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Signaling, Learning and Screening Prior to Trial: Informational Implications of Preliminary Injunctions

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ECONOMIC ANALYSIS GROUP DISCUSSION PAPER

Signaling, Learning and Screening Prior to Trial: Informational Implications of Preliminary Injunctions*

by
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Abstract

The decision to request a preliminary injunction—a court order that bans a party from certain actions until their lawfulness are ascertained in a final court ruling at trial—is an important litigation instrument in many areas of the law including antitrust, copyright, patents, trademarks, employment and labor relations as well as contracts. The process of filing for a preliminary injunction and the court’s ruling on such a request generates information that can affect possible settlement decisions. We consider these implications when there is uncertainty about both the plaintiff’s damages as well as the merits of case in the eyes of the court. Both plaintiff and defendant revise their beliefs about the case strength in dispute once they observe the court’s ruling on preliminary injunctive relief. We study how such learning affects the likelihood of settlement. A precursor to this analysis is the study of the strategic role of preliminary injunctions as a means to signal the plaintiff’s willingness to settle.

Keywords: preliminary injunction, learning, signaling, screening, litigation, pre-trial motion, settlement

JEL classifications: D8 (Information, Knowledge, and Uncertainty), K12 (Contract Law), K21 (Antitrust Law), K41 (Litigation Process), J53 (Labor-Management Relations; Industrial Jurisprudence), L4 (Antitrust Issues and Policies)

1 Introduction

A preliminary injunction (PI) is a court order that can be requested in the course of litigation in order to restrain a party from a disputed activity until the case is decided, either by a settlement agreement or through an ultimate finding by the court. Preliminary injunctions are a common tool used in litigation throughout many areas of the law. In addition to their importance for the economics of litigation, an understanding of PIs is of particular interest to economists in the context of patent-, copyright-, trademark- and anti-trust litigation, including anti-monopoly and merger cases, as well as in labor, employment and contract law.

A few particularly prominent cases in which preliminary injunctions played a role include a 1997 trademark case brought against Microsoft (MS) by Sun Microsystems alleging that MS distributed Internet Explorer 4.0 using the Java Compatible Logo without having passed all compatibility tests—several PIs were granted and the litigants ultimately settled. The same firms were engaged in civil anti-trust litigation in 2002 with Sun claiming that MS was maintaining an illegal monopoly in Intel-compatible operating systems. After the granting of a PI (which was later diminished in scope) the firms settled in 2004. In 2006 Bristol-Myers Squibb was granted a PI against Apotex in a patent-infringement case concerning the blood-thinner Plavix—the case was also subsequently settled. In a 1999 suit concerning software patents Amazon.com obtained a PI against barnesandnoble.com concerning their ‘Express’ checkout—the PI was subsequently revoked on appeal and the case was settled in 2002. In 2001 a PI was issued against Napster in the copyright infringement case involving file-sharing over the Internet—while a partial settlement was reached, Napster ultimately declared bankruptcy in 2002. In 2009 EMC successfully obtained a PI in Massachusetts against a former employee to bar him from starting employment at Hewlett Packard in California in alleged violation of a ‘non-competition covenant.’ Finally, in another current case, the American Trucking Association was partly granted a PI against concession requirements of the ports of Los Angeles and Long Beach; the case is still pending trial.

In this paper we study the role that preliminary injunctions play in the course of litigation by disseminating information and resolving uncertainty. Following the seminal work by P’ng (1983), Grossman and Katz (1983), Bebchuk (1984), Reinganum and Wilde (1986), Nalebuff (1987) and Spier (1992), there is now an extensive literature on how strategic information transmission affects parties’ optimal strategies leading up to and during the course of litigation.¹ Here we consider

¹Spier (2007) gives a general introduction to the economics of litigation, and Daughety and Reinganum (2008) present an accessible introduction to pretrial settlement in particular.

the strategic use of requesting and obtaining a ruling on preliminary injunctive relief. Our focus is two-fold. First, in filing for a PI the plaintiff reveals information about his level of damages. Second, the hearing on the motion and the court’s subsequent determination on the request reveals information about the merits of the case. Both of these considerations affect settlement negotiations in the course of litigation.

When a plaintiff requests a PI the court weighs four factors in determining how to rule on the motion: (1) the likelihood with which the plaintiff will prevail at trial, (2) whether the plaintiff suffers irreparable harm if the defendant is not enjoined, (3) the overall balance of harm between the plaintiff and the defendant, and (4) the public interest.

Concerning the public interest (the fourth criterion) the most important consideration is upholding the law, which is actually addressed by the first factor (see, *e.g.*, Cunningham, 1995).² Hence the fourth criterion is more narrowly construed and generally addresses how nonparties are affected by the PI. Indeed, in the areas of most interest to us, the public interest rarely factors into a ruling on the PI,³ and some argue that the third and fourth criteria be merged to assess the overall effect of a ruling on potential harm (see, *e.g.*, Lewis, 1993/94).

In determining the overall balance of harm the court assesses whether the expected damages from an erroneous grant outweigh the expected damages from an erroneous denial.⁴ In so doing, the court must explicitly assess the first criterion, namely the likelihood that the plaintiff ultimately prevails at trial. Moreover, as indicated by the second criterion, it is incumbent upon the plaintiff to demonstrate that the harm suffered is ‘irreparable.’

Irreparable harm is immediate if, for example, the plaintiff is at risk of going bankrupt or the defendant may become judgment proof. However, the mere fact that damages could be hard to assess (*e.g.*, damages are not verifiable) may result in subsequent remedies being “intolerably random,” (Lichtman, 2003, p. 198)—leading to a finding of irreparable harm. Indeed, especially relevant for our settings, the following have been found to establish irreparable harm: potential loss of market share, potential loss of market advantages, damage to reputation, loss of goodwill,

²For instance, in the case concerning Plavix mentioned at the outset Judge Stein wrote in his ruling that “Although there are competing and substantial public interests at stake on both sides of this litigation, the balance of those competing public interests slightly favors Sanofi. The public interest in lower-priced drugs is balanced by a significant public interest in encouraging the massive investment in research and development that is required before a new drug can be developed and brought to market.”

³Cases where the public interest has been cited in denying a PI generally involve severe disruptions of supply chains or other strong adverse effects to non-litigants (see, *e.g.*, Shapiro, 1993).

⁴This is known as the Leubsdorf-Posner balancing rule. Indeed Judge Posner’s ruling in *American Hospital Supply Corp. v. Hospital Products Ltd.*, 780 F2d 589, 593 (7th Cir. 1986) goes so far as to state that: “This formula [...] is not offered as a new legal standard [...]. It is actually just a distillation of the familiar four (sometimes five) factor test that courts use in deciding whether to grant a preliminary injunction.” See also Leubsdorf (1978).

confusion in the market place, or the encouragement of others to infringe.⁵ In fact, in many instances, including patent, trademark and copyright cases, the plaintiff is “entitled to a legal presumption of irreparable harm [upon a] ‘strong showing’ of likelihood of success” (Shapiro, 1993, p. 337).⁶ Thus, for most settings of concern to us, the critical factor for a successful motion is the first criterion—establishing the merits of the case. Indeed, Leubsdorf (2007, p. 35) states in regard to preliminary relief in general (not just in corporate litigation) that “Under existing law as well as under the Leubsdorf-Posner formulation, the strength of the plaintiff’s case [...] is an important, perhaps the most important, factor in determining whether the plaintiff can obtain preliminary relief.”

Traditionally the threshold for granting a PI was highest in patent-infringement cases compared to other intellectual and industrial property disputes (Cunningham, 1995). However, since its inception in 1982 the Federal Circuit Court of Appeals—which has jurisdiction over patent infringement cases—has lowered the burden of proof for granting a PI from “beyond question” to a standard of “reasonable likelihood.”⁷

While corporate litigation is recognized as an important tool in strategic competition,⁸ despite the importance and frequent use of preliminary injunctions in court proceedings, the analysis of PIs as an integral part of a plaintiff’s strategy at trial has by-and-large been eschewed in the economics literature on litigation. A notable exception is Lanjouw and Lerner’s (2001) study on patent infringement litigation. While they acknowledge the important informational roles of PIs,⁹ they do not consider these implications on the process of litigation as their focus is different. Recognizing the costs associated with PIs, including legal costs, they show that a patent holder may be motivated to ask for a PI in order to impose financial stress on the defendant. As a result, financially weak infringers who face the additional costs associated with the PI are more readily willing to settle at terms favorable to the plaintiff. Their findings are broadly supported by an

⁵See Shapiro (1993), p. 339 and the cases cited therein, but also *Muze Inc. v. Digital On-Demand, Inc.*, 123 F.Supp. 2d 118, 131 (S.D.N.Y. 2000).

⁶See also Lichtman (2003) and especially Samuelson and Bebenek (2009) for a critique of this practice in the context of copyright law.

⁷Cf. *Atlas Power Co. v. Ireco Chemicals*, 773 F.2d 1230, 227 U.S.P.Q. 289 (Fed. Cir. 1985). Consequently there was an increase in the use of PIs (Shapiro, 1993, Shehadeh and Stewart, 2001) as well as an increase in the likelihood of PIs being granted from roughly 40% to over 60% for the 10-year period after the establishment of the court (Cunningham, 1995); similarly in the data from patent-infringement cases studied in Lanjouw and Lerner (2001) roughly half of the PIs requested were granted.

