_d(k)+\gamma\phi C_I) > c$. Under the assumptions in the text, increasing innovation output increases opportunity costs to $C_I > 0$. Denote the lowest value of k that satisfies $(1-p_d(k))(1-p_d(k)+\gamma\phi C_I) > c$ by k_{new}. Because $p_d(k)$ decreases in k, we have $k_{\text{new}} < k^*$. In all firm-law firm pairs for which the law firm found it profitable to file a suit in the baseline case, the law firm still finds it profitable to file a suit when opportunity costs increase to $C_I > 0$. With $C_I > 0$, there are $k^* - k_{\text{new}} = N$ instances in which a case is filed for a firm-law firm pair that would not be filed in the baseline case. Hence, the total number of cases filed increases by N and the probability of a filing across all K firms increases by

$$\Delta \Pr(\text{filed}) = \frac{N}{K} > 0. \tag{A.1}$$

□

Prediction 2: Across all K firms, the chance of being subject to a lawsuit that is dismissed increases as innovation output increases.

Proof: Out of the N additional cases that are filed when innovation output is high, a fraction $\overline{p_d^{\text{new}}}$ is dismissed. $\overline{p_d^{\text{new}}}$ is the average dismissal probability across the N new cases and is given by

$$\overline{p_d^{\text{new}}} = \frac{1}{N}\sum_{k=k_{\text{new}}}^{k^*} p_d(k). \tag{A.2}$$

Because $0 < p_d(k) < 1$, we have that $0 < \overline{p_d^{\text{new}}} < 1$. Hence, the total number of cases that are dismissed increases by $\overline{p_d^{\text{new}}}N > 0$ and the probability of seeing a dismissed case across all K firms increases by

$$\Delta \Pr(\text{filed\&dismissed}) = \frac{\overline{p_d^{\text{new}}}N}{K} > 0. \tag{A.3}$$

□

Prediction 3: Across all K firms, the chance of being subject to a lawsuit that is not dismissed increases as innovation output increases.

Proof: Following the logic of the proof for Prediction 2, the total number of cases that are filed and not dismissed increases by $(1-\overline{p_d^{\text{new}}})N$, and the probability of seeing a case that is filed and not dismissed across all K firms increases by

$$\Delta \Pr(\text{filed\&non-dismissed}) = \frac{(1 - \overline{p_d^{\text{new}}})N}{K} > 0. \tag{A.4}$$

□

Denote by N_{old} and $\overline{p_d^{\text{old}}}$ the number of cases filed, and the average dismissal probability, respectively, in the baseline scenario. The *relative* increase in the number of dismissed lawsuits is given by:

$$\frac{\overline{p_d^{\text{new}}} N/K}{\overline{p_d^{\text{old}}} N_{\text{old}}/K}, \tag{A.5}$$

and the *relative* increase in the number of non-dismissed lawsuits is given by:

$$\frac{(1 - \overline{p_d^{\text{new}}})N/K}{(1 - \overline{p_d^{\text{old}}})N_{\text{old}}/K}. \tag{A.6}$$

We can derive the following prediction:

Prediction 4': Across all K firms, as innovation increases, the relative increase in the chance of being subject to a lawsuit that is dismissed is larger than the relative increase in the chance of being subject to a lawsuit that is not dismissed.

Proof:

$$\frac{\overline{p_d^{\text{new}}} N}{\overline{p_d^{\text{old}}} N_{\text{old}}} > \frac{(1 - \overline{p_d^{\text{new}}})N}{(1 - \overline{p_d^{\text{old}}})N_{\text{old}}} \tag{A.7}$$

can be rewritten as

$$\frac{\overline{p_d^{\text{new}}}}{(1 - \overline{p_d^{\text{new}}})} > \frac{\overline{p_d^{\text{old}}}}{(1 - \overline{p_d^{\text{old}}})}, \tag{A.8}$$

which holds if $\overline{p_d^{\text{new}}} > \overline{p_d^{\text{old}}}$, i.e., if the average quality of the new cases is lower than the average quality of the old cases. This is true by construction of our model.

□

Note that Prediction 4 in the main text is broader than Prediction 4' above, because Prediction 4 does not restrict only to relative increases. In the following, we derive the prediction that the absolute increase in the chance of being subject to a lawsuit that is dismissed is larger than the absolute increase in the chance of being subject to a lawsuit that is not dismissed. Combined with Prediction 4' above, this motivates Prediction 4 in the main paper.

