Patent Trolls: Evidence from Targeted Firms

Abstract

We develop a theoretical model of, and provide the first large-sample evidence on, the behavior and impact of non-practicing entities (NPEs) in the intellectual property space. Our model shows that NPE litigation can reduce infringement and support small inventors. However, the model also shows that as NPEs become effective at bringing frivolous lawsuits, the resulting defense costs inefficiently crowd out firms that, absent NPEs, would produce welfare-enhancing innovations without engaging in infringement. Our empirical analysis shows that on average, NPEs appear to behave as opportunistic "patent trolls." NPEs sue cash-rich firms—and target cash in business segments unrelated to alleged infringement at essentially the same frequency as they target cash in segments related to alleged infringement. By contrast, cash is neither a key driver of intellectual property lawsuits by practicing entities (e.g., Google and Microsoft), nor of any other type of litigation against firms. We find further suggestive evidence of NPE opportunism: targeting of firms that have reduced ability to defend themselves, repeated assertions of lower-quality patents, increased assertion activity nearing patent expiration, and forum shopping. We find moreover that NPE litigation has a real negative impact on innovation at targeted firms: firms substantially reduce their innovative activity after settling with NPEs (or losing to them in court). Meanwhile, we neither find any markers of significant NPE pass-through to end innovators, nor of a positive impact of NPEs on innovation in the industries in which they are most prevalent.

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Clearly defined property rights are a hallmark of well-functioning markets. In the case of intellectual property (IP), however, property rights are complex to define, as unlike ownership of physical assets, the space of ideas is difficult to delineate. The United States and many other countries protect inventors' IP through *patents*, property rights granting inventions' owners sole rights of commercialization or exclusion—the right to block the use or sale of equivalent inventions by others—for a period of time. In the United States, the legal system is the arbiter of patent infringement; hence, legal action (or the threat of legal action) is the main lever by which patent holders challenge alleged intellectual property infringement.

A new organizational form, the *non-practicing entity* (hereafter, *NPE*), has recently emerged as a major driver of patent litigation. NPEs amass patents not for the sake of producing commercial products, but in order to claim license fees and/or litigate against infringement. The rise of NPEs has sparked a debate regarding NPEs' value and impact on innovation: Proponents of NPEs argue that NPEs serve a key financial intermediary role, policing infringement by well-funded firms that could otherwise infringe upon small inventors' IP without consequence. Opponents argue that NPEs simply raise the costs of innovation by exploiting the fact that the costs of legal process, together with the risks that imperfect courts may rule in NPEs' favor even if no infringement has actually occurred (or if the asserted patents would not survive a validity test), mean that the credible threat of legal process can yield rents from producing, innovative firms.[1] In part reflecting the debate on NPEs, in the last few years there have been over a dozen bills introduced in Congress proposing to regulate the licensing and assertion of patents.[2]

[1]Bessen and Meurer (2014) estimate that from 2007 to 2010, litigation (and settlement) losses due to NPEs averaged over $83 billion per year in 2010 dollars (just summing over the losses to publicly traded firms). In magnitude, this corresponds to over 25% of annual United States industrial R&D investment.

[2]In the last four years, Congress has considered the Innovation Act (H.R. 9 and H.R. 3309), the Targeting Rogue and Opaque Letters (TROL) Act (H.R. 2045), the Patent Transparency and Improvements Act (S. 1720), the Patent Quality Improvement Act (S. 866), the Patent Abuse Reduction Act (S. 1013), the Patent Litigation Integrity Act (S. 1612), the Innovation Protection Act (H.R. 3309), the Patent Litigation and Innovation Act (H.R. 2639), the Saving High-tech Innovators from Egregious Legal Disputes (SHIELD) Act (H.R. 845), the Stopping the Offensive Use of Patents (STOP) Act (H.R. 2766), and the End Anonymous Patents Act (H.R. 2024). Meanwhile, the United States Patent and Trademark Office (2015) has undertaken an initiative on "Enhancing Patent Quality."

In this paper, we provide the first large-sample evidence on precisely which corporations NPEs target in litigation, when NPE litigation occurs, and how NPE litigation impacts targeted firms' innovative activity.[3]

We begin with a parsimonious model of an innovative economy in which a large firm must decide whether to innovate, and—conditional on innovating—must also decide whether to reduce the costs of innovation by infringing upon a small inventor's IP. NPEs help small inventors litigate in response to infringement by the large firm, but can also bring nuisance lawsuits when no infringement has occurred.

Our theoretical model supports both sides of the NPE debate: NPE litigation can both reduce infringement and promote a transfer to inventors when infringement occurs, although the value of NPEs to inventors—both in terms of license fees and awards through litigation—is only as large as the fraction of the damage award that NPEs pass through. As NPEs become effective at bringing nuisance lawsuits, however, the resulting defense costs inefficiently crowd out some firms that, absent NPEs, would prefer to engage in innovation without infringing. Somewhat paradoxically, we also find that the possibility of nuisance lawsuits can lead some innovating firms to infringe *more* because avoiding infringement may not deter suit.

The theory illustrates that the key question for assessing NPEs' welfare impact concerns lawsuit targeting behavior: *Do NPEs on average police against true infringement, or do they primarily behave opportunistically, bringing lawsuits irrespective of whether infringement has occurred?* It is impossible for us to directly measure whether targeted firms were actually infringing, especially given that most NPE lawsuits are settled before even early stages of pre-trial discovery occur. However, we can—and do—look to see whether the empirical evidence suggests opportunistic behavior on the part of NPEs.

We work with two independent sources of data on NPE litigation activity: proprietary data from RPX Corporation and hand-coded, finely classified public data assembled by

[3]Based on the body of evidence we document here, in related policy and law pieces, we propose a framework for advance screening aimed at abating patent trolling—particularly nuisance suits—while encouraging well-grounded lawsuits (Cohen et al. (2016, 2017)).

Cotropia et al. (2014). Together, these data sources cover the complete universe of NPE lawsuits from 2005 to 2015; we combine this data on NPE lawsuits with external data on publicly traded firms.

Using our linked data, we show that NPEs appear to behave opportunistically: they target firms that are flush with cash (controlling for all other characteristics) and firms that have had recent, positive cash shocks. NPEs even target firms that earn their profits from business segments having nothing to do with the allegedly infringing segments. Our findings suggest, for example, that an NPE would likely sue a firm regarding alleged information technology infringement even if the firm is earning all its revenue from a lumber division entirely unrelated to the information technology division—and even if the information technology division is unprofitable. Indeed, a one standard-deviation increase in cash level increases the probability of being sued by an NPE by 7.40% ($t = 4.25$)—a twofold increase, and cash holdings in unrelated business segments are almost as predictive of NPE litigation as are cash holdings in segments related to the alleged infringement.

Meanwhile, we find evidence that NPEs may not be policing infringement. The cash-targeting we observe is mostly the behavior of large "patent aggregator" firms; small inventors' lawsuits show a different targeting pattern, in which defendants' cash holdings are not a significant factor. There is also some evidence that NPEs bring lower-quality lawsuits, and evidence that NPEs are actively forum shopping.

In theory, our finding that cash/profitability is a first-order determinant of NPE litigation could simply be picking up a general characteristic of IP litigation, or of litigation more generally. However, our results show otherwise: *Practicing entities* (*PEs*), such as IBM and Intel, do not behave in the same way as NPEs. We hand-collected the universe of patent infringement cases brought by PEs against PEs in our sample period, and find that, if anything, PEs are slightly *less* likely to sue firms with high cash balances.[4] Similarly, we

[4]All of the other key determinants of NPE targeting have (statistically and economically) no impact on PE litigation behavior, with the exception of ongoing, non-IP-related cases, which has a positive impact on targeting for NPEs, but a negative impact for PEs.

found that cash is not a significant determinant of other (non-IP) forms of litigation—tort, contract, securities, environmental, or labor. This comparison suggests that our results on NPE litigation behavior do not just reflect general characteristics of litigation. Rather, our findings are consistent with agent-specific motivations for NPEs in targeting firms flush with cash.

Using several different empirical measures, we also find that NPEs target firms against which they have a higher *ex ante* likelihood of winning. First, we show that NPEs are significantly more likely to target firms that are busy dealing with other, non-IP-related litigation. Being tied up with outside litigation is associated with a roughly 19% ($t = 2.38$) increase in the probability of being sued by an NPE. Moreover, we show that, controlling for all other characteristics, firms with smaller legal teams have a significantly higher probability of being targeted by NPEs. Additionally, echoing and amplifying findings of prior work, we find evidence that NPEs frequently forum-shop, and assert patents that appear to be broader, wordier, and closer to expiry than those asserted by PEs.

Lastly, we examine the real impacts of NPE litigation on targeted firms' innovative activity. Using a differences-in-differences approach, we find that firms that lose to NPEs (either in court or through settlement) reduce their research and development investment by roughly 20% going forward, relative to *ex ante* identical firms.[5] Thus, our evidence suggests that NPE litigation leads to a real decrease in innovation at targeted firms. Of course, when NPEs win lawsuits, some of the losses to the targeted firms—part of the settlement or damage awards, but not the legal costs—should eventually flow back to end inventors. The best available estimates suggest, however, that only a small fraction of the damages won by NPEs are actually paid back to innovators (Bessen et al. (2011); Bessen and Meurer (2014)). As our theoretical model illustrates, when only small transfers reach end inventors, NPEs' value in encouraging invention—both directly and indirectly—is significantly dampened. Moreover, we show empirical evidence consistent with the view that pass-through from NPEs has not

[5]To control for selection of firms targeted by NPEs, we compare firms that are sued by NPEs and "win" to those are sued by NPEs and "lose."

significantly increased innovation by small inventors.

Taken as a whole, our evidence appears most consistent with the view that NPEs on average behave as patent trolls. NPEs chase cash, and have a real negative impact on targeted firms' innovative activity. Alternative interpretations simply do not seem to explain the entire body of evidence. For instance, NPEs' empirically documented level of cash-targeting—which does not appear in PE patent litigation, or in other types of litigation—suggests that the scope and implementation of cash-targeting we see is unique to the NPE organizational form in the IP space. Furthermore, our results on cash-targeting might be consistent with the possibility that targeted firms are knowingly infringing and are stockpiling cash in anticipation of litigation; however, this alternate explanation is at odds with our finding that NPEs are especially likely to target firms that have had cash shocks, and/or are embroiled in non-IP-related lawsuits. Meanwhile, the idea that NPEs solely target firms that profitability infringe on NPEs' intellectual property is inconsistent with our finding that cash holdings in related and unrelated operating segments are almost equally predictive of suit.

The remainder of the paper is organized as follows. Section 1 provides background and a literature review. Section 2 develops our model of the economics of innovation and intellectual property litigation. Section 3 describes our data sources. Section 4 presents our empirical results on NPE targeting. Section 5 shows evidence on the real impacts of NPE litigation behavior on innovation. Section 6 provides a discussion, and Section 7 concludes.

1 Background

A United States inventor's patenting process begins with an application to the United States Patent and Trademark Office (USPTO), which assigns the application to a patent examiner. The examiner's job is to compare the filed patent's claims to prior art, in order to determine whether the claimed invention is patentable, novel, and nonobvious.[6] If the examiner decides

[6] *Prior art* refers to other patents, publications, and publicly disclosed but unpatented inventions that predate the patent application's filing date.

to grant the claims in an application, then the USPTO issues a patent to the applicant.[7] The patentability of a patent's claims can be challenged in administrative proceedings. Patent validity can be challenged in one of the 94 federal district courts by presenting prior art that may have been overlooked by USPTO examiners. Since 2012, it has also been possible to challenge patent validity via administrative proceeding at the Patent Trial and Appeal Board (PTAB).

Since a patent confers the right to exclude others from "practicing" an invention, patent owners can sue anyone who uses, makes, sells, offers to sell, or imports their inventions without legal permission. If a patent infringement lawsuit is not dismissed in its initial stages, it proceeds to the *discovery* phase, in which both the accused infringer (defendant) and the patent owner (plaintiff) supply documents and depositions intended to demonstrate how the allegedly infringing product is made. If a party does not make or sell products or provide services based on the patented invention, then it is likely to have far fewer documents to disclose. Consequently, as NPEs do not produce products, the discovery phase can be far less costly for NPE plaintiffs than for defendants.

If an infringement suit is not settled or dismissed, then a court interprets the parties' claims, making determinations both as to whether the patent is valid and whether infringement occurred. A judge or jury who rules in favor of the patent owner can award monetary damages and/or issue an injunction to prohibit further infringement.[8]

The amount of patent-related litigation has increased threefold since 2005 (see Figure 1).[9] According to a recent United States Government Accountability Office (2013) report, three factors contributed to the rise in IP litigation: (1) the number of patents (especially software-

[7] In 2015, the average time between application and initial examiner report was 17.3 months and, on average, it took 26.6 months for the USPTO to issue a patent. The USPTO granted 325,979 patents in 2015. For other USPTO-related statistics, see `http://www.uspto.gov/about/stats/`.

[8] Following the *eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388* Supreme Court ruling in 2006, injunctions became much harder to acquire, and thus monetary damages became the far more prevalent remedy.

[9] In 2012, the America Invents Act forced the "disjoining" lawsuits based on unrelated infringement claims. Thus, the increase in NPE litigation around 2012 is not quite as sharp as Figure 1 suggests, especially because many NPEs file suits against multiple parties. Even adjusting for this issue, the rise in NPE litigation is still striking.

related patents) with unclear scope has increased; (2) courts have been granted large monetary awards in infringement lawsuits, even for ideas that make only small contributions to a product; and (3) markets place a larger valuation on patents than they did before.

The growth in large-scale NPE patent litigation is a recent development; consequently, the associated empirical literature on NPEs is limited, but growing rapidly.[10,11] Our paper contributes to this literature by providing the first large-sample evidence about which public corporations NPEs choose to litigate, when NPEs bring litigation, and how NPE litigation impacts innovative activity at targeted firms.

Our paper is also related to a literature in economics that examines innovation and patents, suggesting that the impact of patent rights on innovation is highly heterogeneous (Galasso et al. (2015)); in particular, patents may discourage valuable follow-on innovation (Williams (2013); see also Sakakibara and Branstetter (2001); Lerner (2009); Williams (2015)).[12] Consequently, the law and policy literatures have begun to sort out potential deficiencies in the patent system more broadly (see, e.g., Lemley and Melamed (2013); Budish et al. (2015); United States Patent and Trademark Office (2015)), while proposing potential reforms (see Lemley and Shapiro (2006); Schwartz and Kesan (2014); and especially the work of Helmers et al. (2013), which hints at how policy lessons from the United Kingdom could be used to reduce patent trolling in the United States).

Lastly, our work is also related to the literature that examines the choice between settlement and the pursuit of a court decision. Spier (2005) provides an excellent review of

[10]Surveys, clinical, and anecdotal work—finding evidence both in favor of and against NPEs—include the work of Lemley and Shapiro (2005), Bessen and Meurer (2006), Leychkis (2007), Ball and Kesan (2009), Galasso and Schankerman (2010), Bessen et al. (2011), Chien (2013a, 2014), Galasso et al. (2013), Bessen and Meurer (2014), Choi and Gerlach (2014), Cotropia et al. (2014), Feldman (2014), Scott Morton and Shapiro (2014), Tucker (2014), Feldman and Lemley (2015), Smeets (2015), Kiebzak et al. (2016), Feng and Jaravel (2015), Haber and Werfel (2016), and Allison et al. (2017). Sokol (2017) presents recent analysis of the economic impact of NPEs.

[11]A related economic history literature has looked at modern NPEs' predecessors in prior ages of invention, illustrating how NPEs arose as specialized litigation intermediaries (see, e.g., Khan (2013, 2014); Lamoreaux and Sokoloff (1996, 2001); Beauchamp (2016)).

[12]Using data obtained from an NPE (but not studying NPEs, *per se*), Abrams et al. (2013) found an inverted-U relationship between patent citations and patent value (as measured in terms of associated revenue).

the economics of litigation.[13] While we focus solely on intellectual property, our paper is also related to the well-developed literature on the effect of litigation risk on firm activities.[14]

2 Model

We now introduce a model of innovation and NPE litigation. We seek to understand how the real benefits that NPEs can provide small inventors balance with the possibilities of NPE opportunism. We focus on a very simple scenario, in which a firm is aware of a small inventor's patent, and must choose whether to infringe. The NPE serves as a specialized litigation intermediary that can help the small inventor respond to patent infringement—but the NPE is so effective at litigation (or, equivalently, the courts are sufficiently imperfect) that the NPE can sometimes win lawsuits when no infringement has occurred. Thus, the central welfare trade-off is whether (and when) the positive value of NPEs to small inventors outweighs the costs of frivolous litigation. The trade-off we observe is nontrivial because widespread frivolous litigation causes an endogenous, inefficient increase in infringement (firms that know they will get sued anyway might as well infringe) and can also crowd out innovating firms completely. Note that in our model we focus only on NPE litigation given the possibly of intentional infringement on a real invention. We do *not* address NPE activities that are purely rent seeking, such as asserting weak patents or "holding up" firms by making them aware of patented technologies only after innovation and production have occurred; such activities would only reduce the case in support of NPEs (in our model, and in general).

Formally: A firm decides whether to invest in *innovation*, which has payoff v and cost

[13] Previous surveys include those of Cooter and Rubinfeld (1989), Hay and Spier (1998), and Daughety and Reinganum (2000).