⁸See, *e.g.*, Bizjak and Coles (1995) or Briggs, *et al.* (1996) concerning civil anti-trust litigation, or Meurer (1989) or Choi (1998) in regard to patent infringement.

⁹They remark that “in a world with uncertainty about case quality, a PI hearing may be a relatively cheap way to obtain information about how a court would rule in an eventual trial” (p. 586).

analysis of 252 patent infringement suits.¹⁰

In addition, there is a small recent legal literature on the role of PIs in the economics of litigation. Brooks and Schwartz (2005) and Lichtman (2003) both allude to the important role that PIs can play in generating and disseminating information in order to affect litigation and settlement. Brooks and Schwartz observe that “[s]trategic use of preliminary injunctions by plaintiffs is not uncommon. Parties often pursue preliminary actions, knowing that they are likely to get the same judge at the final stage [...] and that judge is unlikely to switch her views of the merits subsequently. This may improve a party’s bargaining power in settlement negotiations” (p. 386). Lichtman notes that “[p]reliminary hearings—whether or not they lead to injunctions—surely do promote settlement by increasing the information available to the parties” (p. 202). While these authors thus explicitly recognize the importance of uncertainty and the dissemination of information in the course of litigation, neither of the studies examine this role of PIs, as both move into other directions.¹¹

We consider the strategic implications of PIs in mitigating two types of incomplete information commonly encountered in litigation. First, a party often has private information about their payoffs, leaving the opposing side uncertain about the motivations and incentives of their adversary. In our setting the defendant is initially unsure about the degree of harm that the plaintiff is suffering. However, a plaintiff’s request for a PI reveals bounds on the plaintiff’s damage level, allowing the defendant to structure settlement offers accordingly. Second, both parties have common, albeit incomplete, information about the case strength. In this regard the hearing and subsequent ruling on a request for preliminary relief reveal information about the merits of the case. As a result, both the request itself and the subsequent hearing and ruling impact settlement decisions.

In Section 2 we present a stylized legal dispute in which a plaintiff suffers damages due to the purported offense of the defendant. The precise extent of the damages is the plaintiff’s private information. Upon filing a suit the plaintiff decides whether or not to move for a PI against the defendant, given that pursuing such a request is costly.¹² Upon observing both whether the plaintiff

¹⁰Another study is Boyce and Hollis (2007), who model how PIs in patent cases can be used to take advantage of damage rules when there is no uncertainty about player’s payoffs.

¹¹Lichtman considers how a particular form of uncertainty about damage levels affects normative implications of the Learned Hand rule and other cost-benefit analyses used in courts; and Brooks and Schwartz focus on efficiency implications of liability *vs.* property rules in the application of injunctive relief.

¹²There are no court costs associated with the motion. However, the plaintiff must still overcome the burden of proof and in doing so the plaintiff locks himself into specific legal strategies and arguments. As a consequence, the costs of preparing the motion can be substantial as it is labor-intensive necessitating considerable attorney time at an accelerated rate. Indeed, Lanjouw and Lerner’s empirical findings suggest that PIs “may be available only to financially stronger plaintiffs” (p. 575) as those who file for a PI tend to be twice as large as those who do not file in terms of cash and equivalents and other measures. Consequently, some practitioners caution against the use of PIs due to their costs (see, *e.g.*, Johnson, 2002).

moved for the PI and the court’s subsequent ruling on it, the defendant makes a take-it-or-leave-it offer for a settlement. If the plaintiff accepts the given settlement offer, the case ends; otherwise it proceeds to trial.

The plaintiff’s motion for a PI plays several informational roles. First, in Section 3, it is demonstrated that the filing for a PI reveals information about the damages suffered by the plaintiff. Hence, in light of the filing decision, the defendant is able to update her beliefs about the unobservable damage level and account for this in making an out-of-court settlement offer. We find that the plaintiff is more inclined to move for a PI with this informational aspect in mind compared to the case without such consideration. Indeed, there always exist plaintiff types who only choose to file for a PI because by doing so they are offered better settlement terms from the defendant. This reveals a signaling effect of a PI in that some plaintiff types file for a PI just to send the signal that they are not suffering low damages.¹³ Interestingly, we show that due to this strategic use of PIs the number of cases that are settled out of court increases, which may result in substantial savings of litigation and court costs.

Second, in Section 4, we consider how the hearing on the PI and the court’s ruling reveal information about the case, which allows litigants to update their beliefs about the case strength. Specifically, we assume that the plaintiff and the defendant hold common beliefs about the case strength that reflect some (legal) uncertainty regarding the issue at hand. In making a ruling on the request for preliminary injunctive relief the court reduces this uncertainty as both parties glean the court’s initial assessment of the merits of the case.¹⁴ We show that a granting of a PI generally leads to less settlement as plaintiffs are more willing to proceed to trial, despite an increased settlement offer from the defendant. Conversely, a denial of a PI increases the chances of out-of-court settlement, despite a reduced settlement offer—providing a possible rationale as to why the granting of a PI should be considered an extreme measure. Finally, while the initial incentive to file for a PI may be unaffected by the anticipation of subsequent learning about the merits of the case, the probability of an out-of-court settlement nonetheless unambiguously increases when accounting for learning due to the hearing and ruling on the PI request.

¹³This is similar to Spier (1992) and Daughety and Reinganum (2002) where by virtue of accepting or rejecting settlement offers defendants reveal information about their types; and it is similar to Posey (1998), who studies the signaling value of hiring an attorney in insurance claims cases and Choné and Linnemer (2010), who consider signaling through pretrial investment in case preparation, which in their model results in augmented expected damage awards by a fixed factor.

¹⁴In particular, *e.g.*, the Federal Rules of Civil Procedure state that “In granting or refusing an interlocutory injunction, the court must [...] state the findings and conclusions that support its action” Fed. R. Civ. P. 52(a)(2). Similar rules apply in States’ courts.

2 The Basic Model

The legal conflict under consideration involves a plaintiff firm (of male gender) and a defendant firm (of female gender), both of whom are risk neutral. Absent the legal dispute firms earn a constant discounted profit stream of Π_i , where $i \in \{p, d\}$, with p and d being mnemonics for the plaintiff and defendant. The implication of the constant discounted profit stream is that litigants have a base payoff of Π_i at any point in time, independent of which stage of the litigation process is reached.

The conflict begins when in order to secure a benefit b the defendant embarks on allegedly unlawful actions that adversely affect the plaintiff firm, *e.g.*, a purported patent, copyright, or trademark infringement, or actions in violation of civil anti-trust, employment or labor laws, or a breach of contract. Due to the actions of the defendant, the plaintiff suffers overall damages of x . The damages may be correlated with b , but they are unverifiable in that they reflect the plaintiff's subjective assessment of counterfactuals concerning his future payoffs. Moreover, the precise extent of these damages are private information of the plaintiff; the defendant knows only the distribution of possible damages, denoted by $F(x)$ with differentiable density $f(x)$ on $[\underline{x}, \bar{x}]$; where $F(x)$ satisfies the reverse monotone hazard rate condition (MHRC), *i.e.*, f/F is non-increasing. $F(\cdot)$ may either reflect *a priori* beliefs about damages, or is the result of remaining uncertainty after some prior unsuccessful settlement negotiations, which are not formally modeled as they do not affect the use of the preliminary injunction. In contrast, the defendant's benefit b is assumed to be common knowledge.¹⁵

The interaction between the parties goes through three phases, depicted in Figure 1. For simplicity, we assume that in the first phase (*i.e.*, the pre-trial motion phase) no damages occur, as these would be sunk in any event and therefore not affect the litigants' strategies. In this phase, upon incurring a cost of c_{PI} , the plaintiff can request preliminary injunctive relief to enjoin the defendant so as to stave off the damages that accrue in the course of further litigation in the second phase, τx .¹⁶ That is, $\tau \in (0, 1)$ denotes the portion of the total damages from the disputed action that accrue during the second phase and are thus subject to the PI, whereas the remainder $(1 - \tau)$

¹⁵In many settings b is private information. However, since the size of b has no direct bearing on the strategic use of the PI for informational purposes, common knowledge about b does not affect our analysis, provided that b and $F(\cdot)$ are uncorrelated. A correlation between b and $F(\cdot)$ is to be expected especially in civil antitrust cases, and possibly also in IP cases (in which case the degree of harm inflicted might also be subject to strategic considerations by the defendant); but less so in contract disputes, where the party being accused of breach generally takes actions in light of outside opportunities. In any event, assuming a correlation between b and $F(\cdot)$, while maintaining that b is also private information, requires that the model account for higher-order beliefs (*i.e.*, the beliefs that the plaintiff has about the defendant's beliefs about x), making the model cumbersome.

¹⁶These damages may be quite substantial as subsequent litigation may last very long (*e.g.*, the patent infringement case of Polaroid *v.* Kodak lasted well over a decade).

