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The Effect of Patent Litigation Insurance: Theory and Evidence from NPEs

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The Effect of Patent Litigation Insurance: Theory and Evidence from NPEs*

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Abstract

We analyze the extent to which private defensive litigation insurance deters patent assertion by non-practicing entities (NPEs). We study the effect that a patent-specific defensive insurance product, offered by a leading litigation insurer, had on the litigation behavior of insured patents' owners, all of which are NPEs. We first model the impact of defensive litigation insurance on the behavior of patent enforcers and accused infringers. We show that the availability of defensive litigation insurance can have an effect on how often patent enforcers will assert their patents. We confirm this result empirically showing that the insurance policy had a large, negative effect on the likelihood that a patent included in the policy was subsequently asserted relative to other patents held by the same NPEs and relative to patents held by other NPEs with portfolios that were entirely excluded from the insurance product. Our findings suggest that market-based mechanisms can deter so-called "patent trolling."

KEYWORDS: NPEs, patents, insurance, litigation

JEL Classification: G22, K41, O34

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1 Introduction

A dramatic increase in patent assertions by so-called patent "trolls" – companies that specialize in the enforcement of patent rights that they otherwise do not use – has been the focal point of U.S. patent law and policy debates for well over a decade. While there is at present no consensus on the overall economic impact of these "non-practicing" entities (NPEs), there is some evidence that NPEs' patent assertion activities negatively effect companies targeted for suit (Tucker, 2014; Cohen et al., 2017), leading many to conclude that NPEs likely have a detrimental effect on innovation more broadly (Bessen and Meurer, 2014; Lemley and Feldman, 2016; Cohen et al., 2016, 2019). In the U.S., these concerns have influenced the passage of a sweeping patent reform package, the introduction of dozens of additional bills, and the issuance of multiple, generally pro-defendant opinions by the Supreme Court, which in the two decades prior had all but ignored patent cases.[1,2]

In addition to drawing the attention of legislators and judges, concerns about the prevalence and expense of NPE patent enforcement have also led tech companies to seek private, market-based solutions. In recent years, for example, companies have banded together to form or fund a number of membership-based organizations that help share costs and align incentives among frequent targets of NPE assertion. While some such entities facilitate cross-licensing agreements among members to stem the flow of patents from tech companies to NPEs (the License on Transfer (LOT) Network), others accumulate funds that can be used to invalidate (Unified Patents) or to purchase (RPX and Allied Security Trust) NPE patents that might otherwise be asserted against their members.[3]

In this paper, we investigate another emerging market-based mechanism with the potential to reduce NPE activity: *defensive patent litigation insurance*. Unlike offensive (or abatement) insurance that reimburses the policyholder for expenses incurred to *enforce* its patent right against an infringer, defensive (or liability) insurance reimburses the policyholder for the cost of *defending* against allegations that it infringed another's patent rights.[4] In the last decade, the market for defensive patent litigation insurance has experienced a surge in demand, with some providers now offering policies specifically for NPE defense.[5] The experience of Octane Fitness, which in 2014 used the proceeds of a defensive

[1] In 2011, the U.S. Congress passed the Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011), which (among other reforms) established a Patent Trial and Appeal Board (PTAB) within the USPTO to review the validity of issued U.S. patents. In the years since, dozens of additional patent reform bills have been introduced in Congress (*Patent Progress*). For a discussion of the U.S. Supreme Court's newfound interest in patent law, see, e.g., Gugliuzza (2017).

[2] Concerns about NPEs have recently spread. In Europe, many worry that the continent's forthcoming Unified Patent Court will attract NPE activity (McDonagh, 2014; Kopelevich, 2017). In China, concerns about patent monetization have arisen in the wake of high-profile NPE suits filed both against Western tech companies like Apple (see Cohen, 2017) and by Western NPEs like WiLAN (see Mitchell, 2016).

[3] As of November 2019, more than 650 companies have joined the LOT network and pledged nearly 2.4 million patent assets. Unified Patents has more than 200 members and, as of March 2020, has challenged the validity of more than 185 patents.

[4] Because commercial general liability insurance policies provide scant, if any, coverage for harms related to IP rights (with the exception of coverage for "advertising injury," which in some circumstances may provide coverage for claims of IP infringement (Mayerson, 1995; Simensky and Osterberg, 1999)), a separate niche market has developed to insure against risks associated with IP infringement (CJA Consultants, 2003; Duchene, 2017). Both offensive and defensive patent litigation insurance are a form of legal-expense insurance, sometimes also referred to as legal-cost insurance. Brown (1952) is often credited with being the originator of the idea of legal-expense insurance (Stolz, 1968).

[5] Providers of defensive patent litigation policies in the U.S. presently include IPISC, RPX, Aon, AIG, Chubb, Lexington,

patent litigation insurance policy to fund its appeal in a high-profile U.S. Supreme Court case,[6] has also brought increased attention to this niche product in the insurance market. While the particular insurance policy in that case was not specifically designed to deter NPE patent assertion, Octane's widely-reported defensive victory nonetheless demonstrated the impact that insurance can have on a party's ability to counter infringement allegations, including the claims of NPEs. Surprisingly, despite the steep rise in both NPE case filings (Marco et al., 2017) and litigation insurance providers and products, there exists to date no systematic empirical evidence of the effect that defensive patent litigation insurance has on the behavior of NPEs and the companies that they sue. Our goal is to fill this gap in the literature.

We study – both theoretically and empirically – the effect of a defensive insurance policy on litigation behavior.[7] We pay special attention to how insurance impacts an NPE's decision to file a lawsuit and (conditional on a suit being brought) the accused infringer's willingness to settle. We first propose a simple model in which an NPE can sue a firm for patent infringement and the parties can negotiate a settlement before trial. For these settlement negotiations, we follow (and eventually extend) Bebchuk (1984) by assuming that the NPE's probability of winning its case is known only to the firm.[8] Before the NPE decides whether to file suit and before the firm observes the NPE's success probability, the firm can obtain patent litigation insurance that covers litigation costs (but not damages), thus improving the firm's outside option in settlement negotiations.[9] Our model assumes that the insurance decision is observed by the NPE. The insurer is a monopolist that uses one of two insurance pricing strategies: a contingent insurance premium that varies with firm size, or a uniform insurance premium offered to all firms, regardless of size.[10]

The NPE's decision to file a lawsuit depends on its expected payoffs from litigation (given the firm's insurance decision) and its total costs of patent assertion. In our framework, the total cost of patent assertion includes both the cost of initiating litigation and an opportunity cost in the form of a lost option value from future infringement suits. This opportunity cost captures the NPE's risk of invalidation and arises because (outside of our model) the firm can attempt to invalidate the asserted patent as part of its defense. If the patent is indeed invalidated, no further infringement suits with potential infringement damages payments are feasible and, consequently, the NPE's future revenue stream is

the Association of National Advertisers (ANA), and Unified Patents. In Europe, London Lloyd's and Allianz offer policies as well.

[6] Octane Fitness, LLC v. ION Health & Fitness, Inc., 572 U.S. 545 (2014).

[7] The defensive insurance policy is a special case of legal-expense insurance as studied, for instance, by Kirstein (2000) or Baik and Kim (2007). Such insurance can be viewed as a form of third-party litigation funding. Faure and de Mot (2012) provide a direct comparison of third-party litigation funding (not including funding via insurance) and legal-expense insurance. Prescott et al. (2014), Prescott and Spier (2016), de Mot and Faure (2016), Spier and Prescott (2019), or Lavie and Tabbach (2020) study the functioning of more general third-party litigation funding mechanisms.

[8] Given this assumption, pretrial settlement negotiations are under asymmetric information. For other classic contributions to the literature on bargaining under asymmetric information in law and economics, see Reinganum and Wilde (1986), Nalebuff (1987), or Kennan and Wilson (1993).

[9] For our model, we assume that the firm retains the decision to settle the case and is in control of the terms of the settlement. We further assume there is no renegotiation with the insurance company. We confirmed the reasonableness of this assumption with the insurance provider.

[10] In our framework, the insurance premium is the monopolist's only choice variable. For a more thorough theoretical analysis of liability insurance policies in different competitive environments, see Lemus et al. (forthcoming).

significantly reduced.[11]

We show that, within our framework, an insured firm will not accept an NPE's settlement offer and therefore will proceed to trial (and place the NPE's future revenue at risk) if sued. Anticipating the effects of insurance on their expected payoffs (from settlement or trial), NPEs with sufficiently high total costs of patent assertion will refrain from filing a lawsuit. NPEs with low total costs of patent assertion, on the other hand, will bring suit irrespective of the firm's insurance status. As a consequence, firms that expect insurance to reduce their litigation exposure (i.e., firms that otherwise anticipate being targeted by higher-cost NPEs) have a higher willingness to pay for insurance than firms that anticipate being sued by low-cost NPEs whether or not they elect to buy insurance. We also show that the firm's willingness to pay increases with firm size (which we assume to be related to potential infringement damages).

The effect of insurance on the firm's willingness to pay, in turn, affects the insurance company's pricing decision. When the insurer uses contingent insurance pricing, firms that anticipate litigation by low-cost NPEs are priced out. In equilibrium, the insurer sets a high premium and provides coverage only to firms for which insurance reduces litigation exposure.[12] As a result, in equilibrium, the insurer never reimburses litigation costs because NPEs sue only firms without insurance. When the insurance premium is uniform (and not a function of firm size), small firms are priced out of the market (because their willingness to pay is lower than the uniform premium), whereas large firms buy insurance even when it does not serve as a deterrent. In this scenario, the insurer reimburses some litigation costs in equilibrium to large firms.

From equilibrium results of the model, we derive three main predictions. First, we find that, for both pricing strategies, the introduction of insurance decreases the likelihood that an NPE brings a patent infringement suit. Second, in a scenario with uniform insurance pricing, we find that insurance also reduces the likelihood that a case, once brought, is settled. Under contingent insurance pricing, this effect vanishes, however. Third, we show that insurance has ambiguous effects on the likelihood that small and medium-sized firms (SMEs) are targeted by NPEs.[13] With contingent pricing, our model predicts a decrease in the likelihood that SMEs are sued; however, with uniform insurance pricing (or a premium structure that is *not sufficiently contingent* on size), our model predicts that SMEs will be targeted more often.

[11] We take a simplified reduced-form approach by assuming that these costs are incurred at the time the NPE files its lawsuit. With this assumption, our work is related to the literature on externalities in litigation (Choi, 1998; Farrell and Merges, 2004; Farrell and Shapiro, 2008), because defending patent infringement suits generates uncompensated positive externalities for one's competitors (in particular when invalidation actions are involved). Note that, for the opportunity costs to arise, we assume the application of offensive non-mutual collateral estoppel (which prevents a patentee from further assertion of a patent that has been held invalid). Mycogen Plant Sci., Inc. v. Monsanto Co., 252 F.3d 1306, 1310 (Fed. Cir. 2001) ("It is undisputed that as a result of collateral estoppel, a judgment of invalidity in one patent action renders the patent invalid in any later actions based on the same patent." (citing Blonder-Tongue Labs., Inc. v. Univ. of Illinois Found., 402 U.S. 313, 349-50 (1971))).

[12] Insurance serves as a litigation deterrent when NPEs have higher opportunity costs of litigation (i.e., higher lost option value of future infringement actions). This means that insurance deters NPEs that expect to lose high revenue streams from licensing or litigation – possibly because they hold weak patents and expect them to be invalidated with a high probability. The insurance deterrence effect is therefore stronger when there are larger externalities in litigation.

[13] The vulnerability of SMEs is a concern that has played a central role in recent patent reform debates in the U.S. and Europe (e.g., European Commission, 2014).

Next, to quantify the effect of litigation insurance on NPEs' litigation behavior, we analyze the effect of a defensive litigation insurance product offered in recent years by the Intellectual Property Insurance Services Corporation (IPISC), a leading provider of insurance policies related to intellectual property (IP) rights. Uniquely among comparable insurance packages, this "troll defense" insurance product insures not against NPE litigation generally, but rather against the assertion of specific patents included on two publicly-accessible lists. If one or more of these patents is asserted against an insured party, IPISC reimburses (subject to deductibles, co-insurance, and caps) the insured company for expenses incurred to defend itself against infringement allegations, including by challenging the patent's validity.[14]

By taking advantage of the policy's applicability to specific patents, we are able to study NPEs' responses to the policy's introduction and, by virtue of this methodology, avoid the difficulties inherent in attempting instead to measure the policy's effect on purchasers. To determine the effect of IPISC's policy on litigation, we employ a difference-in-differences design that compares patent assertions in U.S. district courts before and after the insurance policy's launch. Our treatment group consists of all patents covered by IPISC's NPE insurance policy ("insured patents"). For our comparison group, we use patents that are not covered by the insurance ("uninsured patents"). To address potential spill-over effects between insured and uninsured patents held by the same NPEs, we construct three different comparison groups. Comparison Group 1 comprises all uninsured patents owned by those NPEs that own insured patents. Comparison Group 2 comprises all patents in Comparison Group 1 plus all uninsured patents owned by the parents, subsidiaries, and affiliates of NPEs that own insured patents. Finally, Comparison Group 3 comprises all patents owned by all NPEs that were not impacted by the insurance policy. In addition, we match each set of comparison patents to our set of insured patents using a variety of observable patent characteristics that determined insurance coverage according to information obtained directly from IPISC.

We present three main findings. First, the availability of insurance had a negative effect on the likelihood that a patent included in the policy was subsequently asserted, and our results are robust across all comparison groups that we constructed. Second, among defendants accused of infringing insured patents, we see an increase in the share of SMEs targeted once insurance becomes available. Thus, a potential unintended consequence of insurance may be that NPEs target smaller companies more often, perhaps because SMEs are priced out of the market for litigation insurance when the insurance premium structure is not sufficiently contingent (that is, too uniform). Third, we find that the availability of insurance impacted NPE patent sales and acquisitions. NPEs were less likely to sell insured patents following the launch of IPISC's policy, and NPEs with a relatively large ratio of insured-over-uninsured patents in their portfolios were more likely to acquire new patents post-launch.

Our model and empirical findings shed new light on the dynamics of NPE litigation and, more

[14] The policy does not reimburse any damages payable in case the insured company loses the court case.

broadly, the effects of litigation insurance. Perhaps most importantly from a policy perspective, our results suggest that private market-based mechanisms can deter NPE activity,[15] a finding that has importance for ongoing debates among scholars and policymakers about the need for further legislative or judicial reform of patent systems across the globe. More generally, our paper also advances the study of legal expense insurance. To our knowledge, no empirical studies of patent litigation insurance have been attempted to date, and few have attempted an inferential analysis of legal expense insurance in any context (what few causal studies exist, focus on auto insurance (e.g., Fenn and Rickman, 2001)). Overall, the existing empirical literature is primarily descriptive in nature and concentrates on individuals' access to legal services rather than insurance's effect on outcomes.[16] Similarly, we are aware of just one existing theoretical model of patent litigation insurance (Lemus et al., forthcoming), and very few studies of defensive litigation insurance in any context. The existing theoretical literature focuses on offensive litigation insurance and shows that such policies could be used to deter potential market entrants (van Velthoven and van Wijck, 2001; Heyes et al., 2004; Llobet and Suarez, 2012) and may be attractive even to risk-neutral agents (Kirstein, 2000). Among the few who have examined defensive insurance are Kirstein (2000), who studies the insurance decisions of both parties in an accident model, and Baik and Kim (2007), who model litigation as a contest with delegation and find that a defendant's legal expense insurance may result in more litigation spending. Most relevant to our analysis is Lemus et al. (forthcoming), who study defensive patent litigation insurance (to motivate their work on liability insurance) but focus on the design of optimal liability insurance contracts. Our model differs substantially in that we take the non-price features of the insurance contract as given and assume simple insurance pricing strategies to focus instead on the effect of such an insurance contract on litigation.

The remainder of the article is organized as follows. In Section 2, we develop a model of defensive insurance's impact on NPE behavior. In Section 3, we provide a detailed description of the specific insurance policy used in our analysis and explain our data collection methodology. In Section 4, we discuss the selection of patents into the insurance policy. In Section 5, we present our main empirical results, and we offer concluding remarks in Section 6.

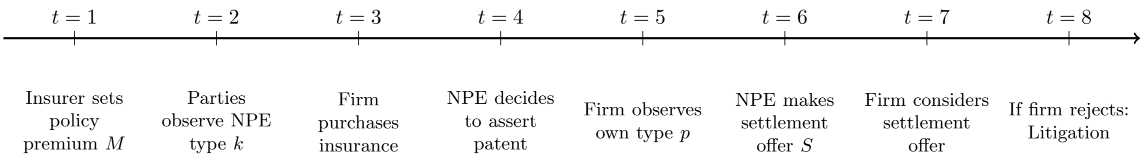
2 Model

For our insurance-litigation model, we extend a simplified version of the model of settlement and litigation with private information in Bebchuk (1984) by considering (1) the insurer's pricing decision for the insurance policy, (2) a potential defendant firm's decision to purchase litigation insurance, and (3) the

[15] We find this despite the difficulties inherent in such deterrence. In many respects, NPE patent assertion resembles a classic collective action problem. For instance, despite decrying NPE lawsuits, operating technology companies are themselves the source of the majority of patents acquired by NPEs (Love et al., 2018). In addition, defending patent infringement suits generates uncompensated positive externalities for one's competitors (Farrell and Merges, 2004).

[16] See for example, Wilson and Wydrzynski (1978) for Canada, Blankenburg (1982) and Kilian (2003) for Germany, Rickman and Fenn (1998) for England and Wales, or Regan (2003) for Sweden).

Figure 1: Timeline



plaintiff NPE's decision to bring a lawsuit. We depict the timeline of our model in Figure 1 and summarize the notation in Table 1.

2.1 Timing and Notation

There are two parties, a firm (a potential defendant) and an NPE (the plaintiff). Both parties are risk neutral. Through its product market activities, the firm of size $\omega > 0$ may infringe an existing patent (held by the NPE)[17] upon which the NPE can sue for patent infringement damages.[18] Potential infringement damages $W > 0$ are a monotonically increasing function of firm size, $W = W(\omega)$, allowing for a simple way to consider firm size in our model.[19]

The NPE's win probability in litigation is denoted by p. It is drawn from a distribution on the support $[\underline{p}, \overline{p}]$, $0 < \underline{p} < \overline{p} \leq 1$, with a pdf $f(\cdot)$ and cdf $F(\cdot)$. For the sake of tractability, we assume the firm's type is uniformly distributed. We further assume $\overline{p} = 1$ so that $p \sim U[\underline{p}, 1]$. As in Bebchuk (1984), we assume that the firm knows the realization of p, while the NPE knows only its distribution.[20]

Before the case goes to trial, the parties enter settlement negotiations in which the NPE makes a take-it-or-leave-it offer S. If the firm accepts the offer, the case is closed. If the firm rejects and the case goes to trial, the firm incurs litigation costs C_d. We assume that the NPE's litigation costs C_p are included in its total costs of patent assertion k, incurred at the time of filing the case in $t = 4$, so that $C_p = 0$.[21] Total costs of patent assertion comprise nominal filing fees as well as opportunity costs

[17] This does not mean that the firm actually copied the infringing technology. To the contrary, copying is rarely alleged in U.S. patent litigation (Cotropia and Lemley, 2009).

[18] Note that while many patentees do attempt to license their rights before filing suit (Lemley et al., 2019), this is not a common strategy among sophisticated NPEs, which tend to file suit without warning in order to secure venue in one of a small number of favorable jurisdictions (Love and Yoon, 2017). This motivates our assumption of assertion without licensing.

[19] For supporting empirical evidence, see, for instance, Mazzeo et al. (2013). For a theoretical motivation, suppose damages are based on reasonable royalties, with ρ the royalty rate and the firm's patent-specific revenues $R(\omega)$ as royalty base. Assuming that revenues are higher for larger firms, so that $R(\omega)$ is increasing in ω, we get potential damages $W(\omega) = \rho R(\omega)$ increasing in ω.

[20] An exogenous value of p is inconsistent with willful infringement (as a consequence of moral hazard) which would presumably be excluded from coverage in any policy actually offered for sale. In principle, any patent infringement could be deemed "intentional" to some extent because all issued patents become public documents. However, in practice, pre-clearance of patent rights is generally regarded as not cost-effective and, in fact, may be practically impossible in some markets (especially those where NPEs are active). Mulligan and Lee (2012) estimate that "[i]n software, for example, patent clearance by all firms would require many times more hours of legal research than all patent lawyers in the United States can bill in a year" because "there are around twenty-four billion new [software] patent-firm pairs each year that could produce accidental infringement." As a result, it is generally assumed that tech firms ignore other firms' patents unless and until they are accused of infringement (Lemley, 2008).

[21] Because the NPE incurs these total costs of patent assertion at the time of filing in $t = 4$ and litigation costs in $t = 8$ are zero, the NPE has no reason to drop a case once the firm has rejected a settlement offer because expected payoffs are non-negative even for the lowest p. The technical assumption in Bebchuk (1984) (that a plaintiff does not drop the case upon the defendant's rejection of the settlement offer) trivially holds true in our model because $C_p = 0$.

