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Patent Litigation Insurance

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Abstract

Empirical studies have found that high litigation costs often discourage small firms from investing in R&D, as they fear their patent will be infringed and they will not be able to afford litigation. As a solution, firms have been encouraged to purchase insurance policies which, by covering legal costs in the event of a trial, serve as a commitment to litigate so that settlement terms are more favorable to the insured, and potential infringement is less likely to occur. However, very few firms are purchasing insurance and the market remains poorly developed throughout the world. I show that firms might be discouraged from buying insurance because of information asymmetries, not only with insurance companies but also with their competitors. I study the situation of a patent holder, who perfectly knows the validity and enforceability (“strength”) of her patent, that has been infringed by a competitor with less information on the patent. The patent holder can purchase insurance to have a credible threat to litigate and increase the infringer’s settlement offer. But the decision to buy an insurance conveys information about the patent strength to the infringer. As a result the patent holder may prefer not to be insured rather than transmitting this information. This signaling effect can yield different equilibriums, in particular a pooling equilibrium “no insurance” where no patent holder purchases an insurance. I study if this situation might be improved by imposing a mandatory insurance or by giving the insurer a share of litigation proceeds.

JEL Classification: D82, K41, G22, O34.

Keywords: litigation, settlement, patent litigation, insurance.

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1 Introduction

Many recent studies point to the substantial escalation in the cost of patent litigation. Since 2001, the cost of patent lawsuits has risen 48%. According to American Intellectual Property Law Association, the costs could also go as high as \$8 million.¹ And with estimates showing the cost of IP litigation rising at almost 20 percent a year, there is no indication that the trend of rising costs will end anytime soon. The potential cost exposure often leads small and medium firms (SMEs) whose patent has been infringed to capitulate at an early stage (accepting low settlement offers from infringers), or not to proceed with litigation at all. Infringers count on the intimidation of high legal costs not to be sued by the the patent holders. This threat of a costly enforcement affects firm's upstream strategies of R&D investment and patenting.²

A solution that has been proposed is patent litigation insurance (PLI), that covers legal costs in case a patent holder has to sue an infringer to enforce his patent.³ In this case, the insurer pays a portion of the legal expenses up to the policy limit: typically 75% of the legal costs up to \$500,000 with annual premiums of \$3,000 to \$4,000 (Wilder, 2001). According to Lanjouw and Shankerman (2001), the objective of PLI is "to strengthen the ability of small firms to enforce their patents and their bargaining power in negotiated settlements". By being insured, the patent holder lets the other party know that she is ready and able to litigate if necessary, which forces a more favorable settlement of a patent dispute for the policyholder. However, despite the fact that PLI has been around since the early 1980s in the U.S., Japan and Europe, only a very small percentage of patent owners have taken advantage of the protection provided by insurance companies.⁴ The main reasons invoked by SMEs are high premiums and insufficient coverage.⁵

In this paper I study a patent holder's incentive to buy a patent litigation insurance, and I offer

¹The American Intellectual Property Law Association states that in U.S. patent infringement cases where the amount in dispute is between \$1 million and \$25 million, total litigation costs average in excess of \$3 million. In cases where the amount in dispute exceeds \$25 million, average total litigation costs are roughly double (AIPLA, Report of the Economic Survey, 2009). Beside these pecuniary costs, clearly a trial also has an additional cost related to the period of uncertainty during the proceedings.

²Several contribution stress this problem: Lerner (1995), Somaya (2003), Harhoff and Reitzig (2004), Lanjouw and Shankerman, (2004), Bessen and Meurer (2006).

³This type of insurance is also called infringement abatement insurance or patent enforcement insurance. Note that there also exists a defensive patent insurance for insured firms that are accused of infringement by a rival company. For instance, a defensive policy may establish an annual premium of between \$20,000 and \$50,000 for one million dollars in coverage, with a deductible ranging from 15% to 25%.

⁴"Patent insurance has not been successful throughout the world", as stated by CJA Consultants Ltd, Patent Litigation Insurance: A Study for the European Commission on Possible Insurance Schemes Against Patent Litigation Risks 10 (2003), available at http://ec.europa.eu/internal_market/indprop/docs/patent/studies/litigation_en.pdf.

⁵Coverage is usually available in the range of \$250,000 to \$10 million. Premiums are calculated based on the number of patents insured under the policy and their relative risk, with premiums ranging from between 1-5% of the insured amount. Policies may also contain deductibles and co-pays that must be covered by the insured.

a possible explanation as to why the insurance market is so poorly developed, even though it is supposed to be efficient as an strategic device for patent holders. The explanation for this market failure differs from the traditional models of adverse selection between insurers and insureds.⁶ I analyze a game of asymmetric information with a patent holder, who has private information on the validity and enforceability of her patent (“patent strength”), and a deep pocketed competitor with poor information on the patent. The patent strength determines the patent holder’s decision to litigate, and the infringer makes a settlement offer if he is litigated. If settlement breaks the parties go to trial and the patent is either found invalid or infringed. Given the legal costs involved by a trial, absent a patent litigation insurance, only incumbents with strong patents will litigate, while others will accommodate entry. However, holding PLI gives the incumbent a credible threat to litigate: PLI acts as a commitment to go to trial which increases the infringer’s settlement offer. But the decision to buy an PLI conveys information about the patent strength to the infringer. Therefore, holders of weak patents will want to mimic strong patent holders, to avoid transmitting information on their patent through their insurance decision. As a result the only possible equilibrium is a pooling equilibrium where all patent holders make the same insurance decision, either “all insurance” or “no insurance”. The latter might describe the current situation of an underdeveloped market for patent litigation insurance.⁷ Then I study how this situation might be improved to make PLI more widely available, through a mandatory PLI – as suggested in a study by the European commission (see footnote 4) –, or the possibility for the insurance company to obtain a share of litigation proceeds.

Two important features of the model are asymmetric information on the patent strength, and the fact that the infringer learns whether the patent holder is insured or not once litigation proceeds. Patentees are better informed than outsiders like insurers and infringers on their patent validity and enforceability, which depend on its claims, specification, prosecution history, and information about the prior art. Although the patent holder is required to disclose to the public a written description of the invention and all the relevant prior art, this disclosure requirement (in 35 U.S.C. par. 112 (1976)) is not strictly enforced in practice.⁸ This is especially true in high

⁶Indeed, in proposition 1, I show that if there was only that adverse selection problem, a market for insurance would always exist.

⁷In the U.K. from 1998 to 2002, Lloyd’s provided patent enforcement coverage but got less than 250 takers. In the U.S., insurance companies like AIG, Chubb, or Lexington have offered insurance to US companies but the insurance was limited to defense only. From 1986 to 1994, a standardized insurance policy (named “Brevetassur”) was created in France, covering 85% of the litigation costs. However most insurance companies quickly stopped selling these policies and terminated those in effect.

⁸As Nordhaus (1969) points out, “the disclosure regulations of the patent system are often evaded”.

technology sectors where most of the prior art is not patented: Allison and Lemley (1998) report that non-patent prior art was not disclosed in the vast majority of the patents they studied from 1989 to 1996. Moreover, outsiders have no direct knowledge of the information exchanged between the patent applicant and the examiner at the Patent Office during the application process, that involves negotiations and sometimes intensive discussions mostly related to the prior art.⁹ Although it is hard to measure, many legal and economics scholars highlight the importance of information, both in insurance markets between patent holders and insurers (Lanjouw and Lerner, 1998) and in patent disputes between patent holders and infringers (Marco and Walsh, 2007). According to Lanjouw and Lerner (1998), the development of patent enforcement insurance markets is “handicapped by the severe information asymmetries [...] that characterize intellectual property: the party that develops the patent is likely to have far greater knowledge of the relevant prior art than the firm that purchases a part-interest in the patent or sells an insurance policy.”¹⁰ Similarly in patent disputes, Meurer (1989) argues that “the patentee knows more about validity than the competitor because during R&D the patentee gained information that is relevant to the issue of validity.[...] Incidental to the development of an innovation the patentee may learn about items of prior art bearing on the question of validity. Not being engaged in the development process, the competitor is likely to know less about the content of the prior art”. Moreover, while the infringer is generally not aware that the patentee is insured or not by the time he infringes on the patent, he learns that information once settlement negotiations proceed. Indeed, it is always in a party’s interest to let the other party know that it is insured, since it strengthens her position in litigation. It is the combination of these two features – asymmetric information on the patent strength and observability of PLI– that makes having PLI or not a powerful signaling device in litigation and settlement.

In the literature on litigation, the usual argument for firms’ incentives to settle is the bargaining surplus created by a settlement, as it avoids the large costs of a trial.¹¹ This result can be reversed when one party has private information about the trial outcome. Following the classical contributions of Bebchuk (1984) and Reinganum and Wilde (1986), the emergence of litigation in equilibrium in most of the existing papers is the result of private information regarding the proba-

⁹This information issue is raised and explained by Harhoff and Reitzig (2004).

¹⁰At best, insurers try to operate opinion from an attorney, or have in-house counsel who use software tools to understand the patent landscape in a particular area. Information asymmetries between patent holders and insurance companies are also underlined in the European Commission Report cited in footnote 4.

¹¹Several papers have study patent litigation and settlement when the trial outcome is uncertain (see for example Aoki and Hu, 1999 and Crampes and Langinier, 2002).

bility that each side prevails in court.¹² In the particular context of patent litigation, Meurer (1989) proposes the first model that explicitly takes the possibility of patent invalidity and resulting court challenges into account. He studies a signaling model where the patent holder has private information regarding the validity of the patent and can make a take-it-or-leave-it offer to the infringer.

My paper is related to the literature on legal expenses insurance (LEI). Kirstein (2000) and van Velthoven and van Wijck (2001) show that LEI may be purchased by risk neutral agents for the strategic purpose of making the plaintiffs threat to go to trial credible and thus improving the bargaining position of the insured.¹³ Heyes, Rickman, and Tzavara (2004) confirm these results for a risk-averse plaintiff when the defendant is uninformed about the actual degree of risk aversion of the plaintiff.¹⁴ Finally, Baik and Kim (2007) compare legal expenses insurance with contingency fees in a moral hazard model where the lawyer of each party makes an unobservable effort to win the case.

To my knowledge there are only two papers specifically on PLI. Buzzacchi and Scellato (2008) show that the enforceability of patents can be improved through litigation insurance. They find that this underdeveloped market of litigation insurance could be presently substituted with higher screening ability of the patent office, and with proper level of punitive damages. Llobet and Suarez (2012) study the interactions between a patent holder and a potential infringer. They show that the potential infringer infringes the patent if he expects the patent holder not to litigate ("patent predation"). PLI then provides the patent holder a commitment to litigate, that will deter infringement. However, the patent holder will litigate to excess if his legal costs are fully covered. Therefore, an optimal PLI policy should incorporate a deductible or co-payment. Both papers recognize the patentee's private benefits of having PLI. In this paper I introduce asymmetric information problems and try to reconcile that result with the contradicting observation that PLI is unsuccessful.

The paper is organized as follows. In Section 2 I present the model. Section 3 briefly studies the situation of symmetric information, while in section 4 I derive the possible equilibriums under asymmetric information and present comparative statics. Section 5 analyze the impact of a mandatory insurance and the share of litigation proceeds between the insurer and the patentee. Section 6

¹²Bebchuk (1984) studies a screening game where the settlement offer is made by the uninformed party, while Reinganum and Wilde (1986) study a signaling game where the settlement offer is made by the informed party. There are alternative situations, where both parties have private information (Schweizer, 1989; Daughety and Reinganum, 1994) or the settlement is multi-period (Spier, 1992; Wang, Kim and Yi 1994).