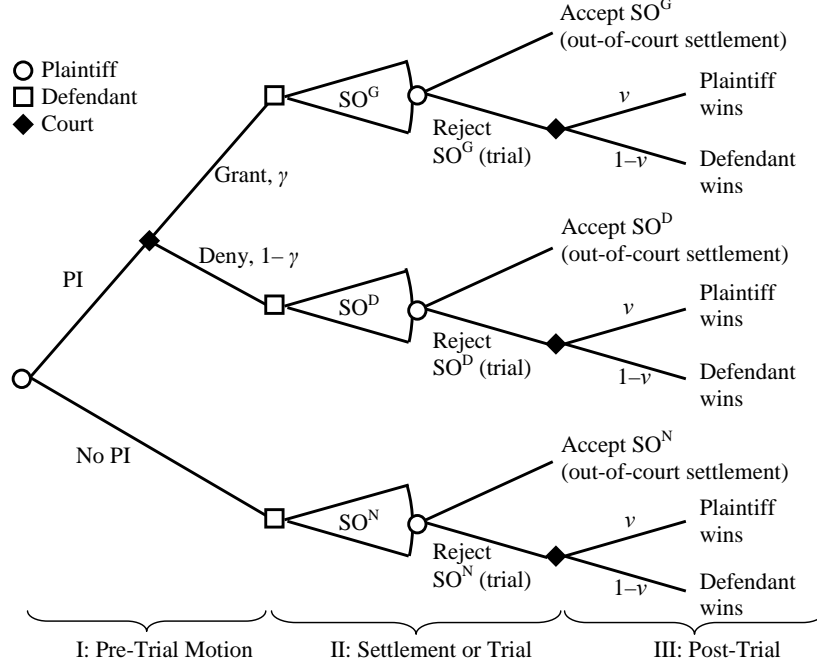


Figure 1: *Structure of the Game*

proportion of damages accrue in the final phase (the post-trial phase) and are thus subject to final adjudication by the court.

In order to focus on the informational implications tied to the use of PIs, we consider their basic ‘defensive’ role designed to prevent current damages; and abstract from their ‘offensive’ use, in which the request is designed to harm the defendant. Therefore we assume that no costs are incurred by the defendant firm in the course of a PI hearing and no benefits accrue to the defendant in the second phase, since otherwise the plaintiff’s filing decision is confounded by how legal costs and a possible grant of the PI affect the defendant’s bargaining position in settlement negotiations.¹⁷

There are two sources of uncertainty in the model. The first is the uncertainty that comes about because the damages suffered by the plaintiff are private information. Specifically, the defendant does not know what type of plaintiff she is facing. The second source of uncertainty is unrelated to this and is given by both parties’ common uncertainty about the legal merits of the case. In characterizing the three phases of the model, we now describe how the two sources of uncertainty are affected by and affect the parties actions.

At the outset of the first phase the plaintiff decides whether or not to seek a preliminary

¹⁷In Subsection 5.2 where we briefly address legal remedies in addition to equitable relief, we also discuss benefits that accrue concurrent to the legal proceedings.

injunction against the defendant. In equilibrium, this decision depends on the damage level x , with only plaintiff types who have sufficiently high damages seeking preliminary injunctive relief. Thus, the decision to file allows some inferences about the plaintiff’s type. If a PI is sought, a hearing on the motion ensues, upon which the court either dismisses the motion or enjoins the defendant. To keep the model tractable, we assume that evidence submitted during the hearing contains no (further) information about the plaintiff’s damages. This assumption is warranted to the degree that the plaintiff’s main objective at the PI hearing is to establish a strong showing on the merits of his case, which frequently then establishes a presumption of harm. Moreover, to the extent that the plaintiff does present evidence of damages, the focus is primarily on showing that harm is irreparable. Nevertheless, our assumption should be viewed as limiting since the plaintiff always has an incentive to substantiate before the court and the defendant a high level of damages. Because we abstract from this possibility, the court’s ruling on the motion is necessarily independent of x and we thus let γ denote the belief that each party commonly holds that a request for a PI is granted.¹⁸

As for the second source of uncertainty, we initially also suppose that the hearing and court’s ruling on a PI are uninformative about the merits of the underlying case, which allows us to isolate the signaling aspects of a PI request that alleviate asymmetric information between the parties. However, in Section 4, we extend the analysis by considering how the hearing and the court’s ruling on the PI allow both parties to learn about the case strength—information that is used to draw inferences about the court’s possible ultimate ruling should the case go through to final adjudication.

There are two stages in the second phase, beginning with settlement negotiations and culminating in the trial and final adjudication should an out-of-court settlement agreement not be reached. Specifically, upon observing both whether the plaintiff moved for the PI and the court’s subsequent ruling on it, the defendant makes a take-it-or-leave-it offer for a settlement, denoted by SO , that allows the disputed behavior to continue in the final phase. That is, the defendant offers to buy the right that the plaintiff claims to be entitled to. If the plaintiff accepts the given settlement offer, the game ends with an out-of-court settlement.¹⁹ Otherwise the trial stage is entered during which

¹⁸It is possible to include an updating of beliefs on damages that is specifically conditioned on the hearing or the ruling, but this significantly complicates the model and does not overturn the findings of the simpler structure.

¹⁹Indeed, it is not unusual for a trial to be agreed to be stayed after a PI ruling specifically so that the litigants have a chance to come to a settlement agreement, see, *e.g.*, *Grundfos Pumps v. Laing Thermotech*, No. C-07-4033 JSW, Stipulation and Order (1) Entering Preliminary Injunction and (2) Ninety Day Stay (N. Cal. Oct. 26, 2008)—a case that was indeed then settled.

litigation costs of $c_i, i \in \{p, d\}$ associated with the actual trial are incurred. Each party bears its own costs regardless of the outcome at trial, that is, the American fee rule is assumed.

For purposes of greater clarity, we assume that the court only considers equitable relief, that is, the court determines the legality of the disputed activity and then issues or denies a permanent injunction.²⁰ In particular, there are two possible underlying states concerning the case. In the ‘valid’ state the plaintiff wins if it comes to a final ruling at trial. That is, the court rules in favor of the plaintiff by permanently enjoining the defendant firm, resulting in continuation payoffs equal to the base profits Π_i for both firms. Alternatively, in the ‘invalid’ state the court—when called upon—finds in favor of the defendant, ruling the disputed behavior to be permissible, in which case base payoffs are modified by $-(1 - \tau)x$ and b , respectively. The prior probability that both parties commonly hold that the case is valid is given by ν .

We conclude by assuring that litigation is a credible option for both parties. For the defendant this is the case whenever the cost of litigation is smaller than the potential gain from her actions weighted by the probability that she prevails in court (*i.e.*, whenever $c_d < (1 - \nu)b$). Similarly, pursuing litigation is credible for all plaintiff types whenever the cost of litigation is less than the smallest level of post-trial damages weighted by the probability of winning the case (*i.e.*, $c_p < \nu(1 - \tau)x$).

Before presenting informational concerns that arise in filing for a PI, we briefly consider the plaintiff’s basic motivation for filing for a PI. That is, we derive the benchmark threshold for filing for a PI when the sole objective is to avert the damages that accrue during the trial phase. Specifically, a plaintiff who refrains from seeking a PI suffers damages of τx during the trial phase. These damages can be averted by filing for a PI at the cost of c_{PI} , provided that the court issues a favorable ruling on the PI and (tentatively) enjoins the defendant, which occurs with probability γ . Thus, a plaintiff files for a PI whenever

$$\begin{aligned} \Pi_p - c_{PI} - (1 - \gamma)\tau x &> \Pi_p - \tau x \\ \iff c_{PI} &< \gamma\tau x. \end{aligned} \tag{1}$$

Abstracting from trivial cases in which the filing for a PI is so cheap that the plaintiff chooses to file regardless of the level of damages, or so costly that none is ever sought, the benchmark motivation

²⁰Depending on the type of the case, litigants may also consider other pre-trial motions and the court may also consider other remedies. For instance, in the data considered in Bizjak and Coles (1995), while over two thirds of cases are filed seeking (only) equitable relief, the remainder expressly (also) seek monetary damages (*i.e.*, legal relief). We briefly address this in Subsection 5.2.

for filing for a PI is given by

$$\text{Benchmark (Myopic/Defensive) Filing Decision: } \begin{cases} PI & \text{for } x \geq \hat{x}_B := \frac{c_{PI}}{\gamma\tau} \\ N & \text{for } x < \hat{x}_B := \frac{c_{PI}}{\gamma\tau}, \end{cases} \quad (2)$$

where PI designates that a request is filed, whereas N identifies the case in which no PI is sought, and $\hat{x}_B \in (\underline{x}, \bar{x})$ denotes the threshold (benchmark) level of damages above which a PI is sought. As noted above, the benchmark use of filing for a PI is purely defensive. We now consider how informational considerations affect the plaintiff's filing decision and, thus, alter the threshold type.

3 Signaling and Screening Prior to Trial

The analysis of the benchmark demonstrates that plaintiff types suffering relatively low damages (below $\hat{x}_B = c_{PI}/\gamma\tau$) refrain from incurring the cost of requesting a PI, whereas those with high damages incur the cost by filing for a PI. Thus, the defendant recognizes that filing for a PI reveals information about the damages suffered by the plaintiff. This, of course, affects the possible settlement offers that the defendant is willing to entertain. Because filing for a PI affects the possible terms of a settlement, the plaintiff, in turn, takes this into consideration when formulating the decision on whether to request a PI—*i.e.*, the plaintiff may use the PI to signal bounds on his damage levels.