Table 1: Model Parameters

Variable	Description
$\omega > 0$	Firm size
$W > 0$	Potential patent infringement damages; monotonically increasing in firm size ω
$p \in [\underline{p}, 1]$	NPE's win probability, with pdf $f(\cdot)$ and cdf $F(\cdot)$; uniformly distributed
$k \in [0, \bar{k}]$	NPE's total costs of patent assertion, with pdf $g(\cdot)$ and cdf $G(\cdot)$; uniformly distributed
$C_d > 0$	Firm's litigation costs
$C_p = 0$	NPE's litigation costs
M; M^m	Insurance premium; profit-maximizing premium
$\Phi(M)$; $C_s(M)$	Insurer's demand function; insurer's marginal costs of providing insurance
$\Pi(M)$	Insurer's profits
$\widetilde{M}$, $\widehat{M}$	Firm's willingness to pay for insurance

stemming from the risk of invalidation (i.e., the lost option value from future infringement law suits).[22] We introduce total costs of patent assertion as an NPE-specific parameter on the support $[0, \bar{k}]$ and will for brevity refer to it as the NPE's *type*. For tractability, we assume that the upper bound of the support of k falls within the following interval:

Assumption 1. *The upper bound for the NPE's type k satisfies the following condition:*

$$\bar{k} \in \left(\frac{C_d}{1-\underline{p}}, \frac{C_d}{1-\underline{p}} \left[1 + \underline{p} + \sqrt{2\left(1+\underline{p}\right)} \right] \right)$$

The lower bound of this interval ensures litigation in equilibrium. The upper bound is for tractability of the insurance pricing decision. The population distribution (assumed to be uniform) of k is common knowledge, with pdf $g(\cdot)$ and cdf $G(\cdot)$.

Before observing the success probability and the NPE's decision to bring suit, the firm has the option to buy a defensive litigation insurance policy at a premium of M. This insurance policy covers the firm's litigation costs when it decides to defend in a patent litigation lawsuit. The firm retains the decision to settle the case and is in control of the terms of the settlement. We further assume there is no renegotiation with the insurance company.

The insurance premium is set by a monopolistic insurer. We restrict the insurer's pricing strategies to a uniform premium with respect to the firm's type p and the NPE's type k.[23] We do consider, however, a pricing strategy that allows the insurer to set an insurance premium as a function of firm size. The insurer chooses the optimal price $M(W)$ given the population densities for $p \sim U[\underline{p}, 1]$ and $k \sim U[0, \bar{k}]$. The insurer operates at marginal costs C_s that are equal to the expected reimbursed litigation costs.

[22] When an NPE asserts a patent, the firm may counter with a defense and/or counterclaim. If the NPE's patent is indeed invalidated, no further infringement suits with potential infringement damages payments are feasible.

[23] We refer to p as the firm's type because the firm has private knowledge over the NPE's win probability in court. The NPE's type k is observed by all parties after the firm makes its insurance purchase decision.

2.2 Information

We have assumed the NPE observes the firm's insurance purchase decision and thus knows the firm's litigation costs ($\tilde{C} = C_d$ without insurance and $\tilde{C} = 0$ with insurance).[24] Our model further contains two random variables. The firm's type p is the NPE's probability of winning at trial. Following Bebchuk (1984), the firm's type is its private information, observed *after* the insurance purchase. The second random variable is the NPE's type. The suing NPE's opportunity cost is a function of the insurance policy (and a function of whether that NPE's patents are included in the policy). By the time the firm buys insurance, it knows the details of the insurance policy and can form expectations about which NPEs are likely affected by the policy and likely to file suit for infringement of a patent that is covered by the policy. This allows the firm to form expectations about the NPE's type k that is likely to file suit (in $t = 4$).

2.3 Equilibrium Analysis

We solve for the subgame perfect equilibrium by backward induction, starting with the last period and gradually moving toward the first stage of the game.

2.3.1 Litigation and Settlement

The analysis in this first step follows Bebchuk (1984). We present the equilibrium settlement offer and settlement likelihood of this subgame (periods $t = 6$, $t = 7$, and $t = 8$) in Lemma 1 below. Notational details are in the proof in the Appendix.

In the last period $t = 8$ of the game (see Figure 1), when the case goes to trial, the NPE's gross expected payoffs (not accounting for costs k) are $A = pW$ and do not depend on the firm's insurance status. The gross payoffs (not accounting for the costs M of purchasing the insurance policy) for the firm are $B(\tilde{C}) = -pW - \tilde{C}$ where $\tilde{C} = C_d$ for the firm without insurance and $\tilde{C} = 0$ for a firm with insurance. If a case is settled, the payoffs are S for the NPE and $-S$ for the firm.

In period $t = 7$, the firm accepts the NPE's settlement offer if $-S \geq B(\tilde{C})$. This condition holds as long as the NPE's success probability at trial is sufficiently high such that $p \geq q = q(S, \tilde{C})$ where

$$q(S, \tilde{C}) = \frac{S - \tilde{C}}{W}. \tag{1}$$

If the firm rejects the offer, the case goes to trial.[25]

[24] In models with symmetric information, litigation does not typically arise in equilibrium. Private information about the success of litigation (as in this paper) is one way of introducing frictions in the settlement negotiations that result in litigation as an equilibrium phenomenon. In Ganglmair et al. (2018), we take a different approach. We have symmetric information about the NPE's success probability, but assume that the firm's insurance decision is not observed by the NPE.

[25] Bebchuk (1984) explicitly assumes that litigation has a positive expected value even for the lowest value of p. Given our assumption of $C_p = 0$, this condition is always satisfied because $A = \underline{p}W \geq 0$.

In $t = 6$, when it makes the settlement offer S, the NPE anticipates that the firm will accept the offer with probability $1 - F(q)$, in which case the parties' payoffs are S for the NPE and $-S$ for the firm. The firm will reject the offer with probability $F(q)$, when $p < q$, and the case moves on to trial. The NPE expects to win at trial with the conditional win probability of $\hat{p}(q) = \frac{\int_{\underline{p}}^{q} x f(x) dx}{F(q)}$. The NPE's payoffs, as a function of the settlement offer S and the firm's litigation costs $\tilde{C} \in \{0, C_d\}$ (through the firm's decision to accept or reject the settlement offer), are denoted by $A(S, \tilde{C}) = (1 - F(q))\, S + F(q)\hat{p}(q)W$. The NPE offers a settlement amount $S = S^*$ so as to maximize these expected payoffs.

Lemma 1 (Settlement)**.**

1. *For a firm without insurance (and $\tilde{C} = C_d > 0$), the equilibrium settlement offer is*

$$S^* = \begin{cases} \underline{p}W + \tilde{C} & \text{if } W \leq \frac{\tilde{C}}{1-\underline{p}} \\ W & \text{if } W > \frac{\tilde{C}}{1-\underline{p}}. \end{cases} \tag{2}$$

   For a firm with insurance (and $\tilde{C} = 0$), any settlement offer $S^* \geq W$ is optimal.

2. *The likelihood of the parties settling the case,*

$$\mathcal{L}^* = \begin{cases} 1 & \text{if } W \leq \frac{\tilde{C}}{1-\underline{p}} \\ \frac{\tilde{C}}{(1-\underline{p})W} & \text{if } \frac{\tilde{C}}{1-\underline{p}} < W < W + \tilde{C} \\ 0 & \text{if } W \geq W + \tilde{C}, \end{cases} \tag{3}$$

   is lower with insurance. For firms without insurance, it is constant ($= 1$) in firm size for small firms and decreasing in firm size for larger firms. For firms with insurance (and $\tilde{C} = 0$), it is equal to zero.

As in Bebchuk (1984), the likelihood of settlement is increasing in litigation costs. We further show that, given no insurance, smaller firms are more likely to settle (and small firms with $W \leq \frac{\tilde{C}}{1-\underline{p}}$ always settle). With insurance, firms never settle.

2.3.2 Patent Assertion

From here on, our model extends the work by Bebchuk (1984). In $t = 4$, the NPE will have observed whether or not the firm purchased insurance. Moreover, it will know its own type (and total costs of patent assertion) k. Given this information, the NPE asserts the patent and brings a patent infringement suit[26] if the expected payoffs from litigation (or settlement), $A^*(\tilde{C}) := A(S^*, \tilde{C})$, outweigh the total costs

[26] Of course, at this stage, before formally filing the case, the parties could enter into pre-filing settlement negotiations. The exact timing of the firm observing the NPE's type does not change this but will merely affect the type of bargaining game the parties will play. We do not consider such settlement negotiations *before* a case is filed but instead refer to He (2020) for a formal treatment.

of patent assertion, $A^*(\tilde{C}) \geq k$, with

$$A^*(\tilde{C}) = \begin{cases} \underline{p}W + \tilde{C} & \text{if } W \leq \frac{\tilde{C}}{1-\underline{p}} \\ \frac{(1+\underline{p})W}{2} + \frac{\tilde{C}^2}{2(1-\underline{p})W} & \text{if } W > \frac{\tilde{C}}{1-\underline{p}}. \end{cases} \tag{4}$$

Lemma 2 (Patent Assertion)**.** *The NPE's expected payoffs from litigation are lower when the firm has purchased insurance, $A^*(C_d) > A^*(0)$. The NPE's decision to file suit is a function of its type k:*

1. *If $k \leq A^*(0)$, the NPE plaintiff always files a lawsuit, regardless of the firm's insurance status.*

2. *If $A^*(0) < k \leq A^*(C_d)$, the NPE files a lawsuit if and only if the firm has not purchased insurance.*

3. *If $k > A^*(C_d)$, the NPE never files suit.*

The NPE benefits from higher C_d as it is able to extract a higher expected settlement from the firm. This further implies that, given the firm's insurance status, the NPE is more likely to bring suit when the firm's litigation costs are higher (the right-hand-side arm of $A^*(C_d)$, for higher values of W, is shifting upward). For low total costs of patent assertion, the NPE always files a suit, regardless of the firm's insurance status. For high total costs of patent assertion, the NPE never files a suit. It is for intermediate values of k where the insurance policy has a litigation-deterrent effect: the NPE files if, and only if, the firm has not purchased an insurance policy.

Corollary 1. *Conditional on the firm's insurance status, the NPE is more likely to sue larger firms. Moreover, insurance is less effective as a deterrent for litigation when firms are larger.*

2.3.3 Insurance Purchase

Given uncertainty about its own type p in $t = 3$, the firm's expected payoffs (*gross* of the insurance premium) when the NPE files suit are

$$B^*(\tilde{C}) = -\left(1 - F(q^*)\right) S^* - F(q^*)\left[\hat{p}(q^*)W + \tilde{C}\right] \tag{5}$$

with $q^* = q(S^*, \tilde{C})$. The firm's payoffs from the case when the NPE decides not to file are normalized to zero. Observing the insurance policy in $t = 1$ allows the firm to form expectations about the NPE's type k and thus anticipate the (respective) NPE's decision to file suit (given the firm's insurance status). The firm's expected payoffs with insurance (now *net* of the insurance premium) are

$$B^*(\tilde{C} = 0) - M = \begin{cases} -\left(1 - F(q^*)\right) S^* - F(q^*)\hat{p}(q^*)W - M & \text{if } k \leq A^*(0) \\ -M & \text{if } k > A^*(0). \end{cases} \tag{6}$$

The expected payoffs for a firm without insurance are

$$B^*(\tilde{C} = C_d) = \begin{cases} -(1 - F(q^*))\, S^* - F(q^*)\, [\hat{p}(q^*)W + C_d] & \text{if } k \leq A^*(C_d) \\ 0 & \text{if } k > A^*(C_d). \end{cases} \tag{7}$$

Notice the different critical thresholds for k in equations (6) and (7). We summarize the firm's decision to purchase insurance as follows:

Lemma 3 (Insurance Decision)**.**

1. *For low NPE types, $k \leq A^*(0)$, the firm buys insurance if $M \leq \widehat{M}(W)$ with*

$$\widehat{M}(W) = \begin{cases} C_d - \frac{(1-\underline{p})W}{2} & \text{if } W \leq \frac{C_d}{1-\underline{p}} \\ C_d \left[1 - \frac{C_d}{2W(1-\underline{p})}\right] & \text{if } W > \frac{C_d}{1-\underline{p}}. \end{cases} \tag{8}$$

2. *For intermediate NPE types, $A^*(0) < k \leq A^*(C_d)$, the firm buys insurance if $M \leq \widetilde{M}(W)$ with*

$$\widetilde{M}(W) = \widehat{M}(W) + \frac{(1+\underline{p})\, W}{2} = \begin{cases} C_d + \underline{p}W & \text{if } W \leq \frac{C_d}{1-\underline{p}} \\ C_d \left[1 - \frac{C_d}{2W(1-\underline{p})}\right] + \frac{(1+\underline{p})W}{2} & \text{if } W > \frac{C_d}{1-\underline{p}}. \end{cases} \tag{9}$$

3. *For high NPE types, $k > A^*(0)$, the firm does not buy insurance.*

The firm's willingness to pay for insurance when the NPE is of intermediate type k (and insurance is an effective deterrent) is higher than when the NPE is of low type (and the NPE files suit regardless of the insurance status), $\widetilde{M}(W) > \widehat{M}(W)$. This deterrence effect comes at additional value to the firm, and the willingness to pay reflects that.

2.3.4 Policy Pricing

At the outset of the game, in period $t = 1$, an insurance company designs an insurance policy and sets a premium M. We take the policy as given and derive the equilibrium insurance premium. We first consider a scenario in which the insurance company can set the insurance premium as a function of firm size (and thus of potential, or expected, damages). For a second (and simpler) scenario, we assume the insurance company sets a uniform premium for the policy.

Firm-Size Contingent Insurance Premium. The insurance company is a monopolist and chooses a premium M^m that maximizes its expected profits

$$\Pi(M) = \Phi(M)\, [M - C_s(M)] \tag{10}$$

where $\Phi(M)$ denotes the demand for insurance and $C_s(M)$ the marginal costs of offering insurance (in the form of litigation costs reimbursements), both as functions of the insurance premium.

For a firm of size ω and potential (or expected) damages $W = W(\omega)$, the insurance company forms expectations about the demand for the insurance policy given the population distribution of the NPE's type k (characterized by its cdf $G(\cdot)$) and the firm's insurance purchase decision (as function of k) in Lemma 3.[27] The demand for insurance is equal to

$$\Phi(M) = \begin{cases} G(A^*(C_d)) & \text{if } M \leq \widehat{M} \\ G(A^*(C_d)) - G(A^*(C_0)) & \text{if } \widehat{M} < M \leq \widetilde{M} \\ 0 & \text{if } M > \widetilde{M}. \end{cases} \tag{11}$$

Given $A^*(C_d) > A^*(0)$ so that $G(A^*(C_d)) > G(A^*(0))$, the demand function is decreasing in the insurance premium.

The marginal costs of insurance are the expected costs from reimbursing litigation costs C_d if a case goes to trial. The insurer incurs these costs when the firm purchases insurance and the NPE sues an insured firm. This is the case for $M < \widehat{M}$ and $k \leq A^*(0)$. Moreover, in case the NPE files a suit, the case goes to trial with probability $1 - \mathcal{L}^*(0) = 1$. Putting the pieces together, the insurer's marginal cost function is

$$C_s(M) = \begin{cases} G(A^*(0))C_d & \text{if } M \leq \widehat{M} \\ 0 & \text{if } M > \widehat{M}. \end{cases} \tag{12}$$

Profits are a step-function of M, and the profit-maximizing premium is $M^m \in \{\widehat{M}, \widetilde{M}\}$. For the lower premium, $M^m = \widehat{M}(W)$, the insurance company incurs marginal costs as it has to reimburse the firm for its litigation costs whenever the firm rejects the NPE's settlement offer. For the higher insurance premium, $M^m = \widetilde{M}(W)$, the insurance company sells fewer policies but does not have to reimburse litigation costs – because the firm purchases insurance only for intermediate values of k, and NPEs with intermediate values of k only file suit against uninsured firms. Because the respective levels of willingness to pay are functions of firm size (or rather, functions of potential damages $W(\omega)$ that are, by assumption, a function of firm size), the insurance premium is a function of firm size.

Lemma 4 (Contingent Insurance Pricing)**.** *The insurance premium is $M^m = \widetilde{M}(W)$ for all $W(\omega)$ so that the firm buys insurance only for intermediate type NPEs. The insurance company does not sell policies to sufficiently large firms with $W(\omega) \geq \frac{2\bar{k}}{1+\underline{p}}$.*

In equilibrium, in the scenario of contingent insurance pricing, the insurance company sets the higher premium. It thus foregoes sales and revenue (because firms purchase insurance only for intermediate

[27]Assuming a firm population with unit mass, the demand function $\Phi(M)$ reflects the share of firms that purchase insurance for a given premium M.

values of k) in exchange for never having to reimburse litigation costs. Because for intermediate levels of k, the NPE does not sue firms with insurance, in equilibrium, the insurance company does not incur any reimbursement costs. Further, observe that for sufficiently large firms (with sufficiently high W), the optimal insurance premium is too high for any firm to purchase an insurance policy. With contingent insurance pricing, we would expect smaller firms to be more eager to buy insurance (at lower cost than larger firms).

Corollary 2. *The equilibrium insurance premium is increasing in firm size.*

With the previous results, we can now characterize the equilibrium outcome of the insurance-litigation game when the insurance premium is a function of firm size.

Proposition 1 (Equilibrium Outcome with Contingent Insurance Pricing)**.** *In the subgame perfect equilibrium of the insurance-litigation game with a firm size-contingent insurance premium, the equilibrium outcome is as follows: The insurer sells the policy at a high premium so that only firms anticipating suit by intermediate type NPEs will purchase it. As a consequence, only NPEs of low type sue for patent infringement (suing only firms without insurance for patent infringement). These cases settle with probability* $\mathcal{L}^* = 1$ *for a settlement amount* $S^* = \underline{p}W + C_d$ *(for low* W*) or strictly positive probability* $\mathcal{L}^* = \frac{C_d}{(1-\underline{p})W}$ *and settlement amount* $S^* = W$ *and (for high* W*).*

Because of the high premium, firms buy insurance only if it serves as a deterrent (for intermediate values of k). This, in return, implies that only NPEs of low type will sue firms for patent infringement. Intermediate-type NPEs, those with relatively higher opportunity costs of litigation (e.g., from higher lost option value of future infringement actions) are deterred. This insurance deterrence effect therefore arises when there are larger externalities in litigation (Choi, 1998; Farrell and Merges, 2004; Farrell and Shapiro, 2008).

In our second scenario with uniform insurance pricing below, we show a more differentiated picture, especially for small firms.

Uniform Insurance Premium. For the second pricing scenario, we assume that the insurance provider is limited in its pricing choices and can set only a uniform insurance premium – not contingent on firm size.

