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

Bernhard Ganglmair[a] Christian Helmers[b] Brian J. Love[b]

[a] *University of Mannheim & ZEW*

[b] *Santa Clara University*

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Abstract

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 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. Assuming that a firm's purchase of insurance is not observed by patent enforcers, we show that the mere availability of defensive litigation insurance can have an effect on how often patent enforcers will assert their patents. Next, we empirically evaluate the insurance policy's effect on the behavior of owners of insured patents by comparing their subsequent assertion of insured patents with their subsequent assertion of their other patents not included in the policy. We additionally compare the assertion of insured patents with patents held by other NPEs with portfolios that were entirely excluded from the insurance product. Our findings suggest that the introduction of this insurance policy had a large, negative effect on the likelihood that a patent included in the policy was subsequently asserted, and our results are robust across different control groups. Our findings also have importance for ongoing debates on the need to reform the U.S. and European patent systems, and 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, to date, no consensus on the overall economic impact of these "non-practicing" entities (NPEs), there is evidence that the patent assertion activities of NPEs have negative effects on the companies that they target 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). 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, tech companies concerned about the prevalence and expense of NPE patent enforcement have begun to embrace private, market-based initiatives. For example, the License on Transfer (LOT) Network, formed by a group of large tech companies, allows its members to commit to cross-licensing agreements that are automatically triggered if a patent is sold to an NPE. Similarly, membership-based companies focus on invalidating patents held by NPEs that threaten member companies (e.g., Unified Patents) or accumulate funds that can be used to purchase patents that might otherwise be asserted against their members (e.g., RPX and Allied Security Trust).[3]

[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 June 2018, more than 200 companies have joined the LOT network and pledged nearly half a million U.S. patents. Unified Patents has more than 200 members and as of June 2018 has challenged the validity of more than 100 patents.

In this paper, we investigate the potential for a different type of market-based mechanism 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] The market for defensive patent litigation insurance has experienced a surge in demand with a few providers now offering policies specifically for NPE defense.[5] The experience of Octane Fitness, which in 2014 used the proceeds of a defensive 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 directed at NPE litigation, it nevertheless underscores the potential impact insurance might have on a party's ability to defend itself against patent infringement claims by NPEs in court. Given the increase in NPE litigation in recent years (Marco et al., 2017) and the subsequent surge in potential demand for an insurance product with an increasing number of providers, it is surprising there is no systematic empirical evidence of the effect of patent litigation insurance on litigation behavior by both plaintiff NPEs and defendant technology adopters. Our goal is to fill this gap in the literature.

We theoretically and empirically study the effect of a defensive insurance policy on litigation behavior. We are particularly interested in the effect of such insurance on the NPE's decision to file a lawsuit and on a case (conditional on being pursued in court) being settled. To this end, we first propose a simple model in which an NPE can sue a technology adopter

[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 such defensive patent litigation policies in the U.S. presently include IPISC, RPX, AIG, Chubb, Lexington, 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).

for patent infringement, and the adopter can bring a patent invalidation action as part of its defense. The model combines two strands of the literature on the economics of litigation: on legal-expense insurance (Kirstein, 2000; Baik and Kim, 2007; Lemus et al., 2017) as a general form of patent litigation insurance,[7] and on externalities in litigation (Choi, 1998; Farrell and Merges, 2004; Farrell and Shapiro, 2008), because defending patent infringement suits (in particular when invalidation actions are involved) generates uncompensated positive externalities for one's competitor.[8] Before the lawsuit is filed, the prospective defendant can obtain patent litigation insurance that will cover her litigation costs (but not damages) and thus improve her outside option in settlement negotiations if the NPE asserts.[9] We find that a technology adopter with insurance is more inclined to defend against an NPE's assertion and less inclined to accept a settlement offer. In (perfect Bayesian) equilibrium of this insurance-litigation game, the adopter either does not buy insurance or buys insurance with a probability less than one – there is no equilibrium in which the adopter buys an insurance policy with certainty. We show that making insurance available decreases the likelihood that an NPE brings a patent infringement lawsuit and also reduces the likelihood that a case, once brought, is settled.

To quantify the effect of litigation insurance on NPE's 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 pack-

[7]Legal-expense 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 (2017), or Lavie and Tabbach (2017) study the functioning of more general third-party litigation funding mechanisms.

[8]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))).

[9]Because the adopter's insurance decision is private, pretrial settlement negotiations are under asymmetric information about the defendant's outside option. For classic contributions to the literature on bargaining under asymmetric information in law and economics, see Bebchuk (1984), Reinganum and Wilde (1986), Nalebuff (1987), or Kennan and Wilson (1993).

ages, this 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 in court, including by challenging the patent's validity.[10] 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, also avoid the difficulties inherent in uncovering the generally confidential fact that any given company has purchased a litigation insurance policy.

We employ a difference-in-difference design to determine the effect of IPISC's policy on litigation by comparing patent assertions in U.S. district courts before and after the insurance policy became available. Our treatment group consists of all patents covered by IPISC's NPE insurance policy. For our control group, we use patents that are not covered by the insurance. To address potential spill-over effects between insured and uninsured patents held by the same NPEs, we construct three separate control groups. Group 1 comprises all uninsured patents that were owned by the same NPEs (those with insured patents). Group 2 comprises all uninsured patents that were owned by the same NPEs or any of its subsidiaries or parents. Group 3 comprises all uninsured patents that were owned by NPEs with portfolios that were entirely excluded from the insurance product. This third set of uninsured patents is least likely to be directly or indirectly affected by the insurance policy. In addition, we match each of these sets of control patents to our set of insured patents using a variety of observable patent characteristics.

Analyzing the effect of patent litigation insurance empirically is difficult since random allocation of insurance is not practically feasible, and we are aware of no existing surveys that either ask firms to reveal whether they have purchased insurance or for NPEs to reveal whether the existence of insurance has influenced their assertion behavior. Despite the obser-

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

vational nature of our data, the ability to identify the specific patents covered by insurance and our difference-in-difference estimation design help us isolate the patent insurance effect by allowing us to account for unobservable patent and NPE characteristics.

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 control groups that we constructed. Second, for the set of cases that are still pursued in court after the insurance becomes available, our results of case outcomes suggest some (albeit weak) evidence of a drop in the likelihood of settlement following the introduction of the insurance. Third, we see an increase in the share of SMEs targeted by NPEs after the insurance becomes available. This could be an unintended consequence of the availability of insurance if NPEs target smaller companies more often because NPEs believe that firms are less likely to purchase insurance.

This paper contributes to our understanding of NPE litigation and the effects of litigation insurance in various ways. First, our results suggest that private market-based mechanisms can deter NPE activity,[11] 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.

To our knowledge, no empirical studies of the effects of patent litigation insurance (or, more generally, legal-expense insurance) have been attempted to date. The existing empirical literature is primarily descriptive in nature and focuses on individuals' access to legal services rather than on the insurance's effects on outcomes (e.g., 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). Few have attempted an inferential analysis of the effect of legal-expense insurance in any context, let alone as it relates to IP litigation.

[11] 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).

What few studies exist, largely focus on auto insurance (e.g., Fenn and Rickman, 2001).[12]

With a few exceptions, most theoretical papers focus on offensive litigation insurance and show that it could be used to deter potential market entrants (van Velthoven and van Wijck, 2001; Heyes et al., 2004; Llobet and Suarez, 2012) or that even risk-neutral agents are inclined to buy insurance in order to improve their bargaining positions (Kirstein, 2000). Little work has been done on defensive litigation insurance. Two central papers in this literature are by Kirstein (2000), who studies the insurance decision of both parties in an accident model, and by 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. Lemus et al. (2017) study defensive patent litigation insurance (to motivate their work on liability insurance) but focus on the design of optimal liability insurance contracts. In our model, we take the insurance contract as given and instead study the effect of such a contract on NPE 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 present the results of our empirical study, and we offer concluding remarks in Section 5.

2 Model

The model we present endogenizes a firm's decision to buy insurance and an NPE's decision to assert a patent after observing the firm's (alleged) infringement. We use this model to show under which circumstances the introduction of defensive patent litigation insurance affects three distinct decisions made during the pendency of a patent infringement lawsuit:

[12]Fenn and Rickman (2001) use data collected from an English motor insurer to study the duration of legal claims. While the effect of various sources of legal funding are not significant on their own, their "results suggest a difference between the settlement hazard for legally aided claims by comparison with those backed by legal expenses insurance," with shorter delays when claims are funded via legal-expense insurance.

(1) the NPE's decision to bring a suit, (2) the firm's decision to defend, and (3) the parties' decision to settle the suit before it is tried in court and decided on the merits. Our model predicts that (for a subset of the parameter space), upon the introduction of insurance NPEs are less likely to assert a patent and, conditional on bringing a patent infringement lawsuit, fewer cases are settled before trial.

We first present the timing and notation of our model and then provide details of our equilibrium analysis. In a last step, we discuss the implications of patent litigation insurance and present empirical predictions from our model.

2.1 Setup

There are two parties, a firm and an NPE. Both parties are risk neutral. The firm is a technology adopter in a product market with (technology-specific) profits of A. Through its product market activities, the firm may infringe an existing patent (for which it has not obtained a license).[13] In the case of infringement, the patent holder can sue for patent infringement damages. For the NPE, litigation bears the risk of invalidation of its patent (when the infringement suit is lost). At the outset, the firm has the option to buy insurance. This insurance policy covers the firm's litigation costs when it decides to defend in a patent litigation lawsuit.[14] We depict the timeline of our model of litigation insurance in Figure 1 and summarize the notation in Table 1. In the sequel, we describe the timing, notation, and payoffs of our model in detail.

$t = 1$**:** The firm can purchase an insurance policy at a fixed cost of $M > 0$.[15] The insurance policy reimburses the firm for its litigation costs.[16] We denote the players' payoffs in

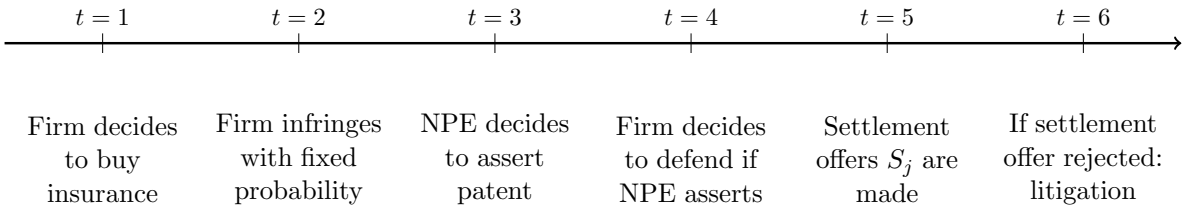
[13]This does not mean that the firm copied the infringing technology. To the contrary, copying is rarely alleged in U.S. patent litigation (Cotropia and Lemley, 2009).

[14]We assume that the policy covers the entire expense associated with litigation; this assumption could be relaxed without altering our main theoretical predictions.

[15]The policy premium is determined at a point where, as far as the infringement risk is concerned, all firms (and thus all potential insurance clients) are identical.

[16]We model the firm's insurance policy as a "defense-cost only" policy (i.e., legal-expense insurance), similar to IPISC's. For a discussion of this aspect of IPISC's policy, see Simensky and Osterberg (1999). For

Figure 1: Timeline of the Insurance-Litigation Game



the insurance case by a subscript i and in the no-insurance case by a subscript ni.

$t = 2$**:** The firm's activities in the product market result in patent infringement with exogenous probability ϕ. This probability is common knowledge, and the firm cannot influence its propensity of infringement through its actions. The assumption of a fixed ϕ rules out issues of moral hazard.[17] We assume that infringement per se does not affect the firm's product market payoffs, which amount to A in both the infringement and no-infringement case.

If the firm does not infringe the NPE's patent (with probability $1-\phi$), the game ends. The NPE's payoffs in this case are $N^0 = 0$. The firm's payoffs are $F_{\text{i}}^0 = A - M$ if it has bought insurance, and $F_{\text{ni}}^0 = A$ otherwise. If the firm infringes on the NPE's patent, the game proceeds to the next stage.

$t = 3$**:** The firm's patent infringement is observed by the NPE, and the NPE can either assert or waive its patent rights.[18] If the NPE waives, the game ends. Its payoffs in

related models with legal-expense insurance, see Kirstein (2000) (general) or Baik and Kim (2007) (patent infringement).

[17]The assumption that ϕ (the firm's "riskiness") is common knowledge also rules out selection on private information (in fact, we assume all parameters in the model are common knowledge). A constant value of ϕ 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 not cost effective and, in fact, is often practically impossible. 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 accused of infringement (Lemley, 2008).

[18]We rule out false positives in litigation. We assume that the firm infringes with probability ϕ and the NPE observes what it believes to be infringement with certainty (conditional on infringement). For our

this case are $N^{\text{na}} = 0$. The firm's payoffs are $F_{\text{i}}^{\text{na}} = A - M$ if it has bought insurance, and $F_{\text{ni}}^{\text{na}} = A$ otherwise. If the NPE asserts its patent, the game proceeds to the next stage.[19]

$t = 4$**:** The firm decides whether to defend against an NPE's patent infringement claim. If the firm defends, the game proceeds to the next stage. If, instead, the firm acquiesces, the game ends, and the firm pays $D \geq 0$ in demanded patent infringement damages. Its total payoffs are then $F_{\text{i}}^{\text{nd}} = A - M - D$ with insurance and $F_{\text{ni}}^{\text{nd}} = A - D$ without insurance. The NPE's payoffs are $N^{\text{nd}} = D$ in both the insurance and the no-insurance case.

$t = 5$**:** Before the case is decided (in $t = 6$), the parties can make settlement offers, S_j. For this settlement bargaining game, we assume that the NPE [firm] makes a take-it-or-leave-it settlement offer S_N [S_F] with probability β [$1 - \beta$]. This parameter β captures the NPE's bargaining power in bilateral negotiations. If the offer is rejected, the game proceeds to the next stage (in which the outcome of litigation is realized). If the offer by party j is accepted, the game ends. We assume that if the parties settle, no litigation costs are incurred. The firm's total payoffs are then $F_{\text{i}}^{\text{s}} = A - M - S_j$ with insurance and $F_{\text{ni}}^{\text{s}} = A - S_j$ without insurance. The NPE's payoffs are $N^{\text{s}} = S_j$ in both the insurance and the no-insurance case.

$t = 6$**:** When the firm infringes on the NPE's patent (in $t = 2$), the NPE asserts (in $t = 3$), the firm decides to defend (in $t = 4$), and party j's settlement offer is rejected (in $t = 5$), the game proceeds to the final litigation stage. Litigation comes at a cost of C_F to the firm and C_N to the NPE. A firm with insurance is reimbursed, so that its

model, this is the same as saying the firm infringes with certainty and the NPE observes infringement with probability ϕ. What is central to both stories is that the NPE does not assert the patent if it does not observe what it believes to be infringement.

[19] While many patentees do attempt to license their rights before filing suit (Lemley et al., 2018), 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).

effective litigation costs are zero.[20]

The outcome of litigation is random, and we assume the NPE wins the case with probability ω. The ex ante chance of winning the case is common knowledge to both players. In case of a win for the NPE, the firm pays damages D. The insurance policy is a defense-cost only policy, so the firm pays damages out of pocket. In case the NPE loses (with probability $1-\omega$), the NPE's patent is invalidated, causing the NPE to lose the option value of suing other firms for patent infringement. We thus assume the firm is found liable for infringing the NPE's patent if and only if the patent is valid.[21]

Suppose this option value of suing other firms for patent infringement is $P \geq 0$. The players' expected payoffs from litigation (that means, when the firm defends in stage $t=4$ and player j's settlement offer in $t=5$ is rejected) are

$$\begin{aligned} F_{\mathrm{i}}^{\mathrm{d}} &= A - \omega D - M \\ F_{\mathrm{ni}}^{\mathrm{d}} &= A - \omega D - C_F \end{aligned}$$

for the firm and

$$N^{\mathrm{d}} = \omega D - (1-\omega)\, P - C_N$$

for the NPE.

2.2 Equilibrium Analysis

In what follows, we first study the player's decisions in an environment of perfect information (i.e., when the firm's purchase of insurance is observed by the NPE). Using the first set of results, we then proceed to the scenario in which the insurance decision is unobservable

[20] For simplicity, we rule out deductibles or co-payments.

[21] To be clear, this is a simplification of actual patent litigation, which can also end in a determination of non-infringement that does not reach patent validity.

Table 1: Notation for Parameters and Decisions

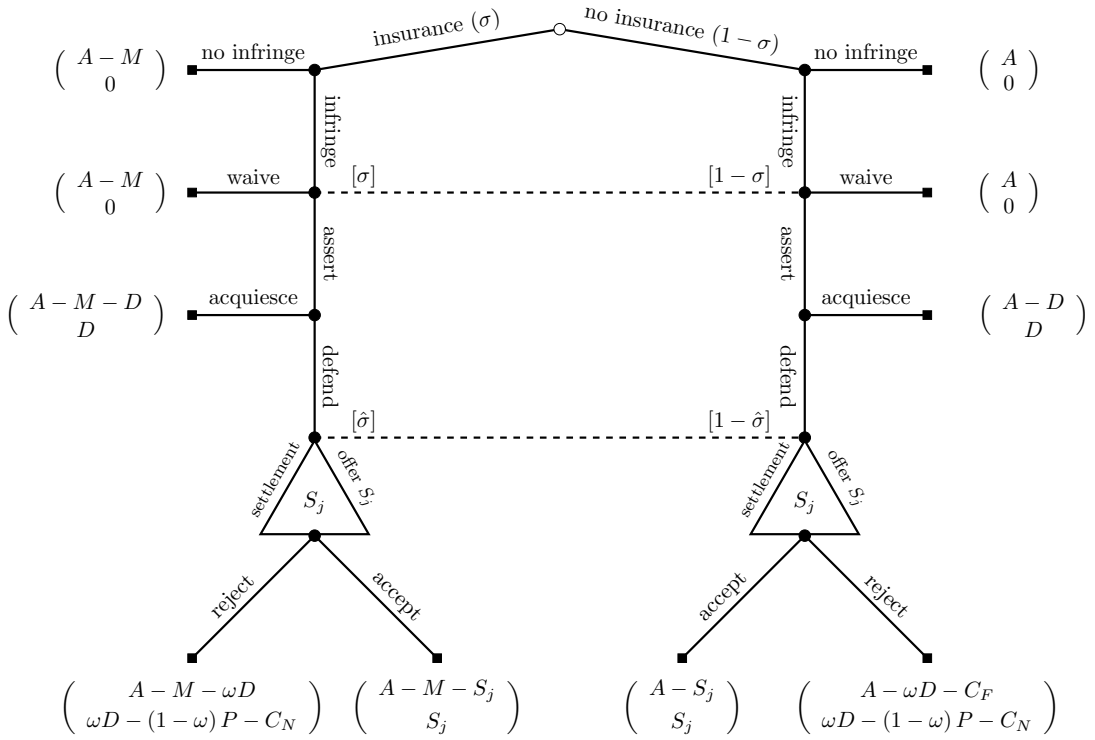
Variable	Description
Model Parameters	
A	Firm's product market profits from adopting the technology
M	Cost of the insurance policy
ϕ	Firm's probability of infringement
D	Infringement damages
S_j	Party j's settlement offer, $j = F$ (firm) or $j = N$ (NPE)
β $[1-\beta]$	Probability of NPE [firm] making the settlement offer (NPE's bargaining power)
C_F	Firm's litigation costs
C_N	NPE's litigation costs
ω	Probability the NPE wins the patent infringement suit
P	NPE's costs (in terms of lost future infringement damage payments) when it loses the patent infringement suit and sees its patent invalidated
Decisions / Mixed Strategies	
σ	Probability that firm buys insurance, $\sigma = \Pr(\text{insurance})$
α	Probability that NPE asserts patent, $\alpha = \Pr(\text{assert})$
δ	Probability that firm defends against NPE's patent assertion, $\delta = \Pr(\text{defend})$
η	Probability that NPE makes the low settlement offer

but fixed (i.e., the NPE believes that the firm bought insurance with probability α). For the settlement negotiations under asymmetric information (described above), we follow the approach in Schmitz (2006).[22] In the final stage, we endogenize the firm's insurance decision and characterize the resulting perfect Bayesian equilibria of this insurance-litigation game.