With these informational dynamics in mind, we analyze the litigants' optimal strategies while hypothesizing that in equilibrium it is known that plaintiff types below a certain threshold level of damages do not file for a PI, whereas those above do. That is, we make use of the following initial conjecture, which is verified in equilibrium.

Conjecture 1 (Monotonicity in Filing for PI) *There exists a damage level \hat{x} such that any plaintiff with damages below \hat{x} does not file for a PI, whereas all others do.*

3.1 Screening: The Defendant's Optimal Settlement Offer

Using backward induction, we begin our analysis at the outset of the second phase of litigation. At this stage the court has already issued its ruling on any PI request if a PI was sought. The proportion τ of damages are sunk so that proposed settlement offers concern the remaining $(1 - \tau)$ proportion of damages that are yet to accrue.

To determine the defendant's optimal settlement offer it must first be established when a plaintiff is willing to accept a proposed settlement. To this end, let V denote the plaintiff's expected payoff. When accepting an arbitrary settlement offer of SO , his payoff is given by the (time-invariant) constant base payoff Π_p , augmented by the amount of the settlement offer SO , and diminished by future losses due to the continued actions of the defendant firm $(1-\tau)x$, *i.e.*, $V^S = \Pi_p + SO - (1-\tau)x$, where the superscript S denotes the out-of-court settlement.²¹

In contrast, if the plaintiff proceeds to trial his payoff consists of the base payoff Π_p , diminished by the costs of litigation c_p and the costs associated with a possible ruling against him at court $(1-\nu)(1-\tau)x$. That is, $V^T = \Pi_p - c_p - (1-\nu)(1-\tau)x$, where the superscript T denotes the decision to go to trial.

Define x^S as the damage level suffered by the plaintiff firm that is just willing to accept a given settlement offer SO . The plaintiff accepts the settlement offer whenever $V^S \geq V^T$, so the marginal plaintiff type is implied by

$$x^S := \frac{SO + c_p}{\nu(1-\tau)}, \quad (3)$$

with all plaintiff types with $x \leq x^S$ settling out-of-court.

In light of the defendant's uncertainty about the plaintiff's damages, in order to determine the optimal offer, she must estimate the likelihood that a settlement offer is accepted, given the history of the game. In light of Conjecture 1, the defendant updates her beliefs about the damage level suffered by the plaintiff upon observing the plaintiff's decision on whether or not to file for a PI. Letting $H \in \{PI, N\}$ denote the history of a PI having been requested (PI) or not (N), and letting \hat{x}^c denote the defendant's conjecture about the plaintiff's cut-off for filing a PI, the defendant's posterior beliefs about the possible damage levels suffered by the plaintiff are given by

$$F^H(x) = \begin{cases} \frac{F(x) - F(\hat{x}^c)}{1 - F(\hat{x}^c)} & x \in [\hat{x}^c, \bar{x}] \text{ and } H = PI \\ \frac{F(x)}{F(\hat{x}^c)} & x \in [x, \hat{x}^c] \text{ and } H = N. \end{cases} \quad (4)$$

Given these beliefs, the (subjective) probability that a plaintiff accepts a given settlement offer SO is thus given by $F^H(x^S)$.

Consider now the defendant's optimal settlement offer. If the litigants settle out-of-court, the defendant pays out SO , the case is dropped and the defendant receives her benefit of b , yielding a

²¹In equilibrium, settlement offers are history-dependent and are denoted by SO^H with H indexing the history of the game. In analyzing the plaintiff's actions, we consider arbitrary offers SO .

payoff of $\Pi_d - SO + b$. If settlement is not reached, the defendant incurs litigation costs c_d , but stands a chance to prevail at trial so that the defendant's payoff is $\Pi_d - c_d + (1 - \nu)b$. Hence, the defendant's (history dependent) expected payoff from making a settlement offer SO is

$$\Pi_d + F^H(x^S)(-SO + b) + (1 - F^H(x^S))(-c_d + (1 - \nu)b). \quad (5)$$

It is worth noting that if the defendant's benefits are very large, her strategy is to simply buy off the plaintiff. Also, if her benefits are very low, she will not make any settlement offer to a plaintiff who has revealed relatively high damages by filing for a PI. In either of these extreme cases the plaintiff makes a filing decision independent of the defendant's strategy and we therefore abstract from these cases.

Having determined the defendant's subjective expected payoff, we can derive the settlement offer she proposes. Making use of the relationship between SO and x^S given in (3) the first order condition of the defendant's problem for interior solutions is given by

$$\frac{F^H(x^S)}{f^H(x^S)} + x^S = \frac{\nu b + c_d + c_p}{\nu(1 - \tau)}. \quad (6)$$

From this the defendant's optimal settlement offers follow.

Lemma 1 (Screening) *Given beliefs \hat{x}^c , the defendant's unique optimal terms of settlement as a function of the plaintiff's filing decision, denoted by SO^H , with $H \in \{PI, N\}$ are*

$$SO^{PI}(\hat{x}^c) = \nu(1 - \tau)x^{PI}(\hat{x}^c) - c_p$$

$$SO^N(\hat{x}^c) = \begin{cases} \nu(1 - \tau)\hat{x}^c - c_p & \text{if } \frac{F(\hat{x}^c)}{f(\hat{x}^c)} + \hat{x}^c < \frac{\nu b + c_d + c_p}{\nu(1 - \tau)}, \\ \nu(1 - \tau)x^N - c_p & \text{else.} \end{cases} \quad (7)$$

with the amounts x^N and x^{PI} being implied by (6) in conjunction with (4).

If the condition on the top branch of SO^N is met, then no interior solution to the defendant's problem exists when no PI is sought, given the defendant's beliefs about the threshold for filing. In this case she simply offers to buy the plaintiff off, in light of the perceived level of damages. Otherwise the interior solution is implied by the bottom branch of SO^N .

Lemma 1 shows how a defendant's optimal settlement offer is affected by her beliefs about the damage level caused by the action. As a result, the defendant makes distinct settlement offers,

depending on whether a PI is requested or not.

3.2 Signaling: The Plaintiff's Decision to File

Given the defendant's possible settlement offers as a function of her beliefs about the threshold plaintiff type \hat{x}^c and the history of whether a PI is requested or not, we derive the plaintiff's choice whether or not to file for a PI. Once the plaintiff files a suit against the defendant without the motion for a PI, he cannot avoid the trial phase damages (the right-hand-side of (1)). Subsequently, the plaintiff can either accept the proposed settlement terms SO^N , or proceed to trial. In the latter case the payoff is equal to $\Pi_p - \tau x - c_p - (1 - \nu)(1 - \tau)x$.

Alternatively, by Lemma 1, the plaintiff can agree to the out-of-court settlement and drop the case, suffering damages of $(1 - \tau)x$. In this case, the payoff is $\Pi_p - \tau x + SO^N - (1 - \tau)x = \Pi_p - \tau x - c_p - (1 - \tau)(x - \nu \min\{x^N, \hat{x}^c\})$. By construction of the settlement offer, a plaintiff with damages below $\min\{x^N, \hat{x}^c\}$ prefers to settle, whereas one with greater damages proceeds to trial. In summary, letting V^N denote the plaintiff's expected payoff from not filing a motion for a PI,

$$V^N = \begin{cases} V^{N,T}(x) := \Pi_p - \tau x - c_p - (1 - \tau)(1 - \nu)x, & x > \min\{x^N, \hat{x}^c\}; \\ V^{N,S}(x|\hat{x}^c) := \Pi_p - \tau x - c_p - (1 - \tau)(x - \nu \min\{x^N, \hat{x}^c\}), & x \leq \min\{x^N, \hat{x}^c\}; \end{cases} \quad (8)$$

where, as before, the superscript S designates an out-of-court settlement, whereas T denotes a continuation to trial.

If the plaintiff seeks a PI, then the defendant draws the inference that the plaintiff's damage levels are high and therefore offers SO^{PI} . Filing for a PI entails the immediate cost of c_{PI} , whereas with probability γ a favorable ruling will stave off the trial phase damages of τx (the left-hand-side of (1)). Regardless of the ruling on the PI, if the plaintiff proceeds to trial he incurs an additional expenditure of c_p , with the possible ultimate ruling in favor of the plaintiff averting damages of $(1 - \tau)x$ with probability ν . Otherwise, if settlement is agreed to, he receives an additional payoff of $SO^{PI} - (1 - \tau)x$. The latter dominates the former for all plaintiff types with $x \leq x^{PI}$. Hence, letting V^{PI} denote the plaintiff's expected continuation payoff when requesting a PI,

$$V^{PI} = \begin{cases} V^{PI,T}(x) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(1 - \nu)x, & x > x^{PI}(\hat{x}^c); \\ V^{PI,S}(x|\hat{x}^c) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(x - \nu x^{PI}(\hat{x}^c)), & x \leq x^{PI}(\hat{x}^c). \end{cases} \quad (9)$$

The plaintiff bases his filing decision on whichever payoff, V^{PI} or V^N , is greater, given his type.

3.3 Signaling Equilibrium

Having derived the litigants' incentives, we now consider the equilibrium and demonstrate the existence and uniqueness of a signaling equilibrium. This requires that there is a unique pair (\hat{x}, \hat{x}^c) with $\hat{x} = \hat{x}^c$. That is, in equilibrium, the defendant's conjecture about the plaintiff's actions must be consistent with the actual decision to request a PI.