The expressions for insurance demand, marginal costs, and profits in equations (10), (11), and (12) continue to apply. In this scenario, however, the insurance company also takes expectations over firm size ω (and thus potential damages W). We do not desire to make any assumptions about the functional form of the distributions ω and W but instead assume an interior solution of the pricing stage of our insurance-litigation game. In this interior solution, the uniform insurance premium is too high for some small firms to ever buy insurance and sufficiently low for some large firms to buy insurance for all but the high NPE types:

$$M > \widetilde{M}(W) \qquad \text{for some} \qquad W < \overline{W}_{\text{small}} \tag{13}$$

$$M < \widehat{M}(W) \qquad \text{for some} \qquad W > \overline{W}_{\text{large}}. \tag{14}$$

Notice that all other (medium-sized) firms are behaviorally equivalent to the firms in our first scenario. These firms buy insurance only for intermediate NPE types (as in Proposition 1). We summarize this interior solution in the following lemma:

Lemma 5 (Uniform Insurance Pricing)**.** *In an interior solution for the pricing stage of the insurance-litigation game, the insurance premium is such that small firms with* $W < \overline{W}_{small}$ *never buy insurance, medium firms with* $W \in [\overline{W}_{small}, \overline{W}_{large}]$ *buy insurance only for intermediate NPE types, and large firms with* $W > \overline{W}_{large}$ *buy insurance for all but high NPE types.*

Given the solution in Lemma 5, the equilibrium outcome of the scenario with a uniform insurance premium is as follows:

Proposition 2 (Equilibrium Outcome with Uniform Insurance Pricing)**.** *In the subgame perfect equilibrium of the insurance-litigation game with a uniform insurance premium as in Lemma 5, the equilibrium outcome is as follows:*

1. *Small firms never buy insurance. As a consequence, all but high-type NPEs sue for patent infringement. These cases settle with probability* $\mathcal{L}^* = 1$ *for a settlement amount* $S^* = \underline{p}W + C_d$ *(for low* W*) or strictly positive probability* $\mathcal{L}^* = \frac{C_d}{(1-\underline{p})W}$ *and settlement amount* $S^* = W$ *(for high* W*).*

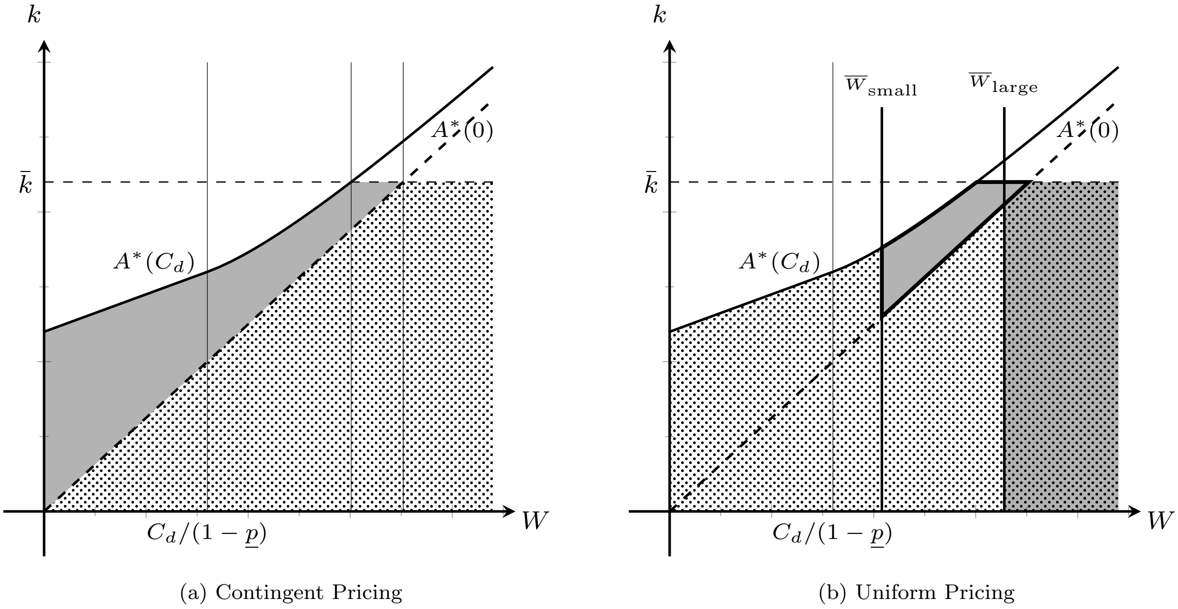
2. *Medium firms buy insurance only when anticipating suit by intermediate type NPEs. As a consequence, only NPEs of low type sue for patent infringement (suing only firms without insurance for patent infringement). These cases settle with probability* $\mathcal{L}^* = 1$ *for a settlement amount* $S^* = \underline{p}W + C_d$ *(for low* W*) or strictly positive probability* $\mathcal{L}^* = \frac{C_d}{(1-\underline{p})W}$ *and settlement amount* $S^* = W$ *and (for high* W*).*

3. *Large firms buy insurance for all but high-type NPEs. As a consequence, only NPEs of low type sue for patent infringement (suing firms with insurance). These cases do not settle.*

2.4 Predictions

Propositions 1 and 2 summarize the equilibrium outcomes of our insurance-litigation game under two different scenarios of policy pricing. In what follows, we derive the predictions of our model from these propositions. Specifically, we ask how the introduction of defensive litigation insurance affects NPE case volume, likelihood of settlement, and the likelihood that NPEs sue SMEs.

Figure 2: Equilibrium Outcome: Insurance and Patent Assertion



In Figure 2, we provide graphical illustrations of the equilibrium outcomes for both pricing scenarios. In each panel, we plot the NPE's expected payoffs from litigation with insurance $A^*(0)$ and without insurance $A^*(C_d)$ against firm size (proxied by potential damages W). The gray-shaded regions depict the respective parameter spaces (firm size and NPE type k) for which firms purchase insurance, and the dot-shaded regions depict the parameter spaces where the NPE brings suit. Regions with both shadings are those where the NPE sues a firm with insurance (and the insurance companies reimburses litigation costs C_d). Recall that without the availability of insurance, the NPE sues in the combined shaded regions (of both panels).

2.4.1 Case Volume

For our first prediction, we ask how the introduction of insurance affects the number of NPE suits filed.

Prediction 1. *The availability of insurance lowers the volume of patent assertions.*

This prediction arises from both pricing scenarios. From Proposition 1 for contingent pricing, we know that only firms (of a given size ω with potential damages $W(\omega)$) facing intermediate NPE types k purchase insurance (gray-shaded region in Panel (a) of Figure 2). For low NPE types, firms do not purchase the policy and are subsequently sued by the NPE (dot-shaded region). Without available insurance, the set of lawsuits is the combined shaded region; with insurance, the set of lawsuits is smaller as the suits from the gray-shaded region are no longer observed in equilibrium.

In the second scenario with uniform pricing, the insurance effect on case volume persists but is weaker. While in the first scenario, the introduction of insurance eliminates cases for intermediate NPE types (irrespective of firm size), in this scenario, insurance only affects whether intermediate type NPEs decide to sue sufficiently large firms with $W \geq \overline{W}_{\text{small}}$. In Panel (b), the respective region is depicted by gray-shaded (and solid-line bordered) region. For small firms (with $W < \overline{W}_{\text{small}}$) and large firms (with low-type NPEs), however, we observe no insurance effect.

2.4.2 Settlement

For our second prediction, we ask how the introduction of insurance affects the likelihood of settlement of suits that are filed.

Prediction 2. *The availability of insurance does not increase the likelihood of settlement (conditional on a lawsuit filed).*

First consider the scenario with contingent pricing. Recall from the discussion above that, here, insured firms are not sued, while firms without insurance *are* sued and moreover settle the suits filed against them at the same rate as they would in world without insurance. Thus, the availability of insurance has no effect on the likelihood of settlement (conditional on patent assertion).

In the scenario with uniform pricing, we expect a lower conditional likelihood of settlement stemming from large firms (with $W > \overline{W}_{\text{large}}$). Large firms facing low-type NPEs (in the combined gray and dot-shaded regions) buy insurance and are sued. Unlike in a world without insurance where firms settle with strictly positive probability, these large firms with insurance (and zero effective litigation costs) will not settle when sued.

2.4.3 Firm-Size Effects

Finally, for our third prediction, we consider the effect of insurance on NPE patent assertion against SMEs, a concern which has played a central role in recent patent reform debates in the U.S. and Europe.

Prediction 3. *The availability of insurance has an ambiguous effect on SMEs. With contingent pricing, SMEs are less likely to be sued by NPEs. With uniform pricing, however, the opposite it true.*

For the scenario with contingent pricing, recall that we find the effect of insurance availability in the set of firms facing intermediate-type NPEs (gray-shaded region in Panel (b) of Figure 2). In this region, insurance serves as a deterrent. The range of NPE types for which that is the case, however, is inversely correlated with firm size, implying that insurance is relatively more effective for small firms than for large firms. Consequently, we expect large firms to be targeted by NPEs relatively more often following the introduction of insurance.

Uniform insurance pricing, however, moves the needle in the opposite direction. The only firms that see a reduction in patent litigation are sufficiently large firms (with $W > \overline{W}_{\text{large}}$). Small firms (with $W \leq \overline{W}_{\text{large}}$) that do not purchase insurance are sued just as often as they would be in a world without insurance. Thus, overall, the share of small firms sued (over all firms) – and thus the relative likelihood that small firms are sued – will increase when insurance becomes available.

Both uniform pricing and fully contingent pricing are, of course, convenient theoretical assumptions. A more realistic pricing structure is likely to lie between these two polar cases. Such a premium structure that is *not sufficiently contingent* on size, that means, it is too uniform, will yield lower insurance adoption rates, making SMEs relatively more attractive targets.

3 Data

Next, to quantify the effect of litigation insurance on NPE behavior, we undertake an empirical analysis of a defensive litigation insurance product offered by IPISC, an insurer that specializes in insurance products related to IP rights.[28] Before presenting the results of our analysis, we provide details on the insurance policy that we study and the methodologies that we follow to construct a database of patents, litigation, and litigant data.

3.1 IPISC NPE Litigation Insurance

The empirical analyses in the sections that follow investigate the impact of IPISC's "troll defense" policy, which was first launched in May 2014. Among other available policies that insure against NPE patent assertion, IPISC's is unique in that it insures only against the enforcement of specific NPE-owned patents listed on two publicly available "menus" that act as complements. Menu 1 contains 200 patents owned by various NPEs, and Menu 2 contains an additional 107. Purchasers have the option to insure against only those patents listed in Menu 1, or they can elect to purchase additional coverage for patents listed in Menu 2.[29] A company that selects the latter option will be insured against any lawsuit enforcing any one of these 307 total patents. Menus 1 and 2 are both published on IPISC's website, and each menu provides the patent number, last-recorded owner, title, and technology classification (assigned by IPISC) of included patents. This information forms the basis for our empirical analysis.

According to the policy, reimbursements are available only for costs incurred to defend against insured patents, both by contesting allegations of infringement in court and by petitioning the Patent Trial and Appeal Board (PTAB) to reconsider the validity of insured patents. The policy expressly excludes coverage for judgments or settlements. Policy limits range from $250,000 to $1 million, with policy terms set at one year. These policy limits are comparable to the contemporary median cost ($850,000) of defending a moderately complex patent suit filed by an NPE (i.e., one with between $1 million and $10 million at stake) and the median cost ($250,000) of challenging a patent's validity before the PTAB

[28]IPISC was founded in 1990 and has sold general litigation defense insurance (not targeted at NPEs) for many years.

[29]Insurance for patents listed in Menu 2 cannot be purchased separately from Menu 1 – i.e., if a company wishes to purchase coverage for Menu 2, it must also purchase coverage for Menu 1.

(AIPLA, 2017). Premiums for coverage against patents listed in Menu 1 range from $2,200 to $19,500 depending on characteristics of the purchaser, and insured parties must additionally pay a deductible set at 2% of their policy limit and thereafter 10% coinsurance. Premiums for coverage against patents listed on both menus vary between $3,000 and $24,500. The deductible and co-insurance for this second package are larger as well, with both set at 20%.

3.2 Data Construction

To study this policy's effect, we assemble a database with three key components. First, we construct the patent portfolios of all NPEs that hold an insured patent, as well as the portfolios of their parents, subsidiaries, and affiliates. Second, we identify all NPE patent infringement suits filed 2010–2016 and all PTAB validity challenges filed during the same period[30] that challenge an NPE-owned patent. Third, we collect basic information about the companies sued for patent infringement in the NPE cases identified above.

3.2.1 NPE Patent Portfolios

To construct a database of patents for use in our empirical analysis, we begin by identifying each insured patent's owner and all entities affiliated with each owner. Together, the two menus covered by IPISC's "troll defense" policy include a total of 307 patents that were owned during the period of our study by a total of 158 unique NPEs,[31] many of which in turn share common corporate parents. Firms specializing in patent assertion commonly distribute (and perhaps obfuscate) ownership of their patent portfolios across a number of subsidiaries (Ewing and Feldman, 2012), some of which own no more than a single patent family or even a single patent. Accordingly, relying on information obtained from RPX, Inc.,[32] we consolidate the 158 immediate owners of insured patents into 78 NPE groups. Of these 78 ultimate owners, 28 are independent entities with no subsidiaries, while 50 are parents that control a network of patent-holding LLCs.[33]

With each insured patent's true owner identified, we next determine whether each entity owns any *uninsured* patents. Again relying on RPX's database of patent-asserting entities, we identify a total of 436 entities affiliated with the 78 NPE groups that hold at least one insured patent. To reconstruct the patent portfolios of these 436 entities, we proceed as follows. We first use the names of these entities to extract from the European Patent Office's Patstat database (version April 2017) the numbers of all

[30] PTAB validity challenges were not available prior to September 16, 2012.

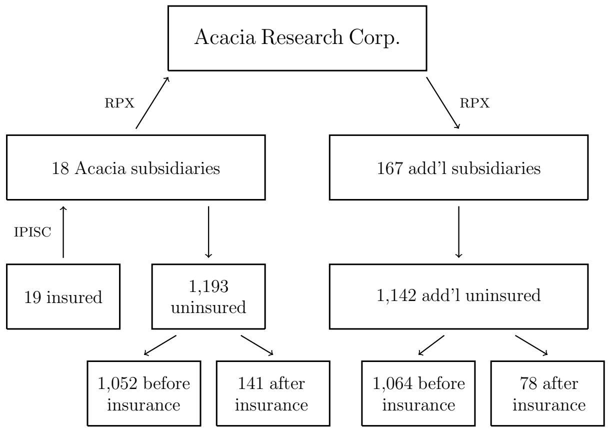
[31] On their face, IPISC's menus list 105 patent owners, two of which we exclude because they are not NPEs. We expand this list of 103 NPEs to 158 because several insured patents were transferred within a group of related NPEs during the period of our analysis, and we include in our analysis all NPEs that held insured patents at any relevant point (55 of which were not listed by name on either menu).

[32] Specifically, we used RPX's Entity Search, available online at `https://search.rpxcorp.com/advanced_search/search_entities`.

[33] Some entities are controlled not by a corporate parent, but instead by an individual (often the inventor of the asserted patents).

patents assigned to each entity. Because NPEs often acquire the patents that they assert and such acquisitions are often not reflected in Patstat, we also search both the USPTO's re-assignment database (Marco et al., 2015) and RPX's database of NPE patent holdings to identify any additional patents transferred to each entity.[34] Next, we search U.S. District Court and PTAB dockets to identify any additional patents enforced or challenged in proceedings to which any of the 436 entities was a party.

Figure 3: Example of Portfolio Construction – Acacia Research Corp.



Having identified the entity that directly holds any insured patents and all other patents in their portfolio, as well as all other entities that belong to the same NPE group and their patent portfolios allows us to construct different sets of patents that we can compare to the set of insured patents:

Comparison Group 1: Cases in which uninsured patents were asserted by any of 158 specific entities listed by IPISC enforcing insured patents.

Comparison Group 2: Cases in which uninsured patents were asserted by any of the 436 entities affiliated with the 78 affected NPE groups, including the uninsured patents in Comparison Group 1.

Comparison Group 1 allows us to compare changes in assertions between insured and uninsured patents for a given NPE and, thus, account for time-invariant unobservable NPE characteristics in addition to patent characteristics. However, a potential concern with this comparison group is the possibility that insurance affects assertion of both insured *and* uninsured patents held by the same NPE. Comparison Group 2 mitigates this concern by including patents asserted by other NPEs within the same NPE groups.

To provide one concrete example of our methodology, consider Acacia Research Corp., the publicly-traded corporate parent of a large network of NPEs. We depict our portfolio construction process for Acacia in Figure 3. During the period of our study, 18 Acacia subsidiaries held a total of 19 insured

[34]For Intellectual Ventures (IV), which has a notoriously complex patent ownership structure (Ewing and Feldman, 2012), we relied instead on the list of patents published on IV's own website: `http://patents.intven.com/finder`.

patents. In addition to these 19 insured patents, the same 18 subsidiaries collectively held 1,193 uninsured patents (1,052 of which were acquired prior to the launch of IPISC's policy). Also, in addition to the 18 subsidiaries that held insured patents, Acacia controls another 167 subsidiaries that collectively held 1,142 more uninsured patents (1,064 of which were acquired before the policy's introduction). In our main analysis below, we compare the assertion of Acacia's 19 insured patents with the assertion of the 1,052 uninsured patents held by the same subsidiaries (Comparison Group 1) before the insurance was launched, as well as the assertion of Acacia's entire portfolio of uninsured patents across all subsidiaries (Comparison Group 2) before the insurance was launched. In additional analysis, we also explore patent acquisitions and their assertions following the launch of the insurance policy.

Finally, for each patent that we identify as belonging to an NPE's portfolio, we extract basic bibliographic information from Patstat and determine whether the patent had been declared essential to a technology standard (Bekkers et al., 2012). Apart from standard patent characteristics such as family size and citations, we also include two measures of patent scope. We use the number of words used in the shortest independent claim and the total number of independent claims as proposed by Marco et al. (2019).[35]

3.2.2 Litigation Data

Next, we merge our database of NPE patent portfolios with case-level data (sourced from MaxVal Group, Inc. and Docket Navigator)[36] to identify all U.S. patent suits filed between 2010 and 2016 that assert a patent held by an affected NPE. We restrict our litigation data to cases filed through 2016 in order to avoid truncation issues caused by (often lengthy) case pendency, and we collect case outcome data through January 2020 for our settlement analysis. We add information on administrative validity challenges (sourced from Unified Patents, Inc.) in the form of petitions for inter partes review (IPR) and covered business method (CBM) review at the PTAB. To ensure that each litigated patent was owned by an affected NPE at the time of suit, we cross-reference litigation dates with USPTO re-assignment records that indicate when patents were acquired or sold.[37] Because NPEs tend to acquire and sell patents often, for most of our analysis we fix NPE patent portfolios at the time of the insurance policy's launch. That is, we only consider patents in each comparison group that were acquired before May 2014 and ignore patents that were sold before May 2014 (see also the Acacia example above in Figure 3). However, in Section 5.4 below, we also analyze affected NPEs' post-insurance patent transactions and

[35] Marco et al. (2019) present evidence suggesting that both metrics are related to patent value and quality. Also, intuitively, patents with broader scope are both (i) more likely to be infringed and, thus, perhaps more likely to be asserted (because they are more likely to capture after-arising technology) and (ii) more likely to be invalidated once asserted (because they are more likely to overlap with preexisting technology that may be discovered in the course of litigation).

[36] MaxVal's Litigation Databank is available at `https://www.maxval.com/litigation-database-services.html`, and Docket Navigator is available at `http://brochure.docketnavigator.com`.

[37] Our analysis includes assertions of patents that were re-assigned within an NPE group, e.g., between two Acacia subsidiaries. At this step, we exclude only cases filed after a relevant patent was re-assigned to an unrelated, third party NPE that was named as the plaintiff in court.

associated district court litigation.

Finally, for use in constructing additional comparison groups, we collect data on the patents asserted, and cases filed, by a large number of NPEs with portfolios that were not affected by IPISC's policy. To compile this list, we use and extend the Stanford NPE Litigation Dataset, which identifies all patent suits filed by NPEs in the U.S. between 2000 and 2015 and links those suits with case-level data sourced from Lex Machina, Inc. (Miller et al., 2017).[38] To ensure comparability between assertions by NPEs that hold insured patents and other NPEs, we limit our use of the Stanford NPE Litigation Dataset to cases filed by PAEs.[39] We use this set of patents to construct a third comparison group:

Comparison Group 3: Cases brought by other NPEs that do not hold any insured patents.

Comparison Group 3, which contains patents held by NPEs not directly affected by the insurance (i.e., included neither in Comparison Group 1 nor Comparison Group 2), helps address concerns with Comparison Groups 1 and 2 that insurance affects assertion of both insured *and* uninsured patents held by the same NPE or NPE group.

3.2.3 Defendant Data

Finally, we source firm-level data from Bureau van Dijk's Orbis dataset for companies sued by NPEs between 2010 and 2016. Our litigation data includes a total of 5,890 unique defendants (including those sued by NPEs that were unaffected by IPISC's policy). We are able to match 92% of these company names to company names in Orbis and extract a number of basic company characteristics, including SIC code, firm size, whether the company is part of a business group, and country of incorporation.

4 Insurance Selection

With our database complete, we next examine the selection of patents into the insurance policy. In interviews with IPISC executives, we learned that the insurer did not perform sophisticated forecasting of future NPE assertions or otherwise rely on unobservable characteristics of patents or their owners. Instead, IPISC selected insured patents primarily using two observable criteria: (a) the number of times that patents had been asserted in court in the past, and (b) an assessment of patents' quality. With respect to prior litigation activity, IPISC stated that it wanted to include patents that had been actively

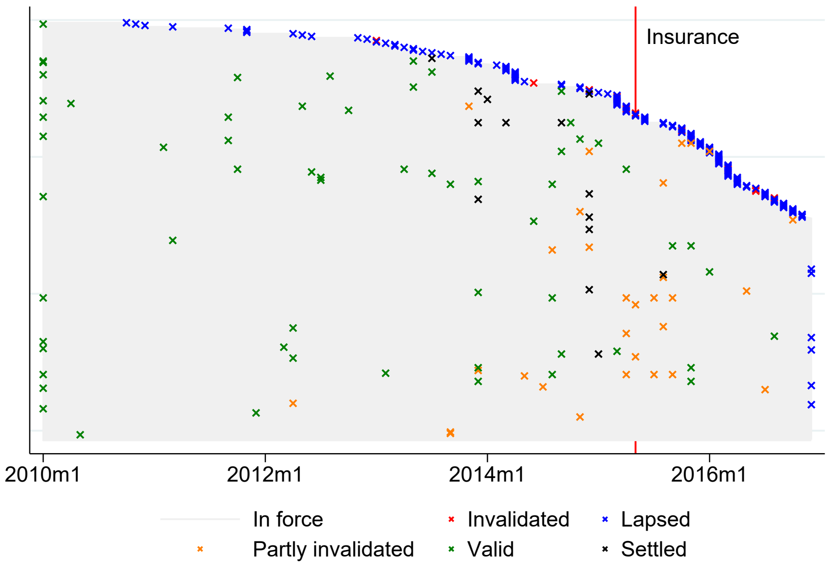
[38] The dataset and a paper describing its creators' methodology and patent owner taxonomy is available at `https://law.stanford.edu/projects/stanford-npe-litigation-dataset`. Because construction of the Stanford NPE dataset is an ongoing process, we extend the Stanford dataset's coverage through 2016 by hand-collecting data (using the same methodology employed by the Stanford dataset's creators) for all U.S. patent cases filed that year. The data for 2010–2016 that we use contains assertions by 1,211 NPEs that are not associated with any of the 78 NPE groups that hold insured patents.