In Figure 2, we depict the full game tree with the payoff vectors for the respective outcomes (with the firm's payoff at the top and the NPE's payoffs at the bottom). For the players' decisions, we employ a mixed-strategy notation. This means, $\sigma \in [0,1]$ denotes the probability that the firm buys insurance, $\alpha \in [0,1]$ denotes the probability that the NPE asserts the patent (conditional on infringement), and $\delta \in [0,1]$ denotes the probability that the firm defends (conditional on assertion). As we show below, under perfect information, the NPE makes a type-contingent settlement offer, which in the absence of insurance will be higher. Under imperfect information, the NPE does not know the firm's type and makes

[22] Asymmetric information is about the value of the firm's outside option. More general results on this are offered, for instance, by Hwang and Li (2017).

Figure 2: Game Tree of the Insurance-Litigation Game



only one offer. We denote by $\eta \in [0,1]$ the probability that the NPE makes the lower offer in that case.

2.2.1 Observable Insurance

In an environment with perfect information, the NPE observes $\sigma \in \{0,1\}$: the firm has either purchased the insurance policy ($\sigma = 1$) or not ($\sigma = 0$).[23] We begin with the branch of the game tree on which the firm has purchased insurance and then proceed to the branch without insurance.

Firm With Insurance. Suppose the firm has defended against an NPE's assertion claim ($t = 4$). Before the parties incur litigation costs (and the firm's is reimbursed by the insurance policy) in $t = 6$, the parties enter settlement negotiations in $t = 5$. The NPE makes a take-

[23]Note that this is a slight abuse of our mixed-strategy notation. The NPE does not observe the firm's mixed strategy σ, but only its realization.

it-or-leave-it offer S_N with probability β. The highest settlement offer S_N the firm is willing to accept is S_N such that $F_{\mathrm{i}}^{\mathrm{s}} = A - M - S_N \geq A - M - \omega D = F_{\mathrm{i}}^{\mathrm{d}}$. The NPE thus offers

$$S_N = \omega D, \tag{1}$$

and the firm accepts. The firm makes its offer S_F with probability $1 - \beta$. The lowest settlement offer the NPE is willing to accept is S_F such that $N^{\mathrm{s}} = S_F \geq \omega D - (1 - \omega) P - C_N. = N^{\mathrm{d}}$. The firm offers

$$S_F = \omega D - (1 - \omega) P - C_N, \tag{2}$$

and the NPE accepts. Observe that S_F is not always positive. If $S_F < 0$, the NPE pays the firm to settle the case in order to avoid the potential loss of its option value P and litigation costs C_N.

Because both parties accept the respective offers, the firm expects to pay and the NPE expects to receive settlement payments of

$$E(S|\sigma = 1) \equiv \beta S_N + (1 - \beta) S_F = \omega D - (1 - \beta) \left[(1 - \omega) P + C_N \right]. \tag{3}$$

Anticipating these expected settlement payments, the firm always defends[24] in $t = 4$ (and settles in $t = 5$) because

$$F_{\mathrm{i}}^{\mathrm{s}} = A - M - E(S|\sigma = 1) \geq A - M - \omega D > A - M - D = F_{\mathrm{i}}^{\mathrm{nd}}.$$

[24]Legal-expense insurance eliminates (ex post) the firm's costs of litigation. The underprovision of litigation (i.e., defending against a patent assertion) as a public good (Farrell and Merges, 2004) does not arise, because the firm always defends. Compare this to the scenario without insurance below in which the firm does not defend if its private costs outweigh its private benefits.

In $t = 3$, the NPE asserts its patent rights if $N^{\mathrm{a}} = E(S|\sigma = 1) \geq 0 = N^{\mathrm{na}}$, or

$$P \leq \frac{\omega D - (1-\beta)\, C_N}{(1-\beta)\,(1-\omega)} \qquad \text{or} \qquad D \geq \frac{(1-\beta)\,[(1-\omega)\, P + C_N]}{\omega}. \tag{4}$$

Condition (4) holds if the NPE's option value P is sufficiently low so that the potential loss from an unfavorable settlement outcome is limited, or if damages D are sufficiently high to compensate for the potential losses.

We can summarize the equilibrium in this scenario as follows: *Given insurance (and the firm's infringement in $t = 2$), the NPE asserts in $t = 3$ if condition (4) holds, the firm always defends, and settlement offers S_j are accepted by both parties (and the case is always settled).*

Firm Without Insurance. Suppose the firm has defended against an NPE's assertion claim. In this scenario without insurance, the NPE makes a take-it-or-leave-it offer such that $F^{\mathrm{s}}_{\mathrm{ni}} = A - S_N \geq A - C_F - \omega D = F^{\mathrm{d}}_{\mathrm{ni}}$. The NPE offers

$$S_N = \omega D + C_F, \tag{5}$$

and the firm accepts. The firm's offer S_F is the same as in the scenario with insurance and given by the expression in equation (2). Note that the NPE's offer in this scenario is lower than when the firm has insurance. Insurance has a strategic value as it serves as commitment in settlement negotiations (Meurer, 1992).

Expected settlement payments are

$$E(S|\sigma = 0) = \omega D + C_F - (1-\beta)\,[(1-\omega)\, P + C_N + C_F]\,. \tag{6}$$

Anticipating $E(S|\sigma = 0)$, the firm defends in $t = 4$ (and settles in $t = 5$) if $F^{\mathrm{s}}_{\mathrm{ni}} =$

$A - E(S|\sigma = 0) \geq A - D = F_{\text{ni}}^{\text{nd}}$. This defense condition can be rewritten as

$$\left.\begin{array}{rcl} D & \geq & \dfrac{C_F - (1-\beta)\left[(1-\omega)\,P + C_N + C_F\right]}{1-\omega} \quad =: \quad \Delta(P) \\ P & \geq & \dfrac{C_F - (1-\omega)\,D - (1-\beta)\left[C_N + C_F\right]}{(1-\beta)\,(1-\omega)} \quad =: \quad \Pi(D) \end{array}\right\}. \tag{7}$$

In $t = 3$, the NPE (anticipating the firm's defense if condition (7) holds) expects payoffs from assertion of $N^{\text{a}}(\delta = 1) = E(S|\sigma = 0)$ if the firm defends and $N^{\text{a}}(\delta = 0) = D$ if the firm acquiesces. The NPE asserts if $N^{\text{a}}(\delta) \geq 0$. This condition holds (and the NPE asserts its patent in $t = 3$) if[25]

$$\left.\begin{array}{rcl} P & \leq & \Pi(D) + \dfrac{D}{(1-\beta)\,(1-\omega)} \\ D & \geq & -\dfrac{1-\omega}{\omega}\Delta(P) \end{array}\right\}. \tag{8}$$

The equilibrium outcomes of this scenario without insurance serve as benchmark case of our theoretical analysis. We summarize them in the following proposition:

Proposition 1 (Equilibrium without Insurance)**.** *In the scenario without insurance, we obtain three equilibrium outcomes:*

- [Early settlement] *For low values of P and D, all cases are settled (early).* **(Eq.1)** *Let condition* (7) *be violated: upon the firm's infringement in $t = 2$, the NPE asserts its patent in $t = 3$, and the firm acquiesces in $t = 4$.*

- [No case] *For high values of P and low values of D, the NPE does not assert and no cases are filed.* **(Eq.2)** *Let condition* (8) *be violated: upon the firm's infringement in $t = 2$, the NPE does not assert its patent in $t = 3$.*

[25] To see this, first note that if $D < \Delta(P)$ (or $P < \Pi(D)$), condition (7) is violated and the firm acquiesces, so that the NPE always asserts. If, instead, $D \geq \Delta(P)$ (or $P \geq \Pi(D)$), then the NPE asserts if $E(S|\sigma = 0) \geq 0$ which holds if condition (8) is satisfied. If condition (8) is violated, the firm decides to defend; the NPE, however, does not find it profitable to assert its patent. It decides to waive.

- [Late settlement] *For low values of P and high values of D, all cases are settled (late).*

  (Eq.3) *Let both conditions* (7) *and* (8) *be satisfied: upon the firm's infringement in $t = 2$, the NPE asserts its patent in $t = 3$, and the firm defends in $t = 4$. Both parties accept the settlement offers by their respective counter-parties in $t = 5$.*

We depict these equilibrium outcomes in Figure 3 in (D, P) space for values of $C_F = C_N = 1/2$, $\omega = 1/4$, and $\beta = 3/4$. The NPE asserts only if the option value P is sufficiently low so that the potential losses from an unfavorable settlement outcome are limited. This is true for both (Eq.1) and (Eq.3). The parameter region for (Eq.2), in which the NPE does not assert, is hinted at in the picture, but applies to values of P outside the range of the graph.[26]

2.2.2 Unobservable Exogenous Insurance

In an environment with imperfect information, the NPE does not observe the firm's insurance decision. For this scenario, we assume the NPE believes that the firm has purchased an insurance policy with constant probability $\sigma \in [0, 1]$.

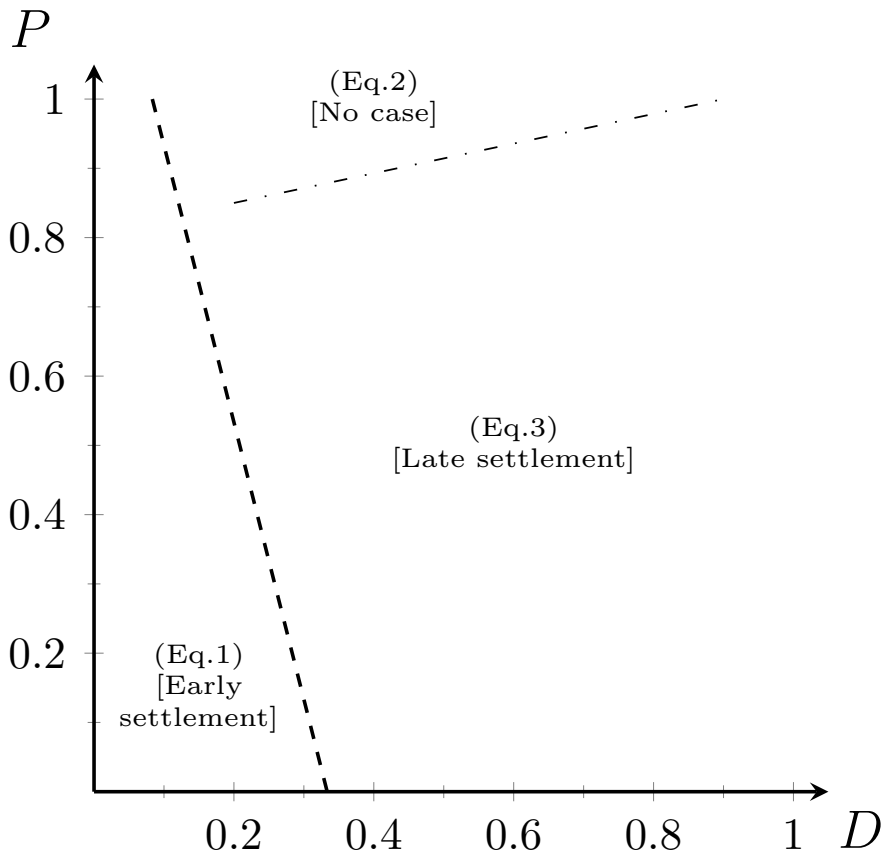
In the subgame in which the NPE asserts, the firm's decision to defend in $t = 4$ allows the NPE to update her beliefs about the firm's type (in $t = 5$). We denote the NPE's posterior beliefs that the firm has bought insurance by $\hat{\sigma} = \Pr(\text{insurance}|\delta)$. The NPE's settlement offer will depend on who she thinks she is facing. For the settlement negotiations, we only discuss the NPE's offer; the firm's offer is given by the expression in equation (2).[27]

If the NPE's offer S_N is such that $S_N > \omega D + C_F$, neither firm type will accept the offer. Any offer S_N such that $\omega D < S_N \leq \omega D + C_F$, the no-insurance type accepts, whereas the insurance type rejects. If the NPE's offer is rejected (and the case goes to trial in which the

[26] Note that the critical thresholds in condition (7) and (8) are the same for $D = 0$; that is, $\Pi(D) = \Pi(D) + \frac{D}{(1-\beta)(1-\omega)}$ for $D = 0$. The two lines in the figure intersect on the vertical axis.

[27] For settlement negotiations under asymmetric information, we follow the approach in Schmitz (2006). The type of the firm does not affect the NPE's payoffs (and her decisions) at this stage. The settlement offer by the firm does therefore not have a signaling function in our model, nor does the offer by the NPE have a screening function.

Figure 3: Equilibrium Outcomes Without Insurance



parties incur their respective litigation costs), her payoffs are $N^{\mathrm{d}} = \omega D - (1-\omega) P - C_N$. At last, both firm types will accept any offer $S_N \leq \omega D$. The NPE offers the lower settlement amount if $\hat{\sigma}$ (i.e., the probability that the case goes to trial if S_N is high) is sufficiently high. We denote this threshold by Σ:

$$\Sigma = \frac{C_F}{(1-\omega) P + C_N + C_F}. \tag{9}$$

The NPE's settlement offer can be summarized as

$$S_{N|\hat{\sigma}} = \begin{cases} \omega D & \text{if } \hat{\sigma} \geq \Sigma \\ \omega D + C_F & \text{if } \hat{\sigma} < \Sigma. \end{cases} \tag{10}$$

The firm's decision to defend is a signal of its insurance type. We assume the NPE

updates her beliefs following Bayes' rule so that

$$\hat{\sigma} = \frac{\sigma\delta_{\text{i}}}{\sigma\delta_{\text{i}} + (1-\sigma)\,\delta_{\text{ni}}} \tag{11}$$

where δ_{i} and δ_{ni} denote the probability of defense for the insurance and the no-insurance type, respectively.

In Lemma 1 below, we characterize the firm's equilibrium defense strategy in the subgame in which the NPE has asserted her patent. We show that, if $D \geq \Delta(P)$, the result is a pooling equilibrium in which both firm types always defend (for all σ) so that the NPE does not obtain any additional information (and $\hat{\sigma} = \sigma$). Similarly for $D < \Delta(P)$ and high σ ($\sigma \geq \Sigma$). If, instead, $D < \Delta(P)$ and $\sigma < \Sigma$, the resulting equilibrium is in mixed strategies in which the no-insurance type defends with probability $\delta_{\text{ni}} = \delta^*$.

Lemma 1. *In the subgame in which the NPE has asserted her patent, the firm's defense strategy and the NPE's settlement offer in perfect Bayesian equilibrium are as follows:*

1. *Both firm types will defend in equilibrium if $\sigma \geq \Sigma$, or if $\sigma < \Sigma$ and $D \geq \Delta(P)$. The NPE's posterior beliefs are $\hat{\sigma} = \sigma$, and the parties settlement offers are given by equations* (10) *for the NPE and* (2) *for the firm.*

2. *Let $\delta_{ni} = \delta^*$ denote the probability that the no-insurance type defends, and let $\eta^* = \Pr(S_N = \omega D)$ and $1 - \eta^* = \Pr(S_N = \omega D + C_F)$ denote the probabilities that the NPE makes the respective settlement offers. If $\sigma < \Sigma$ and $D < \Delta(P)$, then, in equilibrium, the insurance type defends with certainty ($\delta_i = 1$), whereas the no-insurance type defends with probability*

$$\delta^* = \frac{(1-\omega)\,P + C_N}{C_F}\frac{\sigma}{1-\sigma}. \tag{12}$$

The NPE's posterior beliefs are $\hat{\sigma} = \Sigma$. She offers $S_N = \omega D$ with probability

$$\eta^* = 1 - \frac{(1-\omega)\,D + (1-\beta)\,[(1-\omega)\,P + C_N]}{\beta C_F} \tag{13}$$

and $S_N = \omega D + C_F$ with probability $1 - \eta^*$.

Anticipating the outcome characterized in Lemma 1, and upon observing the firm's patent infringement, the NPE decides to assert her patent or waive (in $t = 3$). We summarize this decision in Lemma 2.

Lemma 2. *Upon observing the firm's infringement, the NPE's decision is as follows:*

1. *If $\sigma \geq \Sigma$, the NPE asserts if*

$$\left.\begin{array}{rcl} P & \leq & \Pi(D) + \dfrac{D - \beta C_F}{(1-\beta)\,(1-\omega)} \\ D & \geq & -\dfrac{1-\omega}{\omega}\Delta(P) + \dfrac{\beta C_F}{\omega} \end{array}\right\}. \tag{14}$$

2. *If $\sigma < \Sigma$ and $D \geq \Delta(P)$, the NPE asserts if*

$$\left.\begin{array}{rcl} P & \leq & \dfrac{1-\beta}{1-\beta\,(1-\sigma)}\Pi(D) + \dfrac{D - \beta\sigma\,[C_N + C_F]}{(1-\beta\,(1-\sigma))\,(1-\omega)} \\ D & \geq & -\dfrac{1-\omega}{\omega}\Delta(P) + \dfrac{\sigma\,[(1-\omega)\,P + C_N + C_F]}{\omega} \end{array}\right\}. \tag{15}$$

3. *If $\sigma < \Sigma$ and $D < \Delta(P)$, the NPE asserts if*

$$\begin{array}{rcl} P & \leq & \dfrac{\sqrt{4\,(1-\beta)\,C_F D + [(1-\omega)\,D - (1-\beta)\,C_F]^2\,\sigma}}{2(1-\beta)(1-\omega)\sqrt{\sigma}} - \\ & & \dfrac{[(1-\beta)\,[2C_N + C_F] + (1-\omega)\,D]\,\sqrt{\sigma}}{2(1-\beta)(1-\omega)\sqrt{\sigma}}. \end{array} \tag{16}$$

Combining the strategies summarized in Lemma 1 and 2, we can now characterize outcomes in the perfect Bayesian equilibrium in the game with exogenous but unobserved in-

surance in Proposition 2 below. The construction of these equilibria for the various regions of our parameter space follows from Lemmas 1 and 2. We provide a graphical illustration in Figure 4.