¹³While standard insurance only benefits risk averse individuals by transferring the risk and bringing greater them certainty of outcomes.

¹⁴Other notable papers that model pre-trial behavior taking into account risk aversion are Farmer and Pecorino (1994) and Swanson and Mason (1998). In all these papers the defendant makes a settlement offer when uninformed about the plaintiffs degree of risk aversion.

concludes. All proofs are in the Appendix.

2 Description of the model

I consider a litigious situation where an alleged infringer (D), who has been detected by a patent holder (P), makes her a take-it-or-leave-it settlement offer S . If it is accepted, the firms settle and D pays P a license fee S in exchange for staying in the market, so the market structure is a duopoly and firms' profits are $\Pi^d + S$, $\Pi^d - S$.¹⁵ If the offer is rejected, the case goes to court. The trial cost (e.g. lawyers' fees) is c for each party.¹⁶ With a probability α the patent is judged valid and infringed, D is forced out of the market and P enjoys monopoly profits Π^m . With a probability $1 - \alpha$ the patent is invalidated, so both firms remain on the market and earn duopoly profits Π^d .¹⁷ I do not make any assumption on the background for allocating legal costs, in order to consider both the English ("loser pays") rule – under which the loser pays his/her own and the winner's expenses – and the American rule, where litigants bear their own expenses regardless of the outcome of the trial.¹⁸ Under the English rule, the total trial cost $2c$ is paid by D with a probability α and by P (or I) with a probability $1 - \alpha$, while under the American rule, both D and P (or I) pay c in trial. Let the trial cost paid by D and P (or I) be respectively $c_D = \gamma 2c\alpha + (1 - \gamma)c$ and $c_P = \gamma 2c(1 - \alpha) + (1 - \gamma)c$, where γ ($1 - \gamma$) is the probability of having the costs allocated as in the English (American) system.¹⁹

Prior to infringement, P has the option to purchase a patent enforcement insurance from an insurance company I , that will cover (part of) the costs of a trial if P happens to file for an infringement lawsuit.²⁰ Initially I offers an insurance contract (or a menu of contracts) composed of a premium ρ and a coverage x (a proportion x of the trial costs are covered by I and P must pay the rest). P 's insurance decision is binary: P can either accept the contract and buy the insurance ($\sigma = 1$), or not ($\sigma = 0$). Thus, we can write the payoffs from settlement and trial respectively as

¹⁵I assume that it is illegal for D to offer $S < 0$, so I rule out reverse payments.

¹⁶For simplicity I assume that the settlement cost is 0.

¹⁷Following Meurer (1989), I assume that "some entry barrier other than the patent prevents the entry of other firms". This is a simplifying assumption but the results of the model would hold even if the profits were higher when firms settle than when the patent is invalidated.

¹⁸Nearly all western democracies other than the United States use the English rule.

¹⁹This representation follows Baye, Kovenock and de Vries (2005) and Llobet and Suarez (2012). The comparison of the American and English rules is also considered in several papers, including Shavell (1982), Bebchuk (1984), Reinganum and Wilde (1986), and Meurer (1989).

²⁰Note that the signaling effect of purchasing insurance described in the model would remain if the insurance decision took place after the infringement, as long as D learns about it before making his settlement offer. Anecdotal evidence suggests that a potential infringer is unlikely to know whether the patent holder is insured or not before his entry decision, as opposed to once pre-trial negotiations begin.

- $\Pi^d + S - \sigma\rho$ and $\alpha\Pi^m + (1 - \alpha)\Pi^d - c_P + \sigma[xc_P - \rho]$ for P ,
- $\Pi^d - S$ and $(1 - \alpha)\Pi^d - c_D$ for D , and
- $\sigma\rho$ and $\sigma[\rho - xc_P]$ for I .

Note that the minimum settlement offer accepted by P is $S = \alpha(\Pi^m - \Pi^d) - c_P(1 - \sigma x)$, so an insured P will refuse to settle for $S = 0$ (i.e. accommodate) if and only if $x \geq \frac{c_P - \alpha(\Pi^m - \Pi^d)}{c_P} = \tilde{x}_\alpha$. Moreover, there is room for settlement if the minimum offer P is willing to accept is higher than the maximum offer D is willing to make, i.e. if $x \leq \frac{2c - \alpha(\Pi^m - 2\Pi^d)}{c_P} = \hat{x}_\alpha$. Note that $\hat{x}_\alpha \geq \tilde{x}_\alpha \forall \alpha \in [0, 1]$. P and D benefit from settling for a positive settlement amount if $x \in [\tilde{x}_\alpha, \hat{x}_\alpha]$. P 's payoff in trial can be rewritten as $\Pi^d + c_P(\sigma x_\alpha - \tilde{x}_\alpha) - \sigma\rho$.

The “strength” of the patent α can take two values, depending on whether the patent is respectively weak or strong: $\alpha \in \{\alpha_L, \alpha_H\}$, where $0 \leq \alpha_L < \alpha_H \leq 1$. This probability α is P 's private information, while I and D only know its prior distribution $q, 1 - q$: the patent strength is $\alpha = \alpha_H$ with probability q and $\alpha = \alpha_L$ with probability $1 - q$. Since the trial costs c_P can depend on the patent strength, I denote c_{α_H} and c_{α_L} as the trial cost for a strong patent holder and a weak patent holder, respectively.²¹

I assume that $2c < \Pi^m - 2\Pi^d$: for an “ironclad” patent (that has a patent strength $\alpha = 1$), the total profit from settlement would be lower than the total profit from trial. Moreover, I make the following assumptions on α_L and α_H : $0 \leq \alpha_L < \frac{c_{\alpha_L}}{\Pi^m - \Pi^d}$, and $\frac{c_{\alpha_H}}{\Pi^m - \Pi^d} \leq \alpha_H < \frac{2c}{\Pi^m - 2\Pi^d}$. These inequalities imply that absent an insurance, only a weak patent holder will be willing to settle for $S = 0$, while a strong patent holder will require a positive settlement amount, but there is always room for settlement.²² According to the assumptions, we have: $\tilde{x}_{\alpha_H} \leq 0 < \tilde{x}_{\alpha_L} \leq 1$ and $0 < \hat{x}_{\alpha_H} < \hat{x}_{\alpha_L}$. Note that under the English rule, $\hat{x}_{\alpha_L} \leq 1$, while under the American rule, $\hat{x}_{\alpha_L} > 1$. Throughout the model I assume that the difference between α_H and α_L is relatively large, so that $\tilde{x}_{\alpha_L} \geq \hat{x}_{\alpha_H}$. This means that I allow for situations where the insurance coverage x is such that P_{α_L} accommodates D while P_{α_L} sues D in court.²³ Throughout the text I will refer to P_{α_L} and P_{α_H} as the holder of a weak patent and a strong patent, respectively (and their respective trial costs as c_{α_L} and c_{α_H}).

²¹Note that under the American rule, $c_{\alpha_H} = c_{\alpha_L}$, while under the English rule, $c_{\alpha_H} < c_{\alpha_L}$.

²²Note that $\frac{c_{\alpha_L}}{\Pi^m - \Pi^d}$ depends on the allocation of legal costs, as it is equal to $\frac{c}{\Pi^m - \Pi^d}$ under the American rule, and $\frac{2c(1-\alpha)}{\Pi^m - \Pi^d}$ under the English rule. Therefore, a sufficient condition for the above inequalities to be met is $0 \leq \alpha_L < \frac{c}{\Pi^m - \Pi^d} < \frac{2c}{\Pi^m - \Pi^d + 2c} \leq \alpha_H < \frac{2c}{\Pi^m - 2\Pi^d}$.

²³In the less interesting case where $\tilde{x}_{\alpha_L} < \hat{x}_{\alpha_H}$, lemma 1 still holds but lemma 2 does not hold as there exists a pooling equilibrium “all insurance” $\forall q \in [0, 1]$.

2.1 Preliminary Remarks

There are two key interactions in the model involving information asymmetry. These two interactions take place sequentially, first between I and P , and second between P and D . The latter is a signaling game between P and D : As D learns whether P is insured or not before making his settlement offer, he uses it as a signal on α and updates her priors before offering S .²⁴ The former is an adverse selection problem where I faces two types of patent holders. Let us look at these problems more closely. If there are no information asymmetries at all, I is able to underwrite individualized insurance policies $(\rho_{\alpha_H}, x_{\alpha_H})$ to P_{α_H} and $(\rho_{\alpha_L}, x_{\alpha_L})$ to P_{α_L} , and designs these policies such that P and D settle for a strictly positive amount: $x_\alpha \in [\tilde{x}_\alpha, \hat{x}_\alpha]$.²⁵ D then offers the lowest settlement amount that will be accepted by P , i.e. such that P 's payoff is the same as in trial: $\Pi^d + c_P(x_\alpha - \tilde{x}_\alpha) - \rho$. Without insurance, P_{α_L} accommodates and gets Π^d while P_{α_H} settles for an amount such that she gets her trial payoff $\Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$. Therefore the highest premium I can offer is $\rho_{\alpha_L} = x_{\alpha_L}c_{\alpha_L} - c_{\alpha_L} + \alpha_L(\Pi^m - \Pi^d)$ to P_{α_L} and $\rho_{\alpha_H} = x_{\alpha_H}c_{\alpha_H}$ to P_{α_H} . It is optimal for I to offer the maximum coverage that yields a settlement: $x_{\alpha_L} = \hat{x}_{\alpha_L}$ and $x_{\alpha_H} = \hat{x}_{\alpha_H}$. As a result, the insurance policies that maximize I 's payoff while ensuring that the patent holder wants to be insured are $(\rho_{\alpha_L}, x_{\alpha_L}) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}), \hat{x}_{\alpha_L})$ and $(\rho_{\alpha_H}, x_{\alpha_H}) = (c_{\alpha_H}\hat{x}_{\alpha_H}, \hat{x}_{\alpha_H})$. Note that this situation is slightly different from traditional adverse selection situations, since here the low type α_L may not be the most costly one for the insurer, as a weak patent holder might be more willing to settle or accommodate (and therefore avoid trial costs) than a strong one. To sum up, absent any information asymmetry, all patent holders purchase an (individualized) insurance policy and end up in settlement. This result does not reflect the actual situation where very few patent holders buy an insurance and some cases end up in trial. The next section shows how asymmetric information can explain these observations.

3 Benchmark: Symmetric Information between P and D

As shown in section 2.1, if both interactions taking place in the game (between I and P , and between D and P) involved common information about patent validity, I would be able to underwrite individualized insurance policies to different types of patent holders who would all purchase

²⁴For clarity purposes, throughout the text I refer to P as female and to D as male.

²⁵ I gets the highest payoff if the parties settle (and that payoff is the premium ρ). In fact, P will not purchase an insurance if she ends up accommodating D , while I 's net payoff will be at most 0 if P buys an insurance and ends up in trial.

an insurance, and later on accept the individualized settlement offers made by D . However, like most insurance markets, the PLI market is subject to an adverse selection problem between insurers and patent holders that has been considered as the main cause of market failure so far.²⁶ This is well illustrated by the experience of Sweden described in a Danish report from 2001.²⁷ Between 1988 and 1996, a Swedish insurance company sold patent litigation insurance to 228 Swedish inventors, but was eventually forced to close the scheme for a lack of profitability. The insurance company attributed this failure to its inability to perform a precise assessment of patents.

The objective of the paper is to show that it is not only this adverse selection problem, but its combination with the signaling effect of being insured that can prevent a market for insurance to exist. To show that, let us first focus on the adverse selection problem between I and P , where P has private information on her patent strength α , while still assuming that D is able to observe α before making a settlement offer, so being insured has no signaling effect. I solve the game by backward induction.