We start by computing the ratio of the increase in dismissed and non-dismissed cases as:

$$\frac{\Delta \Pr(\text{filed\&dismissed})}{\Delta \Pr(\text{filed\&non-dismissed})} = \frac{\overline{p_d^{\text{new}}}}{(1 - \overline{p_d^{\text{new}}})}. \tag{A.9}$$

This expression is greater than one, and $\Delta \Pr(\text{filed\&dismissed}) > \Delta \Pr(\text{filed\&non-dismissed})$ if $\overline{p_d^{\text{new}}} > 0.5$, i.e., if the average dismissal probability of the *additional* cases brought when innovation output increases is larger than 50%.

We can use the data to inform us on whether $\overline{p_d^{\text{new}}}$ is likely greater than, or smaller than, 50%. In the data used in this paper, the average dismissal rate is close to 50% (=0.010/0.022) (see Table 1). This average rate is a weighted average of the dismissal rate for cases of actual wrongdoing (e.g., Enron, Worldcom) and cases of lower quality. Since the average dismissal rate among cases of actual wrongdoing should be very low (e.g., dismissing the Enron case seems like a very unlikely event), the average dismissal probability among those cases that are of lower quality needs to be substantially higher than 50%. Importantly, under the assumptions of our model, all of the N additional cases that are now filed when innovation lowers the cost of filing a suit are of *lower quality than even the worst case out of all cases that have been filed and dismissed in the baseline case*. Hence, the data suggest that $\overline{p_d^{\text{new}}} > 0.5$. Using our baseline estimates from Table 2, columns (5) and (6), in equation (A.9) implies that $\overline{p_d^{\text{new}}}$ is around 83%.

Prediction 5: The average losses to the firm's shareholders around the filing of a lawsuit are higher as innovation output increases.

Proof: The average losses to shareholders of non-innovators conditional on a lawsuit filing are given by $L_{NI} = \frac{1}{N_{old}} \sum_{k^*}^{K} (1 - p_d(k))^2$, where N_{old} refers to the number of lawsuits filed in the baseline case where $C_I = 0$. For shareholders of innovators, the average losses conditional on a lawsuit filing are given by

$$L_I = \frac{1}{N_{old} + N} \sum_{k_{new}}^{K} ((1 - p_d(k))^2 + (1 - p_d(k))\gamma\phi C_I + (1 - \phi)C_I).$$

We want to show that $L_I > L_{NI}$.

The proof proceeds in three steps. To simplify notation, denote summation terms in L_I and L_{NI} by:

$$\Psi_{NI}(k) = (1 - p_d(k))^2$$

$$\Psi_I(k) = (1 - p_d(k))^2 + (1 - p_d(k))\gamma\phi C_I + (1 - \phi)C_I.$$

Step 1: The lowest value of the summation terms in L_I and L_{NI}, respectively are:

$$\Psi_{NI}(k^*) = (1 - p_d(k^*))^2$$

$$\Psi_I(k_{new}) = (1 - p_d(k_{new}))^2 + (1 - p_d(k_{new}))\gamma\phi C_I + (1 - \phi)C_I.$$

From the condition of lawyers to bring a suit, we know that:

$$\Psi_{NI}(k^*) = c$$

$$\Psi_I(k_{new}) - (1-\phi)C_I = c,$$

because $(1-\phi)C_I$ represents a sunk cost, not recoverable by lawyers. It thus follows that

$$\Psi_{NI}(k^*) < \Psi_I(k_{new}).$$

Step 2: We now show that $\Psi_{NI}(k^* + \Delta) < \Psi_I(k_{new} + \Delta)$ for any $\Delta > 0$ holds if $p_d(k)$ is linear or convex in k.

The two derivatives at a point k are given by:

$$\Psi'_{NI}(k) = -2(1 - p_d(k))p'_d(k) \tag{A.10}$$

$$\Psi'_I(k) = -2(1 - p_d(k))p'_d(k) - p'_d(k)\gamma\phi C_I \tag{A.11}$$

$\Psi_{NI}(k^* + \epsilon) < \Psi_I(k_{new} + \epsilon)$ holds if a small increase in case quality ϵ at point $k = k^*$ leads to a smaller increase in $\Psi_{NI}(k)$ than the increase in $\Psi_I(k)$ caused by a small increase in case quality at point $k = k_{new}$, which is the case if:

$$\frac{p'_d(k_{new})}{p'_d(k^*)} > \frac{2(1 - p_d(k^*))}{2(1 - p_d(k_{new})) + \gamma\phi C_I}. \tag{A.12}$$