Proposition 2 (Equilibrium with Exogenous Insurance)**.** *Let the firm have insurance with probability $\sigma \in [0, 1]$. The outcomes in perfect Bayesian equilibrium are as follows:*

- [No case] *For sufficiently high values of P and low values of D, the NPE does not assert and no cases are filed.*

  (Eq.a) *If $\sigma \geq \Sigma$ and condition* (14) *is violated, the NPE does not assert. Off the equilibrium path, both firm types defend and the NPE makes a low settlement offer which both firm types accept.*

  (Eq.b) *If $\sigma < \Sigma$, $D \geq \Delta(P)$, and condition* (15) *is violated, the NPE does not assert. Off the equilibrium path, both firm types defend and the NPE makes a high settlement offer which only the no-insurance type accepts.*

  (Eq.c) *If $\sigma < \Sigma$, $D < \Delta(P)$, and condition* (16) *is violated, the NPE does not assert. Off the equilibrium path, the insurance type defends with certainty whereas the no-insurance type defends with probability δ^*; the NPE makes a low settlement offer with probability η^* and a high offer with $1 - \eta^*$, and only the no-insurance type accepts the high settlement offer.*

- [Late settlement] *For intermediate values of P and high values of D, all cases are settled late.* **(Eq.d)** *If $\sigma \geq \Sigma$ and condition* (14) *is satisfied, the NPE asserts, both firm types defend, and the NPE makes a low settlement offer which both firm types accept.*

- [Some late settlement, some trial] *For low values of P and low values of D, some cases are settled and some cases are tried.*

(Eq.e) *If $\sigma < \Sigma$, $D \geq \Delta(P)$, and condition* (15) *is satisfied, the NPE asserts, both firm types defend, and the NPE makes a high settlement offer which only the no-insurance type accepts.*

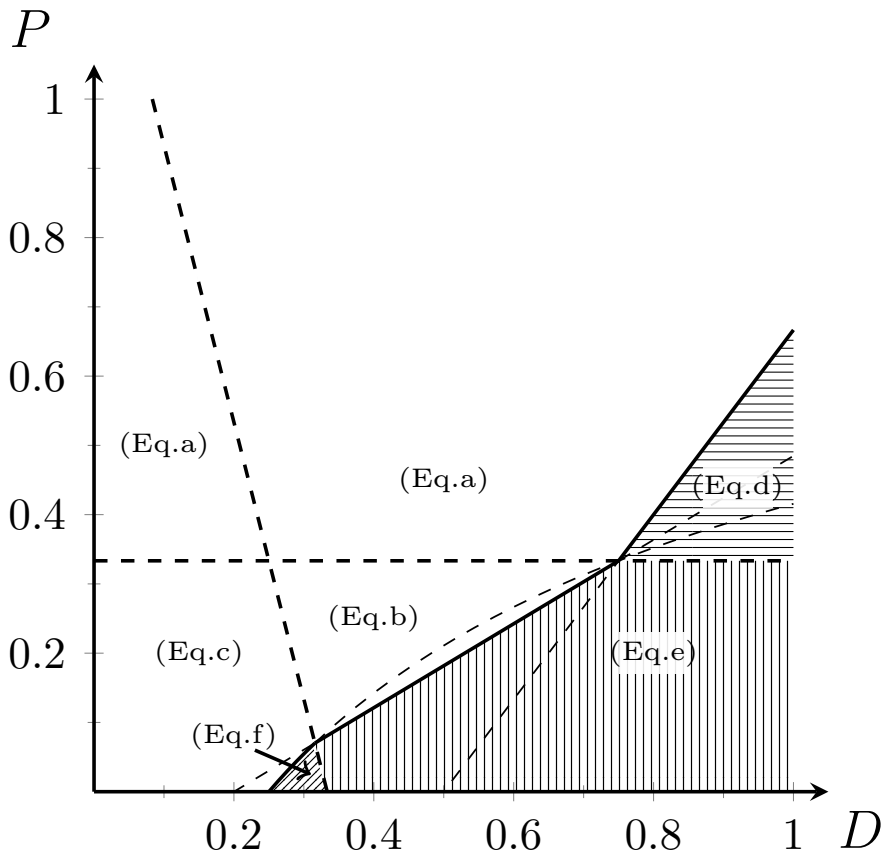
(Eq.f) *If $\sigma < \Sigma$, $D < \Delta(P)$, and condition* (16) *is satisfied, the NPE asserts, the insurance type defends with certainty whereas the no-insurance type defends with probability δ^*; the NPE makes a low settlement offer with probability η^* and a high offer with $1 - \eta^*$, and only the no-insurance type accepts the high settlement offer.*

In Figure 4, we provide a graphical illustrations of the equilibrium outcomes with unobserved exogenous insurance in (D, P) space for values of $C_F = C_N = 1/2$, $\omega = 1/4$, and $\beta = 3/4$. For the probability of insurance, we assume that $\sigma = 2/5$. The NPE asserts only in the shaded regions of the parameter space (for low P or high D). In the non-shaded area of the picture, we do not expect to see infringement suits filed against the firm (outcomes (Eq.a) through (Eq.c)). The insurance type always defends (on and off equilibrium), whereas the no-insurance type defends with certainty only outside the lower-left region of the figure. In that region (for low P and low D, outcome (Eq.f)), the no-insurance type defends with probability strictly less than unity, and we expect to see some settlement and some trials. For higher values of D (outcome (Eq.e)), we expect to see some settlement (for the no-insurance types) and some trials (for the insurance types). At last, for higher values of D and intermediate values of P (outcome (Eq.d)), all cases are settled.

2.2.3 Unobservable Endogenous Insurance

With the results in Proposition 2 for exogenous insurance, we are now ready to consider the firm's insurance decision in $t = 1$. Propositions 3 and 4 below summarize the respective equilibrium outcomes. In equilibrium, the firm buys insurance with probability σ^*, and given this equilibrium strategy, the NPE asserts with probability α^*. Given the assertion decision, the equilibrium in the respective subgames is described in Proposition 2 for $\sigma = \sigma^*$.

Figure 4: Equilibrium Outcomes with Unobserved Exogenous Insurance



For the construction of the respective equilibria, first note that the equilibrium in Proposition (2) reduces to the one in Proposition 1 if $\sigma = 0$. For this no-insurance outcome, the NPE always makes the high settlement offer $S_{N|\hat{\sigma}<\Sigma}$. In Figure 4, the respective condition is captured by the horizontal line – the NPE offers the high offer for all P such that

$$P < \frac{C_F - \sigma\left[C_N + C_F\right]}{\sigma\left(1-\omega\right)}. \tag{17}$$

For $\sigma = 0$, the NPE always makes the high settlement offer, which eliminates equilibrium outcomes (Eq.a) and (Eq.d). Note that condition (7) is not a function of σ. For $D < \Delta(P)$, we further observe that the condition separating outcomes (Eq.c) and (Eq.f) becomes non-binding, and the only equilibrium outcome in this region is that of the mixed-strategy equilibrium (Eq.f). This mixed-strategy equilibrium, however, is degenerate because $\delta^* = 0$.

This outcome corresponds to outcome (Eq.1) in Figure 3. For $D \geq \Delta(P)$, the condition separating outcomes (Eq.b) and (Eq.e) reduces to condition (8). The respective equilibrium outcomes correspond to outcomes (Eq.2) and (Eq.3) in Figure 3.

We first show that, if the insurance M is too high, then in equilibrium the firm will not buy insurance so that $\sigma^* = 0$. The equilibrium outcome is then as summarized in Proposition 1. The introduction of patent litigation insurance has no effect if that insurance is sold at an excessive price.

Proposition 3 (No-Insurance Equilibrium)**.** *If the insurance premium is too high such that*

$$M > \phi\beta C_F, \tag{18}$$

then the firm does not purchase insurance in equilibrium. The equilibrium outcome is the same as in Proposition 1.

We are interested in the effect of insurance on the frequency and outcome of litigation. For this reason, we rule out excessive values of M for the remainder of the analysis. We assume that $M \leq \phi\beta C_F$; some firms do buy insurance. For such a sufficiently low insurance premium, the insurance purchase decision is as follows:

Lemma 3. *Let $M \leq \phi\beta C_F$. In perfect Bayesian equilibrium of the insurance-litigation game, the firm buys insurance with a probability strictly less than unity. More specifically, if*

$$D > \Delta(P) + \frac{M - \phi\beta C_F}{\phi\,(1-\omega)} \tag{19}$$

and condition (8) *is satisfied, the firm buys insurance with probability $\sigma^* \in (0,1)$. Otherwise, the firm does not buy insurance in which case $\sigma^* = 0$.*

We summarize the outcomes in perfect Bayesian equilibrium of the insurance-litigation game as follows:

Proposition 4 (Equilibrium with Endogenous Insurance)**.** *Let $M \leq \phi\beta C_F$. The outcomes in perfect Bayesian equilibrium of the insurance-litigation game are as follows:*

- *For low values of P and D, all cases are settled early.* **(Eq.A)** *If condition* (19) *is violated, the firm does not buy insurance in $t = 1$. Upon the firm's infringement in $t = 2$, the NPE asserts the patent in $t = 3$, and the firm acquiesces in $t = 4$.*

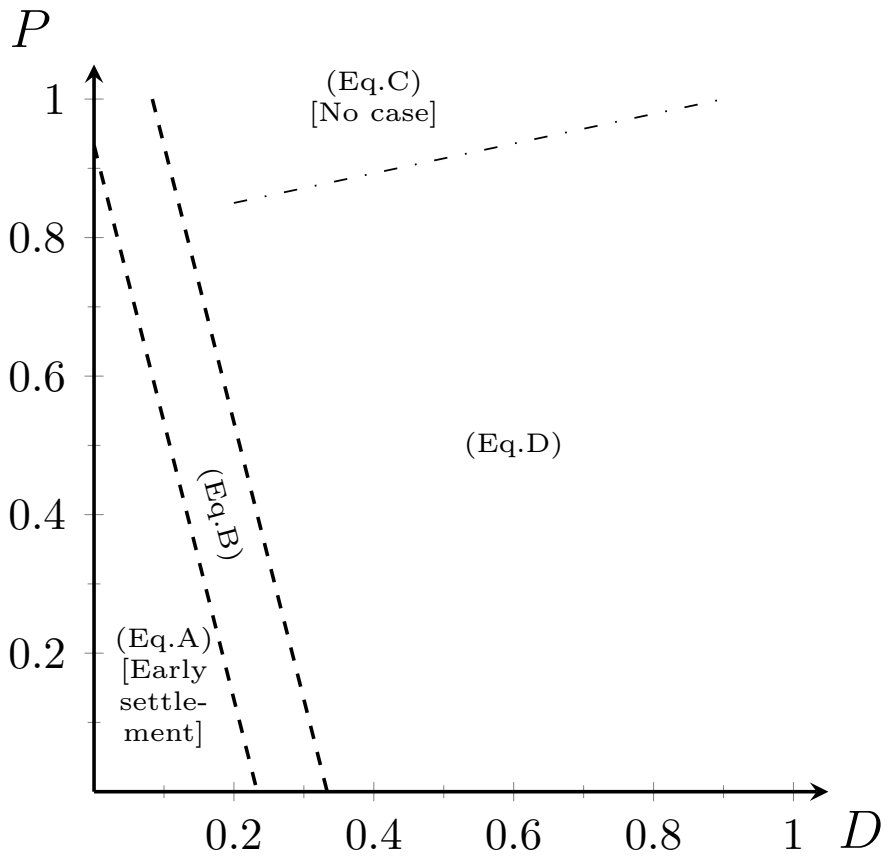
- *For intermediate values of P and D, not all cases are filed. Conditional on the NPE asserting, some cases are settled early and some are settled late.* **(Eq.B)** *If condition* (19) *holds and* (7) *is violated, the firm buys insurance in $t = 1$ with positive probability σ^*. Upon the firm's infringement in $t = 2$, the NPE asserts the patent in $t = 3$ with probability $\alpha^* \in (0, 1)$, the firm with insurance defends, whereas the firm without acquiesces in $t = 4$, and only the no-insurance type accepts the NPE's high settlement offer.*

- *For high values of P and low values of D, no cases are filed.* **(Eq.C)** *If condition* (8) *is violated, the firm does not buy insurance in $t = 1$, and the NPE does not assert the patent in $t = 3$.*

- *For low values of P and high values of D, not all cases are filed. Conditional on the NPE asserting, no cases are settled early and some cases are settled late.* **(Eq.D)** *If conditions* (7) *and* (8) *are satisfied, the firm buys insurance in $t = 1$ with positive probability σ^*. Upon the firm's infringement in $t = 2$, the NPE asserts the patent in $t = 3$ with probability α^*, both firm types defend in $t = 4$, and only the no-insurance type accepts the NPE's high settlement offer.*

Proposition 4 characterizes the equilibrium outcomes of the insurance-litigation game as depicted in Figure 2. A comparison of the equilibrium outcome of the scenario without insurance (Proposition 1, or Proposition 2 for $\sigma = 0$) with the equilibrium outcome of the scenario in which the insurance purchase is the firm's decision (Proposition 4) yields predictions of what to expect when insurance is introduced. We assume that the insurance

Figure 5: Equilibrium Outcomes with Unobserved Endogenous Insurance



premium is sufficiently low so that the results in Proposition 3 do not apply and discuss the implication of an introduction of insurance in the next section.

2.3 Discussion and Predictions

The introduction of insurance has no effect on the equilibrium outcome if D and P are both low (Eq.A), or D is low and P sufficiently high (Eq.C).

- In (Eq.A), without insurance, the firm does not defend and the NPE asserts. With insurance, the firm decides not to buy insurance because prospective damages are too low to justify the expense. In fact, expected damages are so low that the firm decides to acquiesce before it incurs litigation costs.

- In (Eq.C), without insurance, the firm defends once the NPE asserts. Anticipating the

firm's defense, however, the NPE decides to waive. This is because high values of P imply significant losses to the NPE's future returns. This is particularly true for low values of β (NPE has low bargaining power) or low values of ω (the probability that the NPE wins in court is low). Because the NPE does not assert the patent even in the scenario without insurance, the firm has no incentive to purchase insurance when it is available.

The difference between these two outcomes is that in (Eq.C), the firm has nothing to insure against because it does anticipate any lawsuits filed by the NPE. In (Eq.C), the firm expects the NPE to file a lawsuit, but the savings from defending are too low to warrant the insurance expense. The firm prefers to acquiesce and pay the demanded damage payment D.

For higher values of D, but P not too high, the introduction of insurance, in equilibrium, lowers the number of cases filed. Conditional on a case being filed, the availability of insurance further lowers the rate at which cases are settled.

- In (Eq.B), without insurance, the NPE asserts and the firm acquiesces. In the end, all cases are settled early. With insurance, the equilibrium of the insurance-litigation game is in mixed strategies. The firm buys insurance with strictly positive probability to induce the NPE to assert with less than certainty. The reason for the NPE's reluctance to assert when there is a possibility that the firm has insurance is that the firm with insurance will defend. This implies a potential loss for the NPE if the case is tried (when the firm with insurance rejects the NPE's high settlement offer) or if the firm makes the settlement offer (when the NPE's bargaining power is low). For any given value of D, the potential losses stemming from P are now higher than in (Eq.A).

- In (Eq.D), without insurance, the NPE asserts and the firm defends. The NPE has less to lose (because P is relatively low) and the firm has much to defend (because D is relatively high). In the end, all cases are settled late. With insurance, the firm buys insurance with strictly positive probability, again, to induce the NPE to assert with

less than certainty. The underlying mechanism is the same as in (Eq.B).

In both (Eq.B) and (Eq.D) – for higher values of D – some firms buy insurance, inducing the NPE to sometimes waive its patents rights. Compared to the outcomes without insurance, the introduction of insurance leads to fewer cases being filed. In addition, given that the NPE has filed a suit, fewer cases are settled. The main difference between (Eq.B) and (Eq.D) is the timing of settlement. In (Eq.B), some cases are settled early because the firm without insurance decides to acquiesce and pay demanded damages D if the NPE asserts. Of the firms that buy insurance, those who are offered a high settlement offer by the NPE decide to reject this offer and have the case tried in court. The firms that are offered the low settlement offer will accept so that the case is settled late. This means, in (Eq.B), we expect to see both early and late settlement of cases – but overall a lower settlement rate than without insurance. In (Eq.D), both firm types (those that have bought insurance and those that have not) defend if the NPE asserts. This means that in (Eq.D) we do not see early settlement. If settled, cases are settled late. Again, we expect to see an overall lower settlement rate.

3 Data

We next analyze the impact of litigation cost insurance empirically. To do so, we construct a dataset that allows us to observe the litigation behavior of parties following the introduction of one such policy: a "Troll Defense" policy offered by leading insurer IPISC. As described in greater detail below, this policy is unique in that it insures against the enforcement of a publicly available list of NPE-owned patents. We construct a dataset of all patents owned by NPEs impacted by the policy's availability and identify all lawsuits enforcing any of these patents. Using these data, we are able to compare the litigation activity of impacted NPEs, both before and after the availability of insurance. We further control for the selection of insured patents by constructing a variety of matched sets of patents not included in the

insurance policy, and finally we control for the selection of NPEs by comparing the activity of impacted NPEs to a sample of all other NPE patent assertions during the same period of time.

3.1 IPISC NPE Litigation Insurance

We study the "Troll Defense" policy offered by IPISC.[28] This policy, which was first launched in May 2014, is available in two "menus" of patents 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 additionally elect to purchase 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 number, last-recorded owner, title, and technology classification (assigned by IPISC) of included patents. This information forms the basis for our empirical analysis, described below.[30]

Reimbursements are available for costs incurred to defend against insured patents both in court and before the PTAB, which considers petitions to reconsider the validity of issued patents. However, judgments or settlements are not eligible for coverage. Policy limits range from $250,000 to $1 million, and policy terms are set at one year. 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

[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 wants to purchase coverage for Menu 2, it must also purchase coverage for Menu 1.

[30] IPISC also offers a third, more complex option, which supplements Menus 1 and 2 on an ad hoc basis using the insured's SIC code. This policy option additionally provides coverage against the assertion of unlisted patents, provided that (i) the asserted patent falls within the scope of the insured's SIC code (as determined by IPISC), and (ii) the assertion targets the insured's "non-core products." IPISC defines non-core products as "any manufactured product and associated software, hardware and infrastructure any and all of which are not in commercial use and do not contribute more than 2.5% of the insured company's compensation measured at the time of the claim(s) under which reimbursement is sought is/are made and therefore are not core manufactured product(s)."

on Menus 1 and 2 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 NPE Patent Portfolios

Our data collection begins with the two "menus" of patents published on IPISC's website. We refer to the patents on these lists as "insured" patents. Together, these two lists include a total of 307 patents owned by a total of 103 unique NPEs.[31]

However, it is often the case that the specific NPE enforcing any given patent is little more than a shell company owned and controlled by a parent. Indeed, it is common for firms that specialize in patent assertion to 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. Thus, to identify the "real party in interest" behind each patent's enforcement, we next established whether each of these 103 NPEs was an independent company or, instead, part of a larger network of patent-holding entities controlled by a common parent. Relying on information obtained from RPX, Inc.,[32] we determined that 78 NPEs – 28 independent entities and 50 parents[33] – were ultimately the owners of one or more insured patents.