[14] Prior research has investigated the impact of litigation risk on several characteristics, including cash holdings (Arena and Julio (2011)), equity-based compensation (Jayaraman and Milbourn (2009)), IPO underpricing (Lowry and Shu (2002); Hanley and Hoberg (2012)), institutional monitoring and board discipline (Cheng et al. (2010)), conservatism in debt contracting (Beatty et al. (2008)), audit fees (Seetharaman et al. (2002)), and auditors' resignation decisions (Shu (2000)). Papers have also investigated the relationship between managers' financial reporting and disclosure decisions and firms' litigation risk (see, e.g., Skinner (1994, 1997); Francis et al. (1994); Johnson et al. (2000); Rogers and Van Buskirk (2009)).

$k < v$, for net return

$$u \equiv v - k > 0.$$

If the firm does not innovate, then it produces a "safe" product, which has net return normalized to 0. If the firm does innovate, then it may simplify its innovation process by *infringing* upon intellectual property that has been developed and patented by an outside *inventor*. (For now, we assume that there is no possibility that the firm can license the inventor's intellectual property; we later add licensing to the model, and investigate the impact of NPEs on licensing rates.) Infringement reduces the costs of innovation by $\pi > 0$, so that innovation with infringement yields net return

$$v - (k - \pi) = u + \pi$$

for the firm; π represents the cost of "designing around" the invention, which is not spent if the firm infringes.[15]

Once the firm has made its production decisions, the inventor may choose to litigate—either on her own, or through an NPE.[16] For plaintiff e, bringing a lawsuit has fixed-cost c_e and per-unit effort cost w_e. We assume that lawsuits against firms producing the "safe" product are never profitable—for instance, because that product is clearly unrelated to the invention in question—so litigation will only occur if the firm chooses to innovate. However, we do *not* assume that litigation is only profitable in the presence of infringement—that is, we allow for the possibility of *nuisance lawsuits* that occur even in the absence of infringement (or when the asserted patents are invalid).

When bringing a lawsuit, the plaintiff chooses the optimal litigation effort L. Courts are

[15]Note that with this setup, the inventor's IP has real social/technical value (even if it has no outside commercial value), as using the IP reduces the firm's cost of innovation.

[16]In practice, *litigating through an NPE* means that the inventor would transfer ownership of her patent to the NPE (in exchange for the inventor payoffs described in the sequel). The inventor would not typically prefer to license the patent to the NPE in exchange for a constant fraction of future returns, as that would act like a tax on the NPE's returns to litigation, and distort the NPE away from optimal litigation effort (this matches up with historical accounts; see, e.g., Khan (2013, 2014)).

assumed to be imperfect; both the probability of winning and the damages from suit depend on (1) the level of litigation effort, (2) whether infringement has occurred, and (3) whether the inventor herself or an NPE is the plaintiff.

The probability of winning a suit is given by

probability of winning	if(infringement)	if(no infringement)
inventor plaintiff	$\overline{p}_i(L)$	$\underline{p}_i(L)$
NPE plaintiff	$\overline{p}_n(L)$	$\underline{p}_n(L)$

. (1)

We assume that the probability of winning is always weakly increasing in effort (i.e., we have $\overline{p}_i', \overline{p}_n', \underline{p}_i', \underline{p}_n' \geq 0$). Moreover, as NPEs have a comparative advantage in litigation (see, e.g., Khan (2013, 2014); Lamoreaux and Sokoloff (1996, 2001)), we assume that NPEs are always weakly more effective at bringing lawsuits than the inventor is (i.e., $\overline{p}_n(L) \geq \overline{p}_i(L)$ and $\underline{p}_n(L) \geq \underline{p}_i(L)$). We also assume that lawsuits are more likely to be successful when infringement occurs (i.e., that $\overline{p}_i(L) \geq \underline{p}_i(L)$ and $\overline{p}_n(L) \geq \underline{p}_n(L)$).

Analogously, we assume that the damages received upon winning a suit are given by

damages	if(infringement)	if(no infringement)
inventor plaintiff	$\overline{\delta}_i(L)$	$\underline{\delta}_i(L)$
NPE plaintiff	$\overline{\delta}_n(L)$	$\underline{\delta}_n(L)$

. (2)

We assume that damages are weakly increasing in effort (i.e., we have $\overline{\delta}_i', \overline{\delta}_n', \underline{\delta}_i', \underline{\delta}_n' \geq 0$), and that damage awards won by NPEs are weakly higher than those won by individual inventors (i.e., $\overline{\delta}_n(L) \geq \overline{\delta}_i(L)$ and $\underline{\delta}_n(L) \geq \underline{\delta}_i(L)$, again, due to NPEs' comparative advantage). We also assume that damages are higher in the presence of infringement (i.e., that $\overline{\delta}_i(L) \geq \underline{\delta}_i(L)$ and $\overline{\delta}_n(L) \geq \underline{\delta}_n(L)$).

When bringing a lawsuit, the plaintiff $e \in \{i, n\}$ chooses litigation effort L to solve

$$\max_L \{p_e(L)\delta_e(L) - w_e L - c_e\} \equiv V_e,$$

where p_e and δ_e are the appropriate functions in (1) and (2), respectively.[17] The first-order condition

$$p_e'(L)\delta_e(L) + p_e(L)\delta_e'(L) = w_e \tag{3}$$

determines e's optimal level of effort, L^*; this in turn determines the payoffs from suit, which we denote V_e^*. Each of the four possible litigation scenarios (inventor or NPE plaintiff, and presence or lack of infringement) has a different payoff from optimal effort, which we notate as follows:

returns to litigation	if(infringement)	if(no infringement)
inventor plaintiff	$\overline{V}_i^*$	$\underline{V}_i^*$
NPE plaintiff	$\overline{V}_n^*$	$\underline{V}_n^*$

. (4)

Some features of the returns to litigation are apparent immediately from the first-order condition (3). First, shifting either the probability of winning or the damages function upwards increases the optimal effort, as well as the returns to litigation. Moreover, we observe a direct substitution between damages and probability of winning (holding the plaintiff type and firm production decisions constant); this is natural, as the expected returns to suit are exactly the product of the probability of winning and the size of the damage award.

We assume that the NPE shares fraction λ of its litigation surplus with the inventor. That is, if the inventor sues via an NPE, then she receives (expected) payoffs

$$\lambda(\overline{V}_n^* - \overline{V}_i^*) + \overline{V}_i^* \quad \text{and} \quad \lambda(\underline{V}_n^* - \underline{V}_i^*) + \underline{V}_i^*$$

in the cases of infringement and no infringement, respectively. Thus, in the case of infringement, the inventor sues if and only if

$$\max\{\overline{V}_i^*, \lambda(\overline{V}_n^* - \overline{V}_i^*) + \overline{V}_i^*\} \geq 0; \tag{5}$$

[17] For this maximization, we need to assume $\delta_e''(L) \leq 0$, $p_e''(L) \leq 0$, and $c_e \geq 0$—with at least one strict inequality—so that the relevant second-order conditions hold.

in the case of no infringement, the inventor sues if and only if

$$\max\{\underline{V}_i^*, \lambda(\underline{V}_n^* - \underline{V}_i^*) + \underline{V}_i^*\} \geq 0. \tag{6}$$

We recall that NPEs are more effective at litigation than inventors are per unit effort (both in terms of success probability and damages). Thus, examining (3), we see that $\overline{V}_n^* \leq \overline{V}_i^*$ and $\underline{V}_n^* \leq \underline{V}_i^*$ only when the inventor faces far lower costs of litigation effort than the NPE does (i.e., unless the unit litigation effort cost of the inventor, w_i, is much lower than that for the NPE, w_n). If anything, the opposite appears to be true in real markets (see, e.g., Ball and Kesan (2009); Haber and Werfel (2016)): NPEs are sophisticated and specialized in litigation, whereas individual inventors are under-resourced, and rarely skilled at litigation. Thus, (5) and (6) suggest that $\overline{V}_n^* \geq \overline{V}_i^*$ and $\underline{V}_n^* \geq \underline{V}_i^*$, and when inventors choose to sue, they will typically work through NPEs. Moreover, as inventors are often unable to bring lawsuits on their own (due to capability or resource constraints; again, see Ball and Kesan (2009) and Haber and Werfel (2016)), their bargaining power with individual NPEs (embodied in λ) may be low.[18]

Now, we turn to the firm's incentives. We suppose that defending against litigation costs the firm c_f; this includes purely monetary costs, as well as costs from disruption and loss of reputation.[19] Then, if the firm chooses to innovate, it receives the following payoffs:

firm payoff	if(sued)	if(not sued)
if(infringement)	$u + \pi - c_f - \max\{\overline{V}_i^*, \overline{V}_n^* \mathbb{1}_{\overline{V}_n^* \geq \overline{V}_i^*}\}$	$u + \pi$
if(no infringement)	$u - c_f - \max\{\underline{V}_i^*, \underline{V}_n^* \mathbb{1}_{\underline{V}_n^* \geq \underline{V}_i^*}\}$	u

.[20] (7)

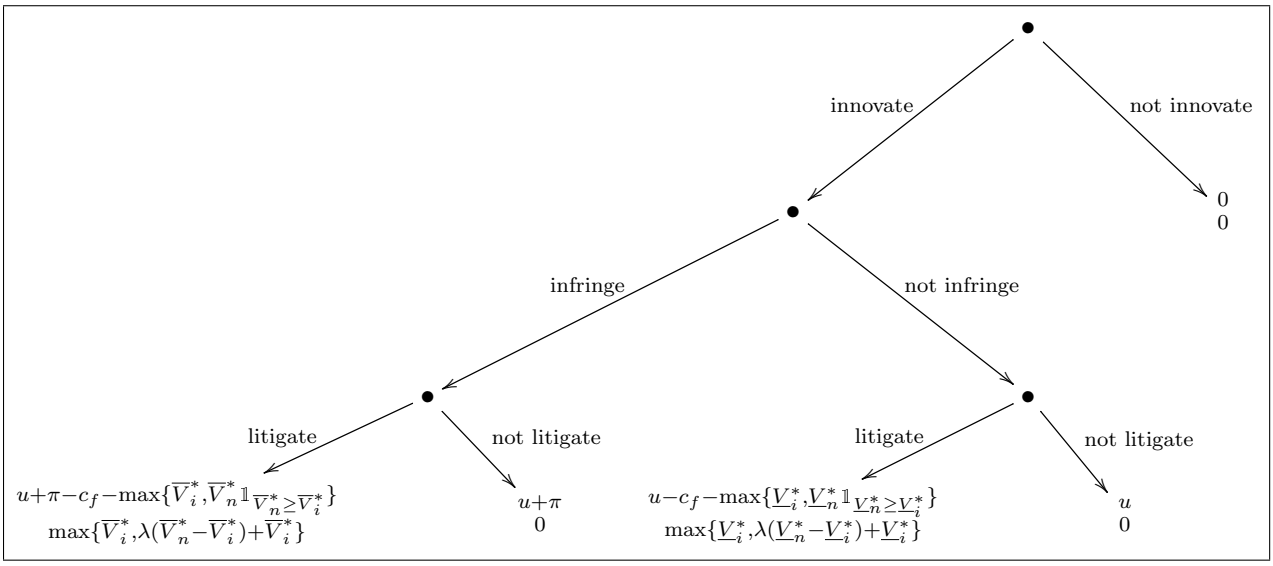
(Note that the firm must pay the full NPE damage award, even though the inventor only

[18] Even though there are many NPEs (on the order of 850 parent companies in our data), there are far, far more small inventors, so the impact of competition on bargaining power, if anything, is likely to favor NPEs.

[19] The analysis extends straightforwardly if the firm's cost of defense depends on the plaintiff's effort, or on whether infringement has occurred.

[20] Here, $\mathbb{1}$ denotes the indicator function.

receives fraction λ of the surplus.) The firm infringes whenever the benefits of doing so exceed the costs. The full extensive form is pictured below.



The Innovation and Litigation Game – First, the firm decides whether to innovate. If the firm chooses to innovate, then it must decide whether to infringe. Then, the inventor litigates (either on her own or through the NPE) if doing so is profitable. For each end node, the top term denotes the firm's payoff, and the bottom term denotes the inventor's payoff.

2.1 Impact of NPEs on Innovation and Infringement

To simplify the analysis, we focus on the case in which the inventor never sues on her own, i.e., when $\overline{V}_n^* \geq \overline{V}_i^*$ and $\underline{V}_n^* \geq \underline{V}_i^*$. In this case, (7) simplifies to

firm payoff	if(sued)	if(not sued)
if(infringement)	$u+\pi-c_f-\max\{\overline{V}_n^*,0\}$	$u+\pi$
if(no infringement)	$u-c_f-\max\{\underline{V}_n^*,0\}$	u

. (8)

All the qualitative results we state here carry over to the full model.

We see that:

- When $\underline{V}_n^* \to 0$, so that the NPE is ineffective at bringing nuisance suits, the availability of the NPE reduces total infringement. A lawsuit occurs only following infringement,

and the firm infringes if and only if

$$u + \pi > c_f + \overline{V}_n^*. \tag{9}$$

Importantly, as $\underline{V}_n^* \to 0$, infringement is strictly lower than if the NPE were absent, as (9) is tighter than $u + \pi > c_f + \overline{V}_i^*$, which is the condition that would determine infringement absent the NPE.

- However, as the NPE becomes better at bringing nuisance suits, that is, as $\underline{V}_n^* \to \overline{V}_n^*$, lawsuits occur whenever the firm innovates (so long as suits are ever profitable), irrespective of whether the firm infringes. In that case, all innovating firms will infringe—even if the benefits of infringement are small.

- Moreover, as $\underline{V}_n^* \to \overline{V}_n^*$, if either the defense costs c_f or the payment $\overline{V}_n^*$ are sufficiently large, then we have

$$u + \pi - c_f - \overline{V}_n^* < 0,$$

so that the firm will choose not to innovate. Consequently, when $\overline{V}_n^*$ is high enough and $\underline{V}_n^* \to \overline{V}_n^*$, the firm *always* chooses not to innovate even if, absent the NPE, the firm would choose to innovate without infringing.

Specifically, the firm chooses not to innovate when $u+\pi-c_f-\overline{V}_n^* < 0$. If $u+\pi-c_f-\overline{V}_i^* < u$, then the firm would innovate without infringing if there were no chance of nuisance suit. Thus, if $\underline{V}_n^*$ is sufficiently high and the benefits of infringement are low ($\pi < c_f + \overline{V}_i^*$), the presence of the NPE results in mid-value range innovations (those having values $u < c_f + \overline{V}_i^* - \pi$) being crowded out of the market.

2.2 Impact of NPEs on IP Licensing

Next, we suppose that the firm uses the inventor's invention (for return π) if it innovates, but the inventor and firm can agree to license terms *ex ante* in exchange for committing not

to litigate.

If the firm innovates and infringes, then the inventor stands to earn

$$\max\{\overline{V}_i^*, \lambda(\overline{V}_n^* - \overline{V}_i^*) + \overline{V}_i^*, 0\}$$

through litigation (recall (5)). Thus, if the firm has all the bargaining power, then it can license the invention for

$$\max\{\overline{V}_i^*, \lambda(\overline{V}_n^* - \overline{V}_i^*) + \overline{V}_i^*, 0\}.^{21} \tag{10}$$

Examining (10), we see that the NPE only improves the terms of licensing for the inventor when $\overline{V}_n^* > \overline{V}_i^*$, that is, when the inventor would prefer to sue through the NPE instead of litigating on her own. But then the value of the license to the inventor is mediated by the rate at which the NPE passes surplus through to the inventor. No inventor gains more through licensing than she would earn through bringing suit (although licensing is more efficient because it saves court costs). In particular, if λ is small—as it would be, say, if there were significant competition among inventors for NPEs' time—then the availability of the NPE has little impact on the inventor's licensing revenues. By contrast, if λ is large—as in the case of significant competition among NPEs for inventors' patents—then the NPEs' presence can lead to significantly higher license fees.

2.3 Welfare Impact of NPEs

Our model illustrates that the welfare impact of NPEs is ambiguous. When NPEs are more effective at bringing lawsuits than individual inventors are, the threat of NPE litigation can reduce infringement and promote a transfer to inventors when infringement occurs. However, the value of NPEs to inventors is mediated by the fraction λ of the surplus that NPEs pass

[21] If the firm splits fraction α of the surplus with the inventor, then (10) is increased by an additional term $\alpha(c_f + \pi)$—but this term is independent of whether the NPE is available, so our qualitative results are unhanged. (The presence of the NPE would not affect α, as the full effect of the NPE on the firm's payoff is already internalized in the maximization term of (5).)

through. NPE-backed lawsuits may help inventors extract licensing fees from firms, but again this effect is mediated by λ; if λ is small, then the inventor cannot extract a significantly higher licensing fee than he would obtain absent the NPE.[22]

Meanwhile, if NPEs become effective at bringing nuisance lawsuits, then in equilibrium NPEs bring lawsuits even absent infringement. Somewhat paradoxically, this leads innovating firms to infringe *more*, as they know that avoiding infringement will not deter suit.[23] Additionally, the cost of nuisance lawsuits inefficiently crowds out welfare-increasing innovation by some firms that, absent NPEs, would prefer to innovate without infringing.