I has the choice between attracting only strong patent holders, or lowering the premium in order to attract all patent holders. As shown in the following proposition, this choice depends on the proportion of strong patent holders q .

Proposition 1.

Under symmetric information between P and D , the insurance contract offered by I depends on whether q is lower or higher than $\underline{q} = \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{c_{\alpha_H}\hat{x}_{\alpha_L}}$:

- *If $q < \underline{q}$, I offers a menu of contracts $(\underline{\rho}, \underline{x}) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}) - c_{\alpha_H}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_H}), \hat{x}_{\alpha_H})$, which is purchased by P_{α_H} , and $(\bar{\rho}, \bar{x}) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}), \hat{x}_{\alpha_L})$, which is purchased by P_{α_L} . D makes settlement offers $S(\alpha_L) = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$ to P_{α_L} and $S(\alpha_H) = c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$ to P_{α_H} , that are both accepted.*
- *If $q \geq \underline{q}$, I offers a contract $(\rho, x) = (c_{\alpha_H}\hat{x}_{\alpha_H}, \hat{x}_{\alpha_H})$, which is purchased only by P_{α_H} . D makes settlement offers $S(\alpha_L) = 0$ to P_{α_L} and $S(\alpha_H) = c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$ to P_{α_H} , that are both accepted.*

Therefore, if there was only an adverse selection problem between the insurer and the patent holder, there would always be a market for insurance, with either all patent holders or only strong patent holders buying insurance. Therefore, the traditional explanation for a market failure does not hold here, as the insurer is always able to make a positive profit.²⁸ Comparing this situation

²⁶See for example the European Commission Report cited in footnote 4.

²⁷Danish Ministry of Trade and Industry, "Economic Consequences of Legal Expense Insurance for Patents" (2001)

²⁸In the standard Rothschild and Stiglitz (1976) set-up, equilibria with insurance may fail to exist because of adverse selection.

to the case with no information asymmetries described in section 2.1 shows that I sees its profits reduced because of adverse selection. On the one hand, if it keeps attracting all patent holders (i.e. if $q < \underline{q}$) it must leave an informational rent to strong patent holders by lowering their premium, such that their insurance contract is incentive compatible so they do not prefer weak patent holders' contract. On the other hand, if it attracts strong patent holders only (i.e. if $q \geq \underline{q}$), I avoids leaving an informational rent to strong patent holders, but the downside is that it gets no profit from weak patent holders.

Note that in the presence of adverse selection, the availability of PLI leaves weak patent holders' situation unchanged when $q \geq \underline{q}$, but it improves it when $q < \underline{q}$ – considering the patent holder and her insurer as a single entity– since it increases the settlement offer made by D from 0 to $c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$. It also improves strong patent holders' situation since it increases the settlement offer made by D from $c_{\alpha_H}(-\tilde{x}_{\alpha_H})$ to $c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$. This is because the availability of a patent litigation insurance provides P a credible threat to litigate. This in turn forces D to increase his settlement offer in order to avoid a trial.

This result highlights the potential benefits of a patent litigation insurance system. Firms who are currently forced to accept low settlement amounts or even to accommodate would obtain higher offers. This in turn potentially increases their incentives to invest in research and development without the fear of being infringed upon and not being compensated. However, despite the fact that there exists a potential market for patent litigation, it is very rarely used by firms. In the following section I show that when patent strength is the patent holder's private information, it may become impossible to have a market for insurance.

4 Asymmetric Information between P and D

In this section, the patent strength α is P 's private information. D and I only observe its distribution $(q, 1 - q)$. This creates a signaling game where D observes the strategy of P to buy an insurance or not, and may be able to infer the possible value of the patent strength. Therefore, the settlement offer is not contingent on the patent strength $\alpha \in \{\alpha_L, \alpha_H\}$ anymore, but instead on P 's insurance decision $\sigma \in \{0, 1\}$. Let us consider different possible equilibria: a separating equilibrium where only strong patent holders purchase an insurance – as it was the case under symmetric information–, a pooling equilibrium where all patent holders purchase an insurance, and a pooling equilibrium where no patent holder purchases an insurance.

4.1 Equilibrium Analysis

Let us first consider the situation where both types of patent holders make different insurance decisions. In that case, after observing P 's insurance strategy σ , D updates his beliefs and is able to perfectly infer the patent strength. The following lemma shows that this type of situation cannot arise in equilibrium.

Lemma 1.

With asymmetric information on the patent strength, there exists no separating equilibrium where both types of patent holders make different insurance decisions.

The intuition is the following. Let us consider a separating equilibrium where P_{α_H} buys an insurance and P_{α_L} does not. When facing an insured patent holder, D know that the patent is strong. If on the one hand the insurance coverage is too high to leave room for a settlement ($x > \hat{x}_{\alpha_H}$), the case goes to court. But since I is not making any profit on weak patent holders, it cannot compensate for the litigation costs it must cover while giving P_{α_H} an incentive to purchase insurance. If on the other hand the insurance coverage is low enough so that there is room for a settlement ($x \leq \hat{x}_{\alpha_H}$), D will make a high settlement offer $S(\sigma = 1) = c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$ so that it is accepted by P_{α_H} . But then there a premium which ensures that strong patent holders buy insurance will give weak patent holders an incentive to buy it as well, since by doing so they will be offered $S(\sigma = 1)$ instead of $S(\sigma = 0) = 0$ and will make a strictly higher profit. Therefore it is impossible to ensure that P_{α_H} will buy an insurance without P_{α_L} wanting to mimic her as well. This latter problem is also encountered by I if it tries to attract only weak patent holders (in a separating equilibrium where P_{α_L} buys an insurance and P_{α_H} does not), since D 's settlement offer to uninsured (supposedly strong) patent holders is $S(\sigma = 0) = -c_{\alpha_H}\tilde{x}_{\alpha_H}$, which attracts P_{α_L} .²⁹

Lemma 1 shows that with asymmetric information, weak patent holders prefer to mimic strong patent holders so that the insurance decision does not transmit any information on the patent strength to the D . We now turn to this type of situation, where both types of patent holder play the same insurance strategy. Let us consider a potential pooling equilibrium where the patent holder purchases an insurance whatever her patent strength. Note that off the equilibrium path, D 's strategy depends on his beliefs off the equilibrium path. Facing an uninsured patent holder, D may want to offer $S(\sigma = 0) = 0$ that would be accepted by weak patent holders (who accommodate) and rejected by strong patent holders (who go to court), or $S(\sigma = 0) = -c_{\alpha_H}\tilde{x}_{\alpha_H}$ that would be

²⁹Recall that $\tilde{x}_{\alpha_H} < 0$.

accepted by all patent holders. I restrict the analysis to the case where D prefers the former than the latter, so that P_{α_L} 's profit off the equilibrium path is the lowest possible (Π^d).³⁰ The reason is that if under these beliefs there are situations where the only equilibrium is a pooling “no insurance” equilibrium, different beliefs will only make that “no insurance” equilibrium more likely. On the equilibrium path, D 's settlement offer depends on the insurance coverage. The following lemma shows the conditions for this type of pooling equilibrium to exist, that depend on two threshold values for q : $\underline{q}$ and $\bar{q} = 1 - \frac{\hat{x}_{\alpha_H}}{\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}}$

Lemma 2.

With asymmetric information on the patent strength, there exists a pooling equilibrium where all patent holders purchase an insurance if and only if $q < \underline{q}$ or $q > \bar{q}$.

The intuition is the following. First, I has no interest in offering a coverage so large that there would be no room for a settlement even with P_{α_L} (i.e. if $x > \hat{x}_{\alpha_L}$), since it would lead to a trial in any case. Second, if I offers a coverage large enough so that there is room for settlement between P_{α_L} and D , but not between P_{α_H} and D , then it will have to bear trial costs for strong patent holders P_{α_H} . This is a profitable option for I as long as the proportion of strong patent holders is low enough ($q < \underline{q}$). Third, it is impossible for I to offer a coverage small enough for P_{α_L} to accommodate (accept $S = 0$), but too large to leave room for a settlement between D and P_{α_H} (i.e. if $\hat{x}_{\alpha_L} < x < \tilde{x}_{\alpha_L}$), since P_{α_L} would have no interest in purchasing the insurance and paying a premium to end up with the same profit Π^d as without insurance. Finally, if the coverage is small enough for P_{α_L} to accommodate, but also leaves room for a settlement between D and P_{α_H} (i.e. if $x \leq \hat{x}_{\alpha_H}$), then D has the choice between making a high settlement offer that will be accepted by all patent holders ($S(\sigma = 1) = c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$), and a low settlement offer that will be accepted only by weak patent holders ($S(\sigma = 1) = 0$). As before, P_{α_L} has no interest in purchasing the insurance if D prefers the latter. However, if the coverage is not too high ($x < q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}$) D prefers the former, which leaves a positive payoff to I (who has no trial cost to bear whatsoever). It is possible to have such a small coverage if and only if the proportion of strong patent holders is large enough, i.e. if $q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H} > 0 \Leftrightarrow q > \bar{q}$.³¹

These results are summarized in Proposition 2, that shows the possible equilibria.

Proposition 2.

With asymmetric information on the patent strength, the equilibrium depends on the proportion of strong

³⁰In other words, I restrict the analysis where D 's beliefs off the equilibrium path are $p = \text{prob}(\alpha = \alpha_H | \sigma = 0) < \bar{q}$.

³¹Recall that $\tilde{x}_{\alpha_H} \leq 0$.

patent holders q .

- For large values of q ($q > \bar{q}$), in equilibrium I offers an insurance contract $(\rho, x) = (c_{\alpha_H}[q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) + \tilde{x}_{\alpha_H}], q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) + \tilde{x}_{\alpha_H})$. All patent holders purchase that contract, D offers a settlement amount $S(\sigma = 1) = qc_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$, that is accepted by all patent holders.
- For small values of q ($q < \underline{q}$), in equilibrium I offers a contract $(\rho, x) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}), \hat{x}_{\alpha_L})$. All patent holders purchase that contract, D offers a settlement amount $S(\sigma = 1) = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$, that is accepted by weak patent holders and rejected by strong patent holders.³²
- For intermediate values of q ($\underline{q} \leq q \leq \bar{q}$), in equilibrium I offers a contract (ρ, x) such that $\rho > xc_{\alpha_H}$, and no patent holder buys an insurance. D offers a settlement amount $S(\sigma = 0) = 0$, which is accepted by P_{α_L} and rejected by P_{α_H} .³³

This result highlights the current issue concerning patent litigation insurance: when the proportion of strong patent holders is intermediate ($\underline{q} \leq q \leq \bar{q}$), insurers are unable to attract patent holders without losing money, which leads to a complete market failure. In that case, the availability of patent litigation insurance does not have any impact on patent holders' payoffs. This case may correspond to the current situation, as both in the US and Europe, only very expensive policies are presently provided by insurance companies, and firms do not purchase them arguing that premiums are too high compared to the coverage ($\rho > xc_{\alpha_H}$). Note that since I have assumed that the difference between α_H and α_L is relatively large (so that $\tilde{x}_{\alpha_L} \geq \hat{x}_{\alpha_H}$, the results suggests that the insurance market failure is likely to happen in industries where the variance in patent quality is high, but the mean quality of patents is intermediate.