With each insured patent's true owner identified, we next sought to determine whether each entity owned any patents not listed on Menus 1 and 2. Because these patents are not covered by the policy, we refer to them as "uninsured" patents. To accomplish this task, we first identified the members of each enforcer's family of patent-enforcing subsidiaries. Again relying principally on RPX's database of patent-asserting entities, we were able to identify

[31]IPISC's menus actually list 105 patent owners, but we exclude two producing entities that also hold patents included in the insurance list. That said, in our analysis, the number of NPEs that hold insured patents is slightly larger because in some instances an NPE listed by IPISC re-assigned the patent to another NPE controlled by the same NPE group during our period of analysis; in these instances we consider the NPE that acquired the patent as part of the group of NPEs that hold insured patents even if it was not explicitly listed on the IPISC insurance list.

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

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

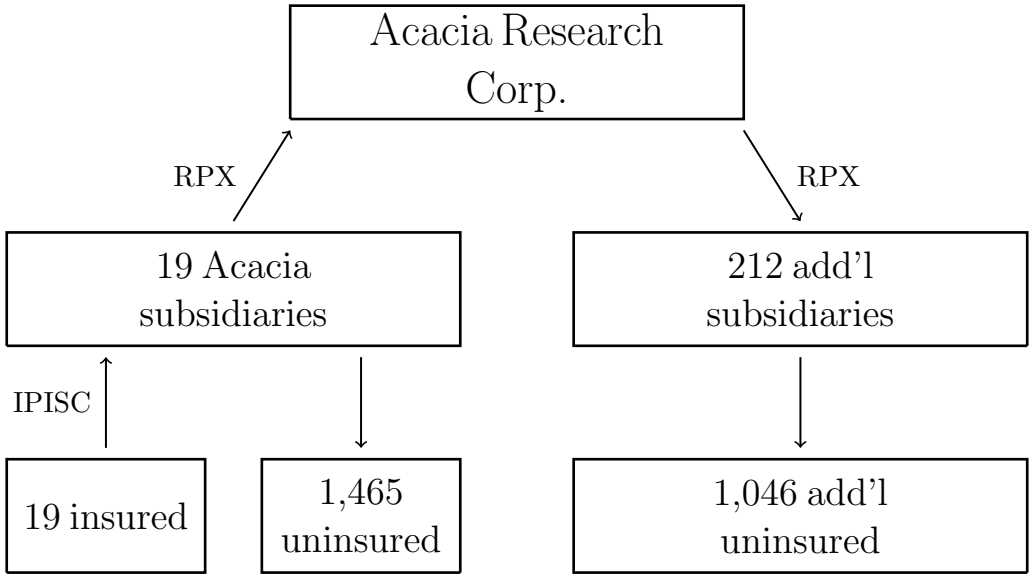
a total of 909 entities affiliated with the 78 NPEs holding insured patents.

To reconstruct the entire patent portfolios of the 909 entities, we proceeded as follows. We first used the names of these entities to extract from the European Patent Office's Patstat database (version April 2017) the numbers of all 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 searched the USPTO's re-assignment database (Marco et al., 2015) to identify any patents transferred to any of the 909 affiliated entities that we identified. We also used information from RPX about patent holdings of these 909 entities to add any patents that were not associated with our set of 909 NPEs through our name match with the Patstat and USPTO re-assignment data. 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.[34] Finally, we cross-checked these data with the district court, PTAB, and Stanford NPE (see below) data for any patents involved in proceedings associated with any of the 909 entities. For all patents that we identified as belonging to an NPEs' portfolio, we also extracted basic bibliographic information about them from Patstat. Finally, we added information on whether a given patent was a declared standard essential patent (SEP) using the database created by Bekkers et al. (2012).

To provide one concrete example of our methodology, consider the case of Acacia Research Corporation, a publicly-traded NPE. See Figure 6 for a depiction of the data. Nineteen patents included in Menus 1 and 2 are owned by 19 Acacia subsidiaries. The number of Acacia subsidiaries that hold insured patents is larger than the number of NPEs that appear on the menus because these patents were often re-assigned to other Acacia subsidiaries and we treat those as if their names had appeared on the menus. Beyond the 19 insured patents, these 19 subsidiaries hold 1,465 additional, uninsured patents. According to RPX, Acacia also controls 212 additional subsidiaries, which in our database collectively own 1,046 additional, uninsured patents. In the analysis below we compare the assertion of

[34] `http://patents.intven.com/finder`.

Figure 6: Data Structure: Example – Acacia Research Corp.



Acacia's nineteen insured patents with the assertion of the 1,465 uninsured patents held by the same subsidiaries (Control Group 1), as well as the assertion of Acacia's entire portfolio of uninsured patents across all subsidiaries (Control Group 2).

3.3 Litigation Data

We next identified all lawsuits enforcing any of the NPE-owned patents that we identified using the methodology described above. We did so by merging our database of patent numbers with case-level data on all U.S. patent suits filed between 2010 and 2016 from MaxVal Group Inc[35] and Docket Navigator.[36] We have information on case outcomes as of July 2018 for all cases in our dataset. Restricting the dataset to cases filed up to 2016 avoids truncation issues related to the lag time for cases to resolve. We also add information on administrative validity challenges in the form of an inter partes review (IPR) or a covered business method (CBM) review at the PTAB. These data were sourced from Unified Patents,

[35]Specifically, MaxVal's Litigation Databank, available at `https://www.maxval.com/litigation-database-services.html`.

[36]`http://brochure.docketnavigator.com`

Inc.[37] Note that we use the USPTO re-assignment data to take into account the dates when a patent was acquired or sold in case it was re-assigned at any point to ensure that a patent was indeed owned by any of the NPE groups in our dataset at the time it was enforced.[38]

Finally, for use in constructing additional control groups, we collected data on the patents asserted by, and cases filed by, a large number of NPEs with portfolios that were not impacted at all by IPISC's "Troll Defense" insurance menus (Control Group 3). We identified these NPEs using 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).[39] Because construction of the Stanford NPE dataset is an ongoing process, we are able to obtain at this time 80% of all patent suits filed during this time period. To bring all our litigation data up to date through the end of 2016, we supplemented the Stanford dataset by hand-collecting data for patent cases filed in 2016 using the same methodology employed by the Stanford dataset's creators. The data for 2010–2016 that we use contains assertions by 1,223 NPEs that are not associated with any of the 78 NPE groups that hold insured patents. We also used these data, which were sourced from Lex Machina, to cross-check the litigation data used in our analysis as well as to double-check that we did not miss any patents owned by any of our 909 NPEs in the construction of our dataset described above.

This process provides us with a database containing all patent infringement cases and PTAB invalidity challenges filed from January 1, 2010 to December 31, 2016[40] that assert or challenge (i) a patent included in Menu 1 or 2 of IPISC's "Troll Defense" policy, (ii) any additional, uninsured patent owned by an entity responsible for enforcing an insured patent,

[37]We also searched the district court and PTAB data for all 909 entity names to identify any asserted patents that did not show up in our search of patent office records. This may happen because a patent re-assignment was not reported to the USPTO or simply not recorded. Any patents identified in this way were added to our set of NPE-owned patents as described in Section 3.2.

[38]This means that if a patent was re-assigned within an NPE group, e.g. between Acacia subsidiaries, we still take the patent into account in our analysis. Only when the patent was re-assigned to a third party and the third party appears as plaintiff in court, we do not take these lawsuits into account in our analysis.

[39]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`.

[40]PTAB invalidity challenges were not available prior to September 16, 2012.

and (iii) all other patents identified in the Stanford NPE dataset as enforced by an NPE. Finally, as shown in Table A-1 in the appendix, nearly all NPEs that hold insured patents are so-called patent assertion entities (PAEs) (as opposed to universities, individual inventors, industry consortia, etc.). To ensure comparability between assertions by NPEs that hold insured patents and other NPEs, we limit the set of NPEs in the Stanford NPE Litigation Dataset also to PAEs.

3.4 Defendant Data

In our analysis, we also use firm-level data to measure the characteristics of defendants in the NPE lawsuits. The firm-level data were sourced from Bureau van Dijk's Orbis dataset. We have a total of 6,050 producing entities that are listed as defendants in the lawsuits brought by any of the NPEs in our dataset (including lawsuits brought by other NPEs that have no association with the insured patents). We matched these company names to company names in Orbis and extracted a number of basic company characteristics, including SIC code, firm size, whether the company is part of a business group, and country of incorporation. Of a total of 6,050 companies, we were able to match 5,502 companies (91 percent).

4 Results

Table A-1 in the appendix lists all 78 NPEs that hold insured patents, as well as the number of patents assigned to them that are – and are not – covered by the IPISC insurance policy. The table also shows how many patents were asserted by each NPE between 2010 and 2016. The table reveals that two out of the 78 NPE groups did not assert any insured patents. The share of insured patents in each NPE's entire portfolio varies substantially. Not surprisingly, for large NPEs such as Acacia and IV, insured patents account for a negligible fraction of their large portfolios. That said, once we focus on patents that have been asserted in court, the share of insured patents increases substantially, even for large NPE groups such as IV

or Acacia. This suggests that IPISC included patents in its insurance policy that had been asserted in the past, as one would expect.

4.1 Patent Characteristics and Selection

We start by comparing the characteristics of insured and uninsured patents to better understand any selection into insurance. Table 2 lists standard patent characteristics for patents included in Menus 1 and 2. Perhaps the most salient result from Table 2 is the age of insured patents.[41] While insured patents are, on the whole, relatively old and have only an average of 3 years of remaining statutory life, this is consistent with prior studies finding that NPEs disproportionately assert older patents (Love, 2013).[42] In addition, because the U.S. Patent Act provides for a six-year statute of limitations,[43] patents can be enforced to recover damages for past infringement well after their expiration date. The table also shows that the majority of patents were acquired, as is common among patents owned by NPEs. However, very few patents are declared standard essential.[44] The table also reveals that the majority of insured patents was indeed enforced at some point while only a small subset was subject to a PTAB invalidation challenge in form of an IPR or CBM.

Figure A-1 in the appendix shows the technology distribution of insured patents. To map patents to technologies, we rely on the technology classification proposed by Schmoch (2008), which is based on International Patent Classification (IPC) codes. The figure as well as a closer look at the patents suggests that they are all related to software, which is in line

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

[42] 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).

[43] See 35 U.S.C. §286.

[44] While NPEs commonly sue implementers of standardized technology, they rarely assert (declared) 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.

Table 2: Comparison of Patent Characteristics

	Menu 1					Menu 2					
Variable	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Diff in means
Age	16.13	17	5.35	4	30	17.61	19	4.26	6	22	1.486**
Remaining patent term	3.35	3.5	5.01	-9	16	2.93	2	3.39	-1	12	0.420
Family size	8.56	6	9.18	1	33	5.75	4	5.26	1	19	2.802***
Forward citations	68.92	30	104.97	0	749	71.99	38	103.23	0	596	-3.070
Backward citations	48.98	28.5	42.91	0	165	42.08	23	39.75	0	123	6.895
NPL citations	29.23	4	39.50	0	121	19.23	3	30.93	0	105	10.001**
SEP	0.07	0	0.26	0	1	0.02	0	0.14	0	1	0.056**
Acquired	0.86	1	0.35	0	1	0.76	1	0.43	0	1	0.102**
Asserted in court	0.79	1	0.41	0	1	0.91	1	0.28	0	1	-0.125***
Challenged at PTAB	0.14	0	0.35	0	1	0.12	0	0.33	0	1	0.018

Notes: Menu 1 contains 200 patents, Menu 2 107 patents; 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); Acquired: re-assigned to NPE according to USPTO Re-assignment Database (0/1); * significant at 10%, ** significant at 5%, *** significant at 1%.

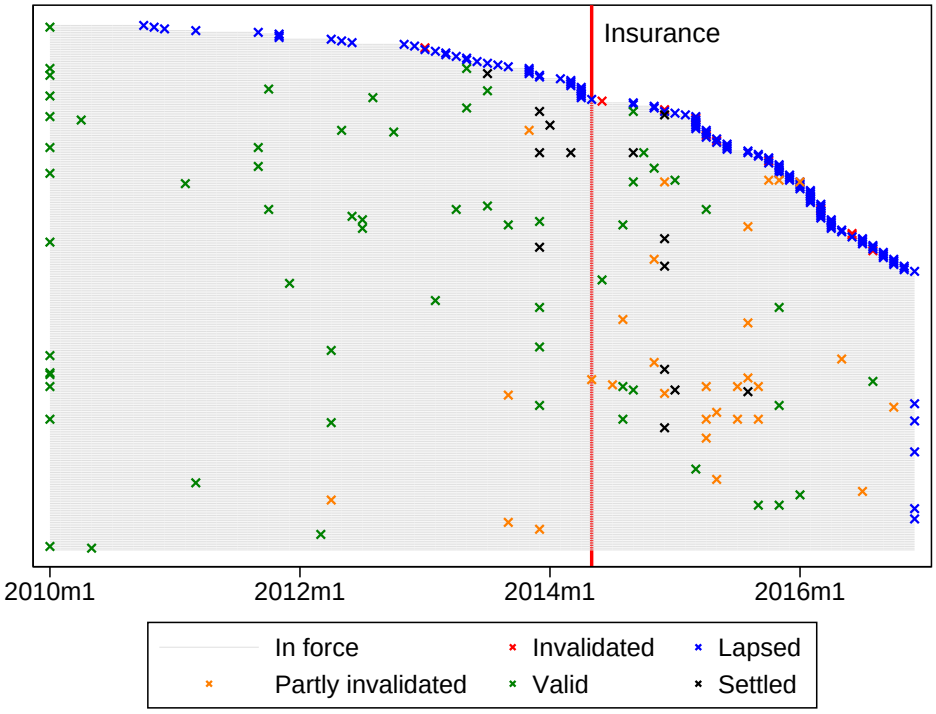
with existing evidence on patents enforced by NPEs (U.S. GAO, 2013).

Figure 7 shows the legal status of insured patents.[45] 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. In some instances, however, a subset of the claims were invalidated. Moreover, there are a number of patents that were invalidated in their entirety,[46] or that expired or lapsed due to non-payment of renewal fees even before the insurance entered into force. 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 7 were asserted in court after they had lapsed. Although this was raised as part of the defense by the defendants, we do not know its impact because the cases settled quickly.

[45]For the purposes of this figure, we complemented the data described in Section 3 with information on validity challenges in form of reexamination.

[46]We take this information into account in our analysis in Section 4.2 below.

Figure 7: Legal status of insured patents (2010–2016)



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. Note that an x in January 2010 means that there had been a validity challenge prior to January 2010.

Next, Table 3 compares insured patents to uninsured patents held by the same 78 NPEs (see Table A-1 in the appendix). The comparison also distinguishes between patents that have been asserted in court and those that have not before the insurance became available. If we look at a comparison between all insured and uninsured patents held by the same NPEs, we see that insured patents are on average only slightly older than uninsured patents (i.e., they have less statutory patent life left); however, they fare better under standard metrics for patent value, such as the number of forward citations received and family size. Insured patents also are more likely to be essential to a technology standard, as well as more likely to have been acquired by their owner. In addition, insured patents are much more frequently asserted in court and challenged at the PTAB. 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 we limit the data to patents that had been asserted before the insurance policy was launched, the differences become much smaller, with some statistically indistinguishable from zero. Relative to previously asserted uninsured patents, insured patents are slightly younger (though there is no significant difference in their remaining patent term), come from patent families of similar sizes, 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). In fact, the table suggests that the determining factor whether a patent is included in the policy is the number of past patent assertions: the median number of assertions is eight for insured patents and two for uninsured patents. The bottom panel of Table 3 repeats the comparison for previously-asserted patents held by other, unrelated (and thus completely uninsured) NPEs. Here, again, we see similar results with the exception of re-assignment rates. And importantly, insured patents remain, to a significant degree, more frequently asserted.

We investigate this further in Table 4 where we show the results of a logit regression

Table 3: Comparison of Patent Characteristics (Insured/Uninsured and Asserted/Nonasserted)

	All patents												
	Insured						Uninsured						
Variable	Mean	Median	SD	Min	Max	Obs.	Mean	Median	SD	Min	Max	Obs.	Diff in means
Age	16.648	18	5.041	4	30	307	16.027	16	4.274	2	55	25,096	0.620**
Remaining patent term	3.208	3	4.518	-9	19	307	4.786	4	4.371	-34	19	25,096	-1.578***
Family size	7.583	5	8.138	1	33	307	4.881	3	6.928	1	84	25,096	2.702***
Forward citations	69.990	31	104.213	0	749	307	28.505	12	55.685	0	1,745	25,096	41.484***
Backward citations	46.576	27	41.906	0	165	307	30.471	16	33.788	0	198	25,096	16.105***
NPL citations	25.749	4	37.002	0	121	307	9.466	1	20.860	0	117	25,096	16.283***
SEP	0.055	0	0.229	0	1	307	0.002	0	0.047	0	1	25,096	0.053***
Acquired	0.824	1	0.381	0	1	307	0.314	0	0.464	0	1	25,096	0.509***
Asserted in court	0.833	1	0.372	0	1	307	0.043	0	0.203	0	1	25,096	0.790***
Challenged at PTAB	0.133	0	0.340	0	1	307	0.012	0	0.109	0	1	25,096	0.121***
	Asserted patents (assertion before insurance became available)												
	Insured						Uninsured						
Variable	Mean	Median	SD	Min	Max	Obs.	Mean	Median	SD	Min	Max	Obs.	Diff in means
Age	17.356	18	4.672	4	30	250	18.128	19	3.536	5	28	890	-0.772***
Remaining patent term	2.624	2	4.173	-9	14	250	2.265	2	3.374	-10	13	890	-0.358
Family size	7.148	5	7.709	1	33	250	7.611	5	10.789	1	84	890	-0.463
Forward citations	77.576	40	111.354	0	749	250	65.792	32	107.019	0	1,276	890	-11.783
Backward citations	43.404	24	39.676	0	155	250	34.664	21	32.779	0	150	890	8.739***
NPL citations	26.016	4	37.217	0	121	250	10.264	1	21.703	0	115	890	15.751***
SEP	0.016	0	0.125	0	1	250	0.010	0	0.100	0	1	890	0.006
# assertions in court	21.976	8	41.895	1	313	250	5.630	2	10.794	1	96	890	16.345***
Acquired	0.840	1	0.367	0	1	250	0.648	1	0.477	0	1	890	0.191***
Challenged at PTAB	0.164	0	0.371	0	1	250	0.198	0	0.399	0	1	890	-0.034
	Asserted patents (assertion before insurance became available)												
	Insured						Uninsured – all other NPEs						
Variable	Mean	Median	SD	Min	Max	Obs.	Mean	Median	SD	Min	Max	Obs.	Diff in means
Age	17.356	18	4.672	4	30	250	16.849	17	4.387	3	37	3,144	0.506*
Remaining patent term	2.624	2	4.173	-9	14	250	4.150	4	4.387	-16	18	3,144	1.526***
Family size	7.148	5	7.709	1	33	250	7.300	5	10.138	1	140	3,144	-0.155
Forward citations	77.576	40	111.354	0	749	250	33.764	12	65.645	0	1,309	3,144	43.811***
Backward citations	43.404	24	39.676	0	155	250	35.309	19	36.715	0	198	3,144	8.094***
NPL citations	26.016	4	37.217	0	121	250	14.936	2	28.352	0	161	3,144	11.079***
SEP	0.016	0	0.125	0	1	250	0.014	0	0.118	0	1	3,144	0.001
# assertions in court	21.976	8	41.895	1	313	250	2.777	1	8.368	1	148	3,144	19.198***
Acquired	0.840	1	0.367	0	1	250	0.926	1	0.261	0	1	3,144	-0.086***
Challenged at PTAB	0.164	0	0.371	0	1	250	0.229	0	0.420	0	1	3,144	-0.065**

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); Acquired: re-assigned to NPE according to USPTO Re-assignment Database (0/1); * significant at 10%, ** significant at 5%, *** significant at 1%.

that predicts at the patent-level whether a given patent is covered by the insurance policy. In specification (1), we use the same variables as in Table 3. In specification (2) we add technology fixed effects (based on a patent's main IPC), and in specification (3) we further add NPE fixed effects. Focusing on specification (2), we see a positive correlation between inclusion in the insurance policy and counts of forward citations, NPL citations, and assertions in court. Adding NPE fixed effects, the SEP variable becomes significant. Overall, it is unclear how these variables that predict selection into the insurance policy affect the probability of assertion once the insurance becomes available. For example, SEPs might be more likely to be asserted in court but for a given NPE, they are less likely to be covered by the insurance. That said, the number of past assertions is positively associated with selection into the insurance policy and they might also be positively associated with future assertions – which is why they are included in the insurance in the first place. In columns (4) and (5), we use uninsured patents held by other NPEs in our estimation. The main difference in the results compared to control group 1 is that patents are less likely to be covered by the insurance if they have been acquired or challenged at the PTAB.