Our results here shed new light on the impacts of "patent reform" legislation targeted at reducing low-quality NPE lawsuits. Reigning in frivolous lawsuits could both reduce crowd-out of innovative firms and (again, almost paradoxically) reduce infringement.[24] Meanwhile, reducing NPE litigation would only significantly affect the licensing revenues and innovation incentives of those inventors who are receiving a very large share of NPE revenues.[25]

In the sequel, we assess the extent to which NPE litigation appears to be opportunistic. We cannot measure the quality of all NPE lawsuits directly, as most never even make it to pre-trial discovery.[26] Hence, we look to see whether NPE lawsuits exhibit patterns that suggest potential opportunism, such as indiscriminate cash-targeting, forum shopping, or assertion of low-quality patents. Then, to get a small look at the inventor side of the equation,

[22] A secondary effect of NPEs, which we do not explicitly model here, is that NPE litigation (or the threat thereof) could reduce infringement in ways that mitigate competition by large players, thus freeing small inventors to practice their own inventions. This effect could provide a benefit to inventors over and above the transfer value, as firms' infringement reduction is independent of whether transfers from litigation goes to inventors or NPEs; however, such benefits only arise in the case that NPE litigation actually reduces infringement, i.e., when most NPE lawsuits are high-quality.

[23] This finding echoes the classical insight of Polinsky and Shavell (1989) that when court error is possible, if plaintiffs' costs are low (or if the gains from suit are sufficiently high), then potential defendants will choose to disobey the law, as they will be sued irrespective of whether they obey the law.

[24] While concerns about crowd-out are frequently cited as a reason for reducing NPE litigation, to our knowledge, the observation that patent reform could in principle reduce infringement is novel to the present work.

[25] There is not much evidence on the degree to which NPE proceeds are passed back to end inventors, but all available estimates suggest that the pass-through is small (see Bessen et al. (2011); Bessen and Meurer (2014)).

[26] Although in practice, the NPE lawsuits that do reach court decisions appear to be lower-quality, on average, than the PE lawsuits that reach court decisions (see Allison et al. (2017)).

we review the evidence on pass-through of NPE proceeds to end inventors, and assess the extent to which NPE litigation appears to have increased small inventor innovation.

3 Data

We obtain information on NPEs from RPX Corporation, a company that tabulates information on NPE behavior, including data on patent litigation.[27] RPX Corporation has collected data going back to 1977, capturing from Public Access to Court Electronic Records (PACER) every lawsuit filed by more than 4000 NPEs (approximately 850 parent companies, and 3300 affiliates); the data is thus systematic, and not based on self-reporting.[28,29] We replicate all of our analysis—and find nearly identical results in magnitude and significance—using the hand-coded, publicly available NPE activity data collected by Cotropia et al. (2014) for the years 2010 and 2012 (see Section 4.9.1 and Appendix Table A4).

Demand letters and other informal patent assertions by NPEs do occur. Informal patent assertions are unreported by nature, so there is unfortunately no comprehensive dataset of these actions. However, it is widely believed that informal patent assertions have been in decline recently, and are projected to decline further. The two biggest factors driving this decline are the decreasing credibility of patent assertions (given the availability of the formal legal channel),[30] and the rise of legislation (both state and federal) to hold entities liable for unsubstantiated demand letters.[31] Furthermore, as many more NPEs are now suing (see Table I, Panel B), non-legally binding letters simply alleging infringement (and asking for money) are becoming less credible signals. The equilibrium result is that the economically

[27]RPX Corporation defines an NPE as "A firm that derives the majority of its revenue from licensing and enforcement of patents." Under this definition, traditional legal entities established to license and enforce patents comprise the majority of NPEs. Additionally, individual inventors may be counted, while universities will not be counted (unless they have patent enforcement subsidiaries).

[28]Chien (2013b) compared a subsample of about 1000 of RPX's codings to her own hand-codings, finding no more than 7% disagreement.

[29]RPX Corporation cleans its raw filing data (for instance, removing some "administrative duplicates" representing the same case, but transferred across districts).

[30]One company executive relayed to us his reply to NPEs that send demand letters: "If you have a truly viable case you will sue; otherwise don't waste my time with this letter(!)."

[31]See, e.g., the Executive Office of the President (2013) report on "Patent Assertion and U.S. Innovation."

large alleged IP infringements appear to be addressed through lawsuits (all of which are in our data), and this is becoming increasingly true over time. We thus feel that RPX Corporation's systematic and exhaustive collection of NPE lawsuit data likely captures the economically important (and increasingly dominant) component of NPE behavior, even though it does not fully capture patent assertions not backed by litigation (see also Feldman and Lemley (2015) for supporting survey evidence). In Table I (Panel A), we present summary statistics on the firms included in our analysis.[32]

According to RPX Corporation, roughly 69% of NPEs' patents were acquired externally (purchased) by NPEs and their subsidiaries, whereas 19% were originally assigned to NPEs.[33] Panel B of Table I shows the time-series of NPE litigation data through our sample period, 2005–2015. The data clearly indicate that there has been a sharp rise in NPE lawsuits over the past decade.

In total, the data provide detailed information on 21300 litigation actions by NPEs (i.e., where an NPE is the plaintiff) and 19621 litigation actions by PEs. RPX's definition of an NPE includes the following organizational forms: (1) *patent asserters*, entities that earn revenue predominantly through asserting patents, (2) *small inventors*, (3) *non-competing entities (NCEs)*, operating companies asserting patents outside their areas of products or services, and (4) *universities (and research institutions)*. In our study, we exclude NCEs and universities, which make up less than 3% of the sample. In the last column of Panel B of Table I, as a further data check, we compare RPX's data on NPEs to that of another frequently used independent data provider, Lex Machina. A comparison of cases in the RPX and Lex Machina datasets indicates that there is little difference between the two data sources, with the correlation between RPX and Lex Machina annual data series in the final two columns of Panel B of Table I being 99.95%.

We focus on the cases in which the defendant firm is publicly traded, as for these defendants we can obtain rich, detailed characteristic data for which reporting is required by the Securities

[32]Appendix Table A1 presents detailed descriptions of the specific data fields used in our study.
[33]The remaining 12% are a blend of originally assigned and acquired patents.

and Exchange Commission (SEC). In Figure 1, we graph the number of NPE and PE case dockets in which the at least one of the defendants is a public firm. By 2015, 11.25% of all publicly traded firms were sued by an NPE. This rise in IP litigation is also depicted in Figure 1, which first shows the total rise in patent litigation over our sample period, and then separates the rise into the cases brought by NPEs and the cases brought by PEs. From Figure 1, it is apparent that the rise in overall IP litigation is entirely driven by NPE lawsuits. PEs' patent litigation has remained constant over the sample period. We revisit and examine more systematically the differences between NPEs' and PEs' patent litigation behaviors in Section 4.2.

We obtain firm-level patent information from the database used by Kogan et al. (2012).[34] This database contains utility patents issued by the USPTO between January 1, 1926 and November 2, 2010, along with citation data on those patents.[35] We obtain information on the in-house legal counsels and law firm associations of public firms from ALM Legal Intelligence, which searches public records to find outside counsel used by companies for corporate, contract, labor, tort, and IP litigation.

To identify involvement in litigation events not related to IP, we use the Audit Analytics Litigation database, which covers the period from 2005 to 2013 and reports information on litigation for Russell 1000 firms from legal disclosures filed with the SEC. Audit Analytics collects details related to specific litigation, including the original dates of filing and locations of litigation; information on plaintiffs, defendants, and judges; and, if available, the original claim amounts and the settlement amounts.

To create our final data set, we merge firm level litigation and patent information with firm level stock return and financial statement data. We use stock return data from the

[34]We thank Leonid Kogan, Amit Seru, Noah Stoffman, and Dimitris Papanikolaou for providing both patent and citation data.

[35]The USPTO defines *utility patents* as patents issued for the invention of new and useful processes, machines, manufactures, or compositions of matter, or new and useful improvements thereof. A utility patent generally permits its owner to exclude others from making, using, or selling the patented invention for a period of up to twenty years from the date of patent application filing. Approximately 90% of the patent documents issued by the USPTO in recent years have been utility patents.

Center for Research in Security Prices (CRSP) database. For each firm, we calculate its monthly market value of equity (MVE) as the product of its shares outstanding multiplied by the firm's common stock price at the end of month t. For each stock–month (i, t), we also calculate the firm's past twelve-month stock returns $(i, t, t-11)$. We drop observations if a stock does not have price, return, or shares outstanding information or if the stock does not have more than two month observations in a year.

We obtain firm firm-level accounting measures (total assets, components of book value of equity, R&D expense, cash level) from the Compustat database maintained by S&P Global. Specifically, we download all annual financial statements from the CRSP-Compustat Merged Annual Database whose fiscal years ended between 2002 and 2014, and whose total assets were not missing or 0. We calculate each firm's book value of equity following Fama and French (1993); we measure book equity as stockholder equity plus balance sheet deferred taxes (Compustat annual item TXDB if available) and investment tax credit (item ITCB if available) minus the book value of preferred stock. Depending on data availability, we use redemption (item PSTKRV), liquidation (item PSTKL), or par value (item PSTK), to represent the book value of preferred stock. The explanatory variables are defined using the financial statements with fiscal year ending one year prior to litigation filing year. Our main variable of interest, *CashLevel*, is the amount of cash held by the firm as reported in its audited annual financial statement. We add 1 and then apply log transformations to all variables, except the dummy variable *CashShock*, which is set equal to 1 if a firm's change in cash in the prior fiscal year is among the top 5% of cash changes in the firm's industry cross-section in that year. Additionally, we construct our main dependent variable—*SuedByNPE* (*SuedByPE*)—as equal to 1 if a given publicly traded firm was litigated by an NPE (PE) in a particular year, and 0 otherwise. For matching litigation files to Compustat GVKEY identifiers, we use a CapitalIQ-Compustat GVKEY concordance file provided by CapitalIQ-Compustat. The final data set contains 50,965 firm-year observations and spans the years 2005 and 2015.

4 Results

4.1 Cash-Targeting

We begin by examining the determinants of NPE litigation behavior. As a start, we parameterize a central concern of opponents to NPEs; namely, that NPEs bring nuisance suits, and that their prime driver is the ability of targeted firms to pay large damages or royalties. We use both levels of cash balances on the balance sheet (*CashLevel*) and changes in cash holdings (*CashShock*) as proxies for the potential proceeds of a suit. We include several firm- and time-level control variables, such as the firm's market value, book-to-market ratio,[36] the prior year's stock market performance, and the number of recent patents issued to the firm, $R\&D$, along with time and firm fixed effects. In Table II, we report OLS regression results of the following specification:

$$SuedByNPE = f(CashLevel, TotalAssets, MVE, BM, R\&D, PastReturn, PatentStock, CashShock).$$

The outcome variable, *SuedByNPE*, is a dummy equal to 1 if the firm was litigated by an NPE in a particular year. *CashLevel* is the total amount of cash reported on the balance sheet as of the beginning of the previous fiscal year. *CashShock* is a dummy variable equal to 1 if the change in cash in the past current fiscal year, compared to the previous fiscal year's cash level, is among the top 95% of cash changes in the firm's industry cross-section. We include industry or firm fixed effects to capture unobserved industry- or firm-level time-invariant factors that are correlated with NPE targeting. Likewise, we include time fixed effects to control for variation in litigation activity specific to a given year and for any time trends in litigation propensity. We report various specifications to show the incremental value of each covariate on overall model fit. Column 4 of Table II represents our preferred specification, which includes firm-level characteristics (market value, book-to-market ratio, asset size, research and development expense, prior stock performance of equity), time and firm fixed effects,

[36] We use Tobin's Q to proxy for investment opportunities.

and our cash variables. We use a log transformation of all variables to minimize the effect of outliers.[37] We cluster our standard errors at the firm level in order to broadly allow for any time-series dependency in the probability of being sued over the course of the sample period.

Table II uncovers a strong and consistent pattern: Firms with larger cash balances and firms with positive shocks to their cash holdings are more likely to be targeted by NPEs. Controlling for other determinants and for firm and time fixed effects, the *CashLevel* coefficient in Column 4, is 0.0565 ($t = 4.25$), is large and significant, as is the *CashShock* coefficient, 0.0167 ($t = 2.06$). To get an idea of the magnitudes, we use the coefficient estimates in the full specification in Column 4. With the average firm-level cash holding of $579 million, the 0.0565 coefficient on *CashLevel* implies that a one standard-deviation increase in cash balance increases the chances of being sued by 7.40%. Given that the unconditional probability of being sued for patent infringement is approximately 8.60%, this is nearly a twofold higher probability of being targeted (16.00% vs. 8.60%). An alternate way to view the economic magnitude is looking at the interquartile change. From Table I, this implies an over 14 percentage point increase in the probability of being sued by an NPE—again an economically large magnitude.

In sum, Table II reveals the strong impact of cash on NPEs' targeting decisions. In particular, in Column 4, both of these effects are estimated including firm and time fixed effects, along with fine controls for firm size, past returns, R&D spending, and patent portfolio size. Thus, the large coefficients can be interpreted as showing that a firm is likely to be targeted by NPEs when it has an abnormally high cash level (or a shock to that cash level) relative to all other firms' cash levels (and shocks).

We have run a number of robustness checks exploring the relationship between cash and NPE litigation. First, in Panel B of Table VIII, we consider specifications identical to those of Table II, but using logit and probit estimation as opposed to OLS. The coefficients on cash

[37]Neither the magnitudes nor the significance levels of our coefficients change appreciably when we do not use the log transformation. We show this in Table 8, showing an identical specification with all unlogged variables.

remain large and significant, with the implied magnitudes even slightly larger in point estimate. Furthermore, we replace the dummy dependent variable *SuedByNPE* with its continuous counterpart *TimesSued*, measuring the number of times a given firm is sued by NPEs in any given year. We estimate the model in OLS (and Tobit) in the table, and find that *CashLevel* remains a large and significant predictor of the intensity with which firms are sued by NPEs. Next, in Appendix Table A3, we test for any impact of multicollinearity on the estimates. From Appendix Table A3, multicollinearity does not appear to be an issue with regard to the magnitude or significance of the estimated impact of cash on NPE suits. In particular, the coefficients on *CashLevel* and *CashShock* remain large, significant, and—importantly—stable irrespective of the addition or deletion of any given control variable. Additionally, we estimate specifications with industry (as opposed to firm) fixed effects, finding nearly identical magnitude estimates and significance on the *CashLevel* and *CashShock* coefficients (Appendix Table A3 Panel B). Lastly, in our main tests, we impute zero if an R&D expense is not explicitly reported in the income statement. Results reported in Panel C of Appendix Table A3 show that excluding R&D expense from the specification or including a dummy variable for observations with missing R&D values does not affect our results.

4.2 Patent Litigation Behavior of Practicing Entities (PEs) & Litigation Behavior against Firms more Generally

A reasonable response to the results in Table II is to expect that cash-targeting should be the behavior of *any* profit-maximizing litigant. It makes little sense to sue a firm—incurring potentially sizable legal costs, along with the opportunity costs of foregone suits—if the target firm has no *ex ante* ability to pay. To examine this more formally, we compare the determinants of NPE IP litigation to those of PE IP litigation, and to the determinants of litigation activity more broadly. Generally, we find that NPEs are unique in the extent to which cash is a first-order determinant of targeting in litigation.

4.2.1 Patent Lawsuits Brought by PEs

NPEs do not have a monopoly on Intellectual Property litigation. PEs like Apple, General Electric, and Intel also sue each other for patent infringement. If our results were simply picking up general characteristics of IP litigation, then we might expect to see PEs behaving in much the same way as NPEs. In order to compare PE and NPE behavior, we collect the time series of patent infringement cases brought by PEs, and compare their determinants to those brought by NPEs over our time period. From Figure 1, the rise in IP litigation is driven by NPE litigation. While NPEs have an exponential-type rise in IP litigation over the sample period, PEs' IP litigation has remained essentially constant. Thus, in an aggregate time-series sense, we do see a difference between the litigation behavior of the two groups.

However, turning to a more formal analysis of the determinants of PE lawsuits, we use an identical set-up to that used for NPEs in Section 4.1. We replicate the specifications used in Table II, but this time we use *SuedByPE* as the dependent variable.[38] The results of this analysis are in Column 1 of Table III. We see that PEs behave very differently from NPEs. Nearly all of the predictors of NPE litigation behavior have a small and insignificant impact on PE litigation behavior. Moreover, the impact of cash goes mildly in the *opposite* direction (in point estimate).

Of course PEs likely have motivations for IP litigation beyond those of NPEs (e.g., competitive responses, defensive tactics, retaliative litigation). However, this comparison does suggest that the results on NPE litigation behavior do not simply reflect general characteristics of IP litigation over time or within the cross-section. Rather, they are consistent with agent-specific motivations for NPEs in targeting firms flush with cash.[39]

[38] *SuedByPE* is a dummy variable equal to 1 if a firm faces IP lawsuits from PEs in a given year.

[39] The *eBay Inc. v. MercExchange, L.L.C.* supreme court case made it more difficult for NPEs to seek injunctive relief in patent lawsuits, while leaving PEs' injunctive relief options effectively unchanged. At least in theory, this could somehow contribute to the difference between PEs' and NPEs' targeting behaviors. (That said, given that NPEs do not produce commercial products—and thus are not in product-market competition with their targets—it is unclear why NPEs would value injunctive relief other than for its ability to pressure cash settlement.) We have re-done our analysis for the pre- and post-*eBay* samples, and find similar results in both, so it seems unlikely that the *eBay*-induced changes in injunctive relief opportunities are driving our findings.

4.2.2 Other Litigation Behavior

We next move on to a more general setting, considering *all* lawsuits filed against publicly traded firms. If the cash-targeting in NPE IP litigation is a general feature of litigation—as we might think—then cash-targeting should show up in other litigation categories. From Audit Analytics, we collected the entire slate of material legal actions taken against publicly traded firms. Audit Analytics covers the 2005–2013 period and reports information on litigation against Russell 1000 firms, recording legal disclosures filed with the SEC.[40]

We run specifications identical to those of Table II, for all other litigation categories. The results are shown in Table III. From Column 2 to 5 of Table III, we see that large amounts of cash are not positively related to non-IP litigation actions (tort, contract, securities, environment, and labor).