Proposition 1 (Equilibrium Existence and Uniqueness) *There exists a proportion of damages accruing in the trial phase $\tilde{\tau} := \frac{\nu}{\gamma+\nu}$ such that whenever $\tau > \tilde{\tau}$, there exists a unique sequential equilibrium.*

To understand the intuition for a minimum proportion of damages accruing in the trial phase ($\tilde{\tau}$), suppose that only a small fraction of the total damages accrue during litigation. Then plaintiff types with very high damage levels request a PI in the hopes of preventing current damages, while those with intermediate damage levels proceed directly to trial without the motion for a PI. However, plaintiff types with very low damages may file for a PI simply to receive a very high settlement offer in response to a filing decision, resulting in a non-monotonic filing decision.

The intuition for the uniqueness of the equilibrium is that the higher is the defendant's belief concerning the threshold type, the higher is the settlement offer that is made; which, in turn, lowers the threshold for making worthwhile the expense of filing for a PI. That is, the plaintiff's incentive to file for a PI moves in the opposite direction of the defendant's belief about the threshold, assuring a unique crossing, and thus a unique equilibrium.

The plaintiff's equilibrium payoff as a function of his type is depicted in Figure 2. For the case depicted (*i.e.*, with $x^N < \hat{x}$) the plaintiff's strategy is given by

$$\text{Filing and Settlement Decisions: } \left\{ \begin{array}{l} PI \\ N \end{array} \right\} \left\{ \begin{array}{l} \left\{ \begin{array}{ll} T & \text{for } x \in (x^{PI}, \bar{x}] , \\ S & \text{for } x \in (\hat{x}, x^{PI}] ; \end{array} \right. \\ \left\{ \begin{array}{ll} T & \text{for } x \in (x^N, \hat{x}] , \\ S & \text{for } x \in [\underline{x}, x^N] . \end{array} \right. \end{array} \right.$$

That is, upon filing for a PI the defendant proposes settlement terms that any plaintiff type with $x \leq x^{PI}$ accepts; those with higher damages proceed to trial. When not filing for a PI the defendant makes a reduced settlement offer which types with $x \leq x^N$ accept.

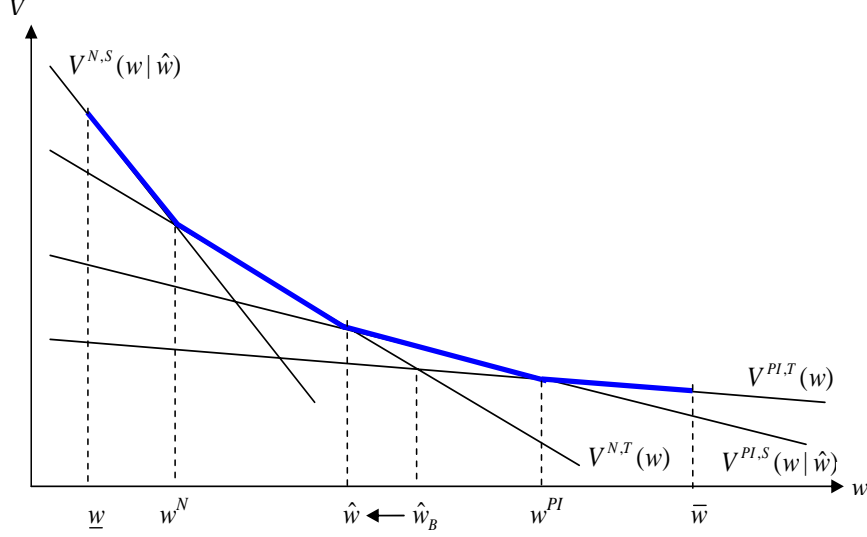


Figure 2: *Plaintiff's Payoff*: $V(x) = \max \{V^{N,S}(x|\hat{x}), V^{N,T}(x), V^{PI,S}(x|\hat{x}), V^{PI,T}(x)\}$

Theorem 1 (Signaling Prior to Trial) *In the unique equilibrium some plaintiff types incur the cost of filing for a PI solely to signal that they do not have low damages in anticipation of thereby obtaining the high settlement offer before settling out-of-court.*

The intuition behind the signaling aspect of the equilibrium is that filing for a PI separates the plaintiff types into two groups (cf. Figure 2). The group that incurred the cost of filing for a PI are offered better settlement terms. Thus, recalling the benchmark threshold type for filing for a PI, \hat{x}_B , given in (2), a plaintiff of type $x \in [\hat{x}, \hat{x}_B)$ files for a PI solely in order to differentiate himself from lower-damage plaintiff types in anticipation of obtaining a more favorable settlement offer, which is then accepted forsaking the possibility of a subsequent trial. While it is also the case that plaintiff types with $x \in [\hat{x}_B, x^{PI}]$ file for a PI and then subsequently settle, these are not engaged in signaling, as they would have incurred the cost of filing for a PI even absent any potential settlement. In sum, whenever $x \in [\hat{x}, \hat{x}_B)$ the plaintiff incurs the cost associated with requesting a PI, not to ward off current harm due to the action of the defendant, but rather as a means of obtaining favorable settlement terms from the defendant in the settlement stage, as the costly filing decision is a credible way to signal that the plaintiff's damages are not low.

A concern encountered in all signaling models is potential welfare losses implied by costly signaling. Due to the important defensive role of PIs in the non-signaling ranges of damages, eliminating the option of PIs to prevent potentially costly signaling is not an appropriate benchmark

consideration for welfare implications of the strategic (*i.e.*, signaling) use of filing for PIs. Instead, to ascertain welfare implications of signaling it is worth considering how the case plays out when litigants are myopic and are unaware of the potential strategic signaling use of filing for a PI. Remarkably, such a comparison reveals that the overall welfare effects of the signaling use of filing for a PI may be positive.

Theorem 2 (Signaling and Increased Likelihood of Settlement) *The probability of out-of-court settlement increases due to signaling compared to the non-strategic benchmark, whenever*

$$\frac{F(\hat{x}_B) - \max\{F(\hat{x}), F(x^N)\}}{F(x_B^{PI}) - F(x^{PI})} > 1, \quad (10)$$

where $x_B^{PI} := x^{PI}(\hat{x}^c = \hat{x}_B)$ is the threshold for settling when offers are made that are consistent with the benchmark (myopic) filing decision \hat{x}_B , given in (2).

The intuition behind the theorem is that the threshold for filing is lower in the signaling equilibrium than in the non-signaling benchmark. On the one hand, this lowers the settlement offer to plaintiff types who file for the PI so that out-of-court settlement becomes less likely among those who file for purely defensive (*i.e.*, non-strategic) reasons. This is welfare decreasing in that for these cases litigants incur trial costs and the court system incurs the costs of administering the trial. On the other hand, however, all plaintiff types that are engaged in signaling will now settle. If the benchmark settlement offer made to plaintiffs who did not file for a PI was insufficiently generous to guarantee an out-of-court settlement (*i.e.*, $x^N < \hat{x}_B$) then plaintiff types in the range of $x \in [\max\{x^N, \hat{x}\}, \hat{x}_B]$ settle only in the signaling equilibrium, whereas in the benchmark they proceed to trial. Whenever the mass of intermediate-damage plaintiff types who end up settling solely due to signaling (*i.e.*, the numerator of (10)) outweighs the mass of high-damage plaintiff types who no longer are made an acceptable settlement offer (*i.e.*, the denominator of (10)), the overall welfare effects of signaling are positive, provided that the costs of initially filing for the PI do not exceed the savings from discontinued litigation upon settlement. The reason behind this is that signaling increases the likelihood of out-of-court settlement and, thus, reduces the costs associated with proceeding to trial. The incidence of increased settlement due to signaling is illustrated in the following example.

Example Consider a uniform distribution of damages, *i.e.*, $F(x) = \frac{x-\underline{x}}{\bar{x}-\underline{x}}$ and suppose that $\tau > \tilde{\tau}$. Then $x_B^{PI} = \frac{1}{2} \left(\hat{x}_B + \frac{\nu b + c_p + c_d}{\nu(1-\tau)} \right)$, whereas $x^{PI} = \frac{1}{2} \left(\hat{x} + \frac{\nu b + c_p + c_d}{\nu(1-\tau)} \right)$ so the welfare losses associated

with high damage plaintiff types who no longer settle out-of-court are proportional to $F(x_B^{PI}) - F(x^{PI}) = \frac{x_B^{PI} - x^{PI}}{\bar{x} - \underline{x}} = \frac{1/2(\hat{x}_B - \hat{x})}{\bar{x} - \underline{x}}$. Moreover, a sufficient condition for there to be an increase in the number of cases settled out-of-court is that $\hat{x} > x^N$,²² since then the gains for intermediate range plaintiff types who now settle are proportional to $F(\hat{x}_B) - F(\hat{x}) = \frac{\hat{x}_B - \hat{x}}{\bar{x} - \underline{x}}$, yielding a net increase that is proportional to $\frac{1/2(\hat{x}_B - \hat{x})}{\bar{x} - \underline{x}} > 0$.

Note that we consider welfare in a narrow sense confined to the particulars of the litigation modeled. Thus, we abstract from potential welfare gains that may accrue in some legal settings due to increased overall legal clarity should a court make a final ruling (see, *e.g.*, Farrell and Merges (2004) or Lemley and Shapiro (2005) concerning the potential value of obtaining final rulings in patent cases). However, if the public good value of legal clarity is positively correlated with damages, then signaling has the added beneficial effect of shifting settlement towards lower-damage cases, with a greater number of high-damage cases obtaining a final adjudication in the court.