[39] Nearly all NPEs that hold insured patents are so-called "patent assertion entities" (PAEs) – that is, business entities that specialize in patent enforcement – as opposed to universities, individuals, patent-holding subsidiaries of operating technology companies, and other types of (technically) non-practicing patent holders that are included in the Stanford NPE Litigation Dataset.

asserted in order to make the policy attractive to potential customers. With respect to quality, IPISC stated that it also sought to assemble a group of patents that were reasonably vulnerable to validity challenges. More specifically, IPISC indicated that it tracked prior rulings on the validity of candidate patents and excluded patents that had already survived two or more challenges.

In Figure 4, we depict the legal status of insured patents. We see that the majority of patents remained in force throughout the entire period observed in our data. The figure also shows that a relatively large number of patents have been challenged through reexamination, IPR, or CBM and in most cases survived the challenge (though in some instances with a subset of claims invalidated).[40] Moreover, there are a number of patents that were invalidated in their entirety, or that expired or lapsed due to non-payment of renewal fees even before the insurance entered into force.[41]

Figure 4: Legal Status of Insured Patents



Notes: The graph plots the legal status of insured patents taking into account administrative invalidity challenges available pre- as well as post-America Invents Act. Each bar shown in the graph represents an insured patent. Note that an x in January 2010 means that there was a validity challenge prior to January 2010.

In Table 2, we compare insured patents to uninsured patents held by the same 78 NPE groups (Comparison Group 2) as well as all other NPEs (Comparison Group 3) to better understand any selection based on observable patent characteristics into insurance (for an overview of all the patent characteristics used see appendix B). The comparison also distinguishes between patents that were and were not asserted in court before the insurance became available. Perhaps the most salient result from Table 2 is the age of insured patents.[42] While insured patents are, on the whole, relatively old (with an

[40]For the purposes of this figure, we complemented the data described in Section 3 with information on two, older forms of administrative patent challenges: ex parte and inter partes reexamination.

[41]We take information on invalidations into account in our analysis in Section 5.1. Before December 2013, patents could only be revived within a two-year window after they lapsed for non-payment. However, since December 2013, patents can be revived at any point, which makes a lapse for non-payment hard to interpret. In fact, four of the lapsed patents in Figure 4 were asserted in court after they had lapsed. Although this was raised by the defendants sued in those cases, we do not know its impact because the cases settled quickly.

[42]By *age* we mean years of the patent's term of protection that elapsed by 2016. Thus, for patents issued from applications

average of just 3 years of statutory life remaining), this is consistent with prior studies finding that NPEs disproportionately assert older patents (Love, 2013).[43] In addition, because the U.S. Patent Act provides for a six-year statute of limitations (35 U.S.C. §286), patents can be enforced to recover damages for past infringement well after their expiration date. The table also reveals that most insured patents were indeed enforced at some point, while only a small subset was subject to a PTAB invalidation challenge in form of an IPR or CBM, and very few patents are declared standard essential.[44]

Table 2 also addresses potential concerns about the impact of two U.S. Supreme Court cases issued during the period that we study. First, the variable "Fee award" presents the share of patents that were asserted in a patent suit in which the court awarded attorney fees to the accused infringer pursuant to section 285 of the U.S. Patent Act (35 U.S.C. §285).[45] This variable captures the possibility that the Supreme Court's April 2014 decision in *Octance Fitness LLC v. ICON Health & Fitness LLC*[46] could confound our results if assertions of insured patents were affected more by the *Octance* decision than assertions of uninsured patents.[47] For example, if insured patents are relatively weaker than their uninsured counterparts, defendants may be less likely to settle post-*Octance* and, thus, more likely to litigate the case to a decision and, potentially thereafter, an attorney fee award. If so, this could lead NPEs to assert insured patents less often post-*Octance* regardless of insurance. The table shows that insured patents were indeed slightly more likely to be asserted in cases that resulted in fee shifting.

Likewise, there is also a potential concern that the U.S. Supreme Court's June 2014 decision in *Alice Corp. v. CLS Bank* may have affected insured and uninsured patents differently and, thus,[48] could have reduced assertions of insured patents regardless of insurance. In *Alice Corp. v. CLS Bank*, the Court restricted the patentability of algorithms implemented in software, particularly the ability to patent generic computer implementations of algorithms that pre-date modern computing. To account for this concern, we create a dummy variable that is equal to one for business method and software patents as defined by Chung et al. (2015).[49] Again, we see that the share of business method and software patents is indeed slightly larger among insured than uninsured patents.

filed on or after June 8, 1995, we compute age as the difference between 2016 and the filing date of the earliest application to which the patent claims priority. The duration of patents issued from applications filed before June 8, 1995 is complicated by the Uruguay Round Agreements Act (Love, 2018). Thus, for these patents, we calculate age as the shorter of (i) the difference between 2016 and the filing date of the earliest application to which the patent claims priority, or (ii) the difference between 2016 and the date on which the patent issued.

[43]Indeed, it is a common enforcement strategy among NPEs to delay assertion until potential infringers have made large, fixed investments in the patented technology, or are otherwise "locked in" to the technology such that switching to an alternative would be especially costly (Lemley and Shapiro, 2007).

[44]While NPEs commonly sue implementers of standardized technology, they rarely assert (declared) standard-essential patents (SEPs) in such cases. According to Contreras (2017), a total of 26 NPEs enforced just 164 U.S. SEPs between January 2000 and July 2015.

[45]The details of the data collection are described in online appendix C.

[46]Octane Fitness, LLC v. ICON Health & Fitness, Inc., 572 U.S. 545 (2014).

[47]Prior to the Court's decision in *Octane*, a case was considered "exceptional" on the merits only if the case was both "objectively baseless" and "brought in subjective bad faith." In *Octane*, the Court rejected this "unduly rigid" test and held that an exceptional case is "simply one that stands out from others." This new, flexible standard significantly expanded district courts' discretion to award litigation costs in patent suits, and thus effectively increased the likelihood that the winning party would be able to obtain such an award.

[48]*Alice Corp. Pty. Ltd. v. CLS Bank Int'l.*, 573 U.S. 208 (2014).

[49]We follow Chung et al. (2015) and define business method and software patents as those in USPC main classes 341, 345, 370, 380, 382, 700-707, 710, 711, 713-715, 717, 726, and 902.

Overall, comparing the complete set of insured with uninsured patents held by affected NPE groups (Comparison Group 2) reveals that insured patents are on average only slightly older than uninsured patents (i.e., they have less statutory patent life left). However, insured patents fare better under standard metrics for patent value, such as the number of forward citations received, family size, and number of independent claims. Insured patents also are more likely to be essential to a technology standard. In addition, insured patents are much more likely to be asserted in court and challenged at the PTAB pre-insurance in line with the selection criteria reported directly by IPISC. This suggests that the patents included in the insurance policy are, as expected, not a random selection of patents held by the NPEs.

However, when limiting the comparison to uninsured patents that were asserted before the insurance policy's launch, the differences identified above become much smaller, with some statistically indistinguishable from zero. Relative to previously asserted uninsured patents, insured patents are slightly younger, come from patent families of similar sizes, have similar independent claim counts, have been identified as essential to a technology standard roughly as often, and have been challenged fewer times before the PTAB. This suggests that selection occurs into assertion – that is, the set of patents that are asserted differs from the set of patents that are never asserted – a reality long recognized by patent system observers (Allison et al., 2004; Marco, 2005; Marco and Miller, 2017).

To further investigate the relative importance of prior assertions for patent selection, in Table 3 we present the results of a logit model to estimate the probability that a given patent is covered by the insurance policy. We present results for the patents in each of our three comparison groups in specifications (1) through (3). Across all specifications, we use the same variables as in Table 2 and add technology fixed effects (based on a patent's main IPC). In all specifications, we see a positive correlation between inclusion in the insurance policy and counts of forward citations, SEP coverage, and (consistent with information disclosed to us by IPISC) pre-insurance assertions in court. Last, comparing insured patents to uninsured patents in Comparison Group 3, we see that insured patents are less likely to have been challenged at the PTAB than uninsured patents held by unaffected NPEs.

5 Results

5.1 Patent Assertion

For our first set of results, we study the effect of the insurance policy on the litigation behavior of NPEs. Our theoretical framework predicts a decrease in the number of assertions in response to the introduction of the policy (Prediction 1).

Simple descriptive analyses provide a first glimpse. The left-hand-side plot in Figure 5 shows the number of assertions of insured and uninsured patents held by the 76 NPE groups (of a total of 78

Table 2: Comparison of Patent Characteristics

All patents

	Insured				Uninsured				
Variable	Mean	Median	SD	Obs.	Mean	Median	SD	Obs.	Diff means
Age	16.648	18	5.041	307	15.795	16	4.186	22,810	0.852**
Remaining patent term	3.208	3	4.518	307	5.049	5	4.264	22,810	-1.840***
Family size	7.583	5	8.138	307	4.691	3	6.411	22,810	2.891***
Forward citations	69.990	31	104.213	307	27.735	12	54.140	22,810	42.254***
Backward citations	46.576	27	41.906	307	30.601	16	33.780	22,810	15.974***
NPL citations	25.749	4	37.002	307	9.419	1	20.608	22,810	16.329***
SEP	0.055	0	0.229	307	0.002	0	0.049	22,810	0.052***
Fee award†	0.039	0	0.194	307	0.001	0	0.028	22,810	0.038***
Business method/software	0.693	1	0.461	307	0.482	0	0.499	22,810	0.211***
Independent claim length	127.804	111	66.679	302	134.690	119	76.573	21,165	-6.885
Independent claims count	5.052	4	4.241	302	3.701	3	3.019	21,165	1.351***
Asserted in court	0.830	1	0.375	307	0.041	0	0.199	22,810	0.788***
Challenged at PTAB†	0.130	0	0.337	307	0.007	0	0.084	22,810	0.123***

Asserted patents (assertion before insurance became available)

	Insured				Uninsured				
Variable	Mean	Median	SD	Obs.	Mean	Median	SD	Obs.	Diff means
Age	17.329	18	4.662	249	18.170	19	3.554	803	-0.841***
Remaining patent term	2.646	2	4.166	249	2.212	2	3.400	803	0.433*
Family size	7.152	5	7.725	249	7.672	5	10.835	803	-0.519
Forward citations	77.277	40	111.477	249	63.894	31	95.399	803	-13.382*
Backward citations	43.502	24	39.725	249	34.917	21	32.851	803	8.584***
NPL citations	26.104	4	37.265	249	10.488	1	22.200	803	15.616***
SEP	0.016	0	0.125	249	0.011	0	0.105	803	0.004
Fee award†	0.048	0	0.214	249	0.016	0	0.126	803	0.032***
Business method/software	0.775	1	0.418	249	0.547	1	0.498	803	0.227***
Independent claim length	132.461	113	68.619	249	121.297	109	65.034	801	11.164**
Independent claims count	5.184	4	4.230	249	4.915	4	6.164	801	0.269
# assertions in court†	20.823	8	39.486	249	5.800	2	10.849	803	15.022***
Challenged at PTAB†	0.160	0	0.367	249	0.196	0	0.397	803	-0.036

Asserted patents (assertion before insurance became available)

	Insured				Uninsured – all other NPEs				
Variable	Mean	Median	SD	Obs.	Mean	Median	SD	Obs.	Diff means
Age	17.329	18	4.662	249	17.383	18	4.165	1,988	0.054
Remaining patent term	2.646	2	4.166	249	3.057	3	4.106	1,988	-0.411
Family size	7.152	5	7.725	249	7.259	4	10.292	1,988	-0.106
Forward citations	77.277	40	111.477	249	39.319	15	78.075	1,988	37.957***
Backward citations	43.502	24	39.725	249	35.155	20	35.921	1,988	8.346***
NPL citations	26.104	4	37.265	249	14.006	2	26.941	1,988	12.098***
SEP	0.016	0	0.125	249	0.017	0	0.129	1,988	-0.001
Fee award†	0.048	0	0.214	249	0.017	0	0.129	1,988	0.031***
Business method/software	0.775	1	0.418	249	0.478	1	0.499	1,988	0.296***
Independent claim length	132.461	113	68.619	249	134.953	119	74.359	1,979	-2.491
Independent claims count	5.184	4	4.230	249	4.419	3	4.138	1,979	0.764***
# assertions in court†	20.823	8	39.486	249	4.312	1	10.049	1,988	16.510***
Challenged at PTAB†	0.160	0	0.367	249	0.187	0	0.390	1,988	-0.026

Notes: Insured patents include patents from both Menu 1 and Menu 2; SD: standard deviation; remaining patent term computed as difference between patent age in 2016 and statutory patent term where for applications filed on or after June 8, 1995 patent age is computed as the difference between priority date and 2016 and statutory patent life is 20 years counting from the priority date – for applications filed before June 8, 1995 patent age is computed as the shorter of (i) the difference between 2016 and the filing date of the earliest application to which the patent claims priority, or (ii) the difference between 2016 and the date on which the patent issued where statutory patent term is 20 years for (i) counting from the priority date and 17 years for (ii) counting from the date of issuance; Forward citations within first 3 years of earliest publication; NPL: non-patent literature; SEP: standard essential patent (0/1); Fee award: equal to one if patent was subject to a fee award under section 285 of the U.S. Patent Act; Business method/software: equal to one if patent is in USPC main classes 341, 345, 370, 380, 382, 700-707, 710, 711, 713-715, 717, 726, and 902; Independent claim length: the number of words used in the shortest independent claim; Independent claims count: the total number of independent claims; † defined over the sample period before the insurance policy became available; * significant at 10%, ** significant at 5%, *** significant at 1%.

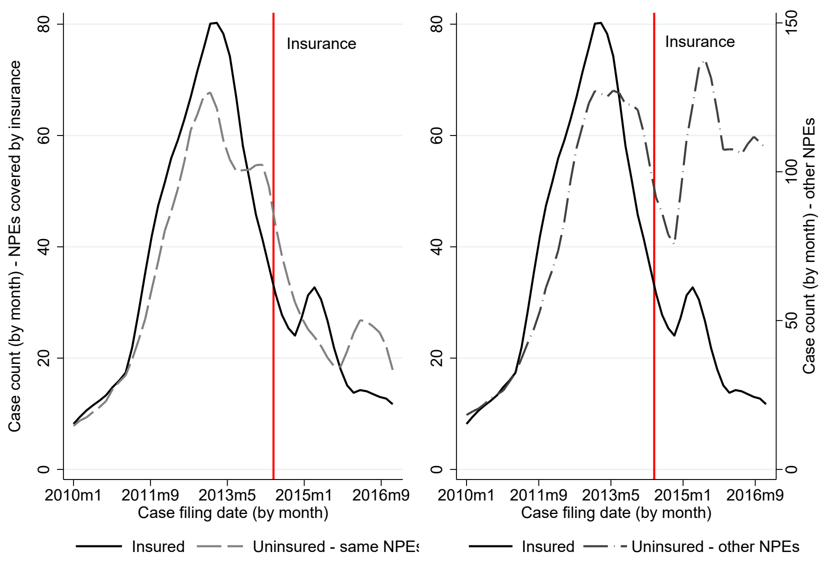
Table 3: Patent-Level Determinants of Policy Coverage

	Insured vs. Uninsured		
	Same NPEs		Other NPEs
	Comparison 1	Comparison 2	Comparison 3
	(1)	(2)	(3)
ln age	-0.004	-0.005*	-0.073***
	(0.003)	(0.003)	(0.017)
ln family size	0.007***	0.006***	-0.001
	(0.001)	(0.001)	(0.005)
ln forward citations	0.003***	0.002***	0.025***
	(0.0006)	(0.0006)	(0.003)
ln backward citations	-0.0005	-0.0008	0.011**
	(0.0009)	(0.0008)	(0.005)
ln NPL citations	0.002***	0.002***	0.003
	(0.0008)	(0.0007)	(0.004)
SEP	0.264***	0.202***	0.187***
	(0.059)	(0.048)	(0.052)
Fee award†	0.091	0.065	0.009
	(0.116)	(0.076)	(0.042)
Business method/software†	-0.002	-0.003*	0.002
	(0.001)	(0.001)	(0.012)
ln independent claim length	-0.001	-0.001	-0.023**
	(0.001)	(0.001)	(0.009)
Independent claims count	0.001**	0.0009**	0.0002
	(0.0004)	(0.0003)	(0.001)
# assertions in court†	0.009***	0.007***	0.005***
	(0.001)	(0.001)	(0.0006)
Challenged at PTAB†	0.220***	0.113***	-0.061***
	(0.051)	(0.034)	(0.013)
Technology FE	YES	YES	YES
Observations	21,177	23,117	3,412
Insured patents	307	307	307
R^2	0.205	0.166	0.175

Notes: OLS regression. Dependent variable = 1 if patent included in insurance policy. Insured patents include patents from both Menu 1 and Menu 2; NPL: non-patent literature; SEP: standard essential patent (0/1); Fee award: equal to one if patent was subject to a fee award under section 285 of the U.S. Patent Act; Business method/software: equal to one if patent is in USPC main classes 341, 345, 370, 380, 382, 700-707, 710, 711, 713-715, 717, 726, and 902; Independent claim length: the number of words used in the shortest independent claim; Independent claims count: the total number of independent claims; † defined over the sample period before the insurance policy became available; all regressions include a dummy variable that is equal to one if ln independent claim length or Independent claims count are missing; robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

NPE groups affected by the policy, i.e., Comparison Group 2) that have filed at least one suit since the policy's introduction in May 2014 (indicated by the vertical red bar).[50] The figure suggests a general increase in NPE patent assertions beginning in 2011,[51] with a subsequent downward trend starting in mid-2013. This latter shift may be attributable to the Supreme Court's grant of certiorari and subsequent decision restricting software patentability in *Alice Corp. v. CLS Bank*. For our purposes, it is sufficient to highlight that the overall litigation pattern between insured and uninsured patents held by the set of 76 NPE groups follows a similar trend until the introduction of IPISC's insurance policy in mid-2014. Once insurance was introduced, assertions for the subset of insured patents dropped further and eventually reached a lower level than assertions of uninsured patents. For comparison, the right-hand-side plot in Figure 5 compares assertions of insured patents with assertions by other NPEs that do not hold any insured patents (Comparison Group 3). While the total number of assertions by other NPEs is larger – as expected due to the large number of enforcing entities – at least until mid-2013, they follow a similar trend compared to assertions of insured patents. Once insurance becomes available, assertions by other NPEs continue unaffected while assertions of insured patents drop considerably.

Figure 5: Number of Court Cases Asserting Insured vs. Uninsured Patents



Notes: Insured patents contain all asserted patents from Menu 1 and Menu 2; the comparison group in the left-hand-side graph consists of all other asserted patents held by the same NPE groups that hold the insured patents (Comparison Group 2); the comparison group in the right-hand-side graph consists of other NPEs that do not hold any insured patents (Comparison Group 3). Data series have been smoothed using local polynomial smoothing.

To further explore what drives the aggregate results shown in Figure 5, we plot the number of patent assertions per month for each NPE group in Figures A-2 and A-3 in the appendix. Figure A-2 (for

[50] The data series shown in Figure 5 was smoothed using a local polynomial smoother. The underlying, unsmoothed data is shown in Figure A-1 in the appendix.

[51] Note that some of this increase is an artifact of changes to joinder rules applicable in patent cases that now prohibit patent holders from joining multiple, unrelated defendants in a single lawsuit (Cotropia et al., 2014).

insured patents) shows that most NPEs were actively asserting their patents in 2012 and 2013, but ceased to do so towards the end of 2014, following introduction of IPISC's policy. That said, a few NPEs continued to assert patents covered by the IPISC policy, especially CTP, Hawk Technology Systems, and NPEs controlled by IPNav and Scott Horstemeyer. Two of these NPEs, Hawk Technology Systems and Scott Horstemeyer, together account for more than half of all post-insurance assertions. For comparison, Figure A-3 shows that assertions of uninsured patents (Comparison Group 3) are (relative to the data shown in Figure A-2) more numerous in 2014 and early 2015 following the introduction of insurance.