So what drives non-IP litigation? The results suggest that the main determinant of non-IP cases is the infraction itself (e.g., polluting a local waterway in the case of an environmental suit). Importantly, these other cases often have more concrete and provable actions taken by the defendant, as opposed to IP infringement, in which the property right is itself more amorphously defined (and so infringement is more subjectively determined). This extra scope given in IP cases makes IP a potentially good candidate for opportunistic, purely profit-driven legal activity.

The sum of the evidence in Tables II and III shows that NPE IP litigation is unique in its cash-targeting nature, in comparison to other forms of litigation, and even within the fine space of IP litigation. In the following sections we explore more closely the behavior of NPEs, and examine whether NPE behavior appears to be—on average—opportunistic legal action.

[40] Audit Analytics collects details related to specific litigation, including the original dates of filing and locations of litigation; information on plaintiffs, defendants, and judges; and, if available, the original claim and final settlement amounts.

4.3 Targeting Unrelated Profits

In this section we examine whether NPEs go after profits *unrelated* to alleged infringement. Using finely reported business segment-level disclosures, we are able to extract and separate profits in the business segments related to the alleged infringement from those profits in unrelated segments.

As of 1976, all firms are required by Statement of Financial Accounting Standards (SFAS) 14 (Financial reporting for segments of a business enterprise, 1976) and SFAS 131 (Reporting desegregated information about a business enterprise, 1998) to report financial information for any industry segment that accounts for more than 10% of total annual sales. Using these segment-level filings, we extract information on industry classification, sales, and cost of goods sold for each segment of each conglomerate between 2005 and 2015. We then use the concordance between international patent classification (IPC) codes and four-digit United States Standard Industrial Classifications (SIC) to identify the conglomerates' segments associated with the NPE-litigated patents.[41]

After identifying segments related to allegedly infringed patents, we split each NPE-targeted firm's segments into *related segments* and *unrelated segments*. A firm's related segments are those segments that could potentially use the litigated patent in regular operations; its unrelated segments are those that could not. We compute each segment group's gross profits by subtracting cost of goods sold from segment group sales.[42]

We note that not all conglomerates report segment-level information in the same format. For example, a conglomerate may report information on one segment only, or it may report cost of goods sold for only one of the segments in which it operates. Therefore, our final sample contains only conglomerates for which we have both cost and revenue data on at least

[41] The concordance file we use was developed by Silverman (2003) and later improved by Kerr (2008). This concordance has been used in several other studies, including those of McGahan and Silverman (2001) and Mowery and Ziedonis (2001).

[42] While we would ideally prefer to measure cash at the segment level in order to make our segment-level analysis completely analogous to the tests in Tables II and III, segment-level cash variables are not reported. Thus, we use profitability (revenues net of costs) at the segment level to proxy for profitability of suit.

one related segment and one unrelated segment.

We estimate a model to test whether the probability of being sued by an NPE is correlated with profits obtained from *unrelated* segments, even after controlling for the profitability of related segments. In this model, we include conglomerate fixed effects to control for conglomerate-level unobserved litigation probability. We also control for industry-wide shocks to profitability, by including a variable measuring the average profitability of the segment's industry.

The results of our segment-level analysis are shown in Table IV. Column 1 of Table IV shows the basic model, while Column 2 includes conglomerate fixed effects. Both columns tell the same story. Consistent with the results in Table II, *RelatedSegmentProfitability* is a large and significant predictor of NPE targeting. But so is *UnrelatedSegmentProfitability*. In other words, NPEs seem not to care where their proceeds come from; an NPE's probability of suing a firm increases with the firm's profits even if those profits are derived from segments unrelated to the patent under litigation. In Column 2 of Table IV, we see that the coefficient on *UnrelatedSegmentProfitability*, 0.0265 ($t = 1.99$), implies that, controlling for the profitability of a segment related to the patent allegedly being infringed, a one standard-deviation increase in a completely unrelated segment's profitability increases the chance of being sued by 0.58% (relative to a mean of 3.18%). This compares to an increase in probability of 0.71% for the same size increase in a related segment's profitability ($t = 2.18$). In contrast, when we run the analogue of Column 1 and 2 for PE firms, we see that *UnrelatedSegmentProfitability* is not related to PE litigation activity.

In sum, the results in Table IV provide additional, finely measured evidence that NPEs behave opportunistically by targeting cash indiscriminately—NPEs target related cash and unrelated cash at essentially the same rate.

4.4 Which NPEs are Driving Cash-Targeting? Patent Assertion Entities vs. Small Inventors

NPEs take many organizational forms. We next explore whether the cash-targeting behavior seen in Tables II and IV varies by NPE type. As mentioned in Section 3, we exclude universities and NCEs from the sample. This leaves essentially two main categories of patent asserters in our data: *patent assertion entities (PAEs)* and *small inventors*. In our sample, 87.98% of the 21,300 cases have a patent assertion entity as a plaintiff, while small inventors bring 9.63% of cases.[43] Detailed information on plaintiff types, as well as comparison to other samples, is provided in Appendix Table A4.

In Table V, we decompose the results shown in Table II by NPE type. In Column 1 of Table V, the regressand takes a value of 1 if the firm is sued by a patent assertion entity (PAE). In Column 2, we reestimate the same specification with the regressand defined as 1 when a firm is sued by a small inventor.

From Table V, we see that the entire cash-targeting effect is driven by patent assertion entities. Columns 1 of Table V show that in cases where a patent assertion entity is involved, *CashLevel* and *CashShock* are large and significant predictors of litigation action. In contrast, in cases involving small innovators, neither *CashLevel* nor *CashShock* are significant predictors of targeting, and both have coefficients that are close to 0. Consequently, we see that patent assertion entities are responsible for nearly the entire magnitude of the coefficients on both cash variables shown in Table II.[44]

[43]The remaining 2.38% of cases are not included in the analysis presented in this section, as those cases could not be clearly assigned to either group.

[44]We might worry about selection here—in principle, those lawsuits brought by small inventors could be precisely the lawsuits that NPEs are unwilling to take *because* they are unlikely to yield large cash payoffs. However, if anything, given the significant costs and difficulties small inventors face when bringing lawsuits on their own (Ball and Kesan (2009); Haber and Werfel (2016)), it seems more likely that selection effects (if any) would go in the opposite direction: All else equal, the lawsuits small inventors bring directly would be the ones of higher direct return to the invetors; this matches up with what our model suggests (see Section 2). In any event, we have confirmed empirically that the characteristics of firms targeted by PAEs are similar to those of firms targeted by small inventors.

4.5 Comparing the Types of Patents Asserted by NPEs and PEs

Allison et al. (2017) compared the NPE and PE lawsuits that reach decisions, finding that NPEs are significantly more likely than PEs to have their patents invalidated

- through summary judgment,
- based on prior art, and
- for inadequate disclosure.[45]

Unfortunately, we cannot directly assess the validity of the full universe of patents that NPEs (or PEs) assert, as validity determinations are not made for cases that are settled prior to judgment.[46] However, we can follow Allison et al. (2017) in looking for systematic differences between the patents NPEs and PEs assert, and attempting to understand how those differences relate to patent quality.[47]

There are many ways to parametrize patent similarity; we use a number of different metrics and measures of patent quality in comparing the patents asserted by NPEs to those asserted by PEs. First, following Love (2014), we examine whether NPEs disproportionately assert patents just before those patents' expiration dates. We show the breakdown of patent age between NPEs and PEs in Table VI. From this table, we first see that NPE-asserted patents are significantly older than PE-asserted patents. From the first row of Table VI, we see that NPEs assert patents that are 25% older than those PEs assert ($t = 20.91$); since proximity to patent expiration should be orthogonal to patent quality, we take this as indicating a quality difference between NPE and PE patent assertions.[48]

[45] More generally, NPEs lose in court significantly more often than PEs do; however, all these results vary significantly by technology, industry, court, and NPE entity type (see Allison et al. (2017)).

[46] Risch (2015) followed the ten most-litigious NPEs over time, finding that many of their patents were *never* tested on their merits.

[47] A number of other scholars have attempted to assess the quality of NPEs' patents. An early literature (e.g., Shrestha (2010); Fischer and Henkel (2012); Risch (2012)) based on small and selected samples suggested that NPEs' patents are equal in quality to PEs' (or even higher-quality). More recent, large-sample evidence suggests, by contrast, that NPEs in fact hold and assert seemingly low-quality patents (see, e.g., Miller (2013); Love (2014); Feng and Jaravel (2015)).

[48] Plaintiffs might choose to litigate older patents rather than newer ones, as damages may be higher (or

NPEs not only appear to be asserting patents closer to expiration than PEs, but relative to PEs, NPEs are much more likely to sue many times on any given asserted patent. In the second row of Table VI, for instance, we see that NPEs litigate each patent they assert 4.5 times as frequently as PEs do (13.02 times for NPEs vs. 2.84 times for PEs ($t = 59.76$)).

Using a recently assembled dataset which contains information on the number of issued, pending, abandoned patents by NBER technology group for each month (Marco et al. (2015)), we see that patents asserted in NPE cases are more likely to be issued at times when the USPTO issues more patents compared to total pending and abandoned applications ($t = 13.74$)—that is, at times when the USPTO is especially busy. Furthermore, and consistent with NPEs asserting broad patents, we also find that patents asserted by NPEs have a significantly higher number of associated technology classes.[49]

When we compare the linguistic content of the claims in patents asserted by NPEs and PEs, we find striking differences. Consistent with the previous finding that NPE patents are broader than PE patents, evidence suggests NPE patents contain significantly more independent claims than PE patents do (4.86 vs. 3.80 ($t = 21.11$)) and more dependent claims (29.98 vs. 21.19 ($t = 22.92$)). Moreover, the descriptions of patents asserted by NPEs contain more words, both in dependent and independent claims, than are found in patents asserted by PEs. For instance, an average patent asserted by NPEs contains 802 words in its independent claims, whereas an average patent asserted by PE contains 531 words (with the difference of 271 words highly significant ($t = 26.54$). The same holds true for lengthier-worded dependent claims, with a difference of 361 words ($t = 26.54$)—802 for NPEs vs. 531 for PEs.

Collectively, our results suggest NPEs assert patents that are significantly different from those of PEs. In particular, NPEs assert patents that are broader in scope and wordier. In addition, they assert these broader patents significantly more aggressively, and closer to the

more targets may be available) once there has been more time for ongoing infringement, or for technology to build upon the patented invention. However, if this were the only driving effect, then we would not see any difference between the ages of patent asserted by NPEs and PEs.

[49]Patents asserted by NPEs (resp. PEs) on average have 5.86 (resp. 4.83) associated technology classes ($t = 21.50$).

expiration of patent rights.

4.6 Geography of NPE Litigation

Even if NPEs target lawsuits opportunistically, this need not show up in outcomes, as courts remain the ultimate arbiters of patent infringement. Thus, for NPEs to target cash successfully, they would—at minimum—need a credible threat of having courts rule in their favor sufficiently often.

Figure 2 shows the geography of NPE patent litigation in the United States. Unsurprisingly, some well-known innovation hubs (e.g., Silicon Valley) have large amounts of NPE IP litigation. However, validating common anecdotal accounts, we see that the preponderance of NPE patent litigation (43% of *all* cases) takes place in the Eastern District of Texas (Marshall, TX). Eastern Texas is not a major innovation center; rather, its courts are favored by NPEs because they are perceived to be plaintiff-friendly (both anecdotally and because of specific rules regarding judgment (Leychkis (2007))).

The practice of "forum shopping" (i.e., "choosing the most favorable jurisdiction or court in which a claim might be heard" (Garner and Black (2004))) is not unique to IP litigation. However, again, even within the space of IP litigation, we see that NPEs seem to "forum shop" a uniquely large amount. NPE cases and PE cases have very different geographic patterns. As noted above, NPEs litigate 43% of their cases in the Eastern District of Texas, while only 7% of PE cases are litigated there. When we run a Wilcoxon test comparing the geographic distributions of NPE and PE litigation, we see a significant difference between the two ($z = 3.91$, $p < 0.001$).[50]

4.7 Probability of Paying

In this section, we test whether proxies for firm's readiness (and ability) to stave off NPE litigation impact firms' probabilities of being targeted. We create two measures: one measure

[50] Our findings here are corroborated by empirical evidence assembled by Allison et al. (2017).

counting the number of lawyers firms have at their disposal, and the second counting how busy firms are with non-IP litigation actions.

The idea of the first measure—number of lawyers—is that large legal teams may serve to deter NPEs because they could to prolong the court (or settlement) process. The second measure—how busy the firm is with outside litigation—is meant capture the within-firm resource constraint on time and costs spent battling litigation. We expect that if NPEs opportunistically target firms that are unlikely to be able to defend themselves, then (1) having many lawyers should deter suits (so there should be a negative coefficient on the number of lawyers), and (2) being involved in extraneous, non-IP cases should draw more suits (so the associated coefficient should be positive).

In order to measure firms' legal teams, we extract data from the ALM Legal Intelligence Database. We obtain a list of all law firms and their clients from ALM Legal Intelligence between 2005 and 2012. Then, we follow the procedure outlined in Appendix Table 2 to define a dummy variable *IPLegalTeamSize* which takes a value of 1 if the firm employs more IP focused law firms than a comparable firm with similar characteristics. Our second measure, *OngoingCases*, measures the existence and number of reported, ongoing non-IP-related litigation actions. From Table VII, we see that controlling for all other characteristics, NPEs are less likely to sue a firm with more legal representation. The coefficient on *IPLegalTeamSize* in Column 1 implies that a one standard deviation increase in IP legal team size decreases the likelihood of suit by 7.2% ($t = 2.13$). NPEs are also more likely to target firms that are busy with ongoing, non-IP litigation. The Column 2 coefficient on *OngoingCases* of 0.0171 ($t = 2.38$) implies that firms that are occupied with large number of non-IP litigation cases are 19% more likely to be targeted by NPEs.

The empirical specification considered in this section also provides evidence against a precautionary savings interpretation of the cash-targeting results shown in Table II. If precautionary savings were driving the relationship seen in Table II, then we would expect the coefficient on *LegalTeamSize* to be positive—firms saving cash to stave off infringement litiga-

tion should also be growing their legal teams(!). (At the very least, under the precautionary savings hypothesis, we would not expect the negative and significant relationship observed in the data.) To believe the precautionary savings hypothesis, we would need to believe that firms are raising cash to preempt litigation at the same time as they are actively *decreasing* their legal representation; this seems unlikely. Instead, the findings as a whole appear more consistent with NPEs acting opportunistically—targeting cash-rich firms that are more likely to settle, either because they have recently reduced their legal teams or because they are embroiled in outside litigation.

4.8 Sum of Evidence

In summary, our empirical evidence shows that:

1. NPEs specifically target litigation against firms that are flush with cash.
2. Cash-targeting appears to be unique to NPE IP litigation.
    - Cash is neither a significant positive predictor of PE IP lawsuit targeting, nor of non-IP lawsuit targeting (rather, these other classes of lawsuits appear to have most of the R^2 driven by infractions themselves).
    - More generally, NPE behavior is different from PE behavior even conditioning on the same type of infraction (alleged IP infringement).
3. NPEs target cash unrelated to the alleged infringement with essentially the same frequency that they target cash related to the alleged infringement.
4. The cash-targeting behavior we observe is driven by large aggregator NPEs, and is not the behavior of small innovators.
5. The patents NPEs assert are seemingly different in quality from those asserted by PEs (in particular, on average NPEs assert patents that broader and closer to expiry). Moreover, NPEs assert patents more aggressively than PEs do.

6. NPEs appear to forum shop, trying the preponderance of their cases in a single district in Texas.

7. NPEs target firms that may have reduced ability to defend themselves against litigation.

While none of our results alone proves opportunistic legal behavior (patent trolling) on the part of NPEs, the mass of the evidence to this point appears most consistent with NPEs behaving as patent trolls.

In line with our evidence, there have been increasingly frequent high-profile anecdotal accounts of trolling by NPEs (nearly always litigated in Marshall, Texas). For instance, Lumen View Technology LLC sued numerous online dating companies for alleged infringement on a patent on computerized matchmaking that United States District Judge Denise Cote later pronounced to be obviously invalid. "There is no inventive idea here," Judge Cote declared, pointing out that "matchmaking" is literally ancient (Mullin (2013)). Meanwhile, MPHJ Technology Investments sued over sixteen thousand small businesses (along with a number of branches of the United States Government) alleging infringement on a patent covering "scan-to-email" functionality. Many of MPHJ's cases were not only dismissed, but prompted countersuits for deceptive practices (Mullin (2014)).

We conduct several robustness checks on our analysis in Section 4.9, and then assess the impact of NPEs on real outcomes in Section 5. We tie back to the theory and discuss welfare implications in Section 6.

4.9 Robustness Tests

In this section, we provide a number of robustness tests, including an out-of-sample test and a number of additional specifications.

4.9.1 Out-of-Sample Test

As mentioned in Section 3, the analyses discussed in the text use data from RPX Corporation, a company that tabulates information on NPE behavior. While the data is all sourced from public documents (namely the USPTO and public court records), RPX retains the dataset itself as proprietary. Cotropia et al. (2014) recently hand-coded and classified NPE IP litigation events for a two-year sample (2010 and 2012), and made this data publicly available at `www.npedata.com`.