4 The Extended Model: Learning

Thus far it has been assumed that a hearing on a PI request and the subsequent court ruling—either approval or denial of the requested injunctive relief—has no informational implications. Strictly speaking, this means that from an informational standpoint the PI ruling is pure noise. In fact, however, both plaintiff and defendant reveal information in the hearing and the resulting court ruling is generally regarded as being indicative of the final ruling that the court makes if the case proceeds to trial. The court’s ruling, for instance, may reflect the court’s best assessment of the merits of the case, which is correlated with the true state of the world concerning the case; and it may also be the case that a judge becomes reluctant to subsequently change her views of the merits, as the cite by Brooks and Schwartz in the introduction might suggest. In any event, as the underlying facts of the case and their legal implications are yet to be further developed in the course of ongoing discovery, the ruling on preliminary injunctive relief cannot be a prefect predictor of the final finding.

To formalize this, we denote by α the frequency with which a PI is denied, even though a subsequent ruling by the court would find for the plaintiff (*i.e.*, when the case is valid). And β gives the frequency with which a defendant is initially enjoined, even though the court would rule

²²The necessary and sufficient condition is that $1/2(\hat{x}_B + \hat{x}) > x^N$.

in favor of the defendant upon further consideration at trial (*i.e.*, the case is invalid).²³ Table 1, then, shows the likelihood matrix for the ruling on PIs, given the true state of the world.

| | | | Ruling: | |
|-------------------|---------|-------------|--------------|----------------|
| | | | Grant | Deny |
| | | | (γ) | $(1 - \gamma)$ |
| Underlying State: | Valid | (ν) | $1 - \alpha$ | α |
| | Invalid | $(1 - \nu)$ | β | $1 - \beta$ |

Table 1: *Likelihood Matrix for Rulings on the Preliminary Injunction*

Given the relationship between PI rulings and the underlying case strength, the probability that a PI is granted when it is filed is

$$\gamma := \nu(1 - \alpha) + (1 - \nu)\beta. \quad (11)$$

After a suit is brought, the parties revise their beliefs about the case strength on the basis of whether a PI is filed and, whenever this is done, what the court's ruling on the request is. Posterior beliefs are denoted by ν^H , where $H \in \{N, G, D\}$ is the case history, with N denoting that no request for a PI is filed, and G and D denoting the court's decision to either grant (G) or deny (D) a request. By Bayes' rule, the updated belief about the likelihood of the plaintiff ultimately prevailing at trial is given by

$$\nu^H = \begin{cases} \frac{(1-\alpha)\nu}{\nu(1-\alpha)+(1-\nu)\beta} = \frac{1-\alpha}{\gamma}\nu, & \text{for } H = G, \\ \frac{\alpha\nu}{\nu\alpha+(1-\nu)(1-\beta)} = \frac{\alpha}{1-\gamma}\nu, & \text{for } H = D, \\ \nu & \text{for } H = N. \end{cases} \quad (12)$$

Finally, while we acknowledge that there may be a systematic court bias in one direction or the other, we assume that a ruling in favor of the PI is always good news for the plaintiff, whereas a ruling against the PI is always good news for the defendant. That is, $\nu^D < \nu < \nu^G$, which requires that $\alpha + \beta < 1$.

²³If one takes the view that—in hindsight—a PI ruling is erroneous when it differs from a final ruling a trial, then a PI grant in an invalid case is referred to as Type-I error, false positive or α error, while denial followed by a finding for the plaintiff is called a Type-II error, false negative, or β error. Our notation is evocative of third convention.

4.1 Screening and Settlement after Learning

Since the filing decision precedes the court's ruling, the defendant's posterior beliefs about the damage level of the plaintiff are captured by the same updating procedure as before (see (4)), given that there exists a threshold level of damages above which a PI is sought.²⁴ If no PI is sought, no learning takes place concerning the case strength and the analysis of the previous section continues to hold. Thus, given beliefs about the threshold for filing, the settlement offer derived previously for the case when no PI is sought remains the same (*cf.* Lemma 1).

However, upon filing for a PI, the subsequent hearing and the court's ruling on the request allows litigants to reassess the case strength, which impacts the plaintiff's willingness to settle. Hence, the defendant's settlement offer is influenced by the hearing and the ruling on the PI. Specifically, optimal (interior) settlement offers after a PI is requested are given by

$$SO^{PI}(\hat{x}^c) = \begin{cases} SO^G(\hat{x}^c) := \nu^G(1 - \tau)x^G(\hat{x}^c) - c_p, \\ SO^D(\hat{x}^c) := \nu^D(1 - \tau)x^D(\hat{x}^c) - c_p, \end{cases} \quad (13)$$

with x^G and x^D being implied by (4) in conjunction with (6) when posterior beliefs (12) replace prior beliefs (Lemma 1).

The impact of these settlement offers on the likelihood of the case proceeding to trial is illustrated in Figure 3 and formalized in the following theorem.

Theorem 3 (Out-of-Court Settlement after Learning) *Out-of-court settlement is more likely after a PI is denied and less likely after a PI is granted, compared to the benchmark without learning.*

To understand Theorem 3, note that a plaintiff who is granted the PI is more optimistic about winning the case than a plaintiff who is denied the motion (*i.e.*, $\nu^D < \nu^G$). In response, the defendant makes a higher out-of-court settlement offer upon a grant of the PI. However, since this increased settlement offer must be paid not only to the threshold type, but also to all infra-marginal types, the defendant's equilibrium offer in response to a grant falls short of what would be needed to offset the increased confidence of the threshold type and the overall measure of plaintiff types that are willing to settle is diminished, *i.e.*, $x^G \leq x^D$. Conversely, when a PI is denied it becomes cheaper to buy off the plaintiff and some of the implied savings are used to increase the threshold

²⁴Again, we conjecture at this point that a monotone equilibrium filing decision exists—a conjecture that is verified subsequently.

type who is made an acceptable out-of-court settlement offer. In sum, out-of-court settlement becomes more likely after a PI is denied, whereas settlement is less likely after a PI is granted. In particular then, plaintiff types with damages $x \in [x^G, x^D]$ settle only upon having their PI request denied compared to when a PI is granted.

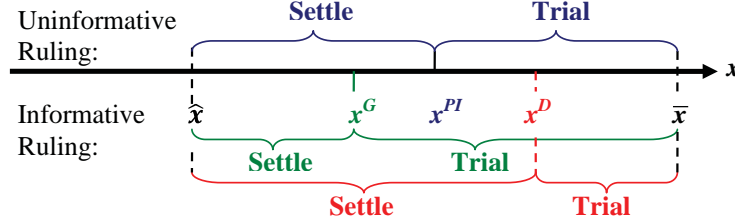


Figure 3: *Out-Of-Court Settlement after Learning*

Theorem 3 suggests that having a high threshold for granting a PI may be advantageous in terms of its facilitation of out-of-court settlement. However, to substantiate this, one needs to solve for the equilibrium *cum* filing decision, since the equilibrium filing decision is made in anticipation of the implications that learning has on subsequent settlement and trial decisions.

4.2 Equilibrium in Anticipation of Learning

We now consider how learning about the case strength on the basis of the court's ruling on the PI affects the signaling equilibrium. The equilibrium is derived as was done previously when there were no informational implications of the court ruling.

Consider first the plaintiff's payoffs. If no PI is sought, no learning takes place concerning the case strength and the analysis of the previous section continues to hold. Thus, payoffs are the same as before and (8) captures the plaintiff's payoffs for the case that no PI is requested. However, the following modification of the plaintiff's payoffs (formerly (9)) after filing for a PI must be made:

$$V^{PI,G} = \begin{cases} V^{G,T}(x) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(1 - \nu^G)x, & x > x^G(\hat{x}^c); \\ V^{G,S}(x|\hat{x}^c) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(x - \nu^G x^G(\hat{x}^c)), & x < x^G(\hat{x}^c), \end{cases} \quad (14)$$

when a PI is granted; whereas

$$V^{PI,D} = \begin{cases} V^{D,T}(x) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(1 - \nu^D)x, & x > x^D(\hat{x}^c); \\ V^{D,S}(x|\hat{x}^c) := \Pi_p - c_{PI} - (1 - \gamma)\tau x - c_p - (1 - \tau)(x - \nu^D x^D(\hat{x}^c)), & x < x^D(\hat{x}^c), \end{cases} \quad (15)$$

when the PI is denied.

Proposition 2 (Existence and Uniqueness with Learning) *When $\tau > \tilde{\tau}$ there exists a unique signaling equilibrium, where $\tilde{\tau}$ is as in Proposition 1.*

To differentiate this case from the model without learning, we denote the critical threshold plaintiff type who is indifferent between filing and not by \hat{x}' . The plaintiff's equilibrium payoff as a function of his type is depicted in Figure 4.