Nonetheless, if we were in a situation where the proportion of strong patent holders is low ($q < \underline{q}$) or high ($q > \bar{q}$) the availability of insurance would have a potential positive impact, as it would have its economic value of a commitment device. Indeed, when $q > \bar{q}$, both weak and strong patent holders' profit (or their combined profit with the insurer) increases by $c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})(q - \bar{q})$.³⁴ Moreover, when $q < \underline{q}$, strong patent holders's situation (combined with insurers) is unchanged,

³²Note that when $q < \underline{q}$, there can also be a separating equilibrium "all insurance" where I offers a menu of policies: $(\rho_1, x_1) = ((c_{\alpha_L} - c_{\alpha_H})(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}), \tilde{x}_{\alpha_L})$, which is purchased by P_{α_H} and yields a settlement offer $S(\rho_1, x_1) = 0$ which is rejected, and $(\rho_2, x_2) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}), \hat{x}_{\alpha_L})$ which is chosen by P_{α_L} and yields a settlement offer $S(\rho_2, x_2) = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$ which is accepted. Settlement strategies and payoffs end up being exactly the same, so I is indifferent between offering a single contract or a menu of contracts.

³³ D 's beliefs off the equilibrium path in this equilibrium have no importance since they do not affect P_{α_H} 's deviation payoff.

³⁴If insurance is not available, D offers $S = -c_{\alpha_H}\tilde{x}_{\alpha_H}$ if $q > \bar{q}$ and $S = 0$ otherwise.

but weak patent holders benefit from the availability of insurance since it increases their profit (combined with the insurer) since they settle for a positive amount instead of accommodating.

The comparison with the benchmark of symmetric information shows that when $q < \underline{q}$ the pooling “all insurance” equilibrium remains – although strong patent holders go to trial instead of settling on a high amount –, but when $q \geq \underline{q}$ the insurer is not able to attract only strong patent holders anymore. This is because weak patent holders want to avoid transmitting information on their patent strength so they mimic strong patent holders. As a result the insurer must also attract weak patent holders if $q \geq \bar{q}$ – which benefits them at the expense of strong patent holders –, and must even renounce on attracting any patent holder if $\underline{q} \leq q \leq \bar{q}$. Therefore, only weak patent holders potentially benefit from information asymmetry.

Note that we could also look at a situation where patent holders hide the fact that they have purchased an insurance.³⁵ This might be a profitable strategy for weak patent holders when strong patent holders do not purchase insurance, as they might be offered a higher settlement amount than if they revealed they were insured (as they would then revealed their type by differentiating themselves from strong patent holders). However, if they were truly not insured, they would also benefit from the higher settlement amount and in addition they would avoid paying a premium to the insurer. Therefore, weak patent holders are better off not buying insurance than buying insurance and hiding it.

4.2 Comparative Statics

Let us first study how the rule of allocating legal costs affects the equilibrium outcome. Note that $\frac{d\bar{x}_\alpha}{d\gamma} > 0$ and $\frac{d\hat{x}_\alpha}{d\gamma} < 0$ if and only if $\alpha < 1/2$, where γ is the probability to have the English rule instead of the American rule. Therefore, the American rule favors settlement more than the English rule for relatively weak patents ($\alpha < 1/2$), and conversely for relatively strong patents ($\alpha > 1/2$).³⁶ The following corollary describes how the rule of allocating legal costs γ affects the equilibrium outcome, when $\alpha_H > 1/2$ – it seems reasonable to assume that strong patents win infringement cases at least 50% of the time.

Corollary 1.

As the rule of allocating legal costs moves from the American rule to the English rule (i.e. as γ increases):

³⁵I am assuming that an insured patent holder cant pretend she is not insured, but an uninsured patent holder cannot pretend she is insured, as the proof of insurance might be required.

³⁶Note that we have assumed $\alpha_L < \frac{c_P}{\Pi^m - \Pi^d}$ and $2c \leq \Pi^m - 2\Pi^d$, which implies $\alpha_L < 1/2$.

- Both $\underline{q}$ and $\bar{q}$ increase,
- The settlement offer made by the defendant to insured plaintiffs decreases when $q < \underline{q}$ and increases when $q > \bar{q}$,
- The expected profit of the strong patent holder (combined with the insurer) increases.³⁷

The intuition is the following. As the rule switches from American to English, the expected cost of going to trial increases for P_{α_H} and decreases for D , by the same amount. Therefore, the settlement amount that will be accepted by P_{α_H} increases, and so does the loss that D will incur if he offers a low settlement amount and thus goes to trial with a probability q . Since they both increase by the same amount, the minimum probability $\bar{q}$ such that D prefers to offer a high settlement amount must increase. The intuition is reversed when $q < \underline{q}$. Indeed, since the expected cost of going to trial increases for P_{α_L} , the settlement amount that she will be accept decreases. However the trial cost (that I must partially incur for strong patent holders) decreases as well, and that second effect dominates the first, so that I 's overall net expected payoff increases, and is positive even for a higher proportion of strong patent holders q . Therefore $\underline{q}$ increases as well. Overall, patent holders benefit from the English rule when the proportion of strong patents is relatively large ($q > \underline{q}$), and from the American rule otherwise (when $q < \underline{q}$). However, it is worth noting that although the use of insurance may be more prevalent under the American rule, the English rule favors strong patent holders' expected payoff, which in turn increases R&D efforts. This suggests that trying to make the insurance market more prevalent by changing the rule of allocating legal fees is not necessarily socially desirable.

The following corollary describes the impact of a change in trial costs (c) and in damages awarded to the patent holder in court when her patent is infringed (that can be represented by Π^m) on the equilibrium outcome.

Corollary 2.

A decrease in the trial cost c or an increase in damages Π^m leads to an increase in $\underline{q}$ and $\bar{q}$.

These results suggest that it might be possible to switch from a “no insurance” pooling equilibrium to an “all insurance” pooling equilibrium by either increasing c (decreasing Π^m) if q is close to $\bar{q}$, or decreasing c (increasing Π^m) otherwise. However this might not always have a positive impact on patent holders profits. For example, in the case where c decreases to $c' < c$ while $q \in [\underline{q}, \bar{q}]$,

³⁷Throughout the model, I consider the combined profit of the patent holder and the insurer. The reason is that the model studies the extreme case where the insurer extracts the premium from the patent holder, although in reality that premium – which is simply a transfer – may be less favorable to the insurer.

the strong patent holder's profit switches from her "no insurance" profit $\Pi^d - c_{\alpha_H} \tilde{x}_{\alpha_H}$ to her "all insurance" profit $\Pi^d + c'_{\alpha_H} (\hat{x}'_{\alpha_H} - \tilde{x}'_{\alpha_H})$. Her profit increases if and only if c' is close to c , but in that case $\underline{q}'$ is close to $\underline{q}$ so there is not much room to switch from one equilibrium to the other.

5 Possible solutions

In this section, I investigate some possible solutions to facilitate the existence of a market for patent litigation insurance which could benefit patent holders.

5.1 Mandatory Insurance

A solution that has been proposed in order to make patent litigation insurance more widespread is a mandatory insurance scheme.³⁸ The idea is that patent holders do not purchase insurance because premiums are currently too high, but a sufficiently widespread insurance scheme would lead to lower premiums and make insurance more attractive. The following proposition describes the impact of a mandatory insurance on the equilibrium.

Proposition 3.

Mandatory insurance has no impact on patent holders' profits (combined with the insurer). Moreover, it brings more cases to court under the English rule of allocating legal costs.

The intuition is the following. The situation is exactly the same as in the pooling equilibrium where all patent holders are insured, except that now since insurance is mandatory, their outside option is not to be uninsured, but to be out of the market and have zero profits. Insurance forces patent holders to purchase insurance even though they find it unprofitable. This gives more leverage to the insurer who is able to increase the premium. Therefore, making insurance mandatory just creates a transfer from patent holders to the insurer, without necessarily changing the settlement and litigation strategies. In particular, under the American rule, a mandatory scheme may make premiums more affordable, but it does not modify the settlement offers nor patent holders' profits. Moreover, under the English rule, although a mandatory scheme expands the use of insurance, it may also give I an incentive to offer a high coverage such that all patent holders reject D 's settlement offer and all cases go to court. Therefore, the increase in litigation may be a necessary evil to an expansion of the market for insurance.

³⁸In 2003, the European Commission called on CJA Consultants, Ltd. to study the feasibility of a mandatory insurance scheme. In 2006, CJA Consultants concluded that such a scheme was feasible. See footnote 4 for the reference.

5.2 Share of litigation proceeds

In this section I study a situation where in addition to receiving a premium ρ from an insured patent holder, the insurer obtains a share $1 - \beta$ of the litigation proceeds. Similarly to the premium previously, the share β is part of the contract that is being offered by I in the first stage, along with the premium ρ and the insurance coverage x . In litigation, when an insured P accepts D 's settlement offer, her profit is $\Pi^d + \beta S$, while I 's profit is $(1 - \beta)S$. When an insured P goes to trial, her expected profit is $\Pi^d + \beta\alpha(\Pi^m - \Pi^d) - c_\alpha(1 - x)$, while I 's profit is $(1 - \beta)\alpha(\Pi^m - \Pi^d) - c_\alpha x$. Now the thresholds below which P is willing to “accommodate” (i.e. settle for $S = 0$) and there is room for settlement are respectively $\tilde{x}'_\alpha = \beta\tilde{x}_\alpha + 1 - \beta$, and $\hat{x}'_\alpha = \beta\hat{x}_\alpha + 1 - \beta$.³⁹ The following proposition shows the effect of allowing I to obtain a share of litigation proceeds (compared to the situation with no share described in proposition 2).

Proposition 4.

Allowing I to obtain a share of litigation proceeds:

- *Results in a pooling “all insurance” $\forall q \in [0, 1]$,*
- *Has no impact on strong patent holders’ profit (combined with the insurer) but may improve weak patent holders’ profit (combined with the insurer).*

The intuition is the following. The insurer can decrease the premium and increase the insurance coverage, while being able to extract more rent from the patent holders, thanks to the share of litigation proceeds it now obtains. This additional leverage allows I to offer a contract such that only weak patent holders will settle on a positive amount, even when the proportion of strong patent holders (who go to court) is high. As a result, I is always able to make a positive payoff by attracting all patent holders with such a contract. These results suggest that allowing the insurer to get a share of litigation proceeds would not only make insurance more widespread, but also improve the situation of weak patent holders. However, it is worth noting that here I am not considering the objective of a social planner, which may be to improve R&D incentives. In that case, it is not clear whether an increase in weak patent holders’ profit is a good thing or not.⁴⁰

³⁹More precisely: $\tilde{x}'_\alpha = \frac{c_\alpha - \alpha\beta(\Pi^m - \Pi^d)}{c_\alpha}$, and $\hat{x}'_\alpha = \frac{\beta(2c - \alpha(\Pi^m - 2\Pi^d)) + c_\alpha(1 - \beta)}{c_\alpha}$.

⁴⁰Indeed, one might think of an model where an innovator makes an R&D effort that results in a strong patent if successful, and a weak patent otherwise. In that case an increase in weak patent holders’ profit decreases the R&D effort.

6 Conclusion

In this paper, I have analyzed the effects patent litigation insurance when a patent holder who has private information on her patent validity and enforceability can sue an infringer. Without information asymmetry between the patent holder and the infringer, insurance has commitment value for the patent holder: purchasing insurance makes litigation more credible, and therefore benefits the patent holder by increasing the settlement offer made by the infringer. However, with asymmetric information on the patent strength, the decision to buy an insurance conveys information about the patent strength to the infringer. As a result the holder of a weak patent may prefer not to buy an insurance rather than transmitting this information. Therefore, the only possible equilibrium is a pooling equilibrium where all patent holders make the same insurance decision, so that having insurance or not does not transmit any information on patent quality. In particular a pooling equilibrium “no insurance” can arise when the proportion of strong patent holders is intermediate. This main insight highlights the fact that despite the large consensus among patent attorneys concerning the usefulness of PLI, the market is still underdeveloped, and the policies offered by insurance companies remain very expensive policies.