4.2 Patent Assertion

Next we analyze whether the litigation behavior of NPEs changed in response to the issuance of the insurance policy. The left-hand-side plot in Figure 8 shows the number of assertions of insured and uninsured patents held by 76 real-NPEs-in-interest over time (76 of the 78 NPE groups asserted at least 1 insured patent – see Table A-1 in the appendix). Insurance was introduced in May 2014 and is highlighted by the vertical red bar. The figure clearly reflects a general increase in NPE patent assertions beginning in 2011.[47] However, there is also a clear downward trend in assertions by NPEs included in IPISC's insurance policy starting in mid-2013, which may be attributable to the Supreme Court's grant of certiorari and subsequent

[47]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).

Table 4: Patent-Level Determinants of Policy Coverage

	Insured vs. Uninsured – same NPEs			Insured vs. Uninsured – all other NPEs	
	(1)	(2)	(3)	(4)	(5)
Remaining patent term	0.001	0.002	0.003	-0.001**	-0.001*
	(0.003)	(0.003)	(0.002)	(0.0008)	(0.0007)
ln family size	-0.005	-0.010	-0.004	-0.004	-0.004
	(0.014)	(0.013)	(0.012)	(0.004)	(0.004)
ln forward citations	0.013	0.012*	0.015**	0.015***	0.013***
	(0.008)	(0.007)	(0.006)	(0.002)	(0.002)
ln backward citations	-0.018	-0.012	-0.009	0.002	0.002
	(0.013)	(0.012)	(0.010)	(0.004)	(0.004)
ln NPL citations	0.046***	0.040***	0.021***	0.006***	0.005**
	(0.008)	(0.007)	(0.007)	(0.002)	(0.002)
SEP	0.072	0.072	-0.054***	-0.019	-0.009
	(0.113)	(0.106)	(0.016)	(0.011)	(0.014)
ln # assertions in court	0.098***	0.103***	0.082***	0.041***	0.039***
	(0.011)	(0.012)	(0.012)	(0.004)	(0.003)
Acquired	0.049 *	0.039	0.010	-0.074***	-0.068***
	(0.025)	(0.024)	(0.025)	(0.018)	(0.017)
Challenged at PTAB	-0.048**	-0.032	0.005	-0.023***	-0.020***
	(0.023)	(0.025)	(0.024)	(0.006)	(0.005)
Technology FE	NO	YES	YES	NO	YES
NPE FE	NO	NO	YES	NO	NO
Obs	897	897	897	2,737	2,737

Notes: Logit regression. Dependent variable = 1 if patent included in insurance policy. Insured patents include patents from both Menu 1 and Menu 2; 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); Acquired: re-assigned to NPE according to USPTO Re-assignment Database (0/1); no results with NPE FE reported for uninsured patents held by other NPEs because there are too many NPE groups (877) to estimate the model; marginal effects reported; robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

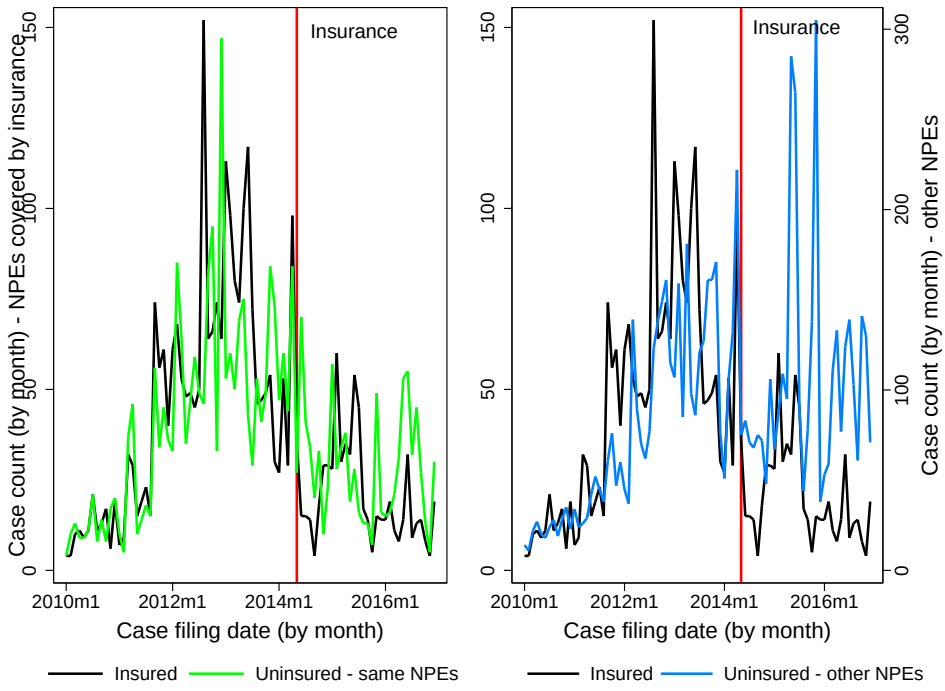
decision restricting software patentability in *Alice Corp. v. CLS Bank*.[48] For our purposes, it is sufficient to highlight that the overall litigation pattern between insured and uninsured patents held by the set of 76 NPE groups follows a similar trend until the introduction of IPISC's insurance policy in mid-2014. Once insurance was introduced, assertions for the subset of insured patents dropped and remained at a lower level than assertions by uninsured patents. For comparison, the right-hand-side plot in Figure 8 compares the assertions of insured patents to assertions by other NPEs that do not hold any insured patents in their portfolios. 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 as assertions of insured patents. Once insurance becomes available, assertions by other NPEs continue unaffected while assertions of insured patents drops considerably.

To further explore what drives the aggregate results shown in Figure 8, we plot the number of patent assertions per month for each NPE group in Figures 9 and 10. Figure 9 shows assertions of insured patents. The figure 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 "Troll Defense" 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 of post-insurance assertions. The figure also shows validity challenges at the PTAB. Overall, there are relatively few such challenges, and with the exception of challenges to patents held by Joao Control & Monitoring Systems, there is no evidence of any increase in validity challenges of insured patents once the insurance becomes available.

For comparison, Figure 10 shows the frequency with which the same NPEs asserted uninsured patents during the same time period. Relative to the data shown in Figure 9, assertions of uninsured patents are more numerous in 2014 and early 2015 following the

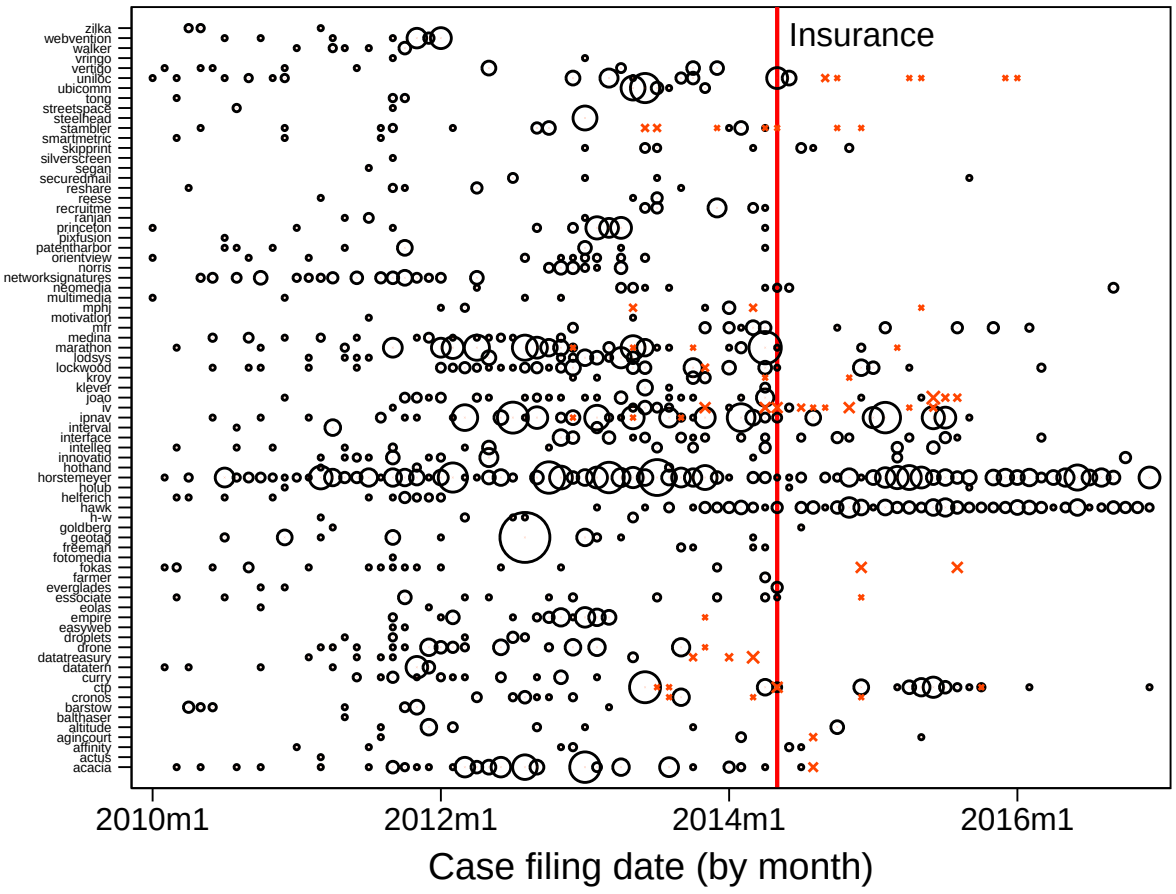
[48] Alice Corp. Pty. Ltd. v. CLS Bank Int'l., 134 S.Ct. 2347 (2014).

Figure 8: Number of Court Cases Asserting Insured vs. Uninsured Patents (by Month, 2010–2016)



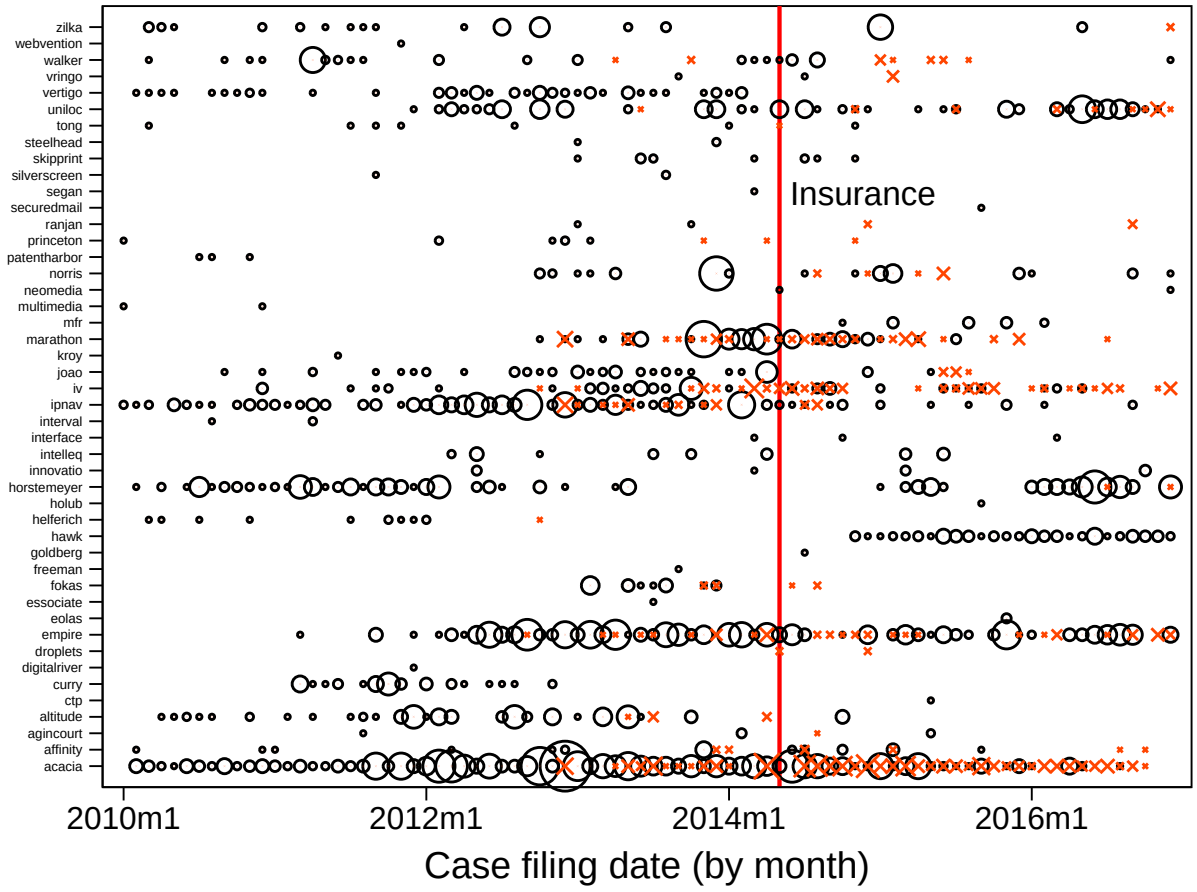
Notes: Insured patents contain all asserted patents from Menu 1 and Menu 2; the control group in the left-hand-side graph consists of all other asserted patents held by the same NPE groups that hold the insured patents; the control group in the right-hand-side graph consists of other NPEs that do not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

Figure 9: Number of Court and PTAB Cases Asserting Insured Patents (by NPE Group and Month, 2010–2016)



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

Figure 10: Number of Court and PTAB Cases Asserting Uninsured Patents (by NPE Group and Month, 2010–2016)



Notes: The size of a bubble indicates the number of court cases by month; the size of an X indicates the number of PTAB CMB/IPR 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.

introduction of insurance. Also PTAB validity challenges are a lot more frequent; Acacia's uninsured patents, in particular, were especially popular targets, though this simply reflects to some extent the size of its patent portfolio (in our set of NPEs, only IV's patent portfolio is larger).

Before analyzing changes in litigation behavior further, Figure A-2 in the online appendix provides another look at the relation between a patent's remaining statutory life and assertion. As highlighted above in Section 4.1, some insured patents are relatively old, which

raises the prospect that their enforcement may naturally have dropped regardless of the insurance. Figure A-2 plots the number of assertions over time taking into account a patent's remaining statutory life at the time of assertion. The graph contains data for both insured and uninsured patents from the same NPE groups. In addition to suggesting generally that these patents were nearing the end of their statutory term when asserted, it reveals that uninsured patents asserted by NPEs that assert insured patents were on average closer to expiration at the time of assertion than insured patents. The median statutory life left at time of assertion is 9 years for insured patents and 7 years for uninsured patents (see also Figure A-3 in the appendix). This means that for the patents eventually covered by the insurance, age (i.e., remaining term of protection) does not appear to represent a barrier to assertion after the insurance became available.[49]

To investigate changes in patent assertions following the introduction of the insurance policy more formally, we compare assertions of insured patents to assertions of three sets of uninsured control patents:

Control group 1a: cases in which uninsured patents were asserted by any of 103 specific entities listed by IPISC enforcing insured patents;

Control group 1b: as in 1a but with uninsured patents matched to insured patents based on patent age, family size, forward citations, backward citations, NPL citations, SEP status, 35 technology classes derived from IPC codes, and a dummy variable indicating whether a patent has been re-assigned;

Control group 2a: cases in which uninsured patents were asserted by any of the 909 entities affiliated with the 78 real NPEs of interest;

[49] In addition, we note that many insured patents were interpreted by their owners as infringed by virtually any business engaged in routine e-commerce or utilizing common consumer electronic products (Love and Yoon, 2013). Accordingly, insured patents could have plausibly been enforced against many thousands of individual defendants – more than, practically speaking, the legal system could have processed prior to their expiration.

Control group 2b: as in 2a but with uninsured patents matched to insured patents using the same characteristics as described in 1b.

Control group 3a: cases brought by other NPEs that do not hold any insured patents;

Control group 3b: as in 3a but with uninsured patents matched using the same characteristics as described in 1b.

Control group 1 allows us to compare changes in assertions between insured and uninsured patents for a given NPE. This allows us to account for time-invariant unobservable NPE characteristics in addition to patent and court characteristics. A potential concern with this control group is the possibility that insurance affects not only assertion of insured, but also of uninsured patents. To mitigate this concern, control group 2 also includes patents asserted by other NPEs within the same NPE groups and control group 3 contains patents held by NPEs not directly affected by the insurance.