Using the conditions to bring a suit, we can rewrite

$$\gamma\phi C_I = \frac{(1 - p_d(k^*))^2 - (1 - p_d(k_{new}))^2}{1 - p_d(k_{new})},$$

such that the condition becomes:

$$\frac{p'_d(k_{new})}{p'_d(k^*)} > \frac{2(1 - p_d(k^*))(1 - p_d(k_{new}))}{(1 - p_d(k_{new}))^2 + (1 - p_d(k^*))^2}. \tag{A.13}$$

Since we know that $1 - p_d(k^*) > 1 - p_d(k_{new})$, which can be rewritten as $(1 - p_d(k^*))^2 + (1 - p_d(k_{new}))^2 > 2(1 - p_d(k^*))(1 - p_d(k_{new}))$, the right-hand side of the above inequality has to be smaller than one. We can thus write:

$$\frac{p'_d(k_{new})}{p'_d(k^*)} \geq 1 > \frac{2(1 - p_d(k^*))(1 - p_d(k_{new}))}{(1 - p_d(k_{new}))^2 + (1 - p_d(k^*))^2}. \tag{A.14}$$

A sufficient condition for the inequality to be satisfied is therefore that $p_d(k)$ is convex or linear.

The argument above works for small changes in case quality, i.e., when adding $\epsilon > 0$ to k^* and k_{new}, respectively. We can show that $\Psi_{NI}(k^* + \Delta) < \Psi_I(k_{new} + \Delta)$ for any $\Delta > 0$ holds if $p_d(k)$ is linear or convex in k, because we can successively apply the same logic to $k^* + \epsilon$ and $k_{new} + \epsilon$ until we reach the desired value Δ.

We have therefore established that:

$$L_{NI} = \frac{1}{N_{old}} \sum_{k^*}^{K} (1 - p_d(k))^2$$

is smaller than

$$\frac{1}{N_{old}} \sum_{k_{new}}^{K-N} ((1 - p_d(k))^2 + (1 - p_d(k))\gamma\phi C_I + (1 - \phi)C_I). \tag{A.15}$$

Step 3: Equation (A.15) represents the average shareholder losses for innovators across all except the N highest quality cases. Since $p_d(k)$ decreases in case quality, losses for any $k > K - N$ exceed the losses for cases of quality $k = K - N$. This implies:

$$L_I > \frac{1}{N_{old}} \sum_{k_{new}}^{K-N} ((1 - p_d(k))^2 + (1 - p_d(k))\gamma\phi C_I + (1 - \phi)C_I), \tag{A.16}$$

which, in turn, implies

$$L_I > L_{NI}.$$

□

A.2.2 Alternative channel: Higher innovation output lowers filing costs for the plaintiff

Successful innovation may make it easier for a law firm to attack, in the sense that valuable innovation output is associated with a lower cost of bringing a suit. Specifically, we provide direct evidence in the Internet Appendix that firms with valuable innovation output issue more forward-looking statements. Such statements are by nature more speculative, thus providing an opening for lawyers to craft a meritless suit upon seeing a stock drop (Rogers, Buskirk, and Zechman (2011)). If the law firm needs to spend less effort and resources in setting up the legal strategy, or if the concern about potential negative repercussions on the law firm's reputation is weaker when the facts of the case are more opaque, then the lawyer's cost c associated with suing high innovation firms is lower.

Prediction 1: Across all K firms, increasing innovation output makes it more likely that a lawsuit is filed.

Proof: Denote by k^* the lowest quality level k which satisfies $(1-p_d(k))^2 > c$. Let innovation output lower filing costs c to $c_{\text{new}} < c$. Denote the lowest value of k that satisfies $(1-p_d(k))^2 > c_{\text{new}}$ by k_{new}. Because $p_d(k)$ decreases in k, we have $k_{\text{new}} < k^*$. In all firm-law firm pairs for which the law firm found it profitable to file a suit in the baseline case when filing costs are c, the law firm still finds it profitable to file a suit when innovation output is high and costs are $c_{\text{new}} < c$. In the high innovation case there are, however, $k^* - k_{\text{new}} = N$ instances in which a case is filed for a firm-law firm pair, which would not be filed in the baseline case in which the filing costs are c. Hence, the total number of cases filed increases by N and the probability of a filing across all K firms increases by

$$\Delta \Pr(\text{filed}) = \frac{N}{K} > 0. \tag{A.17}$$

□

Prediction 2: as above.

Proof: as above. The intuition is simple: when the marginal benefits curve from suing is unchanged, then lowering the marginal cost of suing leads to more lawsuits in general, and more low-quality lawsuits in particular.

Prediction 3: as above.

Proof: as above.

Prediction 4: as above.

Proof: as above.