For a more formal regression analysis of the changes in patent assertions following the introduction of the insurance policy, we construct for each of our three comparison groups, a matched comparison group using one-to-one propensity score matching without replacement based on a list of observable patent characteristics: patent age, family size, forward citations, backward citations, NPL citations, SEP status, the number of words used in the shortest independent claim (independent claim length), the total number of independent claims (independent claims count), 35 technology classes derived from IPC codes, and dummy variables indicating whether a patent was subject to (i) a PTAB challenge prior to the launch of the insurance policy, (ii) a fee award under section 285 of the U.S. Patent Act prior to the launch of the insurance policy, and (iii) whether a patent is a software or business method patent as defined by Chung et al. (2015).

Table 4 compares the average number of assertions before and after the insurance policy became available for the set of insured patents and each comparison sample. The upper panel shows statistics at the case-level whereas the lower panel shows statistics at the patent-level. The table shows that insured patents were collectively asserted in slightly more than 44 court cases per month on average before the insurance became available, after which the average drops to just 20 cases per month. The difference between these two means is statistically significant at 1 percent. When we look at Comparison Group 1, we see that the average number of court cases remains unchanged after the introduction of the insurance, whereas the average number of assertions per month drops significantly when considering the extended Comparison Group 2. Finally, the average number of assertions per month by non-associated NPEs (Comparison Group 3) increases significantly, a pattern observed in Figure 5. When instead considering the number of assertions per patent per month in the lower panel of Table 4, we see that the average number of assertions again drops significantly for both insured patents and the uninsured patents in Comparison Group 2.

To analyze changes in litigation behavior through a regression, we start by specifying equation (15), where we regress: the log of the total number of patent assertions per month ($lncase_t$), (i) on a dummy (0/1) variable that is equal to one for all assertions of an insured patent ($Insured$), (ii) a dummy variable that indicates when the insurance became available ($Postlaunch_t$) which is equal to one from May 2014 onward, and (iii) their interaction ($Insured \times Postlaunch_t$):

Table 4: Comparison of Court Case Counts Between Insured and Uninsured Patents

	Number of court cases (per month)						
	Before			After			
	Mean	Median	SD	Mean	Median	SD	Diff in means
	Insured						
Insured	44.461	45	31.712	20.093	15	13.155	24.367***
	Uninsured						
Comparison Group 1a	12.519	10	9.912	14.656	12	11.258	-2.137
Comparison Group 1b	2.519	1	3.780	3.406	0	6.767	-0.887
Comparison Group 2a	39.307	40.5	28.277	25.156	22.5	15.577	14.151**
Comparison Group 2b	5.250	2	6.967	4.843	2.5	6.792	0.406
Comparison Group 3a	77.307	62	53.919	105.000	83.5	61.906	-27.692**
Comparison Group 3b	16.000	10.5	20.142	16.656	10.5	20.392	-0.656
	Number of court cases (per month) at the patent level						
	Before			After			
	Mean	Median	SD	Mean	Median	SD	Diff in means
	Insured						
Insured	0.391	0	2.144	0.125	0	0.991	0.265***
	Uninsured						
Comparison Group 1a	0.066	0	0.569	0.080	0	0.914	-0.013
Comparison Group 1b	0.076	0	0.656	0.100	0	1.045	-0.023**
Comparison Group 2a	0.094	0	0.932	0.057	0	0.677	0.037***
Comparison Group 2b	0.092	0	0.857	0.080	0	0.820	0.011
Comparison Group 3a	0.053	0	0.719	0.059	0	0.749	-0.006
Comparison Group 3b	0.073	0	1.144	0.075	0	1.110	-0.002

Notes: Insured patents include patents from both Menu 1 and Menu 2; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" matched comparison groups consist of patents matched based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. * significant at 10%, ** at 5%, *** at 1%.

Table 5: Total Number of Court Cases

	Comparison 1		**Comparison 2**		**Comparison 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	1.174***	2.697***	0.117*	2.222***	-0.581***	1.035***
	(0.098)	(0.111)	(0.064)	(0.105)	(0.070)	(0.088)
Post-launch	-0.425	-0.808	-1.207***	-0.769***	-0.783***	-2.127**
	(0.285)	(0.545)	(0.124)	(0.258)	(0.193)	(0.852)
Insured patent×	-0.835***	-0.629**	-0.352***	-0.612***	-1.092***	-0.680***
Post-launch	(0.158)	(0.255)	(0.131)	(0.222)	(0.156)	(0.193)
Month FE	YES	YES	YES	YES	YES	YES
Observations	168	168	168	168	168	168
R^2	0.852	0.724	0.890	0.892	0.885	0.770

Notes: OLS regression. Dependent variable: log number of cases by month. All regressions include a constant. Time period is January 2010 – December 2016; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all comparison groups, we have matched the most similar patents that belong to all other NPEs to the set of insured patents based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

$$lncase_t = \beta_0 + \beta_1 Insured + \beta_2 Postlaunch_t + \beta_3 Insured \times Postlaunch_t + \delta_t + \varepsilon_t, \quad (15)$$

where δ_t are month dummies. Specification (15) asks whether the number of assertions per month for insured patents changes relative to uninsured patents following the introduction of the insurance policy.

Table 5 presents the results of the OLS regression in specification (15). When we use insured patents held by the same NPEs for comparison in columns (1) and (2), we see that the set of insured patents is associated with a significantly larger number of assertions than uninsured patents. The post-launch dummy variable is not statistically significant. The interaction term is negative, indicating that the number of assertions falls significantly by between 46 and 56 percent for the set of insured patents after the insurance is introduced. These results hold both when we use all uninsured patents (as in column (1)) and when we match each insured patent to its most similar uninsured patent (as shown in column (2)). In Columns (3) and (4), we additionally take into account uninsured patents held by other NPEs within the same NPE group (Comparison Group 2). The interaction term in columns (3) and (4) is still negative but smaller in magnitude (compared to the terms in (1) and (2)), implying a drop in the number of assertions by 30–45 percent. The results for Comparison Group 3 likewise suggest a large negative effect of the insurance policy on assertions of insured patents of between 50 and 66 percent.

Next, we run specification (15) at the patent-level which allows us to include patent-level fixed effects

Table 6: Total Number of Court Cases at the Patent-Level

	Comparison 1		**Comparison 2**		**Comparison 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	-0.012***	-0.020	-0.037***	-0.027	-0.012**	-0.047**
	(0.016)	(0.020)	(0.010)	(0.019)	(0.005)	(0.022)
Insured patent×	-0.080***	-0.083***	-0.070***	-0.078***	-0.087***	-0.087***
Post-launch	(0.011)	(0.013)	(0.011)	(0.012)	(0.011)	(0.011)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Observations	54,615	42,687	101,067	42,687	282,171	42,687
R^2	0.008	0.012	0.007	0.013	0.0008	0.009

Notes: OLS FE regression. Dependent variable: log number of cases by patent-month. All regressions include a constant. Time period is January 2010 – December 2016; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all comparison groups, we have matched the most similar patents that belong to all other NPEs to the set of insured patents based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. Robust standard errors clustered at the patent-level. * significant at 10%, ** at 5%, *** at 1%.

and thus analyze changes in assertions for insured relative to uninsured patents:

$$\begin{aligned} lncase_{it} &= \beta_0 + \beta_1 Insured_i + \beta_2 Postlaunch_t + \\ &\quad \beta_3 Insured_i \times Postlaunch_t + \alpha_i + \delta_t + \varepsilon_{it}, \end{aligned} \tag{16}$$

where $lncase_{it}$ denotes the log of the number of assertions of patent i in month t, α_i denotes patent-level fixed effects, and the rest of specification (16) is as defined in specification (15) above.[52]

Table 6 shows the corresponding results. The interaction term captures the difference-in-differences estimate of the insurance effect. The estimated coefficient is negative across all samples, suggesting that assertions for insured patents fell following the introduction of the insurance while accounting for unobservable, time-invariant patent-specific characteristics and a time trend.

This result comports with the findings in our theoretical model (Prediction 1) where we have shown how the availability of defensive litigation insurance lowers the number of patent assertions (i.e., court cases). Likewise, our approach should adequately address concerns about selection into insurance coverage to the extent that it is driven by observable differences between patents, which is consistent with the information we obtained from IPISC about their selection of patents for inclusion in the policy. That said, there could nonetheless exist some omitted unobservable patent characteristics that are correlated with insurance coverage. For example, some patents' claims may exhibit not-readily-quantifiable linguistic differences that could lead to more assertions.

[52] Note that the specification does not include court dummies because there is a concern that these court dummies are 'bad controls' (Angrist and Pischke, 2009).

Accordingly, as a robustness check we perform a randomization test similar to Alsan et al. (2019). Under the null hypothesis that insurance has no effect, we estimate the distribution of the difference in case filings between insured and uninsured patents by randomly allocating insurance across all patents in the sample (10,000 times). We then compare the outcome which we would expect to see if the null hypothesis were true to the observed outcome obtained from the actual data. This allows us to ask how likely the observed outcome is by computing the share of placebo estimates that exceed the observed difference. We perform this test in two ways using all insured and uninsured patents held by all affected NPE groups (Comparison Group 2). First, we randomize treatment within a given NPE group, holding the number of insured patents constant. For example, if NPE Vertigo has 3 insured and 39 uninsured patents, in each iteration we randomly allocate insurance to 3 patents among the NPE's 42 total patents. We implement this approach only for NPE groups that hold at least twice as many uninsured as insured patents, which leaves us with 44 NPE groups (holding 43% of insured patents). Alternatively, to avoid this limitation, we pool all patents across NPEs and simply allocate insurance randomly across 294 patents within the combined pool of 4,882 patents (here we exclude Intellectual Ventures from the sample due its disproportionately large patent portfolio). The corresponding results are shown in Figure A-4 in the online appendix. In the left-hand-side plot we see that if we randomize within NPE groups, 97% of placebo estimates are larger than the actual estimate of -0.148. On the right-hand-side, when we pool all patents, we find that 96% of placebo estimates exceed the actual estimate of -0.353. Hence, both approaches indicate that the difference between insured and uninsured patents observed in the actual data is very unlikely due to chance.

5.2 Case Outcomes

Our second set of results is motivated by the well-documented fact that NPEs commonly settle cases quickly in order to extract licensing payments while avoiding the risk of having their patents invalidated. Because NPEs cannot be counter-sued for infringement (by definition, they do not commercialize technology) and because U.S. courts rarely award fees to prevailing parties (Cotter and Golden, 2018), non-practicing patentees are often able to leverage the high cost of patent litigation defense to extract large settlements even in suits asserting patents that are likely invalid.[53] Indeed, the U.S. Federal Trade Commission (2016) observed in a recent study of the licensing behavior of 22 NPE groups (controlling 327 patent asserting affiliates) that the majority of NPE suits settled quickly, generally within one year, and most often for amounts below the cost of defending the case to even a preliminary ruling on the merits.

The predictions from our theory model (Prediction 2) are mixed. We show no effect of the introduction of the insurance on the settlement rate when the insurance premium varies in firm size. Conversely, when

[53] According to a survey conducted by the AIPLA (2017), the median cost of defending a relatively small patent suit filed by an NPE (i.e., one with less than $1 million at stake) is $500,000.

the insurance premium is uniform (and not contingent on firm size), our model predicts a lower settlement rate after introduction of the insurance.

We estimate specification (17) which asks whether a court case at t asserting patent i settles as a function of the insurance coverage:

$$settle_{it} = \beta_0 + \beta_1 Insured_i + \beta_2 Postlaunch_t + \beta_3 Insured_i \times Postlaunch_t + \alpha_i + \delta_t + \varepsilon_{it}. \tag{17}$$

One concern with the analysis of case outcomes is truncation. Litigation is a lengthy process,[54] and despite having case outcome information through January 2020, some cases in our data remain pending. To avoid this problem, we include in our settlement analysis only cases that were terminated within four years of filing. This still covers 98 percent of cases that involve insured patents and 79 percent of cases involving uninsured patents. Table A-2 in the appendix shows the share of settled cases for insured and uninsured patents across the different comparison groups before and after the insurance became available. We observe a small increase in settlements for insured patents. The pattern is less clear with respect to uninsured patents. Depending on the comparison group, there is an increase or decrease in the share of settled cases.

We further examine the potential effect of insurance on settlement by comparing settlements in cases that assert insured patents with settlements in cases that assert uninsured patents. Table 7 shows the results from estimating equation (17) as a linear probability model. We see no statistically significant effects across comparison groups of the insurance policy on settlements. That said, the coefficient is statistically significant in column (6) – i.e., for the matched Comparison Group 3. Still, the evidence suggests that, overall, the insurance did not have a significant effect on settlement behavior. To probe this result further, we also distinguish between settlements that occurred at a relatively early stage in the litigation and settlements that took place after substantial discovery and pre-trial motions practice. We do so by identifying whether each settlement took place before or after the court's claim construction (i.e., *Markman*) ruling, an important milestone that generally occurs after document production but before motions for summary judgment. However, adding this distinction has little effect on our results because approximately 96 percent of settlements in our sample occurred before claim construction.[55]

5.3 Defendant Size

For our third set of results, we use firm-level data sourced from Orbis to analyze whether the characteristics of defendants targeted by NPEs changed following the introduction of the insurance. Here, we find that NPEs targeted SMEs more often following the introduction of the insurance policy.

[54] According to Lex Machina, for patent cases filed between 2010 and 2014 the median time to summary judgment was 627 days and the median time to trial was 802 days.
[55] The corresponding results are available upon request.

Table 7: Settlement of Court Cases at the Patent Level

	Comparison 1		**Comparison 2**		**Comparison 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	-0.053*	-0.056*	0.046	-0.014	-0.100	-0.345
	(0.030)	(0.032)	(0.033)	(0.042)	(0.098)	(0.123)
Insured patent× Post-launch	0.024	0.029	-0.051	0.006	0.069	0.301***
	(0.024)	(0.027)	(0.033)	(0.037)	(0.060)	(0.104)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Court FE	YES	YES	YES	YES	YES	YES
Observations	7,673	7,291	11,176	7,351	17,831	7,261
R^2	0.051	0.049	0.008	0.024	0.011	0.082

Notes: OLS FE regression. Dependent variable: case settled (0/1). All regressions include a constant. Time period is January 2010 – December 2016; the sample consists only of cases that were terminated within 4 years after filing; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all comparison groups, we have matched the most similar patents that belong to all other NPEs to the set of insured patents based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. Robust standard errors clustered at patent-level. * significant at 10%, ** at 5%, *** at 1%.

Overall, we find that large companies make up about 80 percent of defendants in all NPE cases. Among cases enforcing insured patents, the share of cases targeting SME defendants increases significantly post-insurance, from about 21 percent to 33 percent. In addition, we make a similar observation about the share of defendants that belong to business groups. Overall, about 75 percent of defendants in all NPE cases are part of a business group, and while the share of such defendants falls post-insurance for cases asserting both insured and uninsured patents, the share decreases more in the subset of cases enforcing insured patents (to 67 percent vs. 72 percent for cases enforcing uninsured patents).

To formally establish these results, we estimate the following equation:

$$SME_t = \beta_0 + \beta_1 Insured + \beta_2 Postlaunch_t + \beta_3 Insured \times Postlaunch_t + \delta_t + \varepsilon_t, \quad (18)$$

where SME_t denotes the share of cases that have an SME defendant. All other variables in specification (18) are as in specification (15) above.

Table 8 reports the results from specification (18). As shown in column (3), we find a higher share of SMEs in lawsuits that involve insured patents compared to uninsured patents held by the same NPE groups. However, when we use a matched comparison group, the effect (while still positive) is no longer statistically significant. In columns (5) and (6), we see again that the interaction of insured patents and the post-launch dummy variable is positive and statistically significant for both the complete and matched sets of patents. These results suggest that the share of SMEs targeted post-insurance increased relative to NPEs not directly affected by the insurance. This effect is largely driven by two NPEs,

Table 8: Share of Court Cases with SME Defendant

	Comparison 1		Comparison 2		Comparison 3	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	-0.009	-0.006	0.020	0.0004	0.061***	0.109***
	(0.027)	(0.027)	(0.019)	(0.022)	(0.017)	(0.023)
Post-launch	0.469***	0.448***	0.439***	0.454***	0.146*	0.289***
	(0.068)	(0.044)	(0.093)	(0.080)	(0.078)	(0.069)
Insured patent×	0.036	0.028	0.079**	0.065	0.173***	0.115*
Post-launch	(0.035)	(0.036)	(0.032)	(0.056)	(0.043)	(0.059)
Month FE	YES	YES	YES	YES	YES	YES
Observations	168	168	168	168	168	168
R^2	0.813	0.813	0.820	0.713	0.681	0.628

Notes: OLS regression. Dependent variable: share of cases with SME defendant by month for a given NPE. All regressions include a constant. Time period is January 2010 – December 2016; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all comparison groups, we have matched the most similar patents that belong to all other NPEs to the set of insured patents based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

Hawk and Horstemeyer, which (as shown in Figure A-2 and discussed above) account for the majority of assertions of insured patents after the insurance becomes available.

Our model provides an explanation for the empirical results. Prediction 3 suggests a lower likelihood of insurance adoption among smaller companies in the case of an insurance premium structure that is *not sufficiently contingent* on size, that means, it is too uniform. Such a premium structure will yield lower insurance adoption rates, making SMEs relatively more attractive targets (as we find in the data).

5.4 Substitution Effects

Fourth and finally, we examine the "troll defense" policy's effect on NPEs' patent sales and acquisitions and NPEs' propensity to assert uninsured patents. Given that the NPE business model relies on litigation (or at least the threat thereof), it is possible that the introduction of insurance may lead some NPEs to change the set of patents that they assert. We consider this possibility in three ways.

First, we investigate whether affected NPEs sold insured patents after the insurance policy's launch. As shown in Figure A-7 in the appendix,[56] we see relatively few transactions involving insured patents following the availability of insurance. While 94 total insured patents changed hands in the three-plus years preceding the "troll defense" policy, just four insured patents were sold post-insurance. Two of these passed from one NPE group to another, and two were sold to defensive patent buyers (one to Allied Security Trust and another to Google via the company's 2015 "Patent Purchase Promotion"). Table A-3

[56] Figure A-7 shows all transfers involving insured patents. Note that the data allow us to distinguish between internal transfers between different entities that belong to the same NPE and external transfers. Our focus here is on external transfers.

corroborates more formally the relative infrequency with which insured patents were transferred in the latter half of 2014 and beyond. To produce the estimates shown in this table, we rely on all patents in Comparison Group 2 that were re-assigned (bought and/or sold), and ask whether the likelihood of an insured patent's sale changed post-insurance. The specifications reported in columns (1) and (2) of Table A-3 both include as controls the same patent characteristics used above for matching, and in column (2) we additionally include NPE fixed effects and dummies for the month in which a patent was acquired. In both specifications, we see that the likelihood that an insured patent is sold drops significantly post-insurance. These results may indicate that the insurance is successful not only in deterring assertions, but thereby also in depressing the value of insured patents to the point that they are effectively neutralized.

Second, we investigate whether affected NPEs may have bought or sold *uninsured* patents in response to the insurance.[57] As shown in Figure A-8, affected NPEs frequently re-assigned uninsured patents both before and after the "troll defense" policy's launch (and commonly did so in large multi-patent transactions). In the regressions reported in Table A-4, we ask whether there is a change post-insurance in the likelihood that a given NPE in Comparison Group 2 acquires a new patent (columns (1) and (2)) or sells a patent from its portfolio (columns (3) and (4)) in a given month. All specifications include NPE and month fixed effects. When we include only the post-launch dummy in the specification reported in column (1), we find no evidence that patent acquisitions changed following the launch of the policy. However, when we interact the post-launch dummy with the share of an NPE's patent portfolio covered by the insurance (computed as the ratio of insured to total (i.e., insured plus uninsured) patents at the time the insurance policy was launched in May 2014), we see some evidence indicating that NPEs were more likely to purchase new patents post-insurance. In contrast, there is no change in either column (3) or (4) in the likelihood of selling uninsured patents post-insurance. This result could indicate that NPEs adjust their portfolios by acquiring new patents to assert in place of patents now covered by the insurance.

Third, we ask whether the frequency with which affected NPEs assert uninsured patents changed in reaction to the insurance policy. Here, we again look at the set of uninsured patents that affected NPEs held before the insurance policy was launched in May 2014. Table A-5 in the appendix shows patent-level regression results where we ask whether the number of uninsured patent assertions per month changed following the introduction of the insurance. Columns (1) and (3) show results for the entire sample, and columns (2) and (4) show results for a subset matched to the characteristics of insured patents. Our matched sample results show that the interaction effects are positive and for Comparison Group 2 marginally statistically significant. This provides some, albeit weak evidence that

[57]Given the exceptionally large portfolio held by Intellectual Ventures (>18,000 uninsured patents), we were unable to verify re-assignments for all of Intellectual Ventures' uninsured patents since that would require information on all of Intellectual Ventures's estimated 13,000 shell companies (Ewing and Feldman, 2012) to distinguish internal and external transfers. We therefore exclude Intellectual Ventures from this part of the analysis.