Table 5 shows comparisons of the average number of assertions before and after the insurance policy became available between the set of insured patents and the different control samples. 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 asserted on average in slightly more than 46 court cases a month before the insurance became available. Once the insurance became available, the average drops to 21 cases per month. The difference between these two means is statistically significant at 1 percent. When we look at control group 1 (i.e., uninsured patents held by NPEs that also hold the insured patents), we see that the average number of court cases remains unchanged after the introduction of the insurance. When we take into account all uninsured patents held by other NPEs within the same NPE groups (that the NPEs with insured patents belong to), we see that the average number of assertions per month also drops after the insurance becomes available. Finally, the average number of assertions per month for the control group that consists of other NPEs that have no direct association with insured NPEs increases significantly after the insurance

is made available as shown in Figure 8. Looking at the average number of assertions per patent and month in the lower panel of Table 5, the average number of assertions again drops significantly for insured patents. It also drops for both control groups 1 and 2.

To analyze changes in litigation behavior through a regression, we start by specifying equation (20), 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 based on 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 ($Insured \times Postlaunch_t$):

$$lncase_t = \beta_0 + \beta_1 Insured + \beta_2 Postlaunch_t + \beta_3 Insured \times Postlaunch_t + \delta_t + \varepsilon_t, \qquad (20)$$

where δ_t are month dummies. Specification (20) asks whether the number of assertions per month for insured patents changes relative to uninsured patents following the introduction of the insurance policy. Table 6 shows the corresponding results from the OLS regression in specification (20). When we use insured patents held by the same NPEs as controls 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 slightly more than 50 percent for the set of insured patents after the insurance is introduced. These results hold regardless of whether we use all uninsured patents in column (1) or match uninsured to insured patents in column (2). Columns (3) and (4) contain the results when we also take into account uninsured patents held by other NPEs within the same NPE group. Compared to columns (1) and (2), the interaction term in columns (3) and (4) is still negative but smaller in magnitude, implying a drop in the number of assertions of 30–40 percent. The results when we use the control sample that consists of unrelated NPEs suggest again a large negative effect of the insurance of between

Table 5: 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	46.096	46.5	33.666	21.062	15	13.937	25.033***
	Uninsured						
Control group 1a	15.653	13	14.801	15.687	12	11.654	-0.033
Control group 1b	13.634	11	13.583	13.750	11	11.256	-0.115
Control group 2a	41.519	42	28.969	28.250	27	16.032	13.269**
Control group 2b	23.326	21.5	17.778	18.687	16.5	11.618	4.639
Control group 3a	77.923	61.5	54.228	106.312	85.5	65.291	-28.389**
Control group 3b	27.500	22	21.060	29.656	23.5	22.958	-2.156

	Number of court cases per month at the patent-level						
	Before			After			
	Mean	Median	SD	Mean	Median	SD	Diff in means
	Insured						
Insured	0.412	0	2.278	0.131	0	1.031	0.281***
	Uninsured						
Control group 1a	0.092	0	1.125	0.074	0	0.878	0.018*
Control group 1b	0.096	0	1.069	0.092	0	0.980	0.004
Control group 2a	0.088	0	0.918	0.056	0	0.667	0.032***
Control group 2b	0.089	0	0.903	0.077	0	0.800	0.011
Control group 3a	0.054	0	0.735	0.058	0	0.760	-0.004
Control group 3b	0.069	0	0.946	0.076	0	1.022	-0.007

Notes: Insured patents include patents from both Menu 1 and Menu 2; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" matched control groups consist of patents matched based on the patent characteristics described in Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assignment, and 35 technology classes based on IPC codes). * significant at 10%, ** at 5%, *** at 1%.

Table 6: Total Number of Court Cases (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	1.055***	1.192***	0.062	0.670***	-0.566***	0.481***
	(0.104)	(0.105)	(0.064)	(0.087)	(0.070)	(0.075)
Post-launch	-0.411	-0.392	-1.116***	-0.623*	-0.828***	-1.105**
	(0.307)	(0.332)	(0.104)	(0.316)	(0.233)	(0.551)
Insured patent×Post-launch	-0.776***	-0.767***	-0.375***	-0.562***	-1.072***	-0.774***
	(0.167)	(0.181)	(0.138)	(0.168)	(0.157)	(0.188)
Month FE	YES	YES	YES	YES	YES	YES
Obs	168	168	168	168	168	168
R2	0.827	0.821	0.877	0.834	0.883	0.521

Notes: OLS regression. Dependent variable: log number of cases by month for a given patent. All regressions include a constant. Time period is January 2010 – December 2016; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

54 and 65 percent. Table A-2 in the appendix repeats these regressions for patents included in insurance Menu 1 (the results shown in Table 6 refer to the combination of Menus 1 and 2 where Menu 2 is only available in combination with Menu 1). The results are qualitatively very similar to the ones presented in Table 6.

Next we run specification (20) at the patent-level which allows us to include patent-level fixed effects and hence to analyze changes in assertions for insured relative to uninsured patents:

$$lncase_{it} = \beta_0 + \beta_1 Insured_i + \beta_2 Postlaunch_t + \beta_3 Patent_i \times Postlaunch_t + \gamma IPR_{it} + \alpha_i + \delta_t + \varepsilon_{it}, \quad (21)$$

where $lncase_{it}$ denotes the log of the number of assertions of patent i in month t, α_i denotes patent-level fixed effects, IPR_{it} denotes IPR/CBM challenges at the PTAB and the rest of specification (21) is as defined in equation (20) above. Note that in the estimation, we also include court dummies.

Table 7 shows the corresponding results (Table A-3 in the appendix shows the corresponding results when we restrict the set of insured patents to menu 1). Our focus is again on the interaction term, which is the difference-in-differences estimate of the insurance effect. The estimate is negative across all samples. This also suggests that assertions for insured patents fell following the introduction of the insurance while accounting for unobservable, time-invariant patent-specific characteristics as well as court-specific characteristics and a time trend. This result comports with the findings in our theoretical model where we have shown a nontrivial subset of the parameter space in which availability of defensive litigation insurance lowers the number of patent assertions (i.e., court cases).

To understand what drives the insurance effect suggested by the results shown so far, Figure 11 distinguishes between insured patents that were no longer asserted after the insurance became available and those that were still asserted. There are a total of 87 insured patents that were asserted after the insurance became available while 169 were no longer asserted. The set of insured patents that is no longer asserted is responsible for the majority of assertions during the 2010–2013 period. Assertions start to drop in mid-2014, immediately after the launch of the insurance. However, 49 of the insured patents continue being asserted in 2015 and 20 patents throughout 2016.

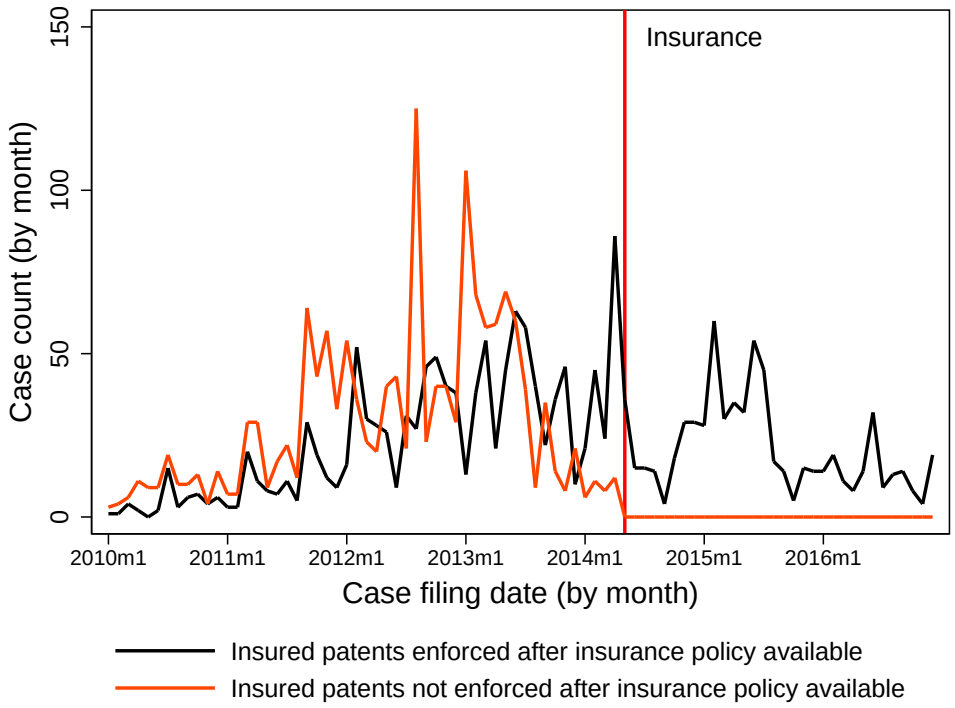
Finally, there is a potential concern that the U.S. Supreme Court's 2014 decision in *Alice Corp. v. CLS Bank* could have led to a drop in assertions by NPEs regardless of insurance. In *Alice*, the Court restricted the patentability of algorithms implemented in software, particularly the ability to patent generic computer implementations of algorithms that pre-date modern computing. While it has long been recognized that these so-called "business method" patents are disproportionately enforced by NPEs, this ruling is unlikely

Table 7: Total Number of Court Cases at the Patent Level (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	-0.037***	-0.065***	-0.005	0.013*	0.005**	-0.0001
	(0.009)	(0.014)	(0.005)	(0.007)	(0.002)	(0.007)
Insured patent×Post-launch	-0.013***	-0.012***	-0.009**	-0.008**	-0.010**	-0.006
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
IPR	-0.306***	-0.298***	-0.378***	-0.333***	-0.495***	-0.487***
	(0.050)	(0.053)	(0.051)	(0.070)	(0.035)	(0.081)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Court FE	YES	YES	YES	YES	YES	YES
Obs	59,823	44,955	112,239	54,615	277,131	73,683
R2	0.730	0.730	0.715	0.727	0.730	0.746

Notes: OLS FE regression. Dependent variable: log number of cases by month. All regressions include a constant. Time period is January 2010 – December 2016; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors clustered at patent-level. * significant at 10%, ** at 5%, *** at 1%.

Figure 11: Number of Court Cases Asserting Insured Patents (by Month, 2010–2016)



Notes: Insured patents contain all asserted patents from Menu 1 and Menu 2.

to drive our results because our comparisons are made among various groups of NPEs. Nevertheless, to investigate whether the decision in *Alice Corp. v. CLS Bank* has any effect on our analysis, we drop all business method patents as defined by U.S. patent classes[50] from our sample and re-run the specifications in (20) and (21). The corresponding results are shown in Tables A-4 and A-5, respectively. They show that our results remain qualitatively unaffected by dropping business method patents from the sample. This is explained by the fact that there are relatively few such patents in our sample: only 24 insured patents, 43 uninsured patents in control sample 1, 69 uninsured patents in control sample 2, and 271 uninsured patents in control sample 3.

4.3 Case Outcomes

In this section, we look at case outcomes. Specifically we look at changes in the likelihood that a case settles. This is motivated by the well-documented fact that NPEs usually attempt to achieve settlements 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.[51] Indeed, the U.S. Federal Trade Commission (2016) observed in a recent study of the licensing behavior of 22 NPEs (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.

Our theory model predicts a lower settlement rate after introduction of the insurance. The private nature of the firm's insurance decision introduces frictions in the settlement

[50] USPC 705 most clearly relates to business methods. In an abundance of caution we additionally dropped patents assigned any USPC in the range 718-726.

[51] 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.

negotiations, resulting in more negotiation breakdown (and fewer pre-trial settlement). The reason for this friction is that an insured firm is less deterred by pending litigation costs and therefore less willing to turn down unfavorable settlement offers by the NPE.

We estimate equation (22) which asks whether a court case at t asserting patent i settles as a function of the insurance coverage:

$$settle_{it} = \beta_0 + \beta_1 Insured_i + \beta_2 Postlaunch_t + \beta_3 Patent_i \times Postlaunch_t + \alpha_i + \delta_t + \varepsilon_{it}. \quad (22)$$

Table A-6 in the appendix shows the share of settled cases for insured and uninsured patents across the different control groups before and after the insurance became available. We note an increase in settlements for both insured and uninsured patents for most of the control samples used. However, although we have case outcome information through July 2018, to some extent this could be an artifact of the "pipeline" of cases in our data. Because litigation is a lengthy process,[52] not enough time has lapsed for a judgment on the merits to have been handed down in some, more-recent cases. Accordingly, the increase in settlements following the introduction of insurance should not be interpreted as a result of the insurance. Therefore, we can only learn about any potential effect of the insurance on settlement by comparing settlements between insured to uninsured patents.

Table 8 shows the results from estimating equation (22) as a linear probability model.[53] Regardless of the control group, the coefficient on the interaction term is negative suggesting a negative association between the availability of the insurance policy and settlements. However, the coefficient is only marginally statistically significant in column (3) i.e. for control group 2. When interpreting these results, it is important to keep in mind that the post-insurance effect is estimated using the set of cases that are still taken to court after the insurance became available.

[52] 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.

[53] Our results are qualitatively unchanged if we used a logit fixed effects regression instead.

Table 8: Settlement of Court Cases (at the Patent Level by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	-0.465***	-0.147	0.312***	0.232	-0.146	0.088
	(0.149)	(0.300)	(0.106)	(0.180)	(0.131)	(0.147)
Insured patent×Post-launch	-0.037	-0.043	-0.077*	-0.051	-0.052	-0.073
	(0.037)	(0.037)	(0.051)	(0.040)	(0.041)	(0.064)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Court FE	YES	YES	YES	YES	YES	YES
Obs	8,767	7,954	12,969	9,420	19,837	9,977
R2	0.055	0.051	0.028	0.036	0.035	0.037

Notes: OLS FE regression. Dependent variable: case settled (0/1). All regressions include a constant. Time period is January 2010 – December 2016; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors clustered at patent-level. * significant at 10%, ** at 5%, *** at 1%.

4.4 Defendant Characteristics

In this section, we use the firm-level data sourced from Orbis to analyze any potential changes in the characteristics of defendants targeted by NPEs following the introduction of the insurance.

Our focus in this section is to analyze whether NPEs targeted more small- and medium-sized entities (SMEs) following the introduction of the insurance. Our theoretical model predicts either no effect or a positive effect of insurance on the likelihood that an SME is targeted. We do not explicitly introduce firm size into the model, but some model parameters are likely to capture firm size. First, suppose smaller firms have smaller production volumes with lower damages. Then, damages D serves as a parameter of firm size. We can look at the effect of firm size from two different angles. In a world with insurance, a lower value of D (and smaller firm size) decreases the likelihood that the firm has insurance, and increases the likelihood that the NPE asserts (compare equilibria (Eq.B)/(Eq.D) and (Eq.A) in Figure 5). On the other hand, introducing insurance has no effect on the equilibrium outcomes if D is too low (compare the equilibria in Figures 3 and 5).

Second, suppose larger firms are more "patient" in settlement negotiations. For them, the legal uncertainty of a pending case is less costly than for small firms. In the economic theory of bargaining, patience confers more bargaining power (e.g., Rubinstein, 1982). This means that SMEs are expected to have less bargaining power, implying a higher value of β in our model. An increase in β increases the parameter set in which the firm does not buy insurance. As a result, SMEs are more likely to have no insurance than larger firms. In equilibrium, the NPE then responds with more assertions when the defendant is an SME.

Third, both the insurance premium M and the firm's litigation costs C_F capture firm size if they are viewed as relative to, e.g., the firm's revenue. In other words, given absolute values of insurance premium and litigation costs, M and C_F are (relatively) higher for SMEs. Our model predicts that the former implies that SMEs are less likely in the insurance equilibrium while the latter means that they are more likely in that equilibrium (Proposition 3). This

implies an ambiguous effect as smaller firms may be more or less likely to buy insurance (in (Eq.B) and (Eq.D) in Figure 5).

To investigate whether NPEs targeted more small- and medium-sized (SMEs) firms following the introduction of the insurance, we estimate the following equation:

$$SME_t = \beta_0 + \beta_1 Insured + \beta_2 Postlaunch_t + \beta_3 Insured \times Postlaunch_t + \delta_t + \varepsilon_t, \qquad (23)$$

where SME_t denotes the share of cases that have at least one SME defendant. All other variables in equation (23) are as in equation (20) above. Before discussing the results, Figures A-4 and A-5 in the appendix show the share of defendants that are SMEs and those that belong to a business group. Figure A-4 shows that around 80 percent of defendants are large companies although the share of large companies is slightly smaller in lawsuits that assert uninsured patents. For insured patents, however, the share of SMEs among defendants increases significantly after the insurance is introduced. Figure A-5 shows that slightly less than 75 percent of defendants belong to a business group; this share is the same regardless of whether lawsuits assert insured or uninsured patents. Here we see a small drop in the share following the introduction of the insurance where the decrease is more pronounced for insured patents (67 percent vs. 72 percent for uninsured patents). This reinforces the impression obtained from Figure A-4 that after the insurance becomes available, the NPEs that continue to assert their patents focus more on smaller, independent companies.

Table 9 shows the results from estimating equation (23). As suggested by Figure A-4, we see a higher share of SMEs in lawsuits that involved insured patents. The post-launch dummy variable is positive and statistically significant for all control groups, suggesting that the share of SMEs targeted post-insurance also increased. This effect is largely driven by two NPEs, Hawk and Horstemeyer, which as shown in Figure 9 and discussed above account for the majority of assertions of insured patents after the insurance becomes available. These two NPEs target relatively more SMEs after the insurance becomes available. This

Table 9: Share of Court Cases with SME Defendant (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	0.036	0.039	0.050**	0.045	0.062***	0.083***
	(0.035)	(0.035)	(0.021)	(0.031)	(0.018)	(0.021)
Post-launch	0.601**	0.598*	0.309***	0.210***	0.164*	0.152
	(0.299)	(0.304)	(0.026)	(0.037)	(0.096)	(0.102)
Insured patent×Post-launch	0.131**	0.138**	0.133***	0.193***	0.160***	0.162***
	(0.054)	(0.053)	(0.037)	(0.043)	(0.039)	(0.042)
Month FE	YES	YES	YES	YES	YES	YES
Obs	168	168	168	168	168	168
R2	0.658	0.663	0.750	0.679	0.692	0.688

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; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

could potentially be explained by a lower likelihood of insurance adoption among smaller companies, hence making them a relatively more attractive target.

5 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 present a model of the impact of defensive litigation insurance on the behavior

of patent enforcers and accused infringers. For our model, we assumed that a firm's purchase of litigation defense insurance is not observed by patent enforcers and showed that the mere availability of defensive litigation insurance can have an effect on how often patent enforcers will assert their patents. More specifically, we derived a nontrivial subset of our parameter space in which the introduction of defense litigation insurance gives rise to a decrease in observed patent assertions as equilibrium outcome. From our model results, we predict a stronger effect on patent assertion and litigation when litigation costs are higher, when the costs of insurance are lower, when the baseline probability of infringement is higher, and when the patent enforcer's losses from potential patent invalidation are higher. We further predict a stronger effect of litigation defense insurance for firms of intermediate size than for smaller or larger firms. We also predict a stronger effect for more uncertain patent infringement cases (in which the probability that the patent enforcer prevails in court is of intermediate value).