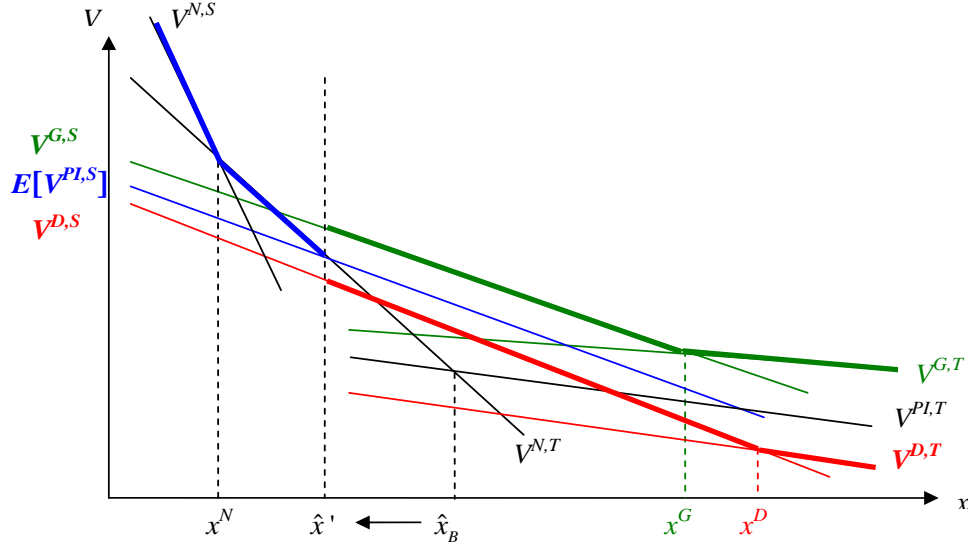


Figure 4: *Plaintiff's Payoffs with Learning depend on the court's ruling for $x \geq \hat{x}'$*

The plaintiff's strategy is given by

$$\text{Filing and Settlement Decisions: } \left\{ \begin{array}{l} PI \\ N \end{array} \right\} \left\{ \begin{array}{l} G \\ D \end{array} \right\} \left\{ \begin{array}{l} T \\ S \end{array} \right\} \begin{array}{l} \left\{ \begin{array}{l} T \text{ for } x > x^G, \\ S \text{ for } x \in (\hat{x}', x^G] ; \end{array} \right. \\ \left\{ \begin{array}{l} T \text{ for } x > x^D, \\ S \text{ for } x \in (\hat{x}', x^D] ; \end{array} \right. \\ \left\{ \begin{array}{l} T \text{ for } x \in (x^N, \hat{x}'] , \\ S \text{ for } x \in [\underline{x}, x^N] . \end{array} \right. \end{array}$$

That is, absent a motion for a PI, the defendant proposes settlement terms which plaintiff types with $x \leq x^N$ accept. Upon filing for a PI, litigants base their subsequent actions on the court's

ruling. If the request is denied, a modest settlement offer is made which nonetheless all but possibly the very highest type accept, as the likelihood of them prevailing at trial is sufficiently diminished. In contrast, upon a grant of the PI, a higher settlement offer is made, which nevertheless is rejected by a greater number of plaintiff types (possibly even all);²⁵ as these now stand a good chance of obtaining a final ruling in their favor.

While the plaintiff's payoffs are affected by the court's ruling because settlement offers and subsequent out-of-court settlement are affected by the court's ruling, this need not impact the incentive to file for a PI in the first place. Indeed, for instance, for a uniform distribution of damages, the decision to file is not affected by the anticipated frequencies α and β , because the expectation of the settlement offer is independent of these. This yields the following theorem.

Theorem 4 (Signaling Independent of Learning) *Despite the fact that learning affects the subsequent settlement decisions, the threshold filing decision can be unaffected by the anticipation of information and learning from the PI hearing and subsequent ruling.*

While the incentive to file is unaffected by the anticipation of learning, this does not imply that the increased likelihood of settling out-of-court upon the denial is offset by the decreased probability of an out-of-court settlement following a granting in terms of the overall probability that the litigants settle out-of-court. In fact, the *ex ante* probability that the case ends in an out-of-court settlement after a PI is filed and ruled upon is unambiguously higher compared to the case where a ruling does not reveal information about the case strength.

Theorem 5 (Increased Out-of-Court Settlement due to Learning) *The overall likelihood of out-of-court settlement when litigants learn about the case strength due to a hearing and ruling on a PI request is strictly greater when compared to the case in which the PI hearing and ruling carry no informational implications when damages are distributed uniformly.²⁶ That is, the decreased expected number of cases settled out-of-court upon a grant is more than offset by the increased expected number of cases that settle following a denial.*

This may be viewed as somewhat surprising, since what is good news for one party is necessarily bad news for the other party so it may not be clear *ex ante* that the overall probability of an out-of-court settlement should be affected by learning. However, the intuition for the result of

²⁵We remark upon such 'corner' settlements in Subsection 5.1.

²⁶Indeed, the result also holds for other distributions, *e.g.*, the power distribution, but in the proof we restrict ourselves to the closed form representations obtained for the uniform distribution.

an increase in the likelihood of out-of-court settlement is directly tied to the insights established by Theorem 3. There it is shown that the defendant is willing to trade off the amount of the settlement offer with the likelihood that settlement takes place. The former affects all plaintiff types who settle (marginal and infra-marginal types); the latter is determined only by the marginal type. Because the number of infra-marginal types is smaller when a PI is denied, the defendant's adjustment towards achieving more out-of-court settlement is more pronounced following a denial of the PI when compared to a grant. Thus, while a ruling in favor of the plaintiff decreases the likelihood of out-of-court settlement, the increased likelihood of out-of-court settlement after a PI denial leads to a greater likelihood of settlement overall—which substantiates Lichtman's assertion, cited in the introduction, that hearings promote settlement.

5 Extensions

5.1 Corner solutions and dropping the case

An immediate implication of learning about the case strength and the resulting shift in settlement offers is that even if interior solutions are assumed for the base model, this assumption need no longer hold. In particular, there are two cases worth discussing. First, when a PI is denied, even the plaintiff type with the highest possible damages \bar{x} may become sufficiently pessimistic about prevailing at trial that he accepts the proposed equilibrium settlement offer, *i.e.*, $\bar{x} \leq x^D$ so the defendant simply buys the plaintiff off. Second, when a PI is granted, the plaintiff's chances at prevailing at trial become so high that no settlement can be reached, *i.e.*, $x^G \leq \hat{x}$ so the defendant and plaintiff automatically proceed to trial without considering settlement.

Thus, whenever the denial of a PI leads to certain settlement, (*i.e.*, $\min \{\bar{x}, x^D(\hat{x}^c)\} = \bar{x}$), then learning leads to fewer plaintiff types filing for a PI (*i.e.*, $\hat{x}' > \hat{x}$). Conversely, if the grant of a PI precludes further settlement (*i.e.*, $\max \{\hat{x}, x^G(\hat{x})\} = \hat{x}$), then learning leads to more plaintiff types filing.

Somewhat distinct from these scenarios is another possibility, namely, that when a PI is granted the defendant's chances of prevailing at trial become so small that she is better off ceasing the disputed behavior and thereby ending the case, *i.e.*, $b \leq \frac{c_d}{1-\nu G}$. While on the surface this may seem to make a filing for a PI more attractive the effect is actually not so clear, since the plaintiff in this case also forsakes a potential settlement offer.

5.2 Legal remedies and injunction bonds

In the main analysis we restrict attention to equitable relief. However, in many cases the party that ultimately prevails at trial may also be entitled to damage awards. Incorporating this in the analysis can affect the parties' incentives to settle or proceed to trial (it may, thus, also affect possible corner solutions), but this would leave the qualitative analysis unaffected. Nevertheless, there are two aspects in which legal remedies specifically affect informational implications of requesting preliminary relief.

First, in some cases a plaintiff who ultimately prevails at trial can also collect damage awards from the defendant in compensation for harm that accrued during the trial phase (treble damages, in fact, in civil antitrust cases). This diminishes the non-strategic incentive for requesting a PI, because anticipated trial-phase damages are effectively reduced to $\tau x - \nu \widetilde{\tau x}$, where $\widetilde{\tau x}$ denotes (the plaintiff's beliefs about) the court's assessment of the damages that are to be reimbursed. The corollary to this reduction in the non-strategic use of PIs is of course that the signaling role of filing for a PI is increased.

Second, sometimes a wrongfully enjoined defendant has a right to compensation from the plaintiff. In particular, when having a preliminary injunction granted, the plaintiff may be asked to post a bond. If the plaintiff prevails at trial (or a settlement agreement is reached) the amount of the bond is returned to the plaintiff. However, if final judgment goes against the plaintiff and it is thus determined that the defendant was wrongfully enjoined, the bond is forfeited and paid out to the defendant to compensate her for the loss of benefits during the trial phase. In our analysis we assumed that no benefits accrue to the defendant during the trial phase, so this point would be moot. If, in departure from this assumption, we require a bond of B to be posted upon the grant of a PI, then this decreases the plaintiff's payoff from requesting a PI by $\gamma(1 - \nu^G)B$. Again, the implication is that the signaling role of filing for a PI becomes more pronounced. However, this is somewhat offset by the newly created incentive of the offensive use of the PI, since now under a grant the defendant is deprived of immediate benefits, which induces a higher settlement offer.