We have re-run all of our analyses on the Cotropia et al. (2014) data; the results of this out-of-sample test are shown in Appendix Table A4. We find the same results using the Cotropia et al. (2014) data as with the RPX data: cash is a large and significant predictor of NPE targeting, and this behavior is driven by PAEs.[51]

4.9.2 Thicket Industries and Additional Specifications

Patent thickets are dense, overlapping webs of patents that make it difficult to commercialize because products may overlap with large numbers of patented technologies. Certain industries are known to be more prone to patent thickets, and those industries themselves have been linked to strategic patenting behavior (Bessen and Meurer (2013)). We test whether the cash-targeting behavior of NPEs differs between thicket- and non-thicket industries.[52] Columns 1-2 of Table VIII, Panel A show the results.

Column 3 runs the same analysis excluding IT firms (SIC Code 35 (e.g., Apple and IBM) and SIC Code 73 (e.g., Yahoo! and Ebay)); again, cash a strong determinant of targeting, nearly identical in magnitude and significance. Column 4 uses a cash measure that incorporates

[51] The estimated magnitudes on cash are actually a bit larger in the Cotropia et al. (2014) sub-sample (given the larger standard deviation of cash in later 2010-2012 period), with the coefficient on large aggregators being roughly triple the size of small innovators, and statistically significantly larger. We also calculate the overlap rate between the RPX and Cotropia et al. (2014) samples for the two years available (2010 and 2012) and find a roughly 90% overlap.

[52] We define thicket industries as those having two-digit SIC codes of 35, 36, 38 and 73, following Bessen and Meurer (2014). These industries encompass software, semiconductors, and electronics, and include firms such as Apple, Google, and Intel.

marketable securities of the firm. The economic magnitude implied by the coefficient of *CashLevel* in this specification is similar to our baseline specification. Column 5 allows additional non-linearities in cash (cash level squared and cubed); neither loads significantly, and allowing non-linearity does not appear to have a impact on the estimated magnitude or significance of the *CashLevel* and *CashShock* coefficients. In this specification, we also include a new variable (*FinancialConstraints*) that measures how financially constrained firms are, and find that it is not a statistically significant predictor of NPE targeting.[53] Finally, in Column 6 we repeat the same specification used in Column 5 using unlogged values of *Cash* and all control variables. This specification affirms *CashLevel* and *CashShock* as large and significant determinants of targeting, showing their robust relation across functional form assumptions.

Panel B of Table VIII shows a number of additional specifications. First, throughout the paper we have used whether or not a firm is sued by an NPE in a given year (*SuedByNPE*). However, a number of firms are sued multiple times by different (or even the same) NPEs within a single year. In Table VIII, Panel B we replace the dependent variable with the the number of times a firm is sued by an NPE in a given year. We find similar results to those presented in Table II: *CashLevel* and *CashShock* are large and significant predictors of the number of times a firm is sued in a given year (both in OLS and Tobit specifications). For instance, Column 1 of Table VIII, Panel B shows a coefficient on *CashLevel* of 0.4439 ($t = 2.71$), implying that a one standard-deviation increase in cash doubles the number of times a firm is targeted by NPEs. Additionally, Columns 3 and 4 of Table VIII, Panel B show the base categorical variable specification of the dependent variable (*SuedByNPE*), but in Probit and Logit regression estimations. Again cash remains a large and significant predictor of NPE targeting behavior.

[53]Here, we use the Hadlock and Pierce (2010) financial constraints index of firms' constraints on accessing the external funds.

5 Impact of NPE Litigation on Real Outcomes

Up to this point, we have examined which firms NPEs target, and when. We now examine the real impacts of NPE litigation on the firms being targeted. Of course the difficulty in obtaining any causal estimates here is that we have a clear selection problem (that is, it might be the case that the firms that NPEs target experience some outcome not because of NPE litigation, but because they share some common unobservable characteristic). We attempt to alleviate selection concerns somewhat by conditioning on being targeted—we compare two groups of firms, both selected to be sued by NPEs. Specifically, we compare all firms targeted by NPEs, separating targeted firms specifically according to whether (1) they were forced to pay out to NPEs (they either lost in court or settled) or (2) the cases against them were dismissed (including when the court ruled against the NPE).[54,55,56]

We test whether losing to an NPE and having an NPE lawsuit dismissed lead in different directions in terms of future R&D productivity. Specifically, we focus on how R&D expenditures on projects differ (pre- and post-litigation) among the two classes of targeted firms.

Table IX reports the difference-in-differences results. From Panel A of Table IX, we see that losing to an NPE has a large and negative impact on future R&D activities—again, even conditioning on being selected for litigation. We compare average annual R&D expense two years following the litigation to average annual R&D expense two years before the litigation. To get an idea of the effect magnitude, the results shown in Panel A imply that firms that lose to a large aggregator NPE (Settled + Won by NPE) invest significantly less in R&D in the years following the loss ($163 million less, $t = 7.18$) relative to firms that were also

[54]We find analogous results if we exclude Settlements from the analysis.

[55]Following Allison et al. (2010), we exclude case outcomes such as "stay," "transfer," and "procedural disposition."

[56]Some firms settle for *de minimus* amounts (e.g., for tax purposes), so our Settled + Won by NPE category may include some targeted firms that did not really lose much money to NPEs in practice. However, including too many firms in the Settled + Won by NPE category would bias against our result, leading us to *underestimate* the costs of losing to NPEs. Similarly, our Dismissed + Lost by NPE category may include some firms that make confidential settlements, but this would again bias against our findings.

targeted by NPEs but won (Dismissed + Lost by NPE).

Panel A also shows that we see no such patterns for PE vs. PE cases—unlike firms that lose to NPEs, firms that lose to PEs show no reduction in R&D investment.[57] Panel B of Table IX runs parallel trends analysis, showing that the firms in our comparison groups had similarly-moving R&D expenditures prior to the NPE lawsuits.

Lastly, Panel C of Table IX shows an analysis of the same firms pre- and post-difference-in-differences analysis, but in a regression framework where more firm-level determinants of R&D can be included. From Panel C, we see that losing to a large aggregator NPE (again, selecting on being targeted) leads to a 1.73% reduction in future R&D expense (scaled by assets).[58] Considering the mean of dependent variable is 8.7%, this magnitude is economically large and statistically significant, representing a roughly 20% reduction ($t = 2.43$) in R&D investment. Again, from Column 3 of Table IX, Panel C, we see that there is no resultant reduction in R&D expenditure following losses in PE vs. PE cases.

In all, the evidence in this section strongly supports the idea that NPEs have a real and negative impact on innovation of United States firms, and that within the IP space—like the cash-targeting behavior we have observed—the negative impact on R&D is unique to NPE lawsuits.

6 Discussion

Our results show that NPEs on average sue firms that have substantial cash holdings. While we cannot observe directly whether infringement has occurred in a given case, our results suggest that cash—rather than policing infringement—drives NPE targeting. Cash is a first-order determinant of NPE IP litigation even when that cash is unrelated to the alleged

[57] We are unsure why PE litigation does *not* appear to cause a reduction in R&D investment—it has been suggested to us that this effect has something to do with the presence of PE vs. PE product market competition, but we are not certain what the mechanism would be. (Indeed, we might have supposed that the relatively higher availability of injunctive relief in PE vs. PE lawsuits would lead to more significant R&D reduction than in NPE vs. PE lawsuits.)

[58] In these tests we control for *CitationCommonality*, a pairwise patent similarity measure provided to us by Ambercite (see Appendix Table A1).

infringement, and even though cash is neither a key driver of PE patent lawsuits nor of non-IP litigation. Meanwhile, NPEs appear to bring lower-quality lawsuits, and there is evidence that NPEs are actively forum shopping.

NPE litigation has a real negative impact on innovation at targeted firms: PEs substantively reduce their innovative activity after settling with NPEs (or losing to them in court). Measuring NPEs' *net* impact on innovation, however, requires accounting for the potential of NPE litigation to positively incentivize innovation by individual inventors. Unfortunately, because most settlement values are not disclosed, we cannot measure the full size of the transfer from PEs to NPEs (much less the transfer from NPEs to end inventors). Furthermore, we cannot measure the increase in innovation incentives that might come from PEs being less likely to infringe (given NPE behavior). Thus, we cannot explicitly measure the potential welfare gains from NPE litigation. Nevertheless, we note that as our theoretical model suggests, the benefits of NPEs in terms of increased innovation incentives for end inventors (both the direct benefits through lawsuits, and the indirect benefits in terms of enhanced licensing potential) depend on the *fraction* of NPE profits passed through to end inventors.

There are three pieces of empirical evidence that speak to the impact of NPEs on inventors' innovation incentives. First, Bessen et al. (2011) directly estimate the pass-through parameter that our theory highlights as the key mediator of NPEs' benefits for end inventors. Bessen et al. (2011) find very low pass-through, estimating that only five cents of every dollar in damages paid by PEs to NPEs makes it back to end innovators. Thus, one would need to believe in a large multiplier (summing both direct and indirect spillover effects) to justify, from a social-welfare perspective, NPE litigation practices as an efficient mechanism to transfer the marginal dollar of innovative capital—*even if all NPE lawsuits were well-founded*. Second, Feldman and Lemley (2015) find evidence that patent licensing does little or nothing to increase innovation—irrespective of whether NPEs or PEs are the licensors. Lastly, we conduct a simple empirical analysis, presented in Table X, in which we measure changes in innovation outcomes in the *exact* technology areas in which NPE litigation is most frequent.

In NPE-heavy areas, both the direct and indirect (incentive) benefits of NPE litigation should be largest, but Table X shows that there has been no observable increase in innovation by small innovators.[59]

The marginal welfare impact of NPEs is also largely determined by the frequency with which NPEs successfully bring "nuisance" cases instead of meritorious ones. As our model suggests, NPE nuisance suits stand to crowd out socially valuable innovation (and possibly to *induce* socially inefficient infringement), without any measurable social gains.

7 Conclusion

We provide the first large-sample evidence on the behavior and impact of NPEs. Our theoretical model illustrates that while NPE litigation can reduce infringement and support small inventors, as NPEs become effective at bringing opportunistic lawsuits, they can inefficiently crowd out firms that would otherwise produce welfare-enhancing innovations without engaging in infringement. Our complementary empirical analysis shows that on average, NPEs appear to behave as opportunistic patent trolls. They sue cash-rich firms—a one standard deviation increase in cash holdings doubles a firm's chance of being targeted by NPE litigation. By contrast, cash is neither a key driver of IP lawsuits by PEs, nor of any other type of litigation against firms. The cash-targeting behavior we observe is driven by large aggregator NPEs, and is not the behavior of small innovators. NPEs even target conglomerate firms that earn their cash from segments having nothing to do with their allegedly infringing patents (profitability in unrelated businesses is nearly as predictive of NPE lawsuits as is profitability in business segments related to NPE-alleged patent infringement). We find further suggestive evidence of NPE opportunism, such as forum shopping, litigation of lower quality patents, as well as targeting of firms that may have reduced ability to defend

[59]Even if small inventors primarily benefit from NPEs via improved licensing opportunities, we would expect this to improve inventors' innovation incentives—and thus lead to an increase in small inventor innovation. As we see no impact of NPE litigation on small inventor innovation, we infer that the licensing pathway is not providing significant new innovation incentives to small inventors.

themselves against litigation. We find moreover that this NPE litigation has a real negative impact on innovation at targeted firms: firms substantively reduce their innovative activity after settling with NPEs (or losing to them in court). Meanwhile, we neither find any markers of significant NPE pass-through to end innovators, nor of a positive impact of NPEs on innovation in the industries in which they are most prevalent.

Setting intellectual property policy regarding patent assertion is first-order. If widespread opportunistic patent litigation makes the United States a less desirable place to innovate, then innovation and human capital—and the returns to that innovation and human capital—will respond accordingly. That said, innovators will also leave if they feel they are not are protected from large, well-funded interests that might infringe on innovative capital without recompense. Our results provide evidence that NPEs—in particular, large patent aggregators—on average do not appear to protect innovation. Rather, our results are consistent with NPEs, on average, behaving as patent trolls that target cash and negatively impact innovative activities at targeted firms. Given our findings, policy should seek to more carefully limit the power of NPEs or, in the framework of our model, introduce cost-shifting or screening measures that reduce the incentive to bring nuisance suits.[60]

[60]To this end, we propose an advance screening solution that would mitigate patent trolling while encouraging high-quality lawsuits (Cohen et al. (2016, 2017)).

References

Abrams, D. S., U. Akcigit, and J. Popadak (2013). Patent value and citations: Creative destruction or strategic disruption? NBER Working Paper No. 19647.

Allison, J. R., M. A. Lemley, and D. L. Schwartz (forthcoming, 2017). How often do patent assertion entities win patent suits? *Berkeley Technology Law Journal*.

Allison, J. R., M. A. Lemley, and J. Walker (2010). Patent quality and settlement among repeat patent litigants. *Georgetown Law Journal 99*, 677–712.

Arena, M. and B. Julio (2011). Litigation risk, cash holdings, and corporate investment. Marquette University and London Business School Working Paper.

Ball, G. G. and J. P. Kesan (2009). Transaction costs and trolls: Strategic behavior by individual inventors, small firms and entrepreneurs in patent litigation. University of Illinois Law & Economics Research Paper No. LE09-005.

Beatty, A., J. Weber, and J. J. Yu (2008). Conservatism and debt. *Journal of Accounting and Economics 45*(2), 154–174.

Beauchamp, C. (2016). The first patent litigation explosion. *Yale Law Journal 125*(4), 848–944.

Bessen, J. E., J. Ford, and M. J. Meurer (2011). The private and social costs of patent trolls. *Regulation 34*(4), 26–35.

Bessen, J. E. and M. J. Meurer (2006). Patent litigation with endogenous disputes. *American Economic Review 96*(2), 77–81.

Bessen, J. E. and M. J. Meurer (2014). The direct costs from NPE disputes. *Cornell Law Review 99*(2), 387–424.

Budish, E. B., B. N. Roin, and H. L. Williams (2015). Do firms underinvest in long-term research? Evidence from cancer clinical trials. *American Economic Review 105*(7), 2044–2085.

Cheng, A., H. He Huang, Y. Li, and G. Lobo (2010). Institutional monitoring through shareholder litigation. *Journal of Financial Economics 95*(3), 356–383.

Chien, C. V. (2013a). Patent assertion and startup innovation. Report of the New America Foundation's Open Technology Institute.

Chien, C. V. (2013b). Patent trolls by the numbers. Santa Clara University Legal Studies Research Paper No. 08-13.

Chien, C. V. (2014). Startups and patent trolls. *Stanford Technology Law Review 17*, 461–506.

Choi, J. P. and H. Gerlach (2014). A model of patent trolls. Michigan State University Working Paper.

Cohen, L., J. M. Golden, U. G. Gurun, and S. D. Kominers (forthcoming, 2017). 'Troll' check? A proposal for administrative review of patent litigation. *Boston University Law Review*.

Cohen, L., U. G. Gurun, and S. D. Kominers (2016). The growing problem of patent trolling. *Science 352*(6285), 521–522.

Cooter, R. D. and D. L. Rubinfeld (1989). Economic analysis of legal disputes and their resolution. *Journal of Economic Literature 27*(3), 1067–1097.

Cotropia, C. A., J. P. Kesan, and D. L. Schwartz (2014). Unpacking patent assertion entities (PAEs). *Minnesota Law Review 99*, 649–703.

Daughety, A. F. and J. F. Reinganum (2000). On the economics of trials: Adversarial process, evidence, and equilibrium bias. *Journal of Law, Economics, and Organization 16*(2), 365–394.

Executive Office of the President (2013). Patent assertion and u.s. innovation. https://www.whitehouse.gov/sites/default/files/docs/patent_report.pdf.

Fama, E. F. and K. R. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics 33*(1), 3–56.

Feldman, R. (2014). Patent demands & startup companies: The view from the venture capital community. *Yale Journal of Law & Technology 16*, 236–284.

Feldman, R. and M. A. Lemley (2015). Do patent licensing demands mean innovation? *Iowa Law Review 101*, 137–189.

Feng, J. and X. Jaravel (2015). Patent trolls and the patent examination process. Harvard University Working Paper.

Fischer, T. and J. Henkel (2012). Patent trolls on markets for technology – An empirical analysis of NPEs' patent acquisitions. *Research Policy 41*(9), 1519–1533.

Francis, J., D. Philbrick, and K. Schipper (1994). Shareholder litigation and corporate disclosures. *Journal of Accounting Research 32*(2), 137–164.

Galasso, A. and M. Schankerman (2010). Patent thickets, courts, and the market for innovation. *RAND Journal of Economics 41*(3), 472–503.

Galasso, A., M. Schankerman, et al. (2015). Patents and cumulative innovation: Causal evidence from the courts. *Quarterly Journal of Economics 130*(1), 317–369.

Galasso, A., M. Schankerman, and C. J. Serrano (2013). Trading and enforcing patent rights. *RAND Journal of Economics 44*(2), 275–312.

Garner, B. A. and H. C. Black (2004). *Black's Law Dictionary*. Thomson/West.

Haber, S. H. and S. H. Werfel (2016). Why do inventors sell to patent trolls? Experimental evidence for the asymmetry hypothesis. *Economics Letters 149*, 64–66.

Hadlock, C. J. and J. R. Pierce (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. *Review of Financial studies 23*(5), 1909–1940.

Hanley, K. W. and G. Hoberg (2012). Litigation risk, strategic disclosure and the underpricing of initial public offerings. *Journal of Financial Economics 103*(2), 235–254.