We empirically evaluated 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 that they own. To do so, we identified the true enforcer of each patent listed in the insurance policy, and identified all patents owned and enforced by that entity (and its subsidiaries, if any). We additionally compared the assertion of insured patents with patents held by other NPEs with portfolios that were entirely excluded from the insurance product.

Merging our data, 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 control 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. Indeed, 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. 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.

Finally, we note that prospects for the improvement of defensive litigation insurance appear to be particularly rosy 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.

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A Appendix: Proofs

Proof of Proposition 1

Proof. Note that conditions (7) and (8) cannot be violated at the same time. The rest of the proof follows from the discussion in the text and is omitted. □

Proof of Lemma 1

Proof. To show the claims in the lemma, we first consider the four candidates for pure-strategy equilibria and then proceed by characterizing the mixed strategy equilibrium in the second claim.

1. In a pooling equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (1, 1)$ in which both insurance types defend, the NPE's posterior beliefs are $\hat{\sigma} = \sigma$. Let's first consider high values of σ so that the NPE's settlement offer is $S_{N|\sigma>\Sigma} = \omega D$. The insurance type (accepting the settlement offer in $t = 5$) defends if $A - M - E(S|\sigma = 1) \geq A - M - D$ which holds true because $E(S|\sigma = 1) \leq \omega D$. The no-insurance type defends if $A - E(S|\sigma = 1) \geq A - D$ which holds true because $E(S|\sigma = 1) \leq \omega D < D$. Now, let's consider low values of σ so that the NPE's settlement offer is $S_{N|\sigma<\Sigma} = \omega D + C_F$. The insurance type (rejecting the settlement offer in $t = 5$) defends if

$$\begin{aligned} A - M - [\beta \omega D + (1 - \beta)[\omega D - (1 - \omega) P - C_N]] &= \\ A - M - E(S|\sigma = 1) &\geq \\ A - M - D & \end{aligned}$$

   which holds true because $E(S|\sigma = 1) \leq \omega D$. The no-insurance type defends if $A - E(S|\sigma = 0) \geq A - D$. This condition holds if $D \geq \Delta(P)$ (or: $P \geq \Pi(D)$). To summarize, there is a pooling equilibrium if $\sigma > \Sigma$ or if $\sigma < \Sigma$ and $D \geq \Delta(P)$.

2. In a separating equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (1, 0)$ in which the insurance type defends and

the no-insurance type acquiesces, the NPE's posterior beliefs (when seeing the firm defending) is $\hat{\sigma} = 1$. The insurance type defends if $A - M - E(S|\sigma = 1) \geq A - M - D$ which always holds. The no-insurance type, however, will not acquiesce (its equilibrium strategy) because $A - D \not\geq A - E(S|\sigma = 1)$. There is no separating equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (1, 0)$.

3. In a separating equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (0, 1)$ in which the insurance type acquiesces and the no-insurance type defends, the NPE's posterior beliefs (when seeing the firm defending) is $\hat{\sigma} = 0$. The insurance type (rejecting the settlement offer in $t = 5$) does not acquiesce (acquiesce is its equilibrium strategy) because if

$$\begin{aligned} A - M - D &\not\geq \\ A - M - [\beta\omega D + (1 - \beta)[\omega D - (1 - \omega)P - C_N]] &= \\ A - M - E(S|\sigma = 1). & \end{aligned}$$

   There is no separating equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (0, 1)$.

4. In a pooling equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (0, 0)$ in which neither insurance type defends, the NPE observing a firm defending is off the equilibrium path. Bayes' rule does not apply. To show that such a pooling equilibrium does not exist, we consider high off equilibrium beliefs, $\sigma' > \Sigma$ and low off-equilibrium beliefs, $\sigma' < \Sigma$. With high off-equilibrium beliefs, $\hat{\sigma} = \sigma'$, both insurance types will accept the NPE's settlement offer $S_{N|\sigma>\Sigma} = \omega D$. The insurance type will not acquiesce because $A - M - D \not\geq A - M - E(S|\sigma = 1)$. No such equilibrium exists. With low off-equilibrium beliefs, $\hat{\sigma} = \sigma'$, the insurance type will reject the NPE's settlement offer $S_{N|\sigma<\Sigma} = \omega D + C_F$.

The insurance type will not acquiesce because

$$\begin{aligned} A - M - D &\ngeq \\ A - M - \left[\beta\omega D + (1-\beta)\left[\omega D - (1-\omega)P - C_N\right]\right] &= \\ A - M - E(S|\sigma = 1). & \end{aligned}$$

No such equilibrium exists.

Summarizing the above discussion, if $\sigma > \Sigma$ or if $\sigma < \Sigma$ and $D \geq \Delta(P)$, there is a pooling equilibrium $(\delta_{\text{i}}, \delta_{\text{ni}}) = (1, 1)$. If $\sigma < \Sigma$ and $D < \Delta(P)$, a pure-strategy equilibrium does not exist. The mixed-strategy equilibrium is one in which the no-insurance type (as the one deviating from the pure strategy) defends with probability $\delta_{\text{ni}} = \delta^*$, whereas the insurance type defends with certainty. The NPE offers the low settlement payment $S_{N|\hat{\sigma}>\Sigma} = \omega D$ with probability η^* and the high offer $S_{N|\hat{\sigma}>\Sigma} = \omega D + C_F$ with probability $1 - \eta^*$.

- The no-insurance type's equilibrium strategy is such that the NPE is indifferent between offering $S_{N|\hat{\sigma}>\Sigma} = \omega D$ and $S_{N|\hat{\sigma}<\Sigma} = \omega D + C_F$. This is the case if $\hat{\sigma} = \Sigma$. Hence, $\delta^* = \delta_{\text{ni}}$ such that $\hat{\sigma}\Sigma$ or, by Bayes's rule,

$$\frac{\sigma\delta_{\text{i}}}{\sigma\delta_{\text{i}} + (1-\sigma)\,\delta_{\text{ni}}} = \Sigma.$$

  Given $\delta_{\text{i}} = 1$, rearranging yields the expression in the lemma.

- The NPE's equilibrium strategy is such that the no-insurance type is indifferent between defending and acquiescing. The payoffs when it acquiesces are $A - D$. The payoffs when she defends are:

$$\beta\left[\eta^*\omega D + (1-\beta^*)\left[\omega D + C_F\right]\right] + (1-\beta)\left[\omega D - (1-\omega)P - C_N\right]$$

The value for η^* such that the two payoffs are equal is

$$\eta^* = 1 - \frac{(1-\omega)\,D + (1-\beta)\,[(1-\omega)\,P + C_N]}{\beta C_F}.$$

This concludes the proof. □

Proof of Lemma 2

Proof. First, let's collect component's for the NPE's expected payoffs from asserting its patent. These expected payoffs are

$$E(N^{\mathrm{a}}) = \begin{cases} E(S|\sigma=1) & \text{if } \sigma \geq \Sigma \\ (1-\beta)\,S_F + \beta\left[(1-\sigma)\,S_{N|\sigma<\Sigma} + \sigma N^{\mathrm{d}}\right] & \text{if } \sigma < \Sigma \text{ and } D \geq \Delta(P) \\ \sigma\left[(1-\beta)\,S_F + \beta S_{N|\sigma>\Sigma}\right] + & \\ (1-\sigma)\left[\delta^*\left[(1-\beta)\,S_F + \beta S_{N|\sigma>\Sigma}\right] + (1-\delta^*)\,N^{\mathrm{nd}}\right] = & \\ (\sigma + (1-\sigma)\,\delta^*)\left[(1-\beta)\,S_F + \beta S_{N|\sigma>\Sigma}\right] + (1-\sigma)\,(1-\delta^*)\,N^{\mathrm{nd}} & \text{if } \sigma < \Sigma \text{ and } D < \Delta(P) \end{cases} \tag{24}$$

where $E(S|\sigma=1)$ is given in equation (3), $S_F = \omega D - (1-\omega)\,P - C_N$ is the firm's settlement offer, $S_{N|\sigma<\Sigma} = \omega D + C_F$ is the NPE's high settlement offer, $S_{N|\sigma>\Sigma} = \omega D$ is the NPE's low settlement offer, $N^{\mathrm{d}} = D$ are the NPE's payoffs when the firm acquiesces, and $N^{\mathrm{nd}} = \omega D - (1-\omega)\,P - C_N$ are the NPE's expected payoffs from litigation when the firm defends but settlement fails.

1. If $\sigma \geq \Sigma$, both firm types will defend and accept the NPE's settlement low settlement offer. The condition to assert is then the same as condition (4). This condition can be rearranged to obtain the condition in the claim, as functions of $\Delta(P)$ or $\Pi(D)$.

2. If $\sigma < \Sigma$ and $D \geq \Delta(P)$, both firm types defend, but the insurance type will not accept the NPE's high settlement offer. Given the NPE's offer (with probability β), with probability σ the NPE's payoffs are the expected payoffs from litigation, and

with probability $1-\sigma$ the payoffs are equal to the settlement offer. These payoffs can rewritten to read:

$$\omega D + C_F - (1 - \beta(1-\sigma))\left[(1-\omega)P + C_N + C_F\right] \geq 0 \tag{25}$$

Rearranging this condition yields the condition in the claim, as functions of $\Delta(P)$ or $\Pi(D)$.

3. If $\sigma < \Sigma$ and $D < \Delta(P)$, the insurance type will defend and the no-insurance type defends with probability δ^*. Moreover, the insurance type does not accept the NPE's high settlement offer. In Lemma 1 we have shown that the NPE makes the low settlement offer ωD with probability η^* and the high settlement offer with probability $1-\eta^*$. Moreover, in the mixed strategy equilibrium of the subgame under consideration here, the firm's strategy is such that the NPE is indifferent between making the low offer (accepted by both firm types) and the high offer (accepted only by the no-insurance type). Without loss of generality, the above expected payoffs use the low-settlement-offer notation, $S_{N|\sigma>\Sigma} = \omega D$. The above expression can be rearranged to yield the condition in the claim. We omit the critical value for D for the sake of brevity. □

Proof of Proposition 3

Proof. We provide the proof of the insurance decision in Proposition 3 as part of the proof of Lemma 3. □

Proof of Lemma 3

Proof. We show the proof of the claim in a number of steps. We consider two regions in the parameter space, one in which condition (7) is violated and one in which it is satisfied. In each region, we first provide the conditions under which $\sigma = 0$ is an equilibrium. Second, we show that $\sigma = 1$ is never an equilibrium. Third, for the subset of the parameter space

in which neither $\sigma = 0$ nor $\sigma = 1$ is an equilibrium, the equilibrium is in mixed strategies, (σ^*, α^*).

The firm's defense condition (7) *is violated:*

1. Suppose $\sigma = 0$ is an equilibrium strategy, then the only equilibrium outcome of the subgame following the insurance decision is (Eq.f) in Proposition 2. The underlying equilibrium, however, is degenerate and the outcome corresponds to outcome (Eq.1) in Proposition 1. The firm's payoffs in this equilibrium are $(1-\phi)\,A + \phi\,[A - D] = A - \phi D$. If the firm deviates and buys insurance so that $\sigma = 1$, then the NPE asserts (anticipating $\sigma = 0$), the firm defends, the NPE makes the high settlement offer with $1 - \eta^*$ which the firm (with insurance) rejects. The firm's payoffs from deviation are

$$(1-\phi)\,[1 - M] + \phi\,[A - M - \omega D + (1-\beta)\,[(1-\omega)\,P + C_N]] \tag{26}$$

   Comparing the payoffs from $\sigma = 0$ and $\sigma = 1$, the firm will thus choose the equilibrium strategy if

$$D \leq \Delta(P) + \frac{M - \phi\beta C_F}{\phi\,(1-\omega)}. \tag{27}$$

   For higher values of D, the firm deviates.

2. Suppose $\sigma = 1$ is an equilibrium strategy. In equilibrium, $\sigma = 1 > \Sigma$ always holds true, so that equilibrium outcome is (Eq.a) in Propsition 2. In this outcome, the NPE does not assert. The firm's payoffs are $A - M$. If the firm deviates (so that $\sigma = 0$), the NPE (anticipating $\sigma = 1$) does not assert. The firm's payoffs are A. For $M > 0$, then firm will always deviate and $\sigma = 1$ is not an equilibrium strategy.

3. If D is such that condition (19) is satisfied, then neither $\sigma = 0$ (with $\alpha = 1$) nor $\sigma = 1$ (with $\alpha = 0$) is an equilibrium strategy. In equilibrium, we must have $\sigma^* \in (0, 1)$ and $\alpha^* \in (0, 1)$.

The firm's defense condition (7) *is satisfied:*

1. Suppose $\sigma = 0$ is an equilibrium strategy, then $\sigma = 0 < \Sigma$ and condition (15) (separating outcomes (Eq.b) and (Eq.e)) in Proposition 2 becomes condition (8) in Proposition 1.

   Let condition (8) be violated, so that the outcome is (Eq.2) in Proposition 1. Because the NPE does not assert, the firm's payoffs are A. If the firm deviates and buys insurance ($\sigma = 1$), the NPE (anticipating $\sigma = 0$) does not assert. The firm's payoffs are $A - M$. For $M > 0$, the firm will not deviate, and $\sigma = 0$ is indeed an equilibrium strategy.

   Let condition (8) be satisfied. The relevant equilibrium outcome is (Eq.e) in Proposition 2: the NPE asserts, the firm defends and accepts the settlement high offer by the NPE. The firm's payoffs are

$$A - \phi \left[\omega D + C_D - (1 - \beta) \left[(1 - \omega) P + C_N + C_F\right]\right] \tag{28}$$

   If the firm deviates ($\sigma = 1$), then it does not accept the NPE's high settlement offer. The firm's payoffs are

$$A - M - \phi \left[\omega D - (1 - \beta) \left[(1 - \omega) P + C_N\right]\right] \tag{29}$$

   Comparing these two payoffs, we conclude that the firm does not deviate (and does not buy insurance) if $M \geq \phi\beta C_F$. Because we have assumed that $M < phi\beta C_F$, the firm does deviate and $\sigma = 0$ is not an equilibrium strategy.

2. Suppose $\sigma = 1$ is an equilibrium strategy, then $\sigma = 1 > \Sigma$. The relevant equilibrium outcomes are (Eq.a) and (Eq.d) in Proposition 2, separated by condition (14) that is not a function of σ.

   Let condition (14) be violated, then the NPE does not assert and the firm's payoffs

are $A - M$. If the firm deviates ($\sigma = 0$), and the NPE does not assert (anticipating $\sigma = 1$), the firm's payoffs are A. The firm deviates and $\sigma = 1$ is not an equilibrium strategy.

Let condition (14) be satisfied, then the NPE asserts, the firm defends, and the NPE makes the low settlement offer which the firm accepts. The firm's payoffs are

$$(1 - \phi)[A - M] + \phi[A - M - \beta(\omega D - (1 - \omega)P - C_N) - (1 - \beta)\omega D] \tag{30}$$

If the firm deviates ($\sigma = 0$), the equilibrium outcome does not change. The firm's payoffs are

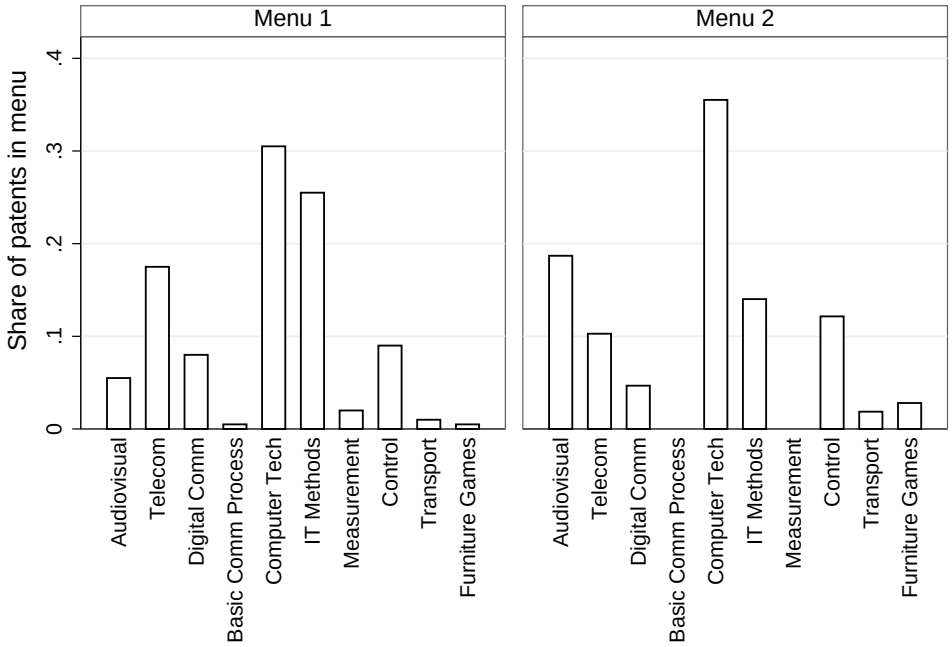
$$(1 - \phi)A + \phi[A - \beta(\omega D - (1 - \omega)P - C_N) - (1 - \beta)\omega D] \tag{31}$$

For $M > 0$, the firm deviates and $\sigma = 1$ is not an equilibrium strategy.