NPEs could have increased assertions of patents similar to those covered by the insurance. That said, the post-launch coefficients reported in columns (3) and (4) nonetheless indicate overall a small drop in post-insurance assertions among uninsured patents. This potential effect is also reflected in Figure A-9 in the appendix, which shows assertions of Comparison Group 2 NPEs' uninsured patents over time. The graph distinguishes between assertions of patents held before the insurance was launched and those acquired afterwards. It also shows that newly acquired patents account for a large number of case filings, which suggests that NPEs relied more heavily on patents acquired after May 2014 for their subsequent litigation campaigns.

6 Conclusion

We analyze the extent to which private defensive litigation insurance deters patent assertion by non-practicing entities (NPEs). We do so by studying the effect of IPISC's recently launched "troll defense" insurance, a policy that insures against costs incurred to defend against the enforcement of specific NPE-owned patents.

First, we model the impact of defensive litigation insurance on the behavior of patent enforcers and accused infringers. We take a simplified version of the settlement negotiation framework by Bebchuk (1984) (in which the plaintiff's win probability in litigation is known only to the defendant) and extend it by explicitly considering the pricing decision in the (monopolistic) market for insurance policies, the firm's decision to purchase insurance, and the NPE's decision to assert a patent. From the equilibrium results of the model, we derive three main predictions. First, we find that making insurance available decreases the likelihood that an NPE brings a patent infringement lawsuit. Second, insurance reduces the likelihood that a case, once brought, is settled when policies are sold at a uniform insurance premium. Under contingent pricing, when the insurance premium is a function of firm size, this effect vanishes. Third, we find ambiguous effects of the availability of insurance on the likelihood that small and medium-sized firms (SMEs) are the preferred litigation target. With contingent pricing, our model predicts a decrease in the likelihood that SMEs are the target of litigation, whereas with uniform insurance pricing (or pricing that is not sufficiently contingent) SMEs are more likely the target.

Next, we empirically evaluate the effect of IPISC's policy on the owners of insured patents by comparing their subsequent assertion of insured patents with their subsequent assertion of other, uninsured patents in their portfolios. To do so, we identify the true enforcer of each insured patent and all patents owned and enforced by that entity (and its subsidiaries, if any). We additionally compare the assertion of insured patents with patents held by other NPEs with portfolios that were entirely excluded from the insurance product.

We find that the availability of insurance had a large, negative effect on the likelihood that a patent included in the policy was subsequently asserted. Moreover, our results are robust across all comparison groups that we constructed. Accordingly, our findings suggest that NPE patent assertion can be deterred by the prospect that companies targeted for suit will take advantage of insurance reimbursement to offset the cost of litigation defense.

This finding has importance for ongoing debates on the need to reform patent systems across the globe to deter so-called patent "trolling." Whatever the merits of specific judicial and legislative reforms presently under consideration, our study suggests that it is also possible for market-based mechanisms to alter the behavior of patent enforcers. It has been argued that one reason legislative and judicial reform is needed is because collective action is unlikely to cure the patent system's ills because defending against claims of patent infringement generates uncompensated positive externalities. Nonetheless, our study suggests that defensive litigation insurance may be a viable market-based solution to complement, or supplant, other reforms that aim to reduce NPE activity.

There is, however, an important limitation to the interpretation of our findings for policy purposes. Because we do not know which companies purchased insurance coverage, we are unable to distinguish in our analysis between the direct effect of the policy (i.e., the fact that insured companies are less likely to be targeted) and the externalities that insurance generates if, unlike in our model, NPEs *cannot* identify which companies have coverage. If few firms have purchased the insurance, our results would suggest that externalities are large. Moreover, the specific policy that we study likely reinforced externalities by publicly disclosing the list of patents covered by the insurance policy thereby providing information on the 'quality' of patents covered by the policy. This information might affect NPEs' ability to effectively assert these patents even against parties that have not purchased insurance coverage.

Finally, we note that prospects for the improvement of defensive litigation insurance appear to be particularly good at this time. Thanks to the increasing availability of patent-related data, dozens of patent analytics companies have been formed in the U.S. alone in recent years. Companies such as Innography and Unified Patents have begun to use machine learning algorithms to score the "value" and "quality" of individual patents, and litigation data providers such as Lex Machina and Docket Navigator have made it easier than ever to predict the number, distribution, and outcome of U.S. patent suits. As the actuarial assessment of patent risks becomes more and more tractable, it seems reasonable to assume that patent litigation insurance will become more common and more cost effective, and thus will have a more substantial effect on NPE business models. Indeed, the increasing availability of policies may reflect this fact as much as any.

References

AIPLA (2017): "2017 Report of the Economic Survey," Report, American Intellectual Property Law Association, Arlington, VA.

Allison, J. R., M. A. Lemley, K. A. Moore, and R. D. Trunkey (2004): "Valuable Patents," *Georgetown Law Journal*, 92, 435–479.

Alsan, M., O. Garrick, and G. Graziani (2019): "Does Diversity Matter for Health? Experimental Evidence from Oakland," *American Economic Review*, 109, 4071–4111.

Angrist, J. D. and J.-S. Pischke (2009): *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton, N.J.: Princeton University Press.

Baik, K. H. and I.-G. Kim (2007): "Contingent Fees Versus Legal Expenses Insurance," *International Review of Law and Economics*, 27, 351–361.

Bebchuk, L. A. (1984): "Litigation and Settlement under Imperfect Information," *RAND Journal of Economics*, 15, 404–415.

Bekkers, R., C. Catalini, A. Martinelli, and T. Simcoe (2012): "Intellectual Property Disclosure in Standards Development," Proceedings from NBER Conference on Standards, Patents & Innovation, NBER.

Bessen, J. and M. J. Meurer (2014): "The Direct Costs of NPE Disputes," *Cornell Law Review*, 99, 387–422.

Blankenburg, E. (1982): "Legal Insurance, Litigant Decisions, and the Rising Caseloads of Courts: A West German Study," *Law & Society Review*, 16, 601–624.

Brown, L. M. (1952): "Legal-Cost Insurance," *The Insurance Law Journal*, 354, 475–.

Choi, J. P. (1998): "Patent Litigation as an Information-Transmission Mechanism," *American Economic Review*, 88, 1249–1263.

Chung, S., K. Han, A. Animesh, and A. Pinsonneault (2015): "Competitive Impacts of IT Innovation: An Empirical Analysis of Software Patents in the IT Industry," in *International Conference on Information Systems: Exploring the Information Frontier, ICIS, 2015*.

CJA Consultants (2003): "Patent Litigation Insurance," Report, European Commission.

Cohen, L., U. Gurun, and S. D. Kominers (2016): "The Growing Problem of Patent Trolling," *Science*, 352, 521–522.

——— (2017): "Empirical Evidence on the Behavior and Impact of Patent Trolls: A Survey," in *Patent Assertion Entities and Competition Policy*, ed. by D. D. Sokol, Cambridge, UK: Cambridge University Press, 27–49.

Cohen, L., U. G. Gurun, and S. D. Kominers (2019): "Patent Trolls: Evidence from Targeted Firms," *Management Science*, 65, 5449–5956.

Cohen, M. (2017): "GPNE vs Apple: The Multi-Year Saga," Online publication: China IPR Blog (January 8, 2017), available at `https://chinaipr.com/2017/01/08/gpne-vs-apple-the-multi-year-saga`.

Contreras, J. L. (2017): "Assertion of Standard Essential Patents by Non-Practicing Entities," in *Patent Assertion Entities and Competition Policy*, ed. by S. D. Daniel, Cambridge, UK: Cambridge University Press.

Cotropia, C. A., J. P. Kesan, and D. L. Schwartz (2014): "Unpacking Patent Assertion Entities (PAEs)," *Minnesota Law Review*, 99, 649–703.

Cotropia, C. A. and M. A. Lemley (2009): "Copying in Patent Law," *North Carolina Law Review*, 87, 1421–1466.

Cotter, T. F. and J. M. Golden (2018): "Empirical Studies Relating to Patents—Remedies," in *Research Handbook on the Economics of Intellectual Property Law*, ed. by P. S. Menell and D. L. Schwartz, Cheltenham, UK: Edward Elgar Publishing, 1st ed.

de Mot, J. and M. Faure (2016): "Third-Party Financing and Litigation Expenditures," *New York University Journal of Law & Business*, 12, 751–778.

Duchene, A. (2017): "Patent Litigation Insurance," *Journal of Risk and Insurance*, 84, 631–660.

European Commission (2014): "Towards a Renewed Consensus on the Enforcement of Intellectual Property Rights: An EU Action Plan," Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee COM/2014/0392, European Commission, Strasbourg, France, available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0392&from=EN.

Ewing, T. and R. Feldman (2012): "The Giants Among Us," *Stanford Technology Law Review*, 1, 1–61.

Farrell, J. and R. P. Merges (2004): "Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help," *Berkeley Technology Law Journal*, 19, 943–970.

Farrell, J. and C. Shapiro (2008): "How Strong Are Weak Patents?" *American Economic Review*, 98, 1347–1369.

Faure, M. and J. de Mot (2012): "Comparing Third-Party Financing of Litigation and Legal Expenses Insurance," *Journal of Law, Economics & Policy*, 3, 743–777.

Federal Trade Commission (2016): "Patent Assertion Entity Activity," Report, Federal Trade Commission, Washington, D.C., available at https://www.ftc.gov/reports/patent-assertion-entity-activity-ftc-study.

Fenn, P. and N. Rickman (2001): "Asymmetric Information and the Settlement of Insurance Claims," *Journal of Risk and Insurance*, 68, 615–630.

Ganglmair, B., C. Helmers, and B. J. Love (2018): "The Effect of Patent Litigation Insurance: Theory and Evidence from NPEs," Unpublished manuscript, available at https://ssrn.com/abstract=3279130.

Gugliuzza, P. R. (2017): "How Much Has the Supreme Court Changed Patent Law?" *Chicago-Kent Journal of Intellectual Property*, 16, 330–352.

He, L. (2020): "A Theory of Pre-filing Settlement and Patent Assertion Entities," *International Journal of Industrial Organization*, 70, Article 102618.

Heyes, A., N. Rickman, and D. Tzavara (2004): "Legal Expenses Insurance, Risk Aversion and Litigation," *International Review of Law and Economics*, 24, 107–119.

Jiam, H. (2015): "Fee-Shifting and Octane Fitness - Appendix," *Berkeley Technology Law Journal*, 30, 645–674.

Kennan, J. and R. Wilson (1993): "Bargaining with Private Information," *Journal of Economic Literature*, 31, 45–104.

Kilian, M. (2003): "Alternatives to Public Provision: The Role of Legal Expenses Insurance in Broadening Access to Justice: The German Experience," *Journal of Law and Society*, 30, 31–48.

Kirstein, R. (2000): "Risk Neutrality and Strategic Insurance," *Geneva Papers on Risk and Insurance*, 25, 251–261.

Kopelevich, S. (2017): "The Impact of the Unitary Patent and the Unified Patent Court on the Prevalence of Patent Trolls in the European Union," Available at http://scholarship.shu.edu/student_scholarship/895/.

Lavie, S. and A. Tabbach (2020): "Judgment-Contingent Settlements," *Journal of Law, Economics, and Organization*, 36, 170–206.

Lemley, M. A. (2008): "Ignoring Patents," *Michigan State Law Review*, 2008, 19–34.

Lemley, M. A. and R. Feldman (2016): "Patent Licensing, Technology Transfer, and Innovation," *American Economic Review*, 106, 188–192.

Lemley, M. A., K. Richardson, and E. Oliver (2019): "The Patent Enforcement Iceberg," *Texas Law Review*, 97, 801–833.

Lemley, M. A. and C. Shapiro (2007): "Patent Holdup and Royalty Stacking," *Texas Law Review*, 85, 1991–2049.

Lemus, J., E. Temnyalov, and J. L. Turner (forthcoming): "Liability Insurance: Equilibrium Contracts under Monopoly and Competition," *American Ecomic Journal: Microeconomics*.

Llobet, G. and J. Suarez (2012): "Patent Litigation and the Role of Enforcement Insurance," *Review of Law & Economics*, 8, 789–821.

Love, B. J. (2013): "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.

——— (2018): "Patent Duration," in *Research Handbook on the Economics of Intellectual Property Law*, ed. by P. S. Menell and D. L. Schwartz, Cheltenham, UK: Edward Elgar Publishing, vol. 2, 1st ed.

Love, B. J., K. Richardson, E. Oliver, and M. Costa (2018): "An Empirical Look at the 'Brokered' Market for Patents," *Missouri Law Review*, 83, 359–407.

Love, B. J. and J. Yoon (2017): "Predictably Expensive: A Critical Look at Patent Litigation in the Eastern District of Texas," *Stanford Technology Law Review*, 20, 1–37.

Marco, A. (2005): "The Option Value of Patent Litigation: Theory and Evidence," *Review of Financial Economics*, 14, 323–351.

Marco, A., S. J. Graham, A. Myers, P. D'Agostino, and K. Apple (2015): "The USPTO Patent Assignment Dataset: Descriptions and Analysis," Economic Working Paper 2015-2, USPTO, Alexandria, Va.

Marco, A. and R. Miller (2017): "Patent Examination Quality and Litigation: Is There a Link?" Economic Working Paper 2017-09, USPTO, Alexandria, Va.

Marco, A., A. Tesfayesus, and A. A. Toole (2017): "Patent Litigation Data from US District Court Electronic Records (1963–2015)," Economic Working Paper 2017-06, USPTO, Alexandria, Va.

Marco, A. C., J. D.Sarnoff, and C. A. deGrazia (2019): "Patent Claims and Patent Scope," *Research Policy*, 48, Article 103790.

Mayerson, M. S. (1995): "Insurance Recovery of Litigation Costs: A Primer for Policyholders and their Counsel," *Tort and Insurance Law Journal*, 30, 997–1014.

Mazzeo, M. J., J. Hillel, and S. Zyontz (2013): "Explaining the 'Unpredictable': An Empirical Analysis of US Patent Infringement Awards," *International Review of Law and Economics*, 35, 58–72.

McDonagh, L. (2014): "Exploring Perspectives of the Unified Patent Court and Unitary Patent Within the Business and Legal Communities," Report, UK Intellectual Property Office, available at `http://openaccess.city.ac.uk/12605/1/UPC_Study.pdf`.

Miller, S. P., A. Aravind, B. Bengfort, C. De La Cerda, M. Dragoni, K. Gibson, A. Itai, C. Johnson, D. Kannappan, E. Kehoe, H. Kim, K. Mladinich, R. Pinho, J. Polansky, and B. Weissenberg (2017): "Introduction to the Stanford NPE Litigation Dataset," Tech. rep., Stanford Program in Law, Science, and Technology.

Mitchell, T. (2016): "Sony patent case shows how legal battles pose new threat in China," Online publication: Financial Times (November 15, 2016), available at `https://www.ft.com/content/ba17282c-ab14-11e6-9cb3-bb8207902122`.

Mulligan, C. and T. B. Lee (2012): "Scaling the Patent System," *NYU Annual Survey of American Law*, 68, 289–317.

Nalebuff, B. (1987): "Credible Pretrial Negotiation," *RAND Journal of Economics*, 18, 198–210.

Prescott, J. and K. E. Spier (2016): "A Comprehensive Theory of Civil Settlement," *New York University Law Review*, 91, 59–141.

Prescott, J., K. E. Spier, and A. Yoon (2014): "Trial and Settlement: A Study of High-Low Agreements," *Journal of Law and Economics*, 57, 699–746.

Regan, F. (2003): "The Swedish Legal Services Policy Remix: The Shift from Public Legal Aid to Private Legal Expense Insurance," *Journal of Law and Society*, 30, 49–65.

Reinganum, J. F. and L. L. Wilde (1986): "Settlement, Litigation, and the Allocation of Litigation Costs," *RAND Journal of Economics*, 17, 557–566.

Rickman, N. and P. Fenn (1998): "Insuring Litigation Risk: Some Recent Developments in England and Wales," *Geneva Papers on Risk and Insurance*, 23, 210–223.

Simensky, M. and E. C. Osterberg (1999): "The Insurance and Management of Intellectual Property Risks," *Cardozo Arts and Entertainment Law Journal*, 17, 321–343.

Spier, K. E. and J. Prescott (2019): "Contracting on Litigation," *RAND Journal of Economics*, 50, 391–417.

Stolz, P. (1968): "Insurance for Legal Services: A Preliminary Study of Feasibility," *University of Chicago Law Review*, 35, 417–476.

Tucker, C. (2014): "Patent Trolls and Technology Diffusion: The Case of Medical Imaging," Unpublished manuscript, Massachusetts Institute of Technology.

van Velthoven, B. and P. van Wijck (2001): "Legal Cost Insurance and Social Welfare," *Economics Letters*, 72, 387–396.

Wilson, L. C. and C. J. Wydrzynski (1978): "Prepaid Legal Services: Legal Rerepresentation for the Canadian Middle Class," *University of Toronto Law Journal*, 28, 25–74.

Appendix

A Formal Proofs

Proof of Lemma 1

Proof. The firm rejects the settlement offer and the case goes to trial if $p < q$ where q is defined in equation (1). The unconditional probability the firm rejects is $F(q)$. It is $F(q) = 0$ if the offer is $S \leq \underline{p}W + \tilde{C}$ so that $q \leq \underline{p}$ (and the firm always accepts). The probability is $F(q) = \frac{q-\underline{p}}{1-\underline{p}}$ if $\underline{p}W + \tilde{C} < S < W + \tilde{C}$ so that the critical threshold is $q \in (\underline{p}, 1)$. Last, if the settlement offer is $S \geq W + \tilde{C}$ so that $q \geq 1$ (and the firm always rejects), the unconditional probability is $F(q) = 1$.

Conditional on the firm rejecting the offer (for $p < q$), the NPE's probability of winning in court is

$$\hat{p}(q) = \frac{\int_{\underline{p}}^{q} x f(x) dx}{F(x)}. \tag{A-1}$$

Given the expressions for $F(q)$ and the values for q, and under some abuse of notation, we can write this conditional probability as:

$$\hat{p}(q) = \begin{cases} \emptyset & \text{if } S \leq \underline{p}W + \tilde{C} \\ \frac{S+\underline{p}W-\tilde{C}}{2W} & \text{if } \underline{p}W + \tilde{C} < S < W + \tilde{C} \\ \frac{1+\underline{p}}{2} & \text{if } S \geq W + \tilde{C}. \end{cases} \tag{A-2}$$

Note that for sufficiently low values of S, the firm will always accept the settlement offer ($q \leq \underline{p}$) and the case never goes to trial ($F(q) = 0$). In this case, the conditional probability is not defined, that is, $\hat{p}(q) = \frac{0}{0}$. We denote the NPE's conditional probability in this case by $\hat{p}(q) = \emptyset$. For intermediate values of S, the firm sometimes rejects the settlement offer ($q \in (\underline{p}, 1)$ and $F(q) \in (0, 1)$), and the conditional probability is equal to $\frac{q+\underline{p}}{2}$. For high values of S, the firm will always rejects the settlement offer ($q \geq 1$ and $F(q) = 1$), and the conditional probability is equal to the unconditional probability, $\frac{1+\underline{p}}{2}$.

Given the expressions for $F(q)$ and $\hat{p}(q)$, we can write the NPE's expected payoffs $A(S, \tilde{C})$ as:

$$A(S, \tilde{C}) = \begin{cases} S & \text{if } S \leq \underline{p}W + \tilde{C} \\ \frac{(1+\underline{p})W}{2} + \frac{\tilde{C}^2-(S-W)^2}{2(1-\underline{p})W} & \text{if } \underline{p}W + \tilde{C} < S < W + \tilde{C} \\ \frac{(1+\underline{p})W}{2} & \text{if } S \geq W + \tilde{C}. \end{cases} \tag{A-3}$$

From this expression, we can quickly determine the optimal settlement offer, S^*. Suppose S is low (first line), then the payoff-maximizing offer is $\underline{p}W + \tilde{C}$. If, instead, the settlement offer is of intermediate value (second line), then payoffs are maximized for $S = W$. The maximized payoffs for $S = W$ are strictly larger than the payoffs for $S = \underline{p}W + \tilde{C}$. Further note that, if $\tilde{C} > 0$ the NPE will never make a high settlement offer $S \geq W + \tilde{C}$ as for such an offer the payoffs are strictly smaller than for an offer $S = W$. If, instead, $\tilde{C} = 0$, any offer $S \geq W$ is strictly higher than for $S \geq W + \tilde{C}$. If $\tilde{C} = 0$, then the payoffs for $S = W$ and any offer $S \geq W^*$ are the same. This is because, for $\tilde{C} = 0$, the optimal offer $S = W$ implies that the firm will never accept the offer but instead choose trial. Any offer exceeding such an offer will induce the same actions.