Hay, B. and K. E. Spier (1998). Settlement of litigation. In P. Newman (Ed.), *The New Palgrave Dictionary of Economics and the Law*, Volume 3, pp. 442–451. Palgrave Macmillan.

Helmers, C., B. Love, and L. McDonagh (2013). Is there a patent troll problem in the UK. *Fordham Intellectual Property Media & Entertainment Law Journal 24*, 509–553.

Jayaraman, S. and T. Milbourn (2009). Does equity-based CEO compensation really increase litigation risk? Working paper, Washington University.

Johnson, M. F., R. Kasznik, and K. K. Nelson (2000). Shareholder wealth effects of the private securities litigation reform act of 1995. *Review of Accounting Studies 5*(3), 217–233.

Kerr, W. R. (2008). Ethnic scientific communities and international technology diffusion. *Review of Economics and Statistics 90*(3), 518–537.

Khan, B. Z. (2013). Selling ideas: An international perspective on patenting and markets for technological innovations, 1790–1930. *Business History Review 87*, 39–68.

Khan, B. Z. (2014). Trolls and other patent inventions: Economic history and the patent controversy in the twenty-first century. *George Mason Law Review 21*, 825–863.

Kiebzak, S., G. Rafert, and C. E. Tucker (2016). The effect of patent litigation and patent assertion entities on entrepreneurial activity. *Research Policy 45*(1), 218–231.

Kogan, L., D. Papanikolaou, A. Seru, and N. Stoffman (2012). Technological innovation, resource allocation, and growth. NBER Working Paper No. 17769.

Lamoreaux, N. R. and K. L. Sokoloff (1996). Long-term change in the organization of inventive activity. *Proceedings of the National Academy of Sciences 93*(23), 12686–12692.

Lamoreaux, N. R. and K. L. Sokoloff (2001). Market trade in patents and the rise of a class of specialized inventors in the 19th-century United States. *American Economic Review 91*(2), 39–44.

Lemley, M. A. and A. D. Melamed (2013). Missing the forest for the trolls. *Columbia Law Review 113*(8), 2117–2189.

Lemley, M. A. and C. Shapiro (2005). Probabilistic patents. *Journal of Economic Perspectives 19*(2), 75–98.

Lemley, M. A. and C. Shapiro (2006). Patent holdup and royalty stacking. *Texas Law Review 85*, 1991–2163.

Lerner, J. (2009). The empirical impact of intellectual property rights on innovation: Puzzles and clues. *American Economic Review 99*(2), 343–348.

Leychkis, Y. (2007). Of fire ants and claim construction: An empirical study of the meteoric rise of the eastern district of Texas as a preeminent forum for patent litigation. *Yale Journal of Law & Technology 9*, 193–232.

Love, B. J. (2014). An empirical study of patent litigation timing: Could a patent term reduction decimate trolls without harming innovators? *University of Pennsylvania Law Review 161*, 1309–1359.

Lowry, M. and S. Shu (2002). Litigation risk and IPO underpricing. *Journal of Financial Economics 65*(3), 309–335.

Marco, A. C., M. Carley, S. Jackson, and A. F. Myers (2015). The USPTO historical patent data files: Two centuries of innovation. Working Paper, United States Patent and Trademark Office.

McGahan, A. M. and B. S. Silverman (2001). How does innovative activity change as industries mature? *International Journal of Industrial Organization 19*(7), 1141–1160.

Miller, S. P. (2013). Where's the innovation: An analysis of the quantity and qualities of anticipated and obvious patents. *Virginia Journal of Law and Technology 18*(1), 1–58.

Mowery, D. C. and A. A. Ziedonis (2001). The geographic reach of market and non-market channels of technology transfer: Comparing citations and licenses of university patents. NBER Working Paper No. 8568.

Mullin, J. (January 14, 2014). Patent stunner: Under attack, nation's most notorious "troll" sues federal gov't. *Ars Technica*.

Mullin, J. (November 23, 2013). FindTheBest destroys "matchmaking" patent, pushes RICO case against troll. *Ars Technica*.

Polinsky, A. M. and S. Shavell (1989). Legal error, litigation, and the incentive to obey the law. *Journal of Law, Economics and Organization 5*(1), 99–108.

Risch, M. (2012). Patent troll myths. *Seton Hall Law Review 42*, 457–497.

Risch, M. (2015). A generation of patent litigation: Outcomes and patent quality. *San Diego Law Review 52*, 67–132.

Rogers, J. L. and A. Van Buskirk (2009). Shareholder litigation and changes in disclosure behavior. *Journal of Accounting and Economics 47*(1), 136–156.

Sakakibara, M. and L. Branstetter (2001). Do stronger patents induce more innovation? evidence from the 1988 Japanese patent law reforms. *RAND Journal of Economics 32*(1), 77–100.

Schwartz, D. L. and J. P. Kesan (2014). Analyzing the role of non-practicing entities in the patent system. *Cornell Law Review 99*(2), 425–456.

Scott Morton, F. M. and C. Shapiro (2014). Strategic patent acquisitions. *Antitrust Law Journal 79*(2), 463–500.

Seetharaman, A., F. A. Gul, and S. G. Lynn (2002). Litigation risk and audit fees: Evidence from UK firms cross-listed on US markets. *Journal of Accounting and Economics 33*(1), 91–115.

Shrestha, S. K. (2010). Trolls or market-makers? an empirical analysis of nonpracticing entities. *Columbia Law Review 110*, 114–160.

Shu, S. Z. (2000). Auditor resignations: Clientele effects and legal liability. *Journal of Accounting and Economics 29*(2), 173–205.

Silverman, B. S. (2003). *Technological Resources and the Logic of Corporate Diversification*. Routledge.

Skinner, D. J. (1994). Why firms voluntarily disclose bad news. *Journal of Accounting Research 32*(1), 38–60.

Skinner, D. J. (1997). Earnings disclosures and stockholder lawsuits. *Journal of Accounting and Economics 23*(3), 249–282.

Smeets, R. (2015). Does patent litigation reduce corporate R&D? An analysis of US public firms. Working Paper, Rutgers University.

Sokol, D. D. (Ed.) (2017). *Patent Assertion Entities and Competition Policy*. Cambridge University Press.

Spier, K. (2005). Economics of litigation. In S. Durlauf and L. Blume (Eds.), *The New Palgrave Dictionary of Economics*. Macmillan.

Tucker, C. E. (2014). Patent trolls and technology diffusion: The case of medical imaging. Working Paper, Massachusetts Institute of Technology.

United States Government Accountability Office (2013). Assessing factors that affect patent infringement litigation could help improve patent quality. GAO-13-465.

United States Patent and Trademark Office (2015). Request for comments on enhancing patent quality. *Federal Register 80*, 6475–6481.

Williams, H. L. (2013). Intellectual property rights and innovation: Evidence from the human genome. *Journal of Political Economy 121*(1), 1–27.

Williams, H. L. (2015). Intellectual property rights and innovation: Evidence from health care markets. In J. Lerner and S. Stern (Eds.), *Innovation Policy and the Economy*, Volume 16. University of Chicago Press.

Table I. Summary Statistics, 2005–2015

Panel A of this table presents summary statistics on the firms included in the tests. Appendix Table I contains the definitions of the variables we use. Total Assets, Market Value, R&D Expense, and Cash is reported in billion USD. In Panel B, we tabulate number of dockets reported in the RPX database by year. RPX records information on cases in which the plaintiff is an NPE or an Operating Company (PE). According to RPX, an NPE is an entity that derives or plans to derive the majority of its revenue from the licensing or enforcement of patents and for which RPX has been unable to obtain verifiable evidence that the entity sells products or services that would make it vulnerable to patent counter-assertion. NPEs contain the following organizational forms: (1) Patent assertion entities (PAE), entities believed to earn revenue predominantly through asserting patents, (2) Individual inventors (INV), (3) Non-competing entities (NCEs): operating companies asserting patents outside their areas of products or services, and (4) Universities and research institutions. In the last column of panel B, we tabulate the number of observations in a different database, Lex Machina, that provides IP litigation information.

Panel A. Summary Statistics on Firm Characteristics

	Mean	Median	St. Dev	P05	P25	P75	P95
Total Assets	13.991	0.719	108.401	0.023	0.165	3.075	32.143
Market Value	3.815	0.454	16.389	0.019	0.112	1.866	15.483
B/M	2.965	0.599	66.765	0.117	0.339	1.000	3.787
Past Return	0.139	0.065	0.706	-0.622	-0.191	0.325	1.077
R&D Expense	0.077	0.000	0.510	0.000	0.000	0.011	0.184
Number of Patents	55.62	0.000	540.80	0.000	0.000	0.000	97.00
Cash	0.579	0.040	4.272	0.001	0.010	0.167	1.776
Sued by NPE	0.086	0.000	0.280	0.000	0.000	0.000	1.000
Sued by PE	0.046	0.000	0.209	0.000	0.000	0.000	0.000

Panel B. Sample Description

	RPX						Lex Machina
	NPE				PE		NPE & PE
	PAE	INV	NCE	University	Practicing Entity	Total	Total
2005	381	172	11	12	1,917	2,493	2,523
2006	499	143	16	11	1,914	2,583	2,581
2007	658	173	16	11	1,831	2,689	2,775
2008	618	222	8	15	1,651	2,514	2,573
2009	633	197	12	16	1,634	2,492	2,547
2010	787	174	19	17	1,693	2,690	2,770
2011	1,520	183	16	14	1,813	3,546	3,575
2012	3,319	161	107	31	1,764	5,382	5,455
2013	3,831	230	9	71	1,873	6,014	6,114
2014	2,881	245	63	22	1,722	4,933	5,070
2015	3,613	152	3	8	1,809	5,585	5,818

Table II. Cash and Probability of Being Sued

In this table, we use a linear probability model to estimate the probability of being sued by an NPE. The outcome variable, Sued by NPE, is a dummy equal to 1 if the firm was litigated by an NPE in a given year. RPX data allows us to observe the type of the NPE. We focus on cases in which the NPE is classified as a patent assertion entity (PAE) or a small inventor (INV). Appendix A1 contains the definitions of the variables we use. We use log transformation for Total Assets, Market Value, B/M, Patent Stock, Past Return, R&D Expense, and Cash Level. The sample contains firm-year observations between 2005 and 2015. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE
Cash Level	0.2073***	0.1021***	0.0994***	0.0581***	0.0565***
	(0.0117)	(0.0119)	(0.0119)	(0.0113)	(0.0133)
Total Assets		-0.0161***	-0.0149***	0.0130**	0.0199**
		(0.0057)	(0.0056)	(0.0059)	(0.0084)
Market Value		0.0740***	0.0720***	0.0610***	-0.0125
		(0.0075)	(0.0075)	(0.0066)	(0.0083)
B/M		-0.0045	-0.0081*	-0.0133***	-0.0150**
		(0.0048)	(0.0049)	(0.0048)	(0.0061)
Past Return		-0.0063***	-0.0072***	-0.0070***	-0.0006
		(0.0021)	(0.0023)	(0.0022)	(0.0025)
R&D Expense		0.1394***	0.1398***	0.1368***	0.1220**
		(0.0342)	(0.0342)	(0.0295)	(0.0483)
Number of Patents		0.0139***	0.0146***	0.0149***	0.0006
		(0.0026)	(0.0026)	(0.0024)	(0.0038)
Cash Shock		0.0199*	0.0163	0.0147*	0.0167**
		(0.0106)	(0.0105)	(0.0089)	(0.0081)
Firm FE	No	No	No	No	Yes
Industry FE	No	No	No	Yes	No
Year FE	No	No	Yes	Yes	Yes
N	50,965	50,965	50,965	50,965	50,965
R2	0.11	0.17	0.18	0.28	0.55

Table III. Is Cash Targeting a General Feature of Litigation?

In Column 1 of this table, we define Sued by PE to be equal to 1 if a firm faces IP lawsuits from practicing entities (PEs) in a given year. The PE litigation information is obtained from RPX. We obtain litigation information on other types of cases from Audit Analytics database. This database includes material federal civil litigation and class action claims disclosed to the SEC by the SEC registrants. Case disclosure comes from the firm, which is responsible for determining whether the case is material for the company. Given the severe penalties involved in not disclosing information that is already public (through PACER), a dominant strategy for a CEO is often disclose not only material information but also potentially non-material information that could later be assessed as being within disclosure guidelines. Furthermore, because our interest lies in the public firms (which are SEC registrants, by definition), Audit Analytics provides a comprehensive database for cases we are interested in. In Columns 2-5, we utilize case classifications reported in Audit Analytics to investigate whether the relation between firm characteristics and NPE litigation differ for different case types. Specifically, in Column 2, we first define the dependent variable to be 1 if the firm is involved in a case related to tort. The other categories include environment, securities, contract, and labor—as defined by PACER. Appendix Table A5 outlines the specific case codes used to identify these cases. We define the dependent variable to be 1 if the firm is sued in the case type specified in the column heading. We use the baseline specification used in Table II to facilitate comparison of coefficients across case types. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

	Sued by PE	Tort	Environment	Securities	Contract	Labor
Cash Level	-0.0016	-0.0228*	-0.0078	-0.0261**	-0.0343***	-0.0004
	(0.0111)	(0.0122)	(0.0067)	(0.0125)	(0.0127)	(0.0036)
Total Assets	0.0127*	-0.0158*	0.0016	0.0354***	0.0059	-0.0012
	(0.0065)	(0.0084)	(0.0028)	(0.0097)	(0.0098)	(0.0031)
Market Value	0.0093	0.0158**	-0.0019	0.0280***	0.0265***	-0.002
	(0.0073)	(0.0079)	(0.0026)	(0.0087)	(0.0095)	(0.0031)
B/M	-0.0012	0.0100**	0.0004	-0.0023	0.0143***	0.0001
	(0.0042)	(0.0042)	(0.0015)	(0.0052)	(0.0048)	(0.0016)
Past Return	-0.0013	-0.0022	0.0005	-0.0048*	-0.0039	-0.0008
	(0.0020)	(0.0017)	(0.0007)	(0.0027)	(0.0024)	(0.0008)
R&D Expense	-0.0108	-0.1590**	-0.0019	-0.0573	-0.2343***	-0.0211
	(0.0494)	(0.0701)	(0.0158)	(0.0424)	(0.0538)	(0.0143)
Number of Patents	-0.0079**	0.0056*	0.0017**	-0.0003	-0.0018	0.0001
	(0.0036)	(0.0034)	(0.0008)	(0.0028)	(0.0034)	(0.0005)
Cash Shock	-0.0037	-0.0055	0.0017	0.0096	0.0221***	0.001
	(0.0070)	(0.0073)	(0.0035)	(0.0080)	(0.0082)	(0.0029)
Number of Employees						0.0033
						(0.0031)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	50,965	42,209	42,209	42,209	42,209	41,213
R2	0.42	0.31	0.23	0.25	0.24	0.24

Table IV. Probability of Being Sued: Related vs. Unrelated Cash Flows

In this table, we report the probability that a conglomerate is sued by an NPE as a function of the gross profitability of related and unrelated segments. The unit of observation is a conglomerate-segment-year. Sued by NPE is a dummy variable equal to 1 if the conglomerate was litigated by an NPE that year. To identify conglomerate's segments that are related to litigated patents, we use the IPC-to-SIC concordance developed by Silverman (2003). We use Thompson Innovation database to identify IPC classification of each asserted patent. We use financial statements disclosed in segment filings end of each year to collect segment-level information on sales and cost of goods sold and calculate segment gross profitability as the difference. Industry Profitability is the average profitability of all firms in the same four-digit SIC. Standard errors, clustered by conglomerate, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

	Segment Sued by NPE	Segment Sued by NPE	Segment Sued by PE
Related Segment Profitability	0.1457**	0.0569**	0.0388**
	(0.0623)	(0.0260)	(0.0181)
Unrelated Segment Profitability	0.0835***	0.0265**	0.0213
	(0.0246)	(0.0133)	(0.0135)
Industry Profitability	-0.0039***	0.0008*	0.0002
	(0.0009)	(0.0005)	(0.0003)
Conglomerate FE	No	Yes	Yes
N	29,405	29,405	29,405
R2	0.02	0.44	0.39

Table V. Cash and Probability of Being Sued: Comparison of PAEs to Small Inventors

In this table, we report the baseline results for different types of NPEs. In Column 1, the regressand takes a value of 1 if the firm is sued by a patent assertion entity (PAE). In Column 1, the regressand takes a value of 1 if the firm is sued by a small inventor. Variable definitions are provided in Table 2. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

	Sued by PAE	Sued by Small Inventor
Cash Level	0.0541***	0.0105
	(0.0135)	(0.0066)
Total Assets	0.0223**	0.0046
	(0.0086)	(0.0041)
Market Value	-0.0148*	-0.0021
	(0.0085)	(0.0045)
B/M	-0.0170***	-0.0038
	(0.0061)	(0.0025)
Past Return	-0.0002	-0.0011
	(0.0025)	(0.0011)
R&D Expense	0.1376***	0.0797*
	(0.0520)	(0.0463)
Number of Patents	0.0024	-0.0025
	(0.0038)	(0.0019)
Cash Shock	0.0166**	-0.0044
	(0.0082)	(0.0052)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	50,965	50,965
R2	0.54	0.36

Table VI. Asserted Patents' Attributes

In this table, we compare patents asserted in two types of cases: NPE vs. PE, and PE vs. PE. For each patent, we first calculate eight different metrics. Age of Patent when asserted (in months) is the time gap between the dates of litigation filing and patent issuance. Times Asserted measures the number of instances the patents have been asserted through litigation. Issue Time Backlog is the ratio of number of patents issued to sum of patents issued, pending and abandoned, at the time of asserted patent's issue month for the asserted patent's NBER technology group and application time cohort. Scope of Patent is the count of asserted patent's U.S. technology classes. Number of Independent and Dependent Claims are based on the claims reported in issued patent. We report the mean values and t-test for the difference across patents asserted in NPE vs. PE, and PE vs. PE cases.