The comparison between the American and the English rules of legal costs allocation shows that although the use of insurance may be more prevalent under the American rule, the English rule favors strong patent holders expected payoff, which in turn increases R&D efforts. This suggests that trying to make the insurance market more prevalent by changing the rule of allocating legal fees is not necessarily socially desirable. Similarly, a decrease in trial costs or an increase in damage awards may make the use of insurance more prevalent thanks to a decrease in trial costs c , it may be accompanied by a decrease in strong patent holders’ profits.

Given this situation, I analyze the impact of mandatory insurance. I show that it does not improve the situation of patent holders. Moreover, the downside of making the use of insurance more prevalent is that more cases go to court under the English rule. Allowing the insurer to obtain a share of litigation proceeds has the same effect of making insurance purchased by all patent holders (in a pooling “all insurance” equilibrium), but it improves the profit of weak patent holders without changing the profit of strong patent holders. Therefore this might be a more desirable solution. Other solution might be interesting to explore, like for example allowing the insurer to (partially) control the decision to accept the settlement offer or not.

7 Appendix

7.1 Proof of Proposition 1

I attracts all patent holders

Let us find the menu of insurance contracts that I offers if it wants to attract all patent holders. Let $(\bar{\rho}, \bar{x})$ be the contract aimed at P_{α_L} and $(\underline{\rho}, \underline{x})$ be the contract aimed at P_{α_H} . Since I wants the coverage to be such that D and P will settle on a positive amount, it must offer $\bar{x} \in [\hat{x}_{\alpha_L}, \hat{x}_{\alpha_L}]$ and $\underline{x} \in [0, \hat{x}_{\alpha_H}]$.

P_{α_H} 's individual rationality constraint is such that she is better off buying $(\underline{\rho}, \underline{x})$ rather than nothing: $\Pi^d + c_{\alpha_H}(\underline{x} - \hat{x}_{\alpha_H}) - \underline{\rho} \geq \Pi^d - c_{\alpha_H}\hat{x}_{\alpha_H} \Leftrightarrow \underline{\rho} \leq c_{\alpha_H}\underline{x}$. Moreover, P_{α_H} 's incentive compatibility constraint is such that she is better off buying $(\underline{\rho}, \underline{x})$ rather than $(\bar{\rho}, \bar{x})$: $\Pi^d + c_{\alpha_H}(\underline{x} - \hat{x}_{\alpha_H}) - \underline{\rho} \geq \Pi^d + c_{\alpha_H}(\bar{x} - \hat{x}_{\alpha_H}) - \bar{\rho} \Leftrightarrow \bar{\rho} - \underline{\rho} \geq c_{\alpha_H}(\bar{x} - \underline{x})$.

P_{α_L} 's individual rationality constraint is such that she is better off buying $(\bar{\rho}, \bar{x})$ rather than nothing: $\Pi^d + c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - \bar{\rho} \geq \Pi^d \Leftrightarrow \bar{\rho} \leq c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L})$. Moreover, P_{α_L} 's incentive compatibility constraint is such that she is better off buying $(\bar{\rho}, \bar{x})$ rather than $(\underline{\rho}, \underline{x})$: $\Pi^d + c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - \bar{\rho} \geq \Pi^d - \underline{\rho} \Leftrightarrow \bar{\rho} - \underline{\rho} \leq c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L})$. (If P_{α_L} buys $(\underline{\rho}, \underline{x})$, since $\underline{x} \leq \hat{x}_{\alpha_H} < \hat{x}_{\alpha_L}$, D offers P_{α_L} a settlement amount equal to 0). It is easy to check that P_{α_L} 's incentive compatibility constraint is not binding. Moreover, P_{α_L} 's individual rationality constraint and P_{α_H} 's incentive compatibility constraint together imply that we must have $\underline{\rho} \leq c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - c_{\alpha_H}(\bar{x} - \underline{x})$. Since we have assumed that $c_{\alpha_L}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_L}) < c_{\alpha_H}\hat{x}_{\alpha_L}$, it implies: $c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - c_{\alpha_H}(\bar{x} - \underline{x}) < c_{\alpha_H}\bar{x}$ (because the left hand side of this inequality is an increasing function of $\bar{x}$ and $\bar{x} \leq \hat{x}_{\alpha_L}$).

Therefore, I offers $\underline{\rho} = c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - c_{\alpha_H}(\bar{x} - \underline{x})$ and $\bar{\rho} = c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L})$. Its payoff is then equal to $q\underline{\rho} + (1-q)\bar{\rho} = c_{\alpha_L}(\bar{x} - \hat{x}_{\alpha_L}) - qc_{\alpha_H}(\bar{x} - \underline{x})$, which is an increasing function of $\underline{x}$ and $\bar{x}$, so I offers the following contracts: $(\underline{\rho}, \underline{x}) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_L}) - c_{\alpha_H}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_H}), \hat{x}_{\alpha_H})$ and $(\bar{\rho}, \bar{x}) = (c_{\alpha_L}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_L}), \hat{x}_{\alpha_L})$, and its resulting payoff is equal to $c_{\alpha_L}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_L}) - qc_{\alpha_H}(\hat{x}_{\alpha_L} - \hat{x}_{\alpha_H})$.

I attracts only strong patent holders

Let us find the insurance contract that I offers if it wants to attract only P_{α_H} . Let (ρ, x) be the contract aimed at P_{α_H} . Like before, the coverage must be such that $x \in [0, \hat{x}_{\alpha_H}]$. P_{α_H} buys the contract if and only if $\rho \leq c_{\alpha_H}x$, while P_{α_L} does not buy it if and only if $\rho > 0$ (this is because she gets offered $S = 0$ when she buys the insurance, since $x \leq \hat{x}_{\alpha_H} < \hat{x}_{\alpha_L}$). Therefore, I offers $\rho = c_{\alpha_H}x$, and its payoff is equal to $qc_{\alpha_H}x$, which is an increasing function of x , so it offers the maximum coverage $x = \hat{x}_{\alpha_H}$ and its resulting payoff is equal to $qc_{\alpha_H}\hat{x}_{\alpha_H}$.

I attracts only weak patent holders

Let us find the insurance contract that I offers if it wants to attract only P_{α_L} . Let (ρ, x) be the contract aimed at P_{α_H} . Like before, the coverage must be such that $x \in [\hat{x}_{\alpha_L}, \hat{x}_{\alpha_L}]$. P_{α_L} buys the contract if and only

if $\rho \leq c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$, while P_{α_H} does not buy it if and only if $\rho > \leq c_{\alpha_H}x$. However, these two inequalities are not compatible, since we have assumed that $c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}) < c_{\alpha_H}\hat{x}_{\alpha_L}$. Therefore, there is no profitable contract that attracts only weak patent holders.

Comparison

It is straightforward that I prefers to attract only strong patent holders rather than all patent holders if and only if $q > \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{c_{\alpha_H}\hat{x}_{\alpha_L}} = \underline{q}$.

7.2 Proof of Lemma 1

7.2.1 Separating equilibrium where only P_{α_H} buys an insurance

When facing an uninsured patent holder, D knows she is weak, so his settlement offer is $S(\sigma = 0) = 0$. When facing an insured patent holder, his settlement depends on the insurance coverage. On the one hand, if $x \leq \hat{x}_{\alpha_H}$ there is room for settlement, so D makes an offer $S(\sigma = 1) = c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$ which is accepted by P_{α_H} and I 's payoff is $q\rho$. On the other hand, if $x \geq \hat{x}_{\alpha_H}$, there is no room for a settlement, so D makes an offer $S(\sigma = 1) = 0$ and P_{α_H} rejects it and I 's payoff is $q(\rho - xc_{\alpha_H})$.

If $x \leq \hat{x}_{\alpha_H}$, the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$ and $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d$. If P_{α_H} deviates from her equilibrium strategy and plays $\sigma = 0$, she rejects $S(\sigma = 0) = 0$ and goes to trial so her deviation payoff is $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$. If P_{α_L} deviates from her equilibrium strategy and plays $\sigma = 1$, she accepts $S(\sigma = 1)$ and her deviation payoff is $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$. It is straightforward that we cannot have $\Pi_{\alpha_H}(\sigma = 1) > \Pi_{\alpha_H}(\sigma = 0)$ and $\Pi_{\alpha_L}(\sigma = 0) > \Pi_{\alpha_L}(\sigma = 1)$, since $\Pi_{\alpha_H}(\sigma = 1) = \Pi_{\alpha_L}(\sigma = 1)$ and $\Pi_{\alpha_H}(\sigma = 0) > \Pi_{\alpha_L}(\sigma = 0)$. Therefore, this separating equilibrium does not exist if $x \leq \hat{x}_{\alpha_H}$.

If on the opposite $x \geq \hat{x}_{\alpha_H}$, the patent holders' payoffs if they play their equilibrium strategies are the same as above. Like above, if P_{α_H} deviates from her equilibrium strategy and plays $\sigma = 0$, she rejects $S(\sigma = 0) = 0$ and goes to trial so her deviation payoff is $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$. If P_{α_L} deviates from her equilibrium strategy and plays $\sigma = 1$, she accepts $S(\sigma = 1) = 0$ and her deviation payoff is $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d - \rho$. Clearly, P_{α_L} has no incentive to deviate. However, P_{α_L} does not deviate if and only if $xc_{\alpha_H} - \rho > 0$ which implies that I 's payoff $q(\rho - xc_{\alpha_H})$ is negative. Therefore, this separating equilibrium does not exist if $x \geq \hat{x}_{\alpha_H}$.

7.2.2 Separating equilibrium where only P_{α_L} buys an insurance

When facing an uninsured patent holder, D knows she is strong, so his settlement offer is $S(\sigma = 0) = -c_{\alpha_H}\tilde{x}_{\alpha_H}$.⁴¹ When facing an insured patent holder, his settlement depends on the insurance coverage. On

⁴¹Recall that $\tilde{x}_{\alpha_H} < 0$.

the one hand, if $x \leq \tilde{x}_{\alpha_L}$, he knows that she will accept any settlement offer, so he offers $S(\sigma = 1) = 0$. On the other hand, if $x \geq \tilde{x}_{\alpha_L}$, the settlement offer has to be strictly positive such that it will be accepted by P_{α_L} . Therefore, D will make an offer $S(\sigma = 1) = c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$ or $S(\sigma = 1) = 0$, if there is room or not for settlement, respectively (i.e. if x is respectively lower or higher than $\hat{x}_{\alpha_L}$).

If $x \leq \tilde{x}_{\alpha_L}$, the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_L}\tilde{x}_{\alpha_L}$ and $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d - \rho$. If P_{α_H} deviates from her equilibrium strategy and plays $\sigma = 1$, she rejects $S(\sigma = 1) = 0$ and goes to trial so her deviation payoff is $\Pi_{\alpha_H}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$. If P_{α_L} deviates from her equilibrium strategy and plays $\sigma = 0$, she accepts $S(\sigma = 0)$ and her deviation payoff is $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$. It is straightforward that we cannot have $\Pi_{\alpha_H}(\sigma = 0) > \Pi_{\alpha_H}(\sigma = 1)$ and $\Pi_{\alpha_L}(\sigma = 1) > \Pi_{\alpha_L}(\sigma = 0)$, since $\Pi_{\alpha_H}(\sigma = 0) = \Pi_{\alpha_L}(\sigma = 0)$ and $\Pi_{\alpha_H}(\sigma = 1) > \Pi_{\alpha_L}(\sigma = 1)$. Therefore, this separating equilibrium does not exist if $x \leq \tilde{x}_{\alpha_L}$.