We obtain the likelihood of settlement, $\mathcal{L}^* = 1 - F(q(S^*, \tilde{C}))$, by combining the expressions for $F^*(q)$ and S^*. The likelihood is equal to zero if $\tilde{C} = 0$ (insurance status) and strictly positive otherwise, given finite W. For $W \leq \frac{\tilde{C}}{1-\underline{p}}$ so that $q \leq \underline{p}$, the equilibrium settlement offer is always accepted so that the likelihood of settlement, $\mathcal{L}^*(\tilde{C}) = 1$, is not a function of W. For higher values of W, L is decreasing in W. □

Proof of Lemma 2

Proof. Follows immediately from the NPE's payoffs in equation (4). □

Proof of Corollary 1

Proof. The NPE is more likely to sue larger firms (conditional on insurance status) if its payoffs are increasing in W, implying that higher type NPEs will eventually find it profitable to sue (larger firms). We have

$$\frac{\partial A^*}{\partial W} = \begin{cases} \underline{p} & \text{if } W \leq \frac{\tilde{C}}{1-\underline{p}} \\ \frac{(1-\underline{p}^2)W^2-\tilde{C}^2}{2(1-\underline{p})W^2} & \text{if } W > \frac{\tilde{C}}{1-\underline{p}}. \end{cases}$$

The first line of this expression is strictly positive by $\underline{p} > 0$. The second line is positive if

$$W > \frac{\tilde{C}}{1-\underline{p}^2}.$$

This is always true given the condition for the second line (and $\frac{\tilde{C}}{1-\underline{p}} > \frac{\tilde{C}}{1-\underline{p}^2}$).

Insurance is an effective deterrent if k is of intermediate value. As W increases, the range for intermediate values of k is decreasing. For the respective range we obtain:

$$A^*(C_d) - A^*(0) = \begin{cases} C_d - \frac{(1-\underline{p})W}{2} & \text{if } W \leq \frac{C_d}{1-\underline{p}} \\ \frac{C_d^2}{(1-\underline{p})W} & \text{if } W > \frac{C_d}{1-\underline{p}} \end{cases}$$

These expressions are decreasing in W. □

Proof of Lemma 3

Proof. The firm's expected payoffs $B^*(\tilde{C})$ are

$$B^*(\tilde{C}) = \begin{cases} -(\underline{p}W + \tilde{C}) & \text{if } W \leq \frac{\tilde{C}}{1-\underline{p}} \\ -\left[\frac{(1+\underline{p})W}{2} + \tilde{C}\left(1 - \frac{\tilde{C}}{2(1-\underline{p})W}\right)\right] & \text{if } W > \frac{\tilde{C}}{1-\underline{p}} \end{cases} \tag{A-4}$$

The firm's insurance purchase decision is by comparison of the payoffs in equations (6) and (7). By equation (A-4), these payoffs depend on W. We consider the firm's decision for low values of W and high values of W.

- For low NPE types with $k \leq A^*(0)$ and low damages such that $W \leq \frac{C_d}{1-\underline{p}}$, the firm buys insurance if $-\frac{(1+\underline{p})W}{2} - M \geq -\underline{p}W - C_d$ or

  $$M \leq C_d - \frac{(1-\underline{p})W}{2} =: \widehat{M}. \tag{A-5}$$

  Note that, because $W \leq \frac{C_d}{1-\underline{p}}$, $\widehat{M} > 0$. For high damages such that $W > \frac{C_d}{1-\underline{p}}$, the firm buys insurance if

  $$-\frac{(1+\underline{p})W}{2} - M \geq -\left[\frac{(1+\underline{p})W}{2} + C_d\left(1 - \frac{C_d}{2(1-\underline{p})W}\right)\right]$$

  or

  $$M \leq C_d\left(1 - \frac{C_d}{2(1-\underline{p})W}\right) =: \widehat{M}. \tag{A-6}$$

  Again, because $W > \frac{C_d}{1-\underline{p}}$, the willingness to pay $\widehat{M}$ is strictly positive.

- For intermediate NPE types with $A^*(0) < k \leq A^*(C_d)$ and low damages such that $W \leq \frac{C_d}{1-\underline{p}}$, the firm buys insurance if

$$M \leq C_d + \underline{p}W =: \widetilde{M}. \tag{A-7}$$

For high damages such that $W > \frac{C_d}{1-\underline{p}}$, the firm buys insurance if

$$M \leq C_d \left(1 - \frac{C_d}{2\left(1-\underline{p}\right)W}\right) + \frac{\left(1+\underline{p}\right)W}{2} =: \widetilde{M} \tag{A-8}$$

- For high NPE types with $k > A^*(C_d)$, the firm will not buy insurance as $-M < 0$.

Some rearranging reveals that $\widetilde{M} = \widehat{M} + \frac{(1+\underline{p})W}{2}$ for all W. □

Proof of Lemma 4

Proof. Given our distributional assumptions and the assumption on the upper bound for $\bar{k}$ (in Assumption 1), we will consider four cases with respect to different values of W. (1) low values of W with $W \leq \frac{C_d}{1-\underline{p}}$ and $A^*(C_d) < \bar{k}$; (2) values of W with $W \in \left(\frac{C_d}{1-\underline{p}}, W'\right)$ such that $A^*(C_d) < \bar{k}$; (3) values of W with $W \in [W', W'')$ such that $\bar{k} \in (A^*(0), A^*(C_d)]$, $W = W'$ such that $\bar{k} = A^*(C_d)$ and $W = W''$ such that $\bar{k} = A^*(0)$), where

$$W' = \frac{\bar{k}\left(1-\underline{p}\right) + \sqrt{\left(1-\underline{p}\right)\left[\bar{k}^2\left(1-\underline{p}\right) - C_d^2\left(1+\underline{p}\right)\right]}}{1-\underline{p}^2}; \tag{A-9}$$

and

$$W'' = \frac{2\bar{k}}{1+\underline{p}}; \tag{A-10}$$

and (4) values of W with $W \geq W''$ such that $\bar{k} \leq A^*(0)$. Note that the term in square roots in the expression for W' is strictly positive if

$$\bar{k} > C_d\sqrt{\frac{1+\underline{p}}{1-\underline{p}}}$$

which always holds because, by Assumption 1, we have

$$\bar{k} > \frac{C_d}{1-\underline{p}} > \frac{C_d}{1-\underline{p}}\sqrt{1-\underline{p}^2} = C_d\sqrt{\frac{1+\underline{p}}{1-\underline{p}}}.$$

Moreover, by Assumption 1, the value for $\bar{k}$ is such that each of these cases is non-trivial (i.e., $\frac{C_d}{1-\underline{p}} < W' < W''$). In Panel (a) of Figure 2, the three critical thresholds for W are depicted by vertical lines.

In each of these four cases, the profit function $\Pi(M) = \Phi(M)\left[M - C_s(M)\right]$ is a step function, and the insurer will set one of two insurance premia: low $\widehat{M}$ or high $\widetilde{M}$. The insurance company chooses the high premium if $\widetilde{\Pi} \geq \max\{\widehat{\Pi}, 0\}$ with $\widetilde{\Pi} = \Pi(\widetilde{M})$ and $\widehat{\Pi} = \Pi(\widehat{M})$. If both $\widetilde{\Pi}, \widehat{\Pi} < 0$ (only with strictly positive demand), the insurance company will not offer an insurance policy.

Case 1: The insurer's demand function is:

$$\Phi(M) = \begin{cases} \frac{C_d + \underline{p}W}{\bar{k}} & \text{if } M \leq \widehat{M} \\ \frac{C_d + \underline{p}W}{\bar{k}} - \frac{(1+\underline{p})W}{2\bar{k}} & \text{if } \widehat{M} < M \leq \widetilde{M} \\ 0 & \text{if } M > \widetilde{M} \end{cases}$$

The marginal costs are:

$$C_s(M) = \begin{cases} \frac{W(1+\underline{p})}{2\bar{k}} C_d & \text{if } M \leq \widehat{M} \\ 0 & \text{if } M > \widehat{M} \end{cases}$$

The profits for the high premium are

$$\widetilde{\Pi} = \frac{\left[2C_d - \left(1-\underline{p}\right)W\right]\left(C_d + \underline{p}W\right)}{2\bar{k}}; \tag{A-11}$$

the profits with the low premium are

$$\widehat{\Pi} = \widetilde{\Pi} - \frac{C_d\left(1+\underline{p}\right)W\left(C_d + \underline{p}W\right)}{2\bar{k}^2}. \tag{A-12}$$

From this last expression, it is easy to see that $\widetilde{\Pi} \geq \widehat{\Pi}$ because $\frac{C_d(1+\underline{p})W(C_d+\underline{p}W)}{2\bar{k}^2} > 0$. Moreover, $\widetilde{\Pi} > 0$ if $2C_d - \left(1-\underline{p}\right)W > 0$ or $W < \frac{2C_d}{1-\underline{p}}$. The latter holds true by Case 1.

Case 2: The insurer's demand function is:

$$\Phi(M) = \begin{cases} \frac{C_d^2}{2W\bar{k}(1-\underline{p})} + \frac{W(1+\underline{p})}{2\bar{k}} & \text{if } M \leq \widehat{M} \\ \frac{C_d^2}{2W\bar{k}(1-\underline{p})} & \text{if } \widehat{M} < M \leq \widetilde{M} \\ 0 & \text{if } M > \widetilde{M} \end{cases}$$

The marginal costs are:

$$C_s(M) = \begin{cases} \frac{W(1+\underline{p})}{2\bar{k}} C_d & \text{if } M \leq \widehat{M} \\ 0 & \text{if } M > \widehat{M} \end{cases}$$

The profits with the high premium are

$$\widetilde{\Pi} = \frac{C_d^2\left[2C_d\left(1-\underline{p}\right)W + \left(1-\underline{p}^2\right)W^2 - C_d^2\right]}{4\bar{k}\left(1-\underline{p}\right)^2 W^2}; \tag{A-13}$$

profits with the low premium are

$$\widehat{\Pi} = \widetilde{\Pi} - \frac{C_d\left(1+\underline{p}\right)\left[C_d\left(C_d+2\bar{k}\right) - W\left(2\bar{k}\left(1-\underline{p}\right) - \left(1-\underline{p}^2\right)W\right)\right]}{4\bar{k}^2\left(1-\underline{p}\right)}. \tag{A-14}$$

We find that $\widetilde{\Pi} \geq \widehat{\Pi}$ if $C_d\left(C_d+2\bar{k}\right) - W\left[2\bar{k}\left(1-\underline{p}\right) - \left(1-\underline{p}^2\right)W\right] \geq 0$ or

$$\frac{C_d^2 + W^2\left(1-\underline{p}^2\right)}{2\left[W\left(1-\underline{p}\right) - C_d\right]} \geq \bar{k}.$$

Given C_d and $\underline{p}$, the critical threshold is minimized for damages

$$\frac{C_d}{1-\underline{p}^2}\left[1+\underline{p}+\sqrt{2\left(1+\underline{p}\right)}\right]$$

for which the critical threshold is

$$\frac{C_d}{1-\underline{p}}\left[1+\underline{p}+\sqrt{2\left(1+\underline{p}\right)}\right].$$

This is the upper bound for $\bar{k}$ in Assumption 1, so that the condition is satisfied and $\widetilde{\Pi} \geq \widehat{\Pi}$. Moreover, $\widetilde{\Pi} > 0$ because $\left(1-\underline{p}^2\right)W^2 - C_d^2 > 0$ by Case 2. To see this, rewrite the condition as $W > \frac{C_d}{\sqrt{1-\underline{p}^2}}$.

Given, by Case 2, $W > \frac{C_d}{1-\underline{p}}$, the condition for $\widetilde{\Pi} > 0$ holds if $\frac{C_d}{1-\underline{p}} > \frac{C_d}{\sqrt{1-\underline{p}^2}}$ which is indeed the case.

Case 3: The insurer's demand function is:

$$\Phi(M) = \begin{cases} 1 & \text{if } M \leq \widehat{M} \\ 1 - \frac{(1+\underline{p})W}{2\bar{k}} & \text{if } \widehat{M} < M \leq \widetilde{M} \\ 0 & \text{if } M > \widetilde{M} \end{cases}$$

The marginal costs are:

$$C_s(M) = \begin{cases} \frac{W(1+\underline{p})}{2\bar{k}} C_d & \text{if } M \leq \widehat{M} \\ 0 & \text{if } M > \widehat{M} \end{cases}$$

The profits for the high premium are

$$\widetilde{\Pi} = \frac{\left[2C_d - \frac{C_d^2}{(1-\underline{p})W} + \left(1+\underline{p}\right)W\right]\left[1 - \frac{(1+\underline{p})W}{2\bar{k}}\right]}{2}; \tag{A-15}$$

profits with the low premium are

$$\widehat{\Pi} = \widetilde{\Pi} - \frac{\left(1+\underline{p}\right)\left[C_d^2 + W\left(2\bar{k}\left(1-\underline{p}\right) - \left(1-\underline{p}^2\right)W\right)\right]}{4\bar{k}\left(1-\underline{p}\right)}. \tag{A-16}$$

We find that $\widetilde{\Pi} \geq \widehat{\Pi}$ if

$$\frac{C_d}{1-\underline{p}} < W \leq \frac{\bar{k} + \sqrt{\bar{k}^2 + \frac{C_d^2(1+\underline{p})}{1-\underline{p}}}}{1+\underline{p}}.$$

Both inequalities hold by the case definition with $W \in [W', W'')$. We have $\frac{C_d}{1-\underline{p}} < W'$ and

$$W'' = \frac{2\bar{k}}{1+\underline{p}} < \frac{\bar{k} + \sqrt{\bar{k}^2 + \frac{C_d^2(1+\underline{p})}{1-\underline{p}}}}{1+\underline{p}}$$

because

$$\sqrt{\bar{k}^2 + \frac{C_d^2\left(1+\underline{p}\right)}{1-\underline{p}}} > \bar{k}.$$

Moreover, $\widetilde{\Pi} > 0$ because $2C_d - \frac{C_d^2}{(1-\underline{p})W}$ (rewritten to read $W > \frac{C_d}{2(1-\underline{p})}$ which holds by Case 3) and $1 - \frac{(1+\underline{p})W}{2\bar{k}}$ (by Case 3 and $W < W''$).

Case 4: The insurer's demand function is:

$$\Phi(M) = \begin{cases} 1 & \text{if } M \leq \widehat{M} \\ 0 & \text{if } \widehat{M} < M \leq \widetilde{M} \\ 0 & \text{if } M > \widetilde{M} \end{cases}$$

The marginal costs are:

$$C_s(M) = \begin{cases} C_d & \text{if } M \leq \widehat{M} \\ 0 & \text{if } M > \widehat{M} \end{cases}$$

The profits for the high premium are

$$\widetilde{\Pi} = 0; \tag{A-17}$$

profits with the low premium are

$$\widehat{\Pi} = \widetilde{\Pi} - \frac{C_d^2}{2W\left(1 - \underline{p}\right)} < 0. \tag{A-18}$$

We find that $\widetilde{\Pi} \geq \widehat{\Pi}$. For $W \geq W''$, the high premium implies zero insurance policy sales. □

Proof of Corollary 2

Proof. As the high willingness to pay in equation (9) is increasing in W,

$$\frac{\partial \widetilde{M}(W)}{\partial W} = \frac{1}{2}\left[1 + \underline{p} + \frac{C_d^2}{\left(1 - \underline{p}\right) W^2}\right] > 0,$$

equilibrium insurance premium is increasing in W. □

Proof of Proposition 1

Proof. From the results in the lemmatas. □

Proof of Proposition 2

Proof. From the results in the lemmatas. □

B Patent Characteristics

In this Appendix we provide an overview of the different measures of patent characteristics used in the analysis:

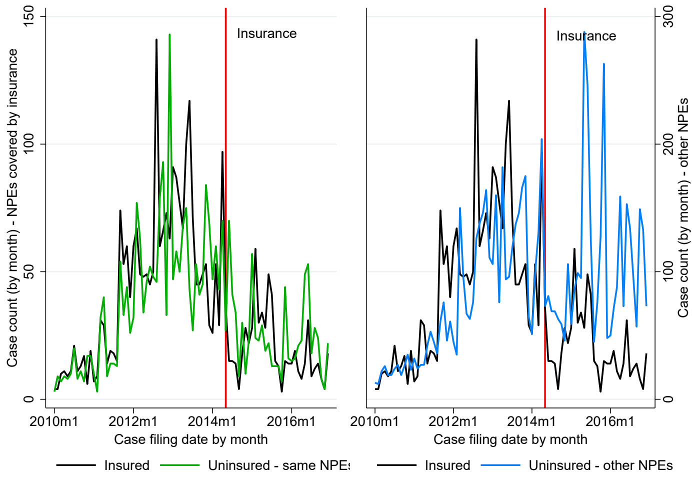
- **Age:** computed as the difference between a patent's priority year and 2016.
- **Remaining patent term:** computed as the difference between patent age in 2016 and statutory patent term, where for applications filed on or after June 8, 1995 patent age is computed as the difference between priority date and 2016 and statutory patent life is 20 years counting from the priority date – for applications filed before June 8, 1995 patent age is computed as the shorter of (i) the difference between 2016 and the filing date of the earliest application to which the patent claims priority, or (ii) the difference between 2016 and the date on which the patent issued where statutory patent term is 20 years for (i) counting from the priority date and 17 years for (ii) counting from the date of issuance.
- **Family size:** the total number of patent family members.
- **Forward citations:** count of forward citations within first 3 years of earliest publication.
- **Backward citations:** count of backward citations.
- **NPL citations:** non-patent literature backward citation count.
- **SEP:** equal to one of a patent is declared essential to a technology standard according to Bekkers et al. (2012).
- **Fee award:** equal to one if patent was subject to a fee award under section 285 of the U.S. Patent Act (see also appendix C below).
- **Business method/software:** equal to one if a a patent is in USPC main classes 341, 345, 370, 380, 382, 700-707, 710, 711, 713-715, 717, 726, and 902 as defined by Chung et al. (2015).
- **Independent claim length:** the total number of independent claims as computed by Marco et al. (2019).
- **Independent claims count:** the total number of independent claims as computed by Marco et al. (2019).
- **# assertions in court:** total number of court cases in which a given patent was asserted prior to the insurance policy becoming available.
- **Challenged at PTAB:** equal to one if a given patent was challenged at the PTAB prior to the insurance policy becoming available.

C Attorney Fee Awards

In this Appendix, we detail how we collected the data used to construct the fee award dummy variable. We identify all attorney fee awards made in U.S. patent suits 2010–2016. We obtained from Docket-Navigator a list of all court orders issued 2010–2016 that (i) granted (in whole or in part) a motion for attorney fees, and/or (ii) determined the amount of fees to award to a successful movant. To test this list's completeness, we cross-referenced with Jiam (2015), which provides a list of fee awards issued between the Supreme Court's April 29, 2014 opinion in *Octane Fitness, LLC v. ICON Health & Fitness, Inc.*, 572 U.S. 545 (2014) and March 1, 2015. We then reviewed each order to determine the procedural posture of the case at the time of the award and to determine the legal basis for the court's award. During this review, we dropped all awards made as part of a default judgment (i.e., awards against parties that did not defend the suit), as well as all awards not made pursuant to Section 285 of the U.S. Patent Act (i.e., the provision at issue in the *Octane Fitness* case). For all remaining awards, we identified the specific parties requesting and opposing the motion for fees and the specific patent(s) referenced in the fee award. Finally, when fee awards were made in consolidated cases or multi-district litigation, we expanded the data to the case-level by matching party-patent pairs to original, pre-consolidation case filings.