	PE vs. PE cases	NPE vs. PE cases	Difference	t-test
Age of Patent when asserted (in months)	76.97	92.58	-15.61	(20.91)
Times Asserted	2.84	13.02	-10.18	(59.76)
Issue Time Backlog	0.31	0.35	-0.04	(13.74)
Scope of Patent	4.83	5.86	-1.03	(21.50)
Number of Independent Claims	3.80	4.86	-1.06	(21.11)
Number of Words in Independent Claims	531.58	802.27	-270.69	(26.54)
Number of Dependent Claims	21.19	29.98	-8.79	(22.92)
Number of Words in Dependent Claims	690.86	1052.41	-361.55	(24.04)
Number of Asserted Patents	14,590	15,261		

Table VII. Impact of Legal Team Size and Outside (non-IP) Litigation

In this table, we use a linear probability model to estimate the probability of being sued by an NPE. The outcome variable, Sued by NPE, is a dummy equal to 1 if the firm was litigated by an NPE in a given year. We introduce two dummy variables to main specification reported in table 2. The first variable, IP Legal Team Size, is a dummy variable that takes a value of 1 if the firm employs more IP focused law firms than a comparable firm with similar characteristics. Appendix Table A2 provides details of IP Legal Team Size calculation. The second variable, Ongoing Cases, takes value of 1 of if the number of ongoing litigation the firm is engaged is more than 10% of sum of ongoing litigation of its peer firms in the same industry-year. The sample contains firm-year observations between 2005 and 2012 in the first column because of data limitation. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

	Sued by NPE	Sued by NPE
Cash Level	0.0592***	0.0563***
	(0.0155)	(0.0132)
Total Assets	0.0323***	0.0197**
	(0.0115)	(0.0083)
Market Value	-0.0324***	-0.0122
	(0.0103)	(0.0083)
B/M	-0.0219***	-0.0151**
	(0.0072)	(0.0061)
Past Return	0.0009	-0.0006
	(0.0029)	(0.0025)
R&D Expense	0.1087*	0.1213**
	(0.0588)	(0.0485)
Number of Patents	0.0009	0.0005
	(0.0040)	(0.0038)
Cash Shock	0.0200*	0.0166**
	(0.0104)	(0.0081)
Legal Team Size	-0.0062**	
	(0.0029)	
Ongoing Cases		0.0171**
		(0.0072)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	37,947	50,965
R2	0.56	0.55

Table VIII. Robustness Tests

In Panel A of this table, we report the results for several robustness tests. In the first two columns, we reports results for thicket industries (i.e., industries that are characterized with dense overlapping intellectual property rights and strategic patenting behavior) and non-thicket industries. In column 3, we exclude IT industry from the sample. We use SIC codes 35, 36, 38 and 73 to identify thicket industries. We use SIC codes 35 and 73 to identify IT firms (see Bessen and Meurer, 2014). In column 4, we use an alternative cash measure (sum of cash and marketable securities) as our main variable of interest. In column 5, we add three new variables to the baseline specification: cash level squared, cash level cubed and Hadlock and Pierce (2010) financial constraints index. This index measures how constrained the firm is in terms of accessing external funds. It combines information on firm asset size, firm asset size squared, and firm age. We use mean firm age for firms whose ages are missing, to keep the sample size constant across specifications (the coefficient of cash is 50 percent larger when we use the subsample that does not have information on firm age). In the last specification, we use unlogged variables. In Panel B, we report several specifications based on different estimation methods. In the first two columns, we change the left-hand side variable to the number of times sued in a given year and use OLS and Tobit respectively. In the last two columns, we use Probit and Logit models respectively.

Panel A. Thicket Industries vs. Non-Thicket Industries

	Sued by NPE Thicket Ind.	Sued by NPE Non-Thicket Ind.	Sued by NPE Exc. SIC=35,73	Sued by NPE Alt. Cash Measure	Sued by NPE All Industries	Sued by NPE Unlogged Variables
Cash Level	0.0891**	0.0515***	0.0543***	0.0324***	0.0613**	0.0074**
	(0.0353)	(0.0143)	(0.0137)	(0.0124)	(0.0291)	(0.0029)
Total Assets	0.0343	0.0192**	0.0187**	0.0217**	0.0209**	0.0205**
	(0.0311)	(0.0085)	(0.0085)	(0.0084)	(0.0092)	(0.0092)
Market Value	0.0014	-0.0178*	-0.0178**	-0.0126	-0.0124	0.0098
	(0.0180)	(0.0095)	(0.0089)	(0.0083)	(0.0083)	(0.0292)
B/M	-0.018	-0.0147**	-0.0156**	-0.0145**	-0.0149**	-0.0015
	(0.0152)	(0.0067)	(0.0064)	(0.0061)	(0.0061)	(0.0014)
Past Return	-0.0017	-0.0006	-0.0008	-0.0002	-0.0006	0.0017
	(0.0052)	(0.0029)	(0.0027)	(0.0025)	(0.0025)	(0.0017)
R&D Expense	0.0578	0.1098*	0.1094**	0.1362***	0.1230**	2.2316*
	(0.0867)	(0.0573)	(0.0508)	(0.0488)	(0.0482)	(1.1895)
Number of Patents	0.0054	-0.0058	-0.0037	0.0007	0.0006	-0.0029*
	(0.0057)	(0.0049)	(0.0041)	(0.0038)	(0.0038)	(0.0015)
Cash Shock	0.0339**	0.0107	0.0211**	0.0202**	0.0167**	0.0219***
	(0.0171)	(0.0092)	(0.0088)	(0.0081)	(0.0081)	(0.0080)
Financial Constraints					0.0012	-0.0054*
					(0.0035)	(0.0032)
Cash Level Squared					-0.0044	-0.0001**
					(0.0218)	(0.0000)
Cash Level Cubed					0.0008	0.0000*
					(0.0040)	(0.0000)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	13,791	37,174	43,430	50,965	50,965	50,965
R2	0.56	0.54	0.54	0.55	0.55	0.55

Panel B. Alternative Estimation Methods

	Sued by NPE OLS (Number of Times Sued)	Sued by NPE Tobit (Number of Times Sued)	Sued by NPE Probit (Sued or Not)	Sued by NPE Logit (Sued or Not)
Cash Level	0.4439***	1.9722***	0.2896***	0.4731***
	(0.1638)	(0.1645)	(0.0466)	(0.0863)
Total Assets	0.2309**	-0.1947*	-0.0113	0.0091
	(0.0939)	(0.1018)	(0.0315)	(0.0623)
Market Value	-0.2695**	2.3869***	0.3408***	0.6016***
	(0.1065)	(0.1151)	(0.0364)	(0.0711)
B/M	-0.1620***	-0.0943	-0.0385	-0.0807
	(0.0392)	(0.1394)	(0.0393)	(0.0825)
Past Return	-0.0147	-0.1791	-0.0087	0.0067
	(0.0146)	(0.1322)	(0.0193)	(0.0398)
R&D Expense	5.9518***	2.6446***	0.1843	0.3067
	(1.8900)	(0.2524)	(0.1274)	(0.2367)
Number of Patents	0.1408**	0.5181***	0.0918***	0.1706***
	(0.0664)	(0.0350)	(0.0120)	(0.0229)
Cash Shock	0.0086	0.1677	0.0564	0.1138
	(0.0580)	(0.2272)	(0.0420)	(0.0764)
Firm FE	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes
N	50,965	50,965	50,965	50,965
R2	0.75	0.14	0.20	0.20

Table IX. Impact of IP Litigation on Real Outcomes

In Panel A of this table, we present the impact of being sued by a NPE, PAE or PE on research and development expenditures in the two years following litigation filing, in comparison to the two years before litigation filing. We use the timing of the case filing as the expectations regarding the case outcome start impacting firm operations after the litigation event becomes common knowledge. Following Allison, Lemley, and Walker (2010), we exclude case outcomes such as "Stayed," "Transfers," and "procedural dispositions." We only use case outcomes RPX codes as "Dismissed," "Settled," "Won by NPE," and "Lost by NPE." In our sample, settlements and won by NPE result in 88 percent of the outcomes, while dismissals and lost by NPE arise in 12 percent of the cases. We compare two groups of firms based on case outcomes of "Settled or Won by NPE" to "Dismissed or Lost by NPE". In the first row of Panel A, we consider the change in R&D expense, before and after litigation filing, comparing defendant firms whose cases were "Settled or Won by NPE" with those whose cases were "Dismissed or Lost by NPE". We compare average R&D expense spending two years following the litigation filing to average R&D expense spending two years before the litigation filing. Using this difference-in-differences design, we report mean of Change in R&D (treated) − Change in R&D (untreated). We note that some settlements do not necessarily involve conditions that could be significantly different from dismissals. Furthermore, a given firm may be sued multiple times in a given year and these cases may end with different outcomes. To define the treatment sample cleanly, we assume that a firm can only be grouped into the treated sample if *all* the cases against that firm in a given year conclude with "Settled or Won by NPE" outcomes. These assumptions assure that the effects we document are conservative. In Panel B, Column 3 we test whether the research outputs of the treated and untreated sets were similar prior to litigation. In the first column of Panel C, we report the results of the OLS regression in which future R&D Expense (scaled by total assets) is regressed on a dummy variable that takes a value of 1 if all the cases filed by NPEs against the firm in a particular year are settled or won by the NPE. The unit of observation is firm-year. To measure the future R&D Expense, we use average of R&D spending two years following the litigation. To calculate Citation Commonality, we do the following: First, we count the number patents citing a given patent of a firm and the asserted patent of NPE. We then add up the these figures for all patents of the firm. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Panel A. Real Effect Analysis

Sued by	Treated	Untreated	N(Treated)	N(Untreated)	Change in R&D around litigation
NPE	Settled + Won by NPE	Dismissed + Lost by NPE	1,929	533	-163.97
					(7.18)
PAE	Settled + Won by PAE	Dismissed + Lost by PAE	1,868	502	-155.02
					(6.60)
PE	Settled + Won by PE	Dismissed + Lost by PE	175	38	167.657
					(1.28)

Panel B. Parallel Trend Analysis

Sued by	Treated	Untreated	Change in R&D (t-3 to t-2)
NPE	Settled + Won by NPE	Dismissed + Lost by NPE	18.951
			(1.18)
PAE	Settled + Won by PAE	Dismissed + Lost by PAE	-1.95
			(0.06)
PE	Settled + Won by PE	Dismissed + Lost by PE	50.79
			(0.31)

Panel C. Real Effects OLS Analysis: Settled + Won by NPE vs. Dismissed + Lost by NPE

Sued by	NPE	PAE	PE
	Future R&D/A	Future R&D/A	Future R&D/A
Dummy (Settled + Won by NPE)	-0.0173**	-0.0179**	0.0058
	(0.0081)	(0.0082)	(0.0306)
Market Value	-0.0238***	-0.0230***	-0.0275**
	(0.0048)	(0.0047)	(0.0127)
B/M	-0.0468***	-0.0447***	-0.1266***
	(0.0070)	(0.0068)	(0.0361)
Past Return	-0.0061	-0.005	-0.0527
	(0.0068)	(0.0069)	(0.0410)
Cash Level	0.0174***	0.0160***	0.0138
	(0.0056)	(0.0055)	(0.0222)
Cash Shock	0.0137*	0.0135*	0.0162
	(0.0071)	(0.0071)	(0.0277)
Citation Commonality	0.0046***	0.0048***	-0.0005
	(0.0008)	(0.0009)	(0.0011)
Ongoing Cases	-0.0513***	-0.0508***	-0.0832**
	(0.0097)	(0.0096)	(0.0333)
Year Fixed Effects	Yes	Yes	Yes
N	2,462	2,370	209
R2	0.13	0.13	0.15

Table X. NPE Litigation and Individual Inventor Patenting Activity, 1995 - 2010

In this table, we estimate an OLS model using past NPE litigation activity to predict the share of all future patents produced by individual innovators (Individual Innovator Share). The unit of observation is year-IPC subclass code. We exclude patents if a technology class (IPC code) is not reported in the Thompson Innovation database. Individual Innovator patents are those which name the same individual as the "innovator" and "assignee." If a patent belongs to multiple IPC subclasses, it is counted towards each. We define past litigation activity by calculating the average number of NPE litigation events in the past 3, 4, and 5 years (Litigation3, Litigation4, and Litigation5). Standard errors are clustered by year and reported in parenthesis. ***, **, and * refer to statistical significance at 1, 5 or 10 percent level.

	Individual Innovator Share	Individual Innovator Share	Individual Innovator Share
Litigation5	-2.0158		
	(2.5914)		
Litigation4		-2.0362	
		(2.3644)	
Litigation3			-2.0699
			(2.1816)
Tech Group FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	8,975	8,975	8,975
R2	0.80	0.80	0.80

Figure 1. Time Series of NPE, PE, and Total IP Litigation.

This figure shows the number of unique dockets in PACER (Public Access to Court Electronic Records) classified as IP cases (PACER code 830) in which at least one of the defendants is a public firm. We use RPX's classification of plaintiffs to split dockets according to whether the plaintiff is an NPE or a PE.

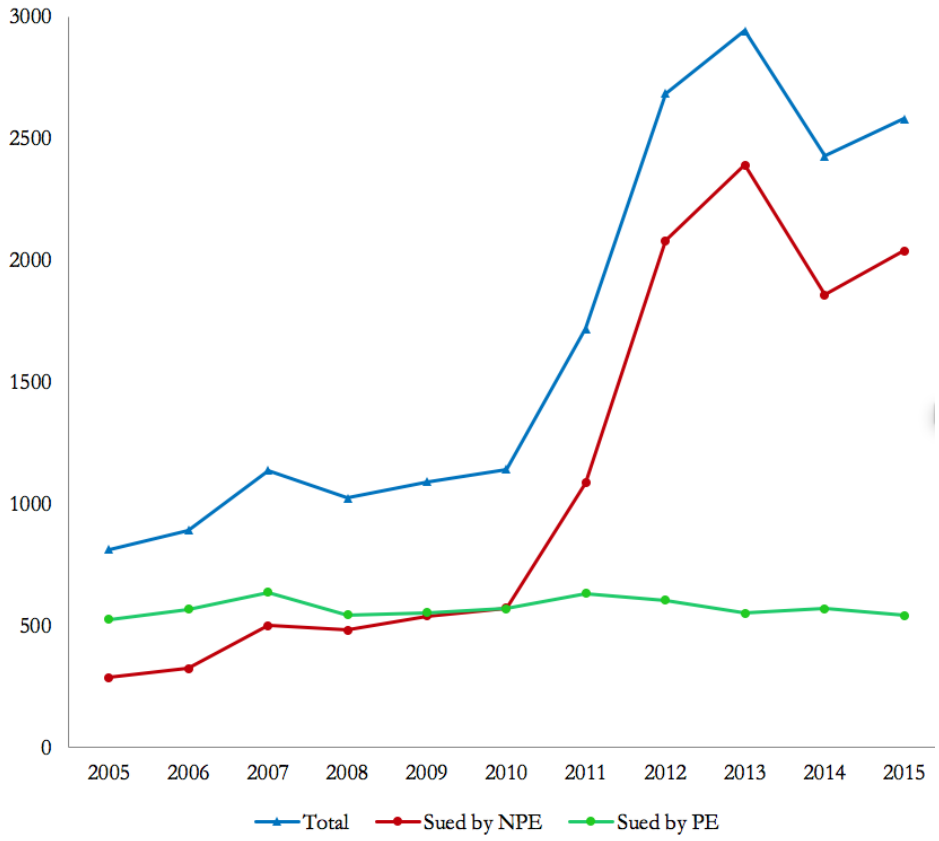
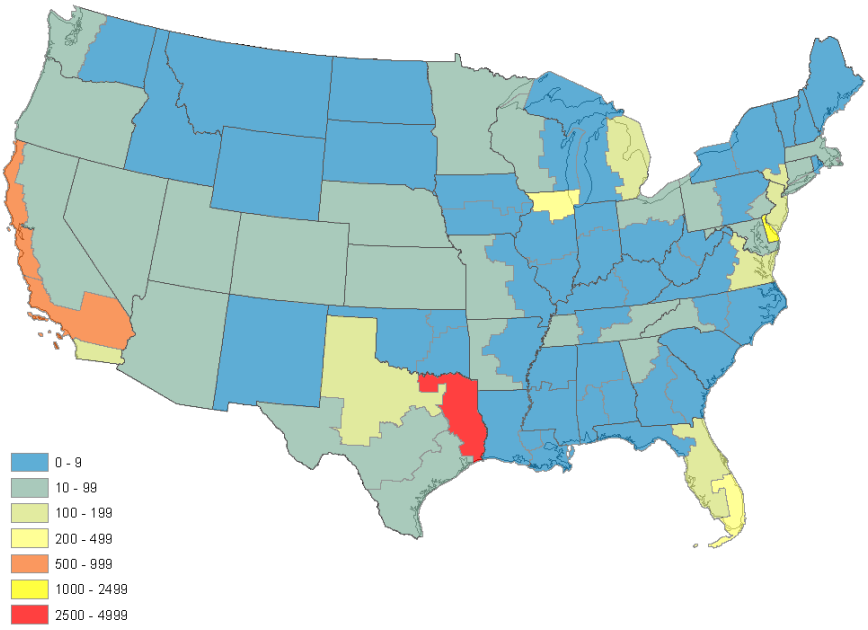


Figure 2. Geography of PAE IP Litigation.