If on the opposite $x \geq \tilde{x}_{\alpha_L}$, the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$ and $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - \rho$ (her payoff is the same whether there is room or not for a settlement). Like above, if P_{α_H} deviates from her equilibrium strategy and plays $\sigma = 1$, she rejects $S(\sigma = 1)$ and goes to trial so her deviation payoff is $\Pi_{\alpha_H}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$. If P_{α_L} deviates from her equilibrium strategy and plays $\sigma = 0$, she accepts $S(\sigma = 0)$ and her deviation payoff is $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$. Like above, we cannot have $\Pi_{\alpha_H}(\sigma = 0) > \Pi_{\alpha_H}(\sigma = 1)$ and $\Pi_{\alpha_L}(\sigma = 1) > \Pi_{\alpha_L}(\sigma = 0)$, since $\Pi_{\alpha_H}(\sigma = 0) = \Pi_{\alpha_L}(\sigma = 0)$ and $\Pi_{\alpha_H}(\sigma = 1) > \Pi_{\alpha_L}(\sigma = 1)$. Therefore, this separating equilibrium does not exist if $x \geq \tilde{x}_{\alpha_L}$.

7.3 Proof of Lemma 2

$$x > \hat{x}_{\alpha_L}$$

Note that this situation is impossible under the American rule, where $\hat{x}_{\alpha_L} > 1$. D makes an offer $S(\sigma = 1) = 0$, that is rejected by all patent holders, so I 's expected payoff is equal to $\rho - qxc_{\alpha_H} - (1 - q)xc_{\alpha_L}$. For P_{α_H} to purchase the insurance we need to have $\rho < xc_{\alpha_H}$, which implies that I 's payoff is negative. Therefore there is no such pooling equilibrium if $x > \hat{x}_{\alpha_L}$.

$$\tilde{x}_{\alpha_L} < x < \min\{\hat{x}_{\alpha_L}, 1\}$$

D chooses to offer $S(\sigma = 1) = c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$ and $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - \rho$, while their deviation payoffs are $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$ and $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d$. Therefore, P_{α_H} does not deviate if $\rho < xc_{\alpha_H}$ and P_{α_L} does not deviate if $\rho < c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$.

Note that since we have assumed that $(c_{\alpha_L} - c_{\alpha_H})\hat{x}_{\alpha_L} \leq \tilde{x}_{\alpha_L}c_{\alpha_L}$, it implies $xc_{\alpha_H} \geq c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$. Therefore I offers $\rho = c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$ and its profit is equal to $c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - qxc_{\alpha_H}$. That profit is an increasing function of x , so I offers the maximum possible x : $x = \hat{x}_{\alpha_L}$, so its expected payoff is equal to $\hat{x}_{\alpha_L}(c_{\alpha_L} - qc_{\alpha_H}) - c_{\alpha_L}\tilde{x}_{\alpha_L}$,

which is positive if and only if $q \leq \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{\hat{x}_{\alpha_L} c_{\alpha_H}} = \underline{q}$. If that inequality is satisfied, there exists a pooling equilibrium where all patent holders purchase an insurance.

$$\hat{x}_{\alpha_H} < x < \tilde{x}_{\alpha_L}$$

Here D chooses to offer $S(\sigma = 1) = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, P_{α_L} 's profit is $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d - \rho$, which is lower than her profit if she deviates $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d$. Therefore, she has no incentive to buy an insurance, and the only possible equilibrium is an equilibrium where no patent holder purchases an insurance.

$$x < \hat{x}_{\alpha_H}$$

Here D has the choice between offering $S(\sigma = 1) = c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$, that will be accepted by all patent holders, and $S(\sigma = 1) = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . D prefers the latter if and only if $x > q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}$. In that case, P_{α_L} has no incentive to purchase an insurance and the only possible equilibrium is one where no patent holder buys an insurance. However, if $x \leq q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}$ - which is possible if and only if $q \geq 1 - \frac{\hat{x}}{\tilde{x} - \hat{x}}$ - then the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 1) = \Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$. The maximum premium I can offer is $\rho = xc_{\alpha_H}$. Its profit is equal to ρ , so I offers the maximum possible coverage x : $x = q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}$, and its expected payoff is equal to $c_{\alpha_H}[q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}]$, which is positive if and only if $q \geq 1 - \frac{\hat{x}_{\alpha_H}}{\tilde{x}_{\alpha_H} - \hat{x}_{\alpha_H}}$. Therefore, there exists a pooling equilibrium where all patent holders purchase an insurance if and only if $q \geq \bar{q}$.

To sum up, the only possible equilibrium is a pooling "all insurance" equilibrium when $q \leq \underline{q}$, or $q \geq \bar{q}$. Otherwise the only possible equilibrium is a pooling "no insurance" equilibrium. Note that $\underline{q} = \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{\hat{x}_{\alpha_L} c_{\alpha_H}} < \bar{q} = 1 - \frac{\hat{x}_{\alpha_H}}{\tilde{x}_{\alpha_H} - \hat{x}_{\alpha_H}}$ iff α_L is relatively low and/or α_H is relatively high.

7.4 Proof of Proposition 2

Follows directly from text.

7.5 Proof of Corollary 1

7.5.1 Proof that $\frac{d\bar{q}}{d\gamma} > 0$ if $\alpha_H > 1/2$

$\frac{d\bar{q}}{d\gamma}$ is of the sign of $\frac{d\hat{x}_{\alpha_H}}{d\gamma} \tilde{x}_{\alpha_H} - \frac{d\tilde{x}_{\alpha_H}}{d\gamma} \hat{x}_{\alpha_H} = -\frac{dc_{\alpha_H}}{d\gamma} \frac{2c - \alpha_H(\Pi^m - 2\Pi^d)}{c_{\alpha_H}^2}$. Since $\frac{dc_{\alpha_H}}{d\gamma} = c(1 - 2\alpha_H)$, it yields $\frac{d\bar{q}}{d\gamma} > 0$ if and only if $\alpha_H > 1/2$

7.5.2 Proof that $\frac{dq}{d\gamma} > 0$ if $\alpha_H > 1/2$

$\frac{dq}{d\gamma}$ is of the sign of $\hat{x}_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})\frac{d(c_{\alpha_L} - c_{\alpha_H})}{d\gamma} + c_{\alpha_H}(\tilde{x}_{\alpha_L}\frac{d\hat{x}_{\alpha_L}}{d\gamma} - \hat{x}_{\alpha_L}\frac{d\tilde{x}_{\alpha_L}}{d\gamma}) = f(\gamma)$. We can rewrite $f(\gamma)$ as $f(\gamma) = \frac{c}{c_{\alpha_L}}[2c_{\alpha_L}(\alpha_H - \alpha_L)(2c + \alpha_L\Pi^d - c_{\alpha_L}) + c_{\alpha_H}(1 - 2\alpha_L)(c_{\alpha_L} - 2\alpha_L(\Pi^m - \Pi^d))] = \frac{c}{c_{\alpha_L}}g(\gamma)$. Moreover, $g'(\gamma) = 2c(1 - 2\alpha_L)[(\alpha_H - \alpha_L)(2c + \alpha_L\Pi^d - c_{\alpha_L}) + (1 - 2\alpha_H)(c_{\alpha_L} - \alpha_L(\Pi^m - \Pi^d)) + \alpha_L(c_{\alpha_L} - c_{\alpha_H})]$. The expression inside the brackets is an increasing function of γ (its derivative is $1 - \alpha_H - 3\alpha_L + 4\alpha_H\alpha_L$), and it is equal to $c(1 - \alpha_H - \alpha_L) + \alpha_L((\alpha_H - \alpha_L)\Pi^d - (1 - 2\alpha_H)(\Pi^m - \Pi^d))$ when $\gamma = 0$, which is positive. Therefore, $g'(\gamma) > 0$. When $\gamma = 0$, $g(\gamma) = c[2(\alpha_H - \alpha_L)(c + \alpha_L\Pi^d) + (1 - 2\alpha_L)(c_{\alpha_L} - \alpha_L(\Pi^m - \Pi^d))]$. The expression in brackets is an increasing function of α_H , and positive when $\alpha_H = 1/2$, so $g(\gamma) > 0$, which implies that $\frac{dq}{d\gamma} > 0$.

7.5.3 Proof that $\frac{dS(\sigma=1)}{d\gamma} > 0$ when $q > \bar{q}$ if $\alpha_H > 1/2$

$S(\sigma = 1) = c_{\alpha_H}((q\hat{x}_{\alpha_H} + (1 - q)\tilde{x}_{\alpha_H}) - \tilde{x}_{\alpha_H}) = c_{\alpha_H}q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) = q[(2c - \alpha_H(\Pi^m - 2\Pi^d)) - (c_{\alpha_H} - \alpha_H(\Pi^m - \Pi^d))] = q[2c + \alpha_H\Pi^d - c_{\alpha_H}]$. If $\alpha_H > 1/2$, $\frac{dc_{\alpha_H}}{d\gamma} = c(1 - 2\alpha_H) < 0$. Therefore, $\frac{dS(\sigma=1)}{d\gamma} > 0$.

7.5.4 Proof that $\frac{dS(\sigma=1)}{d\gamma} < 0$ when $q < \underline{q}$

$S(\sigma = 1) = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L}) = 2c + \alpha_L\Pi^d - c_{\alpha_L}$. It follows that $\frac{dS(\sigma=1)}{d\gamma} = -\frac{dc_{\alpha_L}}{d\gamma} = -c(1 - 2\alpha_L)$, which is negative since $\alpha_L < 1/2$.

7.5.5 Proof that the expected combined profit of the strong patent holder and insurer increases with γ

Let $\bar{q}_A$ and $\bar{q}_E$, and $\underline{q}_A$ and $\underline{q}_E$ be the values of $\bar{q}$ and $\underline{q}$ with the American rule and the English rule, respectively, with $\bar{q}_A < \bar{q}_E$, and $\underline{q}_A < \underline{q}_E$.

The expected profit of the strong patent holder and the insurer is equal to $\Pi^d + \int_0^{\bar{q}} [c_{\alpha_H}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_H})]f(q)dq + \int_{\underline{q}}^{\bar{q}} [-c_{\alpha_H}\tilde{x}_{\alpha_H}]f(q)dq + \int_{\underline{q}}^1 [qc_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})]f(q)dq$. Under the American rule, this expression is equal to $\Pi^d + \int_0^{\bar{q}_A} [c - \alpha_L(\Pi^m - 2\Pi^d) + \alpha_H(\Pi^m - \Pi^d)]f(q)dq + \int_{\underline{q}_A}^{\bar{q}_A} [\alpha_H(\Pi^m - \Pi^d) - c]f(q)dq + \int_{\bar{q}_A}^1 [\alpha_H\Pi^d + c]f(q)dq$. After simplifying, this expression is equal to $F(\underline{q}_A)[2c - \alpha_L(\Pi^m - 2\Pi^d)] + F(\bar{q}_A)[\alpha_H(\Pi^m - \Pi^d) - c] + [\alpha_H\Pi^d + c] \int_{\bar{q}_A}^1 qf(q)dq$.

Under the English rule, this expression is equal to $\Pi^d + \int_0^{\bar{q}_E} [-\alpha_L(\Pi^m - 2\Pi^d) + \alpha_H(\Pi^m - \Pi^d + 2c)]f(q)dq + \int_{\underline{q}_E}^{\bar{q}_E} [\alpha_H(\Pi^m - \Pi^d + 2c) - 2c]f(q)dq + \int_{\bar{q}_E}^1 \alpha_H(\Pi^d + 2c)f(q)dq$. After simplifying, this expression is equal to $F(\underline{q}_E)[2c - \alpha_L(\Pi^m - 2\Pi^d)] + F(\bar{q}_E)[\alpha_H(\Pi^m - \Pi^d + 2c) - 2c] + \alpha_H(\Pi^d + 2c) \int_{\bar{q}_E}^1 qf(q)dq$.