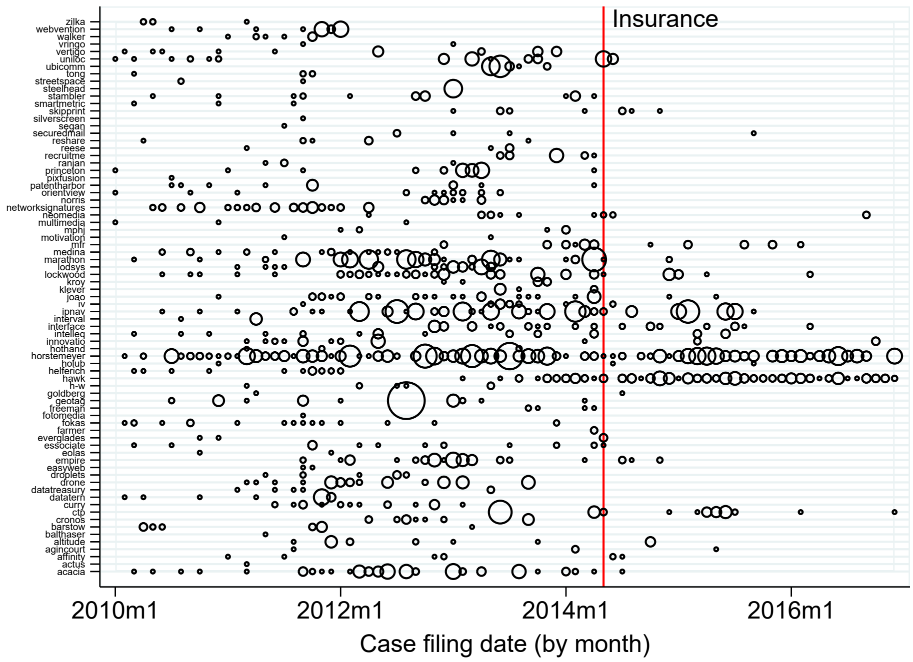
D Additional Figures

Figure A-1: Number of Court Cases Asserting Insured vs. Uninsured Patents



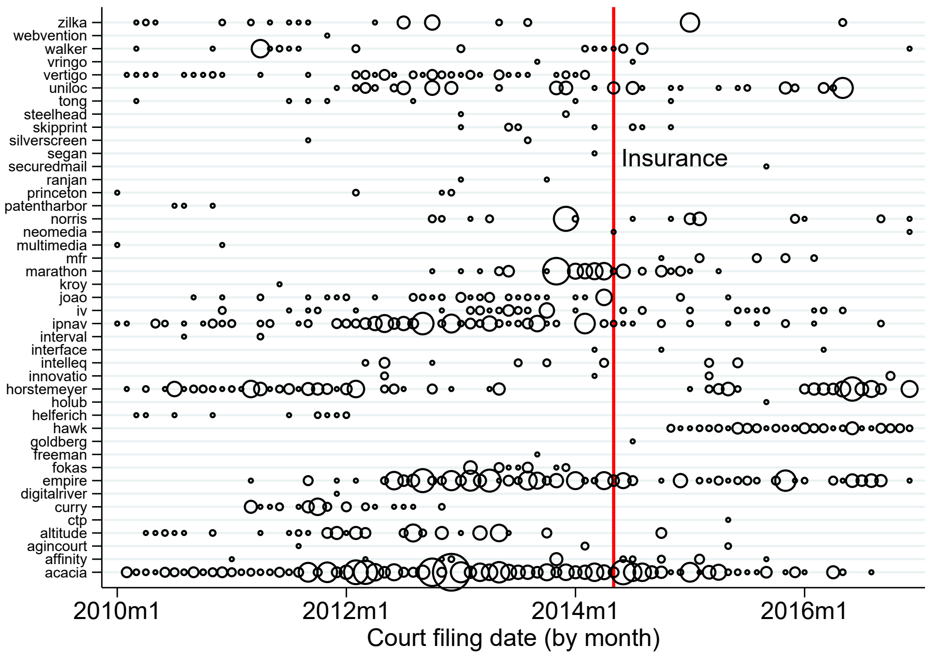
Notes: Insured patents contain all asserted patents from Menu 1 and Menu 2; the comparison group in the left-hand-side graph consists of all other asserted patents held by the same NPE groups that hold the insured patents (Comparison Group 2); the comparison group in the right-hand-side graph consists of other NPEs that do not hold any insured patents (Comparison Group 3).

Figure A-2: Number of Court Cases Asserting Insured Patents



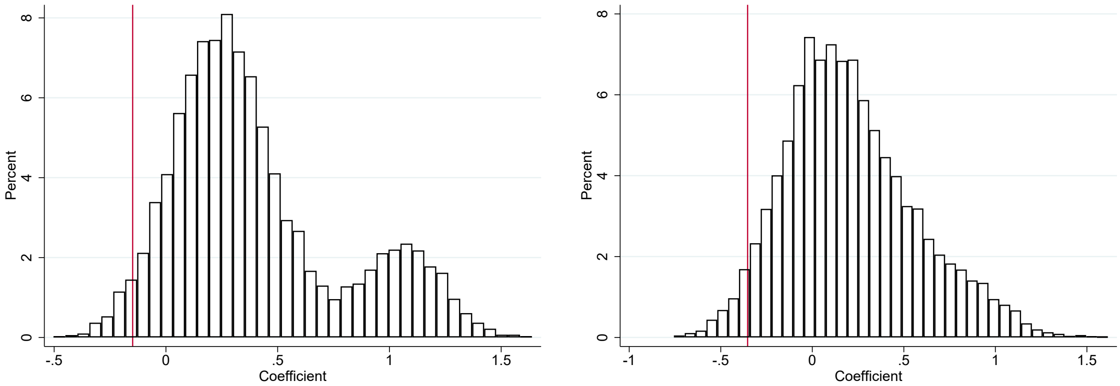
Notes: The size of a bubble indicates the number of district court cases by month; insured patents contain all asserted patents from Menu 1 and Menu 2.

Figure A-3: Number of Court Cases Asserting Uninsured Patents



Notes: The size of a bubble indicates the number of court cases by month; uninsured patents are all asserted patents held by NPE groups not covered by Menu 1 and Menu 2 of the IPISC insurance policy (Comparison Group 3).

Figure A-4: Permutation Test



(a) Insurance randomized within NPE group

(b) Insurance randomized across all patents

Notes: The figure shows the distribution of the difference in case filings between insured and uninsured patents by randomly allocating insurance across all patents in the sample (10,000 times). For plot (a), insurance is randomly allocated within the portfolio of a given NPE. The sample consists of NPE groups that hold at least twice as many uninsured as insured patents. For plot (b) we use all NPE groups and pool all patents across NPEs (we exclude Intellectual Ventures from the sample). Plot (a) shows that 97% of placebo estimates are larger than the actual estimate of -0.148. Plot (b) shows that 96% of placebo estimates are larger than the actual estimate of -0.353.

Figure A-5: Defendants by Size (Court Cases)

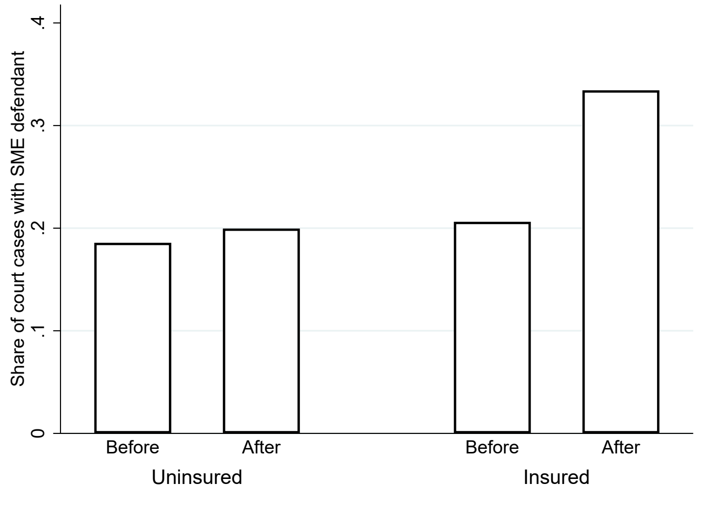


Figure A-6: Defendants by Business Group (Court Cases)

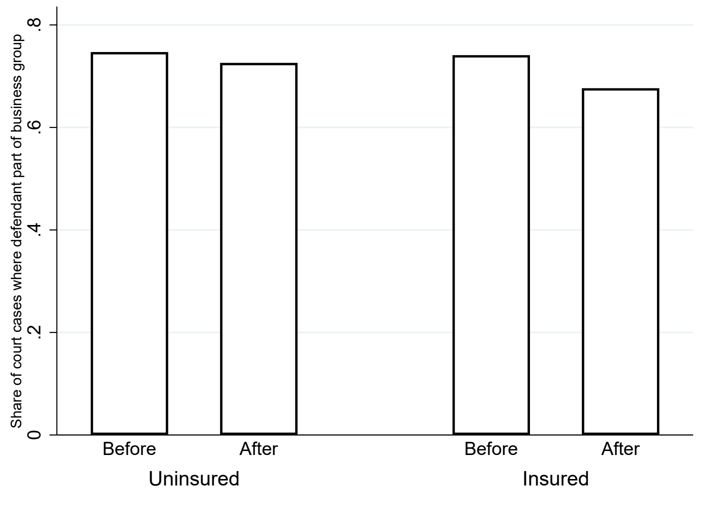
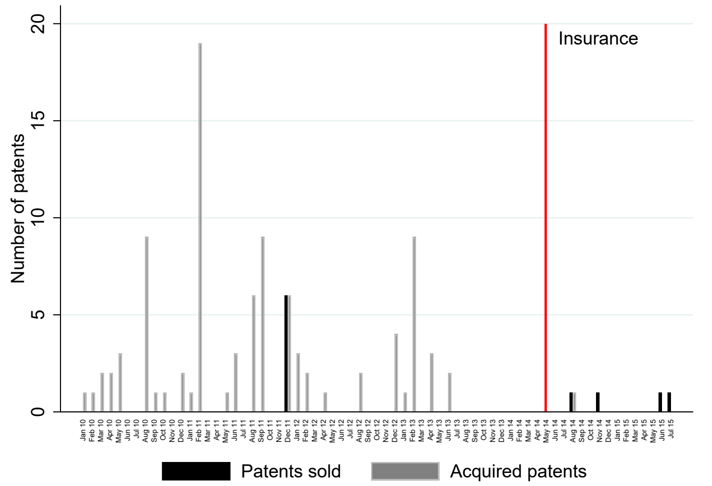
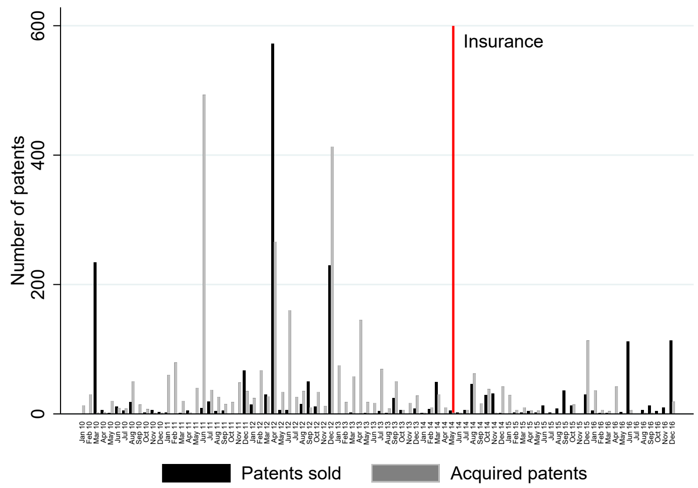


Figure A-7: Patent Sales and Acquisitions of Insured Patents



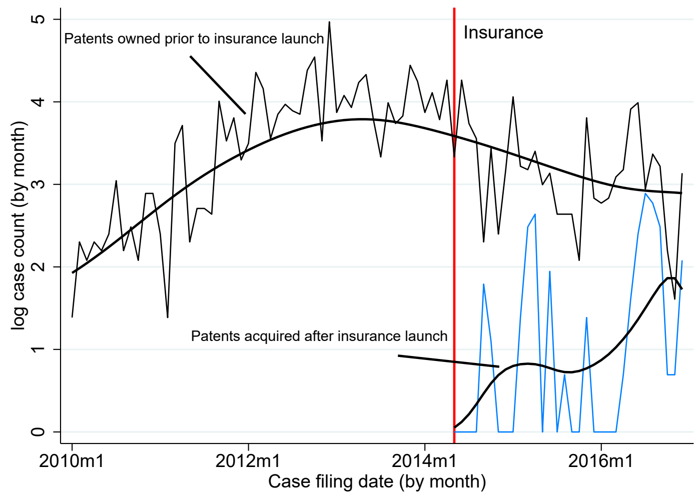
Notes: The figure only shows external re-assignments (re-assignments between entities that belong to the same NPE are excluded).

Figure A-8: Patent Sales and Acquisitions of Uninsured patents



Notes: The figure only shows external re-assignments (re-assignments between entities that belong to the same NPE are excluded).

Figure A-9: Patents Assertions by Portfolio



Notes: The figure shows assertions associated with uninsured patents held by NPEs in Comparison group 2.

E Additional Tables

Table A-1: NPE Groups and Patent Portfolios

NPE		insured patents		uninsured patents		Share insured/uninsured	
Name	Type	all	asserted	all	asserted	all	asserted
Acacia	PAE	19	17	2,116	401	0.009	0.044
Actus	PAE	4	4	0	0	ONLY INSURED	ONLY INSURED
Affinity	PAE	2	2	25	13	0.080	0.153
Agincourt	PAE	2	2	11	2	0.181	1.000
Altitude	PAE	3	3	140	46	0.021	0.065
Antor	PAE	1	1	1	0	1.000	0
Balthaser	PAE	1	1	1	0	1.000	ONLY INSURED
Barstow	PAE	4	4	0	0	ONLY INSURED	ONLY INSURED
Cronos	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
CTP	PAE	2	2	7	1	0.285	2.000
Curry	PAE	1	1	10	7	0.100	0.142
Datatern	PAE	2	2	1	0	2.000	ONLY INSURED
Datatreasury	PAE	6	6	12	0	0.500	ONLY INSURED
Digitalriver	PAE	1	1	103	6	0.009	0.166
Drone	PAE	1	1	1	0	1.000	ONLY INSURED
Droplets	PAE	2	2	4	1	0.500	2.000
Easyweb	PAE	5	5	1	0	5.000	ONLY INSURED
Empire	PAE	3	3	69	37	0.043	0.081
Eolas	Univ. Heritage	2	2	14	0	0.142	ONLY INSURED
Essociate	PAE	1	1	1	0	1.000	ONLY INSURED
Everglades	PAE	1	1	1	0	1.000	ONLY INSURED
Farmer	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Fokas	PAE	4	4	34	8	0.117	0.500
Fotomedia	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Freeman	Indiv.	1	1	4	1	0.250	1.000
Geotag	PAE	1	1	2	0	0.500	ONLY INSURED
Goldberg	PAE	3	3	12	2	0.250	1.500
H-W	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Hawk	PAE	1	1	5	3	0.200	0.333
Helferich	PAE	6	6	21	21	0.285	0.285
Holub	PAE	13	13	20	2	0.650	6.500
Horstemeyer	PAE	35	31	55	34	0.636	0.911
Hothand	PAE	1	1	6	0	0.166	ONLY INSURED
Innovatio	PAE	18	17	15	9	1.200	1.888
Intelleq	PAE	1	1	3	2	0.333	0.500
Interface	PAE	2	2	5	2	0.400	1.000
Interval	PAE	4	4	35	4	0.114	1.000
Ipnav	PAE	10	10	369	64	0.027	0.156
Intellectual Ventures	PAE	14	8	18,225	146	0.0007	0.054
Joao	PAE	4	4	40	9	0.100	0.444
Klever	PAE	1	1	11	6	0.090	0.166
Kroy	PAE	1	1	2	1	0.500	1.000
Lockwood	PAE	3	3	1	0	3.000	ONLY INSURED
Lodsys	PAE	4	4	0	0	ONLY INSURED	ONLY INSURED
Marathon	PAE	8	8	130	36	0.061	0.222
Medina	PAE	10	7	6	4	1.666	1.750
MFR	PAE	24	1	40	2	0.600	0.500
Motivation	PAE	1	1	2	0	0.500	ONLY INSURED
MPHJ	PAE	5	5	6	0	0.833	ONLY INSURED
Multimedia	PAE	4	4	13	11	0.307	0.363
Neomedia	PAE	4	3	28	6	0.142	0.500
Network Signatures	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Norris	PAE	3	3	28	11	0.107	0.272
Orientview	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Patentharbor	PAE	1	1	1	1	1.000	1.000
Pixfusion	PAE	2	2	3	0	0.666	ONLY INSURED
Princeton	PAE	1	1	7	7	0.142	0.142
Ranjan	PAE	1	1	4	3	0.250	0.333
Recruitme	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Reese	PAE	1	1	8	1	0.125	1.000
Reshare	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Securedmail	PAE	5	5	3	2	1.667	2.500
Segan	PAE	1	1	26	4	0.038	0.250
Silverscreen	PAE	1	1	4	2	0.250	0.500
Skipprint	PAE	3	3	6	6	0.500	0.500
Smartmetric	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Sph	PAE	1	0	15	15	0.066	0
Stambler	Indiv.	3	3	4	0	0.750	ONLY INSURED
Steelhead	PAE	1	1	2	2	0.500	0.500
Streetspace	PAE	1	1	5	0	0.200	ONLY INSURED
Tong	PAE	11	10	141	13	0.078	0.769
Ubicomm	PAE	3	3	4	0	0.750	ONLY INSURED
Uniloc	PAE	1	1	129	18	0.007	0.055
Vertigo	PAE	3	2	39	3	0.076	0.666
Vringo	PAE	2	2	67	6	0.029	0.333
Walker	PAE	5	5	576	48	0.008	0.104
Webvention	PAE	1	1	5	5	0.200	0.200
Zilka	PAE	3	3	128	48	0.023	0.062

Notes: PAE: Patent Assertion Entity; Indiv.: Individual; Univ. Heritage: University Heritage.

Table A-2: Comparison of Settlement Counts Between Insured and Uninsured Patents

	Court cases settled					
	Before		After		Diff	
	#	%	#	%		
	Insured					
Insured	4,479	97.24	947	98.24	-0.99	*
	Uninsured					
Comparison Group 1a	1,081	93.19	871	92.36	0.82	
Comparison Group 1b	887	92.69	701	91.75	0.93	
Comparison Group 2a	3,834	95.16	1,480	93.85	1.31	**
Comparison Group 2b	1,108	94.70	569	93.13	1.57	
Comparison Group 3a	6,495	92.47	4,942	94.37	-1.89	***
Comparison Group 3b	1,060	92.58	454	83.15	9.42	***

Notes: The sample consists only of cases that were terminated within 4 years after filing; insured patents include patents from both Menu 1 and Menu 2; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; Comparison 3: comparison group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all comparison groups, we have matched the most similar patents that belong to all other NPEs to the set of insured patents based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement; * significant at 10%, ** at 5%, *** at 1%.

Table A-3: Sales of Insured Patents

	Patent sale	
	(1)	(2)
Insured patent	0.063**	0.002
	(0.029)	(0.026)
Post-launch	-0.473***	-0.642***
	(0.035)	(0.105)
Insured ×	-0.440***	-0.112***
Post-launch	(0.049)	(0.029)
Patent characteristics	YES	YES
NPE FE	NO	YES
Month acquired FE	NO	YES
Observations	2,308	2,308
R^2	0.372	0.586

Notes: OLS regression. Dependent variable: dummy variable equal to one if patent was sold in a given month. All regressions include a constant. Time period is January 2010 – December 2016; patent characteristics described in the main text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes); robust standard errors clustered at the NPE-level. * significant at 10%, ** at 5%, *** at 1%.

Table A-4: Patent Sales and Acquisitions

	Patent acquisitions		Patent sales	
	(1)	(2)	(3)	(4)
Post-launch	-0.052	-0.077	0.052	0.064
	(0.053)	(0.056)	(0.037)	(0.040)
Intensity‡ × Post-launch		0.094*		-0.044
		(0.052)		(0.041)
NPE FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES
Observations	3,116	3,116	3,116	3,116
R^2	0.025	0.015	0.020	0.025

Notes: OLS regression. Dependent variable: dummy variable equal to one if NPE acquired a patent in a given month in columns (1) and (2), dummy variable equal to one if NPE sold a patent in a given month in columns (3) and (4). All regressions include a constant. Time period is January 2010 – December 2016; ‡ Intensity defined as number of insured patents divided by total number of patents held by given NPE before insurance was launched; robust standard errors clustered at the NPE-level. * significant at 10%, ** at 5%, *** at 1%.

Table A-5: Total Number of Court Cases at the Patent Level: Uninsured Patents

	Comparison 1		Comparison 2	
	All	Matched‡	All	Matched‡
	(1)	(2)	(3)	(4)
Post-launch	0.003	-0.002	-0.034***	-0.037***
	(0.014)	(0.014)	(0.009)	(0.009)
Matched patent× Post-launch		0.008		0.011*
		(0.008)		(0.006)
Patent FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES
Observations	32,951	32,951	79,800	79,800
R^2	0.013	0.014	0.011	0.011

Notes: OLS regression. Dependent variable: log number of cases by month. All regressions include a constant. Time period is January 2010 – December 2016; Comparison 1: comparison group consists of court cases in which uninsured patents were asserted by the same NPEs that hold insured patents; Comparison 2: comparison group consists of court cases in which uninsured patents were asserted by the same NPE groups that the NPEs that hold insured patents belong to; ‡ "Matched" is set of uninsured patents which were obtained from matching each insured patents to its most similar uninsured patent based on the patent characteristics described in the text (patent age, family size, forward citations, backward citations, NPL citations, SEP, fee award, business method/software patent, independent claim length, independent claims count, PTAB challenge, and 35 technology classes based on IPC codes) using propensity score one-to-one matching without replacement. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

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