This map charts PAE IP litigation intensity across court districts.



Appendix – Patent Trolls: Evidence from Targeted Firms

Appendix Table A1: Definitions of Variables

	Definition	Source
NPE/PE Litigation	A dummy variable equal to 1 if a firm was litigated by an NPE or a PE in a given year.	**RPX**
NPE Litigation (CKS Sample)	A dummy variable equal to 1 if the firm was litigated by an NPE in 2010 or 2012.	**npedata.com**
Citation Commonality	To construct this, we use the Ambercite data, which provides the pairwise similarity between any two patents as the number of patents citing the patent pair together. We aggregate this to the portfolio level of patents for each firm, and compare it to any given patent that is asserted against the firm.	**Ambercite.com**
R&D Expense	R&D Expense reported on annual income statement.	**Compustat**
Patent Stock	Number of patents issued to the firm in the past five years. We use the final year of the KPSS database (2010) to proxy for the patent stock of companies between 2011 and 2014.	**Kogan et al. (2012)**
IP Legal Team Size	A dummy variable equal to 1 if the firm employs more IP focused law firms than a comparable firm with similar characteristics. See Appendix Table A2 for details.	**ALM Legal Intelligence**
In-house Counsel	A dummy variable equal to 1 if a firm employs an in-house counsel.	**ALM Legal Intelligence**
Ongoing Cases	A dummy variable equal to 1 of if the number of ongoing litigation the firm is engaged is more than 10% of sum of that of its peers in the same industry-year.	**Audit Analytics**
Market Value	Market value of firm equity as of the end of the previous fiscal year.	**Compustat**
Total Assets	Total firm assets as of the end of the previous fiscal year.	**Compustat**
Book to Market	Ratio of firm book value of equity to market value of equity as of the end of the previous fiscal year. (Book value of equity is the sum of stockholders equity (SEQ), Deferred Tax (TXDB), and Investment Tax Credit (ITCB), minus Preferred Stock (PREF).Depending on data availability, we use redemption (item PSTKRV),liquidation (item PSTKL), or par value (item PSTK) to represent the book value of preferred stock.	**Compustat**
Past Return	Stock market return to equity corresponding to the fiscal year.	**CRSP**
Cash Level	The firm's level of cash at the end of the previous fiscal year.	**Compustat**
Cash Shock	A dummy variable that takes a value of 1 if change in cash in the past fiscal year is among the top 5% of cash changes in its industry.	**Compustat**

Appendix Table A2: Measuring Legal Team Size

In this table, we measure firms' IP legal team sizes, using a model that predicts the number of IP law firms used by comparable firms. We obtain list of all law firms and their client lists from ALM Legal Intelligence (from 2005-2012). For each law firm reported in the ALM database, we collect two pieces of information from firm websites: (a) whether the law firm has an IP litigation practice, and (b) how important the law firm's IP practice is within the law firm. We calculate each firm's IP legal team size variable after incorporating this additional information. Specifically, we regress log number of (one plus) IP law firms representing the firm in a given year on total assets of the firm, an indicator variable representing the existence of in-house council, log number of (one plus) law firms representing the firm in all non IP cases, and firm fixed effects. We use the residual of this estimation to measure of IP Legal Team Size for each firm-year (IP Legal Team Size=1 when residuals>0.) To accommodate the possibility that a given firm may choose not to report representation by law firms in a particular year, we impute the missing observations by using the representation information in the most immediate previous year (our results are not sensitive to this imputation method).

	Number of IP Law Firms	Number of IP Law Firms	Number of IP Law Firms	Number of IP Law Firms
Other Law Firm	0.8173***			0.8212***
	(0.0080)			(0.0082)
Total Assets		0.2290***		-0.0206**
		(0.0241)		(0.0085)
In-house Counsel			0.6702***	-0.026
			(0.0601)	(0.0261)
Firm FE	Yes	Yes	Yes	Yes
N	37,947	37,947	37,947	37,947
R2	0.95	0.7	0.71	0.95

Appendix Table A3: Alternative Specifications

In this appendix, we examine the results documented in Table II under different specifications. In Panel A, we confirm the stability of results on Cash Level by including and excluding variables one-at-a-time. In Panel B, we replace firm fixed effects with industry fixed effects. In Panel C, we report the specification with alternative treatments of missing research and development expense variable.

Panel A. Assessing Multicollinearity

	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE
Cash Level	0.0565***	0.0711***	0.0612***	0.0563***	0.0557***	0.0564***	0.0614***	0.0596***
	(0.0133)	(0.0124)	(0.0129)	(0.0133)	(0.0133)	(0.0133)	(0.0132)	(0.0131)
Total Assets	0.0199**			0.0122	0.0153*	0.0201**	0.0248***	0.0204**
	(0.0084)			(0.0075)	(0.0082)	(0.0083)	(0.0084)	(0.0083)
Market Value	-0.0125		-0.0034		-0.0065	-0.0127	-0.0118	-0.0121
	(0.0083)		(0.0073)		(0.0078)	(0.0081)	(0.0083)	(0.0083)
B/M	-0.0150**		-0.0110*	-0.0107*		-0.0146***	-0.0153**	-0.0152**
	(0.0061)		(0.0060)	(0.0059)		(0.0056)	(0.0061)	(0.0061)
Past Return	-0.0006		-0.0013	-0.0013	0.0021		-0.0008	-0.0007
	(0.0025)		(0.0025)	(0.0024)	(0.0023)		(0.0025)	(0.0025)
R&D Expense	0.1220**		0.1347***	0.1205**	0.1229**	0.1221**		0.1217**
	(0.0483)		(0.0481)	(0.0482)	(0.0484)	(0.0483)		(0.0483)
Number of Patents	0.0006		0.0007	0.0007	0.0006	0.0006	0.0016	0.0006
	(0.0038)		(0.0038)	(0.0038)	(0.0038)	(0.0038)	(0.0038)	(0.0038)
Cash Shock	0.0167**		0.0172**	0.0164**	0.0170**	0.0168**	0.0166**	
	(0.0081)		(0.0081)	(0.0081)	(0.0081)	(0.0081)	(0.0081)	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	50,965	50,965	50,965	50,965	50,965	50,965	50,965	50,965
R2	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

Panel B. Specification with Industry Fixed Effects instead of Firm Fixed Effects

	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE	Sued by NPE
Cash Level	0.0581***	0.2033***	0.0690***	0.0551***	0.0558***	0.0576***	0.0768***	0.0602***
	(0.0113)	(0.0111)	(0.0101)	(0.0117)	(0.0113)	(0.0113)	(0.0111)	(0.0111)
Total Assets	0.0130**			0.0548***	0.0062	0.0131**	0.0092	0.0130**
	(0.0059)			(0.0042)	(0.0053)	(0.0059)	(0.0059)	(0.0059)
Market Value	0.0610***		0.0715***		0.0704***	0.0605***	0.0678***	0.0615***
	(0.0066)		(0.0047)		(0.0057)	(0.0066)	(0.0067)	(0.0066)
B/M	-0.0133***		-0.0065	-0.0505***		-0.0121***	-0.0100**	-0.0131***
	(0.0048)		(0.0043)	(0.0047)		(0.0047)	(0.0047)	(0.0048)
Past Return	-0.0070***		-0.0071***	-0.0045**	-0.0055**		-0.0075***	-0.0071***
	(0.0022)		(0.0022)	(0.0023)	(0.0021)		(0.0022)	(0.0022)
R&D Expense	0.1368***		0.1333***	0.1619***	0.1337***	0.1371***		0.1372***
	(0.0295)		(0.0298)	(0.0290)	(0.0295)	(0.0295)		(0.0295)
Number of Patents	0.0149***		0.0147***	0.0180***	0.0146***	0.0149***	0.0213***	0.0149***
	(0.0024)		(0.0024)	(0.0025)	(0.0024)	(0.0024)	(0.0023)	(0.0024)
Cash Shock	0.0147*		0.0147	0.0231**	0.0141	0.0150*	0.0166*	
	(0.0089)		(0.0089)	(0.0090)	(0.0089)	(0.0089)	(0.0090)	
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	50,965	50,965	50,965	50,965	50,965	50,965	50,965	50,965
R2	0.28	0.23	0.28	0.28	0.28	0.28	0.28	0.28

Panel C. Specification with and without R&D Expense variable.

	Sued by NPE	Sued by NPE	Sued by NPE
Cash Level	0.0565***	0.0614***	0.0565***
	(0.0133)	(0.0132)	(0.0133)
Total Assets	0.0199**	0.0248***	0.0199**
	(0.0084)	(0.0084)	(0.0084)
Market Value	-0.0125	-0.0118	-0.0125
	(0.0083)	(0.0083)	(0.0083)
B/M	-0.0150**	-0.0153**	-0.0150**
	(0.0061)	(0.0061)	(0.0061)
Past Return	-0.0006	-0.0008	-0.0006
	(0.0025)	(0.0025)	(0.0025)
R&D Expense	0.1220**		0.1214**
	(0.0483)		(0.0484)
Number of Patents	0.0006	0.0016	0.0006
	(0.0038)	(0.0038)	(0.0038)
Cash Shock	0.0167**	0.0166**	0.0167**
	(0.0081)	(0.0081)	(0.0081)
Missing(R&D)			-0.0030
			(0.0103)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	50,965	50,965	50,965
R2	0.55	0.55	0.55

Appendix Table A4: NPE Categories and Analysis Using Alternative Sample from Cotropia, Kesan, and Schwartz (2014)

In Panel A of this appendix, we utilize a second sample, constructed by Cotropia, Kesan, and Schwartz (2014) and provided on npe-data.com (CKS). CKS hand-coded all patent-holder litigants from the years 2010 and 2012, and classified the nature of the litigants. CKS broke down the litigants into several categories of NPEs (such as "large aggregators" and "patent holding companies"). To accommodate comparability across databases, we matched plaintiff types into three broad categories: (1) Patent Assertion Entities (PAE), (2) Small Innovator, and (3) Other. We report the percentages of litigation by category, as a percentage of total cases with NPE plaintiffs. In tabulating the CKS database, we separated out 3,950 observations that are classified as PEs (labeled as "operating companies" by CKS). These cases are used to replicate our PE vs. PE analysis. In first column of Panel B, we conduct the same analysis as in Table II, for 2010 and 2012 using RPX data. In columns 2-5, we replicate our table V using the CKS data. Because the CKS data cover only two years (2010 and 2012), we cannot include firm fixed effects in the specification; however, we do include 4-digit SIC code fixed effects to capture industry-specific variation. In the last column of Panel B, we report the baseline result after excluding IT firms (SIC Code 35 (e.g., Apple and IBM) and SIC Code 73 (e.g., Yahoo and Ebay)). In Panel C, we perform a similar analysis for PE vs. PE cases. In column 1, we use RPX data for years 2010 and 2012. In Column 2, we define Sued by PE to be equal to 1 if a firm faces IP lawsuits from practicing entities (PEs) in a given year, as defined in CKS sample. In Column 3, we exclude pharmaceutical industries from the sample. Standard errors, clustered by firm, are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Panel A. NPE Classification Comparison

	RPX Database (2005-2015)			CKS Database (2010 and 2012)
PAE	NPE	87.98%	62.43%	Patent holding company
			10.13%	Large aggregator
Small Innovator	Inventor(s)	9.63%	15.67%	Individual/family trust
			1.31%	IP Holding company of operating
			3.22%	Technology development company
Other	NCE	1.31%	5.70%	Failed operating company/failed st.
	University/ Research Institute	1.07%	1.55%	University/College
	Number of cases (docket x court)	21,300	3,753	Number of cases (docket x court)

Panel B. Analysis using Data from Cotropia, Kesan and Schwartz (2014) : NPE vs. PE cases

	RPX	CKS	CKS	CKS	CKS
	Sued by NPE	Sued by NPE	Sued by PAE	Sued by Small Inventor	Sued by NPE (excluding IT)
Cash Level	0.0332*	0.0360**	0.0401***	0.0038	0.0384**
	(0.0199)	(0.0170)	(0.0126)	(0.0102)	(0.0158)
Total Assets	0.0321***	-0.0051	-0.0072	-0.0039	0.0043
	(0.0118)	(0.0074)	(0.0074)	(0.0035)	(0.0071)
Market Value	0.0702***	0.0354***	0.0284**	0.0181***	0.0234**
	(0.0166)	(0.0113)	(0.0113)	(0.0055)	(0.0107)
B/M	-0.0245*	-0.0177***	-0.0172***	-0.0015	-0.0207***
	(0.0125)	(0.0064)	(0.0064)	(0.0031)	(0.0070)
Past Return	-0.0101*	-0.0064*	-0.0058	-0.0021	-0.0072*
	(0.0052)	(0.0035)	(0.0035)	(0.0017)	(0.0040)
R&D Expense	0.1511***	0.1061	0.1122*	0.0566**	-0.003
	(0.0529)	(0.0674)	(0.0677)	(0.0247)	(0.0525)
Number of Patents	0.0175***	0.0125***	0.0084**	0.0044**	0.0062
	(0.0039)	(0.0041)	(0.0033)	(0.0019)	(0.0045)
Cash Shock	0.0081	0.0101	0.0105	0.0087	0.0016
	(0.0205)	(0.0173)	(0.0166)	(0.0112)	(0.0174)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	8,746	8,746	8,746	8,746	6,406
R2	0.35	0.17	0.16	0.13	0.17

Panel C. Analysis using Data from Cotropia, Kesan and Schwartz (2014) : PE vs. PE cases

	RPX	CKS	CKS
	Sued by PE	Sued by PE	Sued by PE (Excluding Pharma.)
Cash Level	-0.0125	0.0165	0.0209
	(0.0177)	(0.0161)	(0.0157)
Total Assets	0.0005	-0.0094	-0.0117*
	(0.0086)	(0.0070)	(0.0069)
Market Value	0.0493***	0.0405***	0.0381***
	(0.0108)	(0.0105)	(0.0103)
B/M	-0.0009	-0.0061	-0.0074
	(0.0067)	(0.0049)	(0.0050)
Past Return	-0.0036	0	-0.0001
	(0.0030)	(0.0037)	(0.0041)
R&D Expense	0.1591***	0.1177***	0.1404***
	(0.0414)	(0.0343)	(0.0454)
Number of Patents	0.0106***	0.0140***	0.0149***
	(0.0032)	(0.0027)	(0.0030)
Cash Shock	0.0076	0.0243	0.0317**
	(0.0177)	(0.0157)	(0.0150)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	8,746	8,746	8,209
R2	0.23	0.19	0.19

Appendix Table A5. PACER Nature of Suit Codes

This appendix lists the lawsuit codes and their descriptions as classified by PACER (https://www.PACER.gov/documents/natsuit.pdf).

Suit Type	PACER Suit Code	Nature of Suit
TORT	310	Airplane
	315	Airplane Product Liability
	320	Assault, Libel, & Slander
	330	Federal Employers's Liability
	340	Marine
	345	Marine Product Liability
	350	Motor Vehicle
	355	Motor Vehicle Product Liability
	360	Other Personal Injury
	362	Personal Injury- Medical Malpractice
	365	Personal Injury- Product Liability
	367	Personal Injury - Health Care
	368	Asbestos Personal Injury Product Liability
	375	False Claims Act
	370	Other Fraud
	371	Truth in Lending
	380	Other Personal Property Damage
	385	Property Damage Product Liability
CONTRACT	110	Insurance
	120	Marine
	130	Miller Act
	140	Negotiable Instrument
	150	Recovery of Overpayment & Enforcement of Judgment
	151	Medicare Act
	152	Recovery of Defaulted Student Loans (Excl. Veterans)
	153	Recovery of Overpayment of Veteran's Benefit
	160	Stockholders's Suit
	190	Other Contract
	195	Contract Product Liability
	196	Franchise
LABOR	710	Fair Labor Standards Act
	720	Labor/Management Relations
	730	Labor/Management Reporting & Disclosure Act
	740	Railway Labor Act
	751	Family and Medical Leave Act
	790	Other Labor Litigation
	791	Employee Retirement Income Security Act
SECURITIES	850	Securities/Commodities/Exchange
ENVIRONMENT	893	Environmental Matters

Appendix Table A6: PE vs. PE case coding

This appendix reports the criteria used to code case outcome variables for the PE vs. PE sample. We find docket numbers of PE vs. PE cases in Lex Machina and record "Patent Case Resolution." We then read the judgment to identify the nature of dismissal or the party that judgment favored. In cases where the judgment refers to stipulated dismissal, we code the outcome as "settlement." In Panel B, we report the distribution of PE vs. PE cases based on outcome.

Coded as	Criteria
Settlement	Likely Settlement: Stipulated Dismissal
Won by Plaintiff	Judgment: Consent Judgment : Claimant Win
Won by Defendant	Judgment: Consent Judgment : Claim Defendant Win
Dismissed	Judgement: Trial : Dismissed with prejudice
Dismissed	Judgement: Trial : Dismissed w/o prejudice
Not included	Stayed, Transfers or procedural dispositions

	PE vs. PE (%)	NPE vs. PE (%)
Dismissed	5.99	6.49
Lost by Plaintiff	9.53	5.68
Settled	72.73	87.39
Won by Plaintiff	11.75	0.45
Total dockets	451	6,042