Since $\underline{q}_E > \underline{q}_A$, $F(\underline{q}_E) > F(\underline{q}_A)$. Therefore, $F(\underline{q}_E)[2c - \alpha_L(\Pi^m - 2\Pi^d)] > F(\underline{q}_A)[2c - \alpha_L(\Pi^m - 2\Pi^d)]$. Moreover, since $\bar{q}_E > \bar{q}_A$, $F(\bar{q}_E) > F(\bar{q}_A)$, and since $\alpha_H > 1/2$, $[\alpha_H(\Pi^m - \Pi^d + 2c) - 2c] > [\alpha_H(\Pi^m - \Pi^d) - c]$. Therefore, $F(\bar{q}_E)[\alpha_H(\Pi^m - \Pi^d + 2c) - 2c] > F(\bar{q}_A)[\alpha_H(\Pi^m - \Pi^d) - c]$. Finally, since $\alpha_H > 1/2$, $\alpha_H(\Pi^d + 2c) > [\alpha_H\Pi^d + c]$, and since $\bar{q}_E > \bar{q}_A$, $\int_{\bar{q}_E}^1 qf(q)dq > \int_{\bar{q}_A}^1 qf(q)dq$. Therefore, $\alpha_H(\Pi^d + 2c) \int_{\bar{q}_E}^1 qf(q)dq > [\alpha_H\Pi^d + c] \int_{\bar{q}_A}^1 qf(q)dq$.

$[\alpha_H \Pi^d + c] \int_{\bar{q}_A}^1 q f(q) dq$. As a result, the expected payoff of the strong patent holder combined with the infringer increases as we switch from the American rule to the English rule.

7.6 Proof of Corollary 2

7.6.1 Proof that $\frac{d\bar{q}}{dc} < 0$ and $\frac{d\bar{q}}{d\Pi^m} > 0$

$\bar{q} = 1 - \frac{\hat{x}_{\alpha_H}}{\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}} = \frac{\alpha_H(\Pi^m - \Pi^d) - c_{\alpha_H}}{2c + \alpha_H \Pi^d + c_{\alpha_H}}$. Therefore, $\frac{d\bar{q}}{dc}$ is of the sign of $-\frac{dc_{\alpha_H}}{dc} [2c - \alpha_H(\Pi^m - 2\Pi^d)] < 0$. Moreover, it is straightforward that $\frac{d\bar{q}}{d\Pi^m} > 0$.

7.6.2 Proof that $\frac{dq}{dc} < 0$ and $\frac{dq}{d\Pi^m} > 0$

$\underline{q} = \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{c_{\alpha_H} \hat{x}_{\alpha_L}}$. Under the American rule, $\underline{q} = \frac{\alpha_L(\Pi^m - \Pi^d)}{c}$, and under the English rule, $\underline{q} = \frac{(1 - \alpha_L)\alpha_L(\Pi^d + 2c)}{(1 - \alpha_H)(2c - \alpha_L(\Pi^m - 2\Pi^d))}$. It is straightforward that $\frac{dq}{dc} < 0$ and $\frac{dq}{d\Pi^m} > 0$ in both cases.

7.7 Proof of Proposition 3

7.7.1 $x > \hat{x}_{\alpha_L}$

Note that this is only possible under the English rule. D makes an offer $S = 0$, which is rejected by all patent holders, so P_{α_L} 's payoff is $\Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - \rho$ and P_{α_H} 's payoff is $\Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$. Therefore, if $x(c_{\alpha_L} - c_{\alpha_H}) < c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}$, I offers $\rho = \Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$, so its payoff is $\Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - qc_{\alpha_H}x - (1 - q)c_{\alpha_L}x$, which is an increasing function of x , so I offers the maximum coverage $x = \frac{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_L} - c_{\alpha_H}}$. If on the opposite $x(c_{\alpha_L} - c_{\alpha_H}) \geq c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}$, I offers $\rho = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$, so its payoff is $\Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - qc_{\alpha_H}x - (1 - q)c_{\alpha_L}x$, which is a decreasing function of x , so I offers the minimum coverage $x = \frac{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_L} - c_{\alpha_H}}$. Therefore both cases are equivalent and yield the same premium $\rho = \Pi^d + \frac{c_{\alpha_L}c_{\alpha_H}(\tilde{x}_{\alpha_L} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}}$. The resulting payoff for I is equal to $\Pi^d - c_{\alpha_L}\tilde{x}_{\alpha_L} + q(c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H})$.

7.7.2 $\tilde{x}_{\alpha_L} < x < \min\{\hat{x}_{\alpha_L}, 1\}$

D offers $S = c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, P_{α_L} 's payoff (which is lower than the payoff of P_{α_H}) is $\Pi_{\alpha_L} = \Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - \rho$, so I offers $\rho = \Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L})$. I 's profit is $\Pi^d + c_{\alpha_L}(x - \tilde{x}_{\alpha_L}) - qxc_{\alpha_H}$, which is an increasing function of x , so I offers the maximum possible x : $x = \min\{\hat{x}_{\alpha_L}, 1\}$, and its expected payoff is equal to $\Pi^d + \min\{\hat{x}_{\alpha_L}, 1\}(c_{\alpha_L} - qc_{\alpha_H}) - c_{\alpha_L}\tilde{x}_{\alpha_L}$.

7.7.3 $\hat{x}_{\alpha_H} < x < \tilde{x}_{\alpha_L}$

Here D chooses to offer $S = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, P_{α_L} 's profit is $\Pi^d - \rho$, so I offers $\rho = \Pi^d$. I 's profit is $\Pi^d - qxc_{\alpha_H}$, which is a decreasing function of x , so I offers the minimum possible x : $x = \hat{x}_{\alpha_L}$, and its expected payoff is equal to $\Pi^d - q\hat{x}_{\alpha_L}c_{\alpha_H}$.

7.7.4 $x < \hat{x}_{\alpha_H}$

If $x > q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$, D offers $S = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . In that case, P_{α_L} 's profit is $\Pi^d - \rho$, so I offers $\rho = \Pi^d$. I 's profit is $\Pi^d - qx c_{\alpha_H}$, which is a decreasing function of x , so I offers the minimum possible x , which is $x = q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$ iff $q > \bar{q}$, and $x = 0$ otherwise. Therefore, if $q > \bar{q}$, I offers $x = q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$ and its payoff is $\Pi^d - qc_{\alpha_H}[q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}]$. If on the contrary $q \leq \bar{q}$, I offers $x = 0$ and its payoff is Π^d .

If $x \leq q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$ (which is possible if and only if $q > \bar{q}$), D offers $S = c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$, that will be accepted by all patent holders. In that case, all patent holders' profit is $\Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H}) - \rho$, so I offers $\rho = \Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$ and its payoff is $\Pi^d + c_{\alpha_H}(x - \tilde{x}_{\alpha_H})$, which is an increasing function of x , so I offers the maximum x : $x = q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$, and its payoff is $\Pi^d + qc_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$.

It is easy to check that when $q > \bar{q}$, I prefers to offer $x = q\hat{x}_{\alpha_H} + (1-q)\tilde{x}_{\alpha_H}$, so its payoff is $\Pi^d + qc_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$. When $q \leq \bar{q}$, I offers $x = 0$ and its payoff is Π^d .

It is straightforward that (7.7.3) is a dominated strategy for I .

Under the English rule, I 's payoff is higher in (7.7.2) than in (7.7.4) if and only if $q < \frac{c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}{c_{\alpha_H}\tilde{x}_{\alpha_L}} = \underline{q}_E$. Therefore:

- If $q \leq \underline{q}_E$, I chooses either 7.7.2 (which yields a settlement offer $S = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$), or 7.7.1 (which yields a settlement offer $S = 0$).⁴²
- If $\underline{q}_E < q \leq \bar{q}_E$, I chooses either 7.7.4 or 7.7.1 (and both yield a settlement offer $S = 0$).⁴³
- If $\bar{q}_E < q$, I chooses 7.7.4, which yields a settlement offer $S = c_{\alpha_H}q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$.

The comparison with the case where insurance is not mandatory (Proposition 2) shows that mandatory insurance does not change the profit of patent holders. Moreover, it may bring more cases to court if I chooses 7.7.1, which is possible if only if $\frac{c_{\alpha_L}\hat{x}_{\alpha_L}}{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H} + c_{\alpha_H}\hat{x}_{\alpha_L}} < q < \underline{q}$, or $\frac{c_{\alpha_L}\tilde{x}_{\alpha_L}}{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}} < q < \bar{q}$.

Under the American rule, (7.7.1) is impossible. Moreover, I 's payoff is higher in (7.7.2) than in (7.7.4) if and only if $q < \frac{\alpha_L(\Pi^m - \Pi^d)}{c} = \underline{q}_A$. Therefore:

- If $q \leq \underline{q}_A$, I chooses 7.7.2 (which yields a settlement offer $S = c_{\alpha_L}(1 - \tilde{x}_{\alpha_L})$)
- If $\underline{q}_A < q \leq \bar{q}_A$, I chooses 7.7.4 (which yields a settlement offer $S = 0$)
- If $\bar{q}_A < q$, I chooses 7.7.4 which yields a settlement offer $S = c_{\alpha_H}q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$.

The comparison with the case where insurance is not mandatory (Proposition 2) shows that mandatory insurance does not change the profit of patent holders (and the settlement strategies do not change).

⁴² I prefers 7.7.2 to 7.7.1 if and only if $q < \frac{c_{\alpha_L}\hat{x}_{\alpha_L}}{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H} + c_{\alpha_H}\hat{x}_{\alpha_L}}$.

⁴³ I prefers 7.7.4 to 7.7.1 if and only if $q < \frac{c_{\alpha_L}\tilde{x}_{\alpha_L}}{c_{\alpha_L}\tilde{x}_{\alpha_L} - c_{\alpha_H}\tilde{x}_{\alpha_H}}$.

7.8 Proof of Proposition 4

7.8.1 Separating Equilibria

First let us consider a separating equilibrium where only weak patent holders purchase insurance. When facing an uninsured patent holder, D knows she is strong, so his settlement offer is $S(\sigma = 0) = -c_{\alpha_H} \tilde{x}_{\alpha_H}$.⁴⁴ When facing an insured patent holder, his settlement depends on the insurance coverage. First, if $x \leq \hat{x}'_{\alpha_L}$, he knows that she will accept any settlement offer, so he offers $S(\sigma = 1) = 0$. Second, if $\hat{x}'_{\alpha_L} < x \leq \hat{x}'_{\alpha_L}$, D will make an offer $S(\sigma = 1) = \frac{c_{\alpha_L}}{\beta}(x - \hat{x}'_{\alpha_L})$. Third, if $\hat{x}'_{\alpha_L} \leq x$, D makes an offer $S(\sigma = 1) = 0$ that is rejected by P_{α_L} . In the first case P_{α_L} 's payoff is $\Pi^d - \rho$, while in the two other cases her payoff is $\Pi^d + c_{\alpha_L}(x - \hat{x}'_{\alpha_L}) - \rho$. Moreover, P_{α_H} 's payoff is $\Pi^d - c_{\alpha_H} \tilde{x}_{\alpha_H}$. Their deviation payoffs are $\Pi^d - c_{\alpha_H} \tilde{x}_{\alpha_H}$ for P_{α_L} and $\Pi^d + c_{\alpha_H}(x - \hat{x}'_{\alpha_H}) - \rho$ for P_{α_H} . Clearly, there is no contract such that P_{α_H} does not buy it and P_{α_L} does.