3. If condition (14) be violated, then $\sigma = 0$ is the only equilibrium. If the condition is satisfied, then neither $\sigma = 0$ (with $\alpha = 1$) nor $\sigma = 1$ (with $\alpha = 0$) is an equilibrium strategy. In equilibrium, we must have $\sigma^* \in (0, 1)$ and $\alpha^* \in (0, 1)$. □

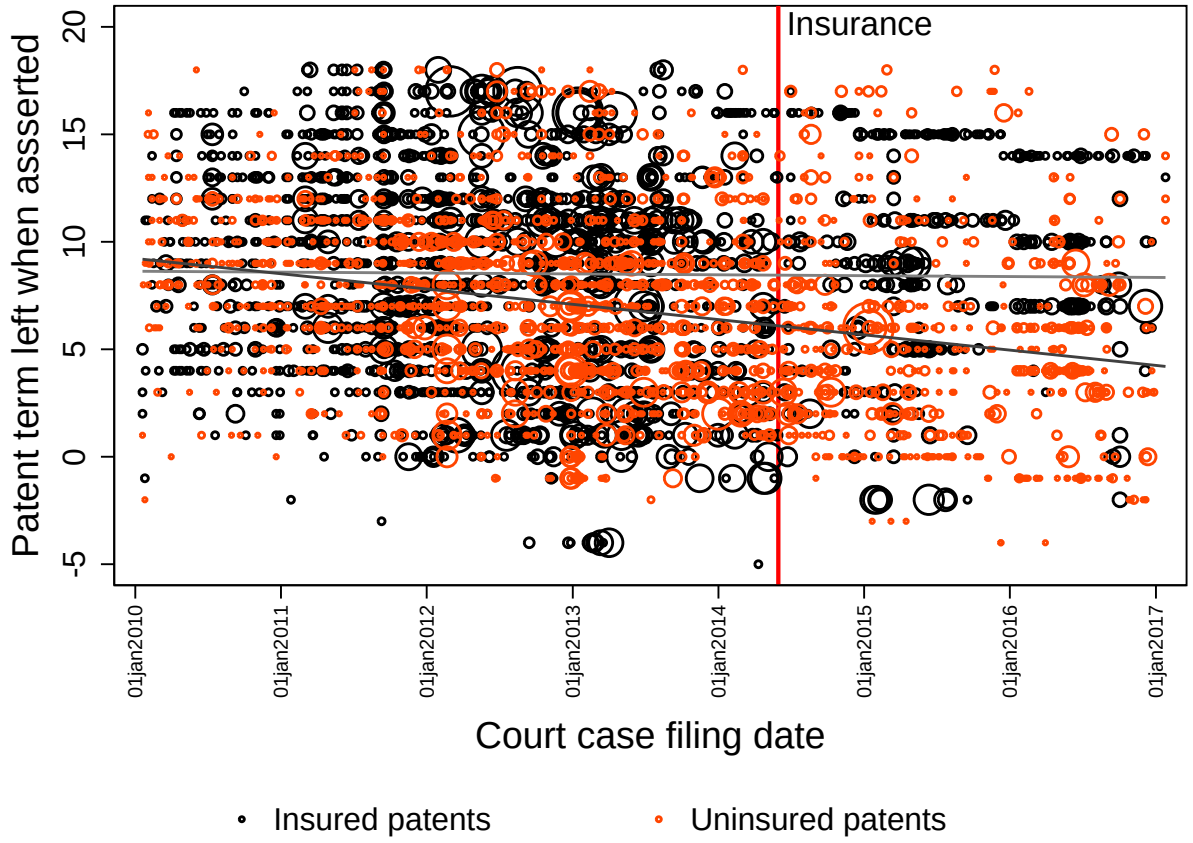
B Appendix: Figures

Figure A-1: Technology Distribution of Insured Patents



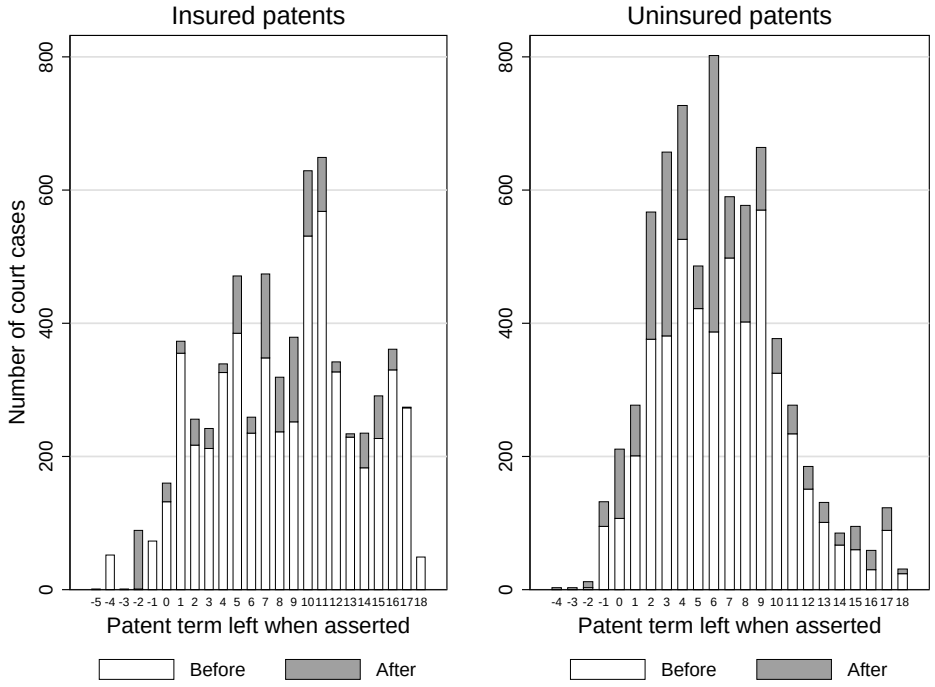
Notes: Menu 1 contains 200 patents, Menu 2 107 patents; patents mapped into technology areas using a patent's main IPC codes.

Figure A-2: Number of Court Cases by Age of Asserting Patents (2010–2016)



Notes: The size of a bubble indicates the number of court cases by case filing date; insured patents contain all asserted patents from Menu 1 and Menu 2; uninsured patents are all asserted patents held by NPE groups not covered by Menu 1 and Menu 2 of the IPISC insurance policy; patent term left at time of assertion computed as difference between patent age at time of assertion 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 time of assertion 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 time of assertion and the filing date of the earliest application to which the patent claims priority, or (ii) the difference between time of assertion 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.

Figure A-3: Age of Insured and Uninsured Patents at Time of Assertion



Notes: Patent term left at time of assertion computed as difference between patent age at time of assertion 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 time of assertion 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 time of assertion and the filing date of the earliest application to which the patent claims priority, or (ii) the difference between time of assertion 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.

Figure A-4: Defendants by Size (Court Cases 2010–2016)

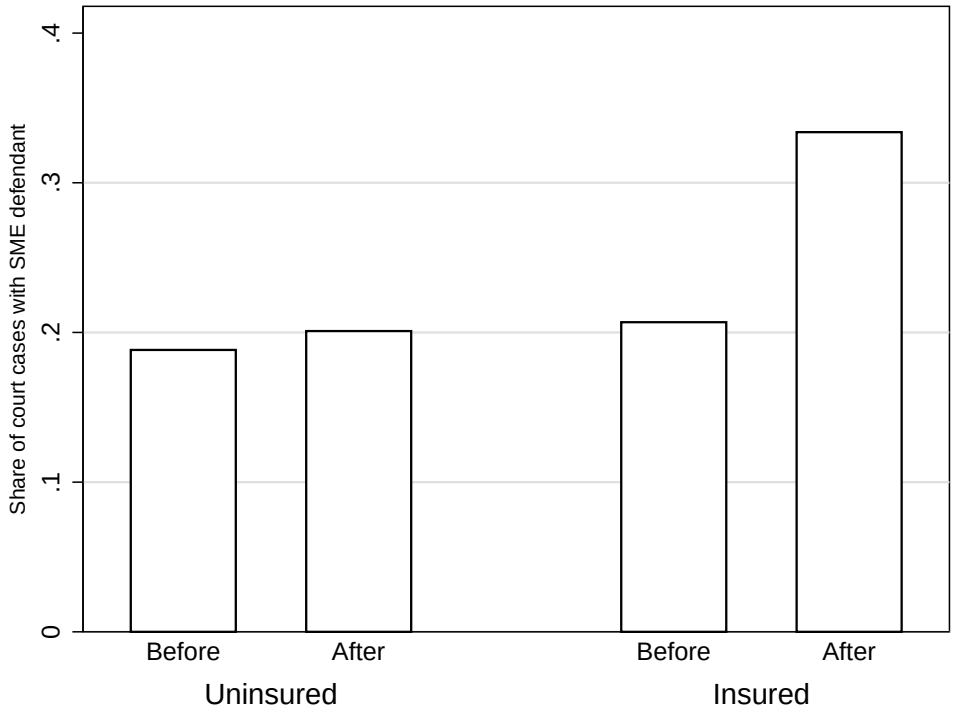
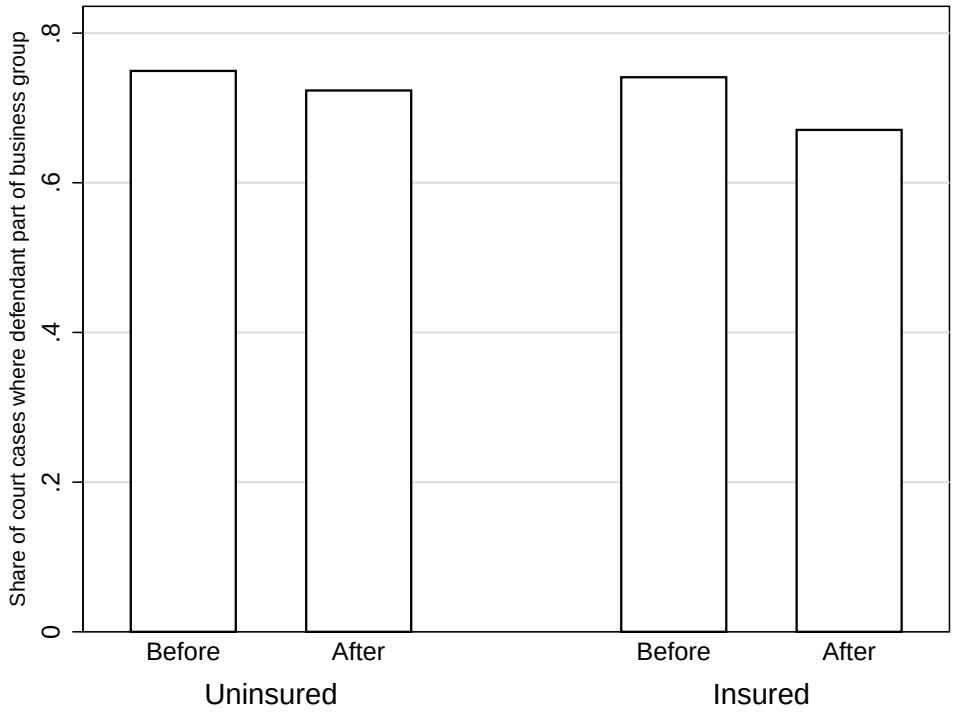


Figure A-5: Defendants by Business Group (Court Cases 2010–2016)



C Appendix: 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	2,530	451	0.007	0.037
Actus	PAE	4	4	5	0	0.800	ONLY INSURED
Affinity	PAE	2	2	35	14	0.057	0.142
Agincourt	PAE	2	2	11	2	0.181	1.000
Altitude	PAE	3	3	1,184	57	0.002	0.052
Antor	PAE	1	0	1	0	1.00	0
Balthaser	PAE	1	1	11	0	0.090	ONLY INSURED
Barstow	PAE	4	4	1	0	4.00	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	13	6	0.076	0.166
Datatern	PAE	2	2	1	0	2.000	ONLY INSURED
Datatreasury	PAE	6	6	12	0	0.500	ONLY INSURED
Digitalriver	PAE	1	0	103	3	0.009	0
Drone	PAE	1	1	1	0	1.00	ONLY INSURED
Droplets	PAE	2	2	4	0	0.500	ONLY INSURED
Easyweb	PAE	5	5	1	0	5.000	ONLY INSURED
Empire	PAE	2	2	189	56	0.010	0.036
Eolas	Univ. Heritage	2	2	18	1	0.111	2.000
Essociate	PAE	1	1	6	4	0.166	0.250
Everglades	PAE	1	1	1	0	1.00	ONLY INSURED
Farmer	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Fokas	PAE	4	4	35	6	0.114	0.667
Fotomedia	PAE	6	6	77	0	0.077	ONLY INSURED
Freeman	Indiv.	1	1	4	1	0.250	1.000
Geotag	PAE	1	1	3	0	0.333	ONLY INSURED
Goldberg	PAE	3	2	12	1	0.250	2.000
H-W	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Hawk	PAE	1	1	7	3	0.142	0.333
Helferich	PAE	6	6	33	20	0.181	0.300
Holub	PAE	13	13	20	2	0.650	6.500
Horstemeyer	PAE	35	23	55	16	0.636	1.437
Hothand	PAE	1	1	6	0	0.166	ONLY INSURED
Innovatio	PAE	18	17	16	7	1.125	2.428
Intelleq	PAE	1	1	14	2	0.071	0.500
Interface	PAE	2	2	5	2	0.400	1.000
Interval	PAE	4	4	37	4	0.108	1.000
Ipnav	PAE	9	6	475	82	0.019	0.073
Intellectual Ventures	PAE	14	14	18,452	135	0.0007	0.103
Joao	PAE	4	4	40	8	0.100	0.500
Klever	PAE	1	1	11	0	0.090	ONLY INSURED
Kroy	PAE	1	1	2	1	0.500	1.000
Lockwood	PAE	3	3	1	0	3.000	ONLY INSURED
Lodsys	PAE	4	3	0	0	ONLY INSURED	ONLY INSURED
Marathon	PAE	8	8	192	57	0.041	0.140
Medina	PAE	10	7	7	0	1.428	ONLY INSURED
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	1	0.307	4.000
Neomedia	PAE	4	3	28	4	0.142	0.750
Network Signatures	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Norris	PAE	3	3	28	10	0.107	0.300
Orientview	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Patentharbor	PAE	1	1	1	1	1.000	1.000
Pixfusion	PAE	2	2	2	0	1.000	ONLY INSURED
Princeton	PAE	1	1	9	9	0.111	0.111
Ranjan	PAE	1	1	4	2	0.250	0.500
Recruitme	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Reese	PAE	1	1	8	0	0.125	ONLY INSURED
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	3	0.038	0.333
Silverscreen	PAE	1	1	4	2	0.250	0.500
Skipprint	PAE	4	4	6	5	0.667	0.800
Smartmetric	PAE	1	1	0	0	ONLY INSURED	ONLY INSURED
Sph	PAE	1	0	15	0	0.066	ONLY INSURED
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	162	13	0.067	0.769
Ubicomm	PAE	3	3	4	0	0.750	ONLY INSURED
Uniloc	PAE	1	1	171	24	0.006	0.041
Vertigo	PAE	3	3	39	6	0.076	0.500
Vringo	PAE	2	2	68	1	0.029	2.000
Walker	PAE	5	5	859	54	0.006	0.092
Webvention	PAE	1	1	5	5	0.200	0.200
Zilka	PAE	3	3	153	35	0.019	0.085

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

Table A-2: Total Number of Court Cases – Insured Patents on Menu 1 (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	0.971***	1.256***	0.062	0.798***	-0.698***	0.857***
	(0.109)	(0.112)	(0.064)	(0.091)	(0.071)	(0.095)
Post-launch	-0.291	-0.615	-1.116***	-0.804*	0.722**	-1.416*
	(0.225)	(0.176)	(0.104)	(0.416)	(0.303)	(0.763)
Insured patent×Post-launch	-0.816***	-0.909***	-0.375***	-0.443**	-1.084***	-0.988***
	(0.161)	(0.179)	(0.138)	(0.182)	(0.157)	(0.193)
Month FE	YES	YES	YES	YES	YES	YES
Obs	168	168	168	168	168	168
R2	0.821	0.815	0.877	0.830	0.891	0.791

Notes: OLS regression. Dependent variable: log number of cases by month for a given patent. All regressions include a constant. Time period is January 2010 – December 2016; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

Table A-3: Total Number of Court Cases at the Patent Level – Insured Patents on Menu 1 (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	0.008	0.012	-0.008	-0.004	0.003	-0.015
	(0.009)	(0.011)	(0.006)	(0.010)	(0.002)	(0.010)
Insured patent×Post-launch	-0.015***	-0.014***	-0.014**	-0.014***	-0.016**	-0.012**
	(0.005)	(0.005)	(0.006)	(0.004)	(0.006)	(0.006)
IPR	-0.015***	-0.399***	-0.460***	-0.391***	-0.495***	-0.587***
	(0.005)	(0.048)	(0.036)	(0.043)	(0.035)	(0.048)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Court FE	YES	YES	YES	YES	YES	YES
Obs	47,563	30,679	104,011	37,063	268,903	48,907
R2	0.747	0.751	0.728	0.742	0.724	0.760

Notes: OLS FE regression. Dependent variable: log number of cases by month. All regressions include a constant. Time period is January 2010 – December 2016; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors clustered at patent-level. * significant at 10%, ** at 5%, *** at 1%.

Table A-4: Total Number of Court Cases – excluding business method patents (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Insured patent	1.038***	1.148***	0.035	0.547***	-0.607***	0.586***
	(0.105)	(0.106)	(0.068)	(0.083)	(0.076)	(0.093)
Post-launch	-0.715**	-0.697***	-1.259***	-0.830***	-0.815***	-0.631***
	(0.289)	(0.227)	(0.202)	(0.233)	(0.252)	(0.136)
Insured patent×Post-launch	-0.752***	-0.789***	-0.379**	-0.485***	-1.050***	-0.777***
	(0.169)	(0.176)	(0.148)	(0.165)	(0.159)	(0.185)
Month FE	YES	YES	YES	YES	YES	YES
Obs	168	168	168	168	168	168
R2	0.825	0.550	0.862	0.487	0.463	0.782

Notes: OLS regression. Dependent variable: log number of cases by month for a given patent. All regressions include a constant. Time period is January 2010 – December 2016; all patents in USPC 705, 718, 719, 720, 725, and 726 excluded from sample; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors. * significant at 10%, ** at 5%, *** at 1%.

Table A-5: Total Number of Court Cases at the Patent Level – excluding business method patents (by Month, 2010–2016)

	Control 1		**Control 2**		**Control 3**	
	(a) All	(b) Matched	(a) All	(b) Matched	(a) All	(b) Matched
	(1)	(2)	(3)	(4)	(5)	(6)
Post-launch	0.001	-0.072***	-0.008	0.010	0.003*	-0.005
	(0.007)	(0.016)	(0.006)	(0.008)	(0.002)	(0.008)
Insured patent×Post-launch	-0.013***	-0.011***	-0.008**	-0.009***	-0.011**	-0.008**
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
IPR	-0.294***	-0.283***	-0.370***	-0.303***	-0.490***	-0.542***
	(0.048)	(0.053)	(0.051)	(0.057)	(0.037)	(0.057)
Patent FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Court FE	YES	YES	YES	YES	YES	YES
Obs	54,036	39,000	104,100	49,500	253,620	61,344
R2	0.732	0.728	0.714	0.725	0.729	0.758

Notes: OLS FE regression. Dependent variable: log number of cases by month. All regressions include a constant. Time period is January 2010 – December 2016; all patents in USPC 705, 718, 719, 720, 725, and 726 excluded from sample; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" for all control 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes) using caliper matching. Robust standard errors clustered at patent-level. * significant at 10%, ** at 5%, *** at 1%.

Table A-6: Comparison of Settlement Counts Between Insured and Uninsured Patents

	Court cases settled			
	Before		After	
	#	%	#	%
	Insured			
Insured	4,180	77.94	871	84.81
	Uninsured			
Control group 1a	1,097	78.02	793	81.67
Control group 1b	671	77.30	547	78.59
Control group 2a	3,786	78.52	1,459	83.04
Control group 2b	1,743	81.45	727	81.69
Control group 3a	5,918	71.93	4,218	80.82
Control group 3b	1,557	71.36	1,138	80.25

Notes: Insured patents include patents from both Menu 1 and Menu 2; Control 1: control group consists of court cases in which uninsured patents were asserted by the the same NPEs that hold insured patents; Control 2: control group consists of court cases in which uninsured patents were asserted by the the same NPE groups that the NPEs that hold insured patents belong to; Control 3: control group consists of court cases brought by NPEs that do not belong to "insured NPE groups;" control group consists of court cases brought by NPEs that do not belong to "insured NPE groups" where 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 Section 4.1 above (patent age, family size, forward citations, backward citations, NPL citations, SEP, re-assigned, and 35 technology classes based on IPC codes).