Second, let us consider a separating equilibrium where only strong patent holders purchase insurance. When facing an uninsured patent holder, D knows she is weak, so his settlement offer is $S(\sigma = 0) = 0$ and P_{α_L} 's profit is Π^d . When facing an insured patent holder, D 's settlement depends on the insurance coverage.

First, if $x \leq \hat{x}'_{\alpha_H}$, he offers $S(\sigma = 1) = 0$ which is accepted. Therefore P_{α_H} 's profit is $\Pi^d - \rho$, which is lower than her deviation profit $\Pi^d - c_{\alpha_H} \tilde{x}'_{\alpha_H}$. Therefore there is no such equilibrium when $x \leq \hat{x}'_{\alpha_H}$.

Second, if $\hat{x}'_{\alpha_H} < x \leq \hat{x}'_{\alpha_H}$, D offers $S(\sigma = 1) = \frac{c_{\alpha_H}}{\beta}(x - \hat{x}'_{\alpha_H})$, which is accepted. Therefore, P_{α_H} 's profit is $\Pi^d + c_{\alpha_H}(x - \hat{x}'_{\alpha_H}) - \rho$, which is also P_{α_L} 's deviation profit. Clearly there is no contract such that P_{α_H} buys it but P_{α_L} does not, so there is no such equilibrium when $\hat{x}'_{\alpha_H} < x \leq \hat{x}'_{\alpha_H}$.

Third, if $\hat{x}'_{\alpha_H} \leq x$, D offers $S(\sigma = 1) = 0$, which is rejected by P_{α_H} . Therefore, I 's payoff is $\rho + qc_{\alpha_H}[\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H} - x]$. A contract such that P_{α_H} 's profit is higher than her deviation profit implies that I 's payoff is negative. Therefore, there is no such equilibrium when $\hat{x}'_{\alpha_H} \leq x$.

7.8.2 Pooling Equilibria

As before, since my objective is to make the existence of the pooling equilibrium “all insurance” most likely, I restrict the analysis to the case where P_{α_L} 's profit off the equilibrium path is the lowest possible (Π^d).

7.8.3 $x > \hat{x}'_{\alpha_L}$

Note that this situation is impossible under the American rule, where $\hat{x}'_{\alpha_L} > 1$. D makes an offer $S(\sigma = 1) = 0$, that is rejected by all patent holders. Similarly to Proposition 2, a contract that gives P_{α_H} and P_{α_L} an incentive to purchase the insurance implies that I 's payoff is negative. Therefore there is no pooling equilibrium if $x > \hat{x}'_{\alpha_L}$.

⁴⁴Recall that $\tilde{x}_{\alpha_H} < 0$.

7.8.4 $\hat{x}'_{\alpha_L} < x < \min\{\hat{x}'_{\alpha_L}, 1\}$

D chooses to offer $S(\sigma = 1) = \frac{c_{\alpha_L}}{\beta}(x - \hat{x}'_{\alpha_L})$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, the patent holders' payoffs if they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \hat{x}'_{\alpha_H}) - \rho$ and $\Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_L}(x - \hat{x}'_{\alpha_L}) - \rho$, while their deviation payoffs are $\Pi_{\alpha_H}(\sigma = 0) = \Pi^d - c_{\alpha_H}\tilde{x}_{\alpha_H}$ and $\Pi_{\alpha_L}(\sigma = 0) = \Pi^d$. Therefore, P_{α_H} does not deviate if $\rho < c_{\alpha_H}(x - \hat{x}'_{\alpha_H} + \tilde{x}_{\alpha_H})$, and P_{α_L} does not deviate if $\rho < c_{\alpha_L}(x - \hat{x}'_{\alpha_L})$. Note that $c_{\alpha_H}(x - \hat{x}'_{\alpha_H} + \tilde{x}_{\alpha_H}) > c_{\alpha_L}(x - \hat{x}'_{\alpha_L})$ if and only if $x < \frac{c_{\alpha_L}\hat{x}'_{\alpha_L} - c_{\alpha_H}(\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}}$.

If $x < \frac{c_{\alpha_L}\hat{x}'_{\alpha_L} - c_{\alpha_H}(\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}}$, I offers $\rho = c_{\alpha_L}(x - \hat{x}'_{\alpha_L})$, so its payoff is equal to $c_{\alpha_L}(x - \hat{x}'_{\alpha_L})(1 + (1 - q)\frac{1-\beta}{\beta}) - qc_{\alpha_H}(x - \hat{x}'_{\alpha_H} + \tilde{x}_{\alpha_H})$, which is an increasing function of x . Therefore, I offers the minimum coverage $x = \min\{\frac{c_{\alpha_L}\hat{x}'_{\alpha_L} - c_{\alpha_H}(\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}}, \hat{x}'_{\alpha_L}\}$. Note that $\frac{c_{\alpha_L}\hat{x}'_{\alpha_L} - c_{\alpha_H}(\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}} < \hat{x}'_{\alpha_L}$ if and only if $\beta < \frac{-c_{\alpha_L}\tilde{x}_{\alpha_L}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$. In that case, I 's payoff becomes equal to $\frac{1-q}{\beta} \frac{c_{\alpha_L}c_{\alpha_H}}{c_{\alpha_L} - c_{\alpha_H}}(\beta\tilde{x}_{\alpha_L} + (1-\beta)\tilde{x}_{\alpha_H})$, which is an increasing function of β , so I offers $\beta = \frac{-c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, which yields a payoff equal to $(1-q)c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$ for I . In the other case, I 's payoff becomes equal to $c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})(1 - q(1 - \beta)) - qc_{\alpha_H}(\beta\hat{x}_{\alpha_L} + (1 - \beta)\tilde{x}_{\alpha_H})$, which is a decreasing function of β , so I offers $\beta = \frac{-c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, which yields a payoff equal to $(1-q)c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$ for I .

If $x \geq \frac{c_{\alpha_L}\hat{x}'_{\alpha_L} - c_{\alpha_H}(\hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H})}{c_{\alpha_L} - c_{\alpha_H}}$, I offers $\rho = c_{\alpha_H}(x - \hat{x}'_{\alpha_H} + \tilde{x}_{\alpha_H})$, so its payoff is equal to $(1-q)[c_{\alpha_H}(x - \hat{x}'_{\alpha_H} + \tilde{x}_{\alpha_H}) + \frac{1-\beta}{\beta}c_{\alpha_L}(x - \hat{x}'_{\alpha_L})]$, which is an increasing function of x . Therefore, I offers the maximum coverage $x = \hat{x}'_{\alpha_L}$, and its resulting payoff is equal to $(1-q)[c_{\alpha_H}(\beta\hat{x}_{\alpha_L} + (1-\beta)\tilde{x}_{\alpha_H}) + (1-\beta)c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})]$, which is an increasing function of β , so I offers $\beta = \frac{-c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, which yields a payoff equal to $(1-q)c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$ for I .

Therefore, there exists a pooling "all insurance" equilibrium where I offers $\beta_1^{share} = \frac{-c_{\alpha_H}\tilde{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, $x_1^{share} = \hat{x}_{\alpha_L} + (1 - \hat{x}_{\alpha_L})(1 - \beta_1^{share})$ and $\rho_1^{share} = \beta_1^{share}c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$. The resulting settlement offer D makes to insured patent holders is $S_1^{share}(\sigma = 1) = c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})$.

7.8.5 $\hat{x}'_{\alpha_H} < x \leq \tilde{x}'_{\alpha_L}$

Here D chooses to offer $S = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . Therefore, P_{α_L} 's profit is $\Pi^d - \rho$, while her deviation payoff Π^d , so there is no possible situation where P_{α_L} wants to buy insurance while I makes a positive profit. Therefore, there is no pooling equilibrium "all insurance" when $x > \hat{x}'_{\alpha_H}$.

7.8.6 $\tilde{x}'_{\alpha_H} < x \leq \hat{x}'_{\alpha_H}$

Here D has the choice between offering $S(\sigma = 1) = \frac{c_{\alpha_H}}{\beta}(x - \hat{x}'_{\alpha_H})$, that will be accepted by all patent holders, and $S(\sigma = 1) = 0$, that will be accepted by P_{α_L} and rejected by P_{α_H} . D prefers the latter if and only if $x > q\hat{x}'_{\alpha_H} + (1-q)\tilde{x}'_{\alpha_H}$. In that case, P_{α_L} has no incentive to purchase an insurance and the only possible equilibrium is one where no patent holder buys an insurance. However, if $x \leq q\hat{x}'_{\alpha_H} + (1-q)\tilde{x}'_{\alpha_H}$ - which is possible if and only if $q \geq \frac{\bar{q}}{\beta} \Leftrightarrow \beta \geq \frac{\bar{q}}{q}$, which requires that $q \geq \bar{q}$ - then the patent holders' payoffs if

they play their equilibrium strategies are $\Pi_{\alpha_H}(\sigma = 1) = \Pi_{\alpha_L}(\sigma = 1) = \Pi^d + c_{\alpha_H}(x - \hat{x}'_{\alpha_H})$. P_{α_H} (who has the highest deviation payoff) does not deviate if and only if $x > \hat{x}'_{\alpha_H} - \tilde{x}_{\alpha_H} = (1 - \beta)(1 - \tilde{x}_{\alpha_H})$. I 's profit is equal to $(1 - \beta)\frac{c_{\alpha_H}}{\beta}(x - \hat{x}'_{\alpha_H})$, which is an increasing function of x , so I offers the maximum coverage: $x = q\hat{x}'_{\alpha_H} + (1 - q)\tilde{x}'_{\alpha_H}$, and its payoff becomes $(1 - \beta)c_{\alpha_H}q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$, which is a decreasing function of β .

Therefore, if $q \geq \bar{q}$, there exists a pooling "all insurance" equilibrium where I offers $\beta_2^{share} = \frac{\bar{q}}{q}$, $x_2^{share} = (1 - \beta_2^{share})(1 - \tilde{x}_{\alpha_H})$ and $\rho_2^{share} = 0$. The resulting settlement offer D makes to insured patent holders is $S_2^{share}(\sigma = 1) = c_{\alpha_H}q(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H})$.

7.8.7 $x \leq \hat{x}'_{\alpha_H}$

Here D offers $S = 0$, which is accepted by all patent holders. Therefore, P_{α_H} 's payoff is $\Pi^d - \rho$, which is lower than her deviation payoff. Therefore there is no pooling equilibrium "all insurance".

To sum up, when $q < \bar{q}$, the only possible equilibrium 7.8.4. Compared to proposition 2, the settlement offer and the combined profits of patent holder and insurer are the same when $q < \underline{q}$, and the settlement offer and the combined profits of the weak patent holder and insurer are higher when $\underline{q} \leq q < \bar{q}$, while the combined profits of the strong patent holder and the insurer remain the same. When $q \geq \bar{q}$, I has the choice between 7.8.4 and 7.8.6. In that case I prefers 7.8.4 if and only if $q > 1 - \frac{c_{\alpha_H}\hat{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, which implies that $S_1^{share}(\sigma = 1) > S_2^{share}(\sigma = 1)$. Therefore, compared to proposition 2, the settlement offer and the combined profits of patent holder and insurer are the same when $\bar{q} \geq q < 1 - \frac{c_{\alpha_H}\hat{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})}$, and the settlement offer and the combined profits of the weak patent holder and insurer are higher when $1 - \frac{c_{\alpha_H}\hat{x}_{\alpha_H}}{c_{\alpha_H}(\hat{x}_{\alpha_H} - \tilde{x}_{\alpha_H}) - c_{\alpha_L}(\hat{x}_{\alpha_L} - \tilde{x}_{\alpha_L})} \leq q$, while the combined profits of the strong patent holder and the insurer remain the same.

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