5.3 The British rule in the allocation of litigation costs

Under the American fee rule, each party bears its own litigation costs regardless of the outcome at trial, which has been assumed throughout the paper. Under the alternative British rule, in contrast, the losing party bears all the litigation costs. A change in the governing rule in the allocation of

litigation costs affects the litigants' payoffs and thus their decisions concerning settlement offers and the motion for a PI. Specifically, assuming that trial costs are reimbursed, but costs associated with the PI are not, the plaintiff who goes directly to trial without filing for a PI need not pay his litigation cost c_p if he wins the case, whereas he must additionally bear the defendant's litigation cost c_d given a loss at trial. That is, the rule change from the American to the British rule has the net impact of $\nu^H c_p - (1 - \nu^H) c_d$ on the plaintiff's expected payoff of going to trial, where $H \in \{G, D\}$. Hence, the likelihood of a filing for a PI and of an out-of-court settlement hinge upon the relative magnitude of litigation costs, the prior, and the posterior beliefs. For simplicity, assuming that $c_p = c_d = c$, the rule change has the net impact of $c(2\nu^H - 1)$ on the expected payoff of going to trial. For the case of $c(1 - 2\nu^D) > 0 > c(1 - 2\nu^G)$, the cost-governing rule change from American to British rules can make out-of-court settlement even more likely when a PI is denied, but less likely when it is granted; compared to the previous analysis.

This analysis continues to hold even if some of the costs associated with the PI are also ruled to be reimbursable; although if such a ruling also applies to costs incurred by the defendant (which for simplicity we have assumed to be zero), then the initial filing for a PI and a continuation through trial become less likely as the plaintiff's expected payoffs are diminished accordingly.

6 Conclusion

Corporate litigation is recognized to be an important tool used in competition. In many such instances, such as in civil anti-trust, patent, copyright, trademark, employment and labor relations, and contract cases, preliminary injunctions are an integral part of a litigant's legal strategy. The primary legal rationale for the preliminary injunction is its defensive use to give a plaintiff the opportunity to avert damage that the disputed behavior is causing while the litigants prepare for and pursue a court trial. This motivation is reflected in our model in that plaintiffs with high damages are inclined to file a request for a PI, whereas those with low damages do not. While there has been some discussion of the offensive use of PIs elsewhere, we show that even when considering the defensive use of PIs plaintiffs have an incentive to use the filing of a PI strategically. In particular, our paper is the first to formally model the dissemination of information in the process of the strategic use of preliminary injunctions motions.

We find that when there is private information about the plaintiff's damages, the motion for a PI signals bounds of the damage levels to the defendant. As a result of this, PIs are more

readily requested when compared to the initial motivation that solely relies on the prevention of current damages. While this strategic use, thus, goes beyond the purely defensive role of PIs, this may nonetheless be overall welfare increasing as it can increase the likelihood of an out-of-court settlement. In particular, fewer high-damage cases will be settled out-of-court, but this can be more than offset by a greater number of lower damage cases that settle and no longer burden the courts. However, to conclude that courts should therefore increase their propensity to grant PIs in order to thereby increase the use of PIs is erroneous, because in doing so the signaling value of the filing decision is actually diminished.

In addition to considering signaling motivations as an underlying incentive to file for a PI, we consider the informational effects that arise due to the hearing on the motion and the court's subsequent ruling on the request. In the wake of the hearing on the motion and the court's ruling, litigants are able to glean information about the case strength and, thus, reassess their chances of ultimately prevailing at trial. In particular, when the court declines to enjoin the defendant and denies the request for a PI, litigants' beliefs that the plaintiff will ultimately prevail at trial are diminished. As a consequence, lower settlement offers are made by the defendant, yet these are accepted with greater frequency, precisely because the alternative of continued litigation is less attractive to the plaintiff. Similarly, out-of-court settlements become less likely after a PI is granted by the court as plaintiffs become sufficiently confident of being able to prevail at trial.

While the anticipation of learning about the merits of the case need not affect the primary motivation for filing for a PI, we find that the hearing and the court's ruling nonetheless unambiguously increase the *ex ante* likelihood that litigants will come to an out-of-court settlement, which does suggest that PIs in particular as well as other pre-trial motions in general should possibly be facilitated. However, a simple increase in the likelihood that a PI is granted (*i.e.*, lowering the threshold for granting a PI) may not be effective, since out-of-court settlement becomes less likely after the PI is granted. But, lowering the costs of PI by not forcing the plaintiff to lock in a strategy, say, by bifurcating the trial and having a different judge hear the case after the PI, may help, although this may also result in a diminished role of learning, since now the judge making the final ruling may differ in her assessment from the judge who makes the PI ruling.

The theoretical analysis yields some testable empirical implications. Thus, if it is possible to distinguish between cases with greater and less uncertainty about damages, then the former will more frequently have requests for preliminary relief, since PI filings are also used to overcome uncertainty about damages by signaling bounds on damages. Moreover, if damages can be ascertained

(or reasonable well estimated) *ex post*, *i.e.*, after settlement takes place, then the signaling role of PIs should result in a negative correlation between the incidence of a PI being requested and the terms of settlement, since signaling shifts settlement to lower-damage cases. Lastly, because signaling is tied to the cost of filing for a PI and signaling can increase the likelihood of out-of-court settlement, there should be a positive correlation between the costs incurred in requesting a PI and the subsequent likelihood of settlement.

While empirical predictions tied to signaling may suffer from data limitations in terms of being able to distinguish between different types of cases, the empirical prediction implied by learning is straight forward. Namely, conditioned on a ruling on a given PI request, the incidence of settlement should be more prevalent upon a denial compared to a granting of the PI, because in the former case the defendant exploits the diminished legal position of the plaintiff to achieve more out-of-court settlements.

Appendix of Proofs

Proof of Lemma 1 Note first that since F has the MHRC, so do posterior beliefs F^H , which ensures the uniqueness of x^S for a given history. Moreover, given the assumption that a defendant is willing to make an offer to a plaintiff type who files, but is unwilling to buy him off, an interior solution follows for the history in which a PI was sought. This establishes $SO^{PI}(\hat{x}^c)$.

If a PI is not sought, then surely terms of settlement are proposed. If the condition on the top branch in (7) is met, then no interior solution to the defendant's problem exists, given her beliefs about the threshold for filing. In this case the defendant offers full compensation for the perceived damages. Otherwise the interior solution is implied by the bottom branch. \square

Proof of Proposition 1 (8) and (9) jointly determine the set of all possible critical thresholds \hat{x} that leave the plaintiff indifferent between requesting a PI and not, given any beliefs that the defendant may have. Since a defendant will never offer more than is absolutely necessary to induce the plaintiff to accept a settlement offer, for any set of beliefs $\min \{x^N(\hat{x}^c), \hat{x}^c\} = x^N(\hat{x}^c)$. That is, the threshold plaintiff—when refraining from filing—will at best only just be bought off. Therefore, $V^{N,T}(\hat{x}^c) \geq V^{N,S}(\hat{x}^c|\hat{x}^c), \forall \hat{x}^c$. Moreover, having postulated that the defendant's benefits are sufficiently high to warrant making an offer to the plaintiff who files for a PI, $V^{PI,S}(\hat{x}^c|\hat{x}^c) \geq V^{PI,T}(\hat{x}^c)$. And therefore, in equilibrium, the threshold plaintiff type must be indifferent between going straight to trial without filing for a PI and filing for a PI followed by an out-of-court settlement.

In sum, at the threshold, $V^{N,S}(\hat{x}) \leq V^{N,T}(\hat{x}) = V^{PI,S}(\hat{x})$.

Since, for any beliefs \hat{x}^c , $V^{N,T}$ and $V^{PI,S}$ are linear in x , they intersect only once and whenever $\tau > \frac{\nu}{\gamma+\nu} =: \tilde{\tau}$ the latter is flatter so the monotonicity of the filing decision holds (*i.e.*, Conjecture 1 is verified). Hence, for any belief \hat{x}^c there exists a function that determines the threshold type \hat{x} , call this function $\hat{x} = \theta(\hat{x}^c) : [\underline{x}, \bar{x}] \rightarrow [\underline{x}, \bar{x}]$, which is implied by $V^{N,T}(\theta) = V^{PI,S}(\theta|\hat{x}^c)$, *i.e.*,

$$\hat{x} \equiv \theta(\hat{x}^c) = \frac{c_{PI} - \nu(1-\tau)x^{PI}(\hat{x}^c)}{\gamma\tau - \nu(1-\tau)}, \quad (16)$$

where from (6) in conjunctions with (4) $x^{PI}(\hat{x}^c)$ is implied by

$$Z(x^{PI}, \hat{x}^c) := \frac{\nu b + c_d + c_p}{\nu(1-\tau)} - \frac{F(x^{PI}) - F(\hat{x}^c)}{f(x^{PI})} - x^{PI} = 0.$$

Since the density of prior beliefs is continuous, $x^{PI}(\hat{x}^c)$ is continuous, and therefore so is $\theta(\hat{x}^c)$. Hence, by Brouwer's fixed point theorem there exists an equilibrium. Moreover, $\frac{dx^{PI}}{d\hat{x}^c} = -\frac{Z_{\hat{x}^c}}{Z_{x^{PI}}}$ is positive, since the denominator is negative by the sufficiency of the defendant's first-order-condition, due to the MHRC, and the numerator is positive, since $\frac{f(\hat{x}^c)}{f(x^{PI})} > 0$. Hence $\theta(\cdot)$ is downward sloping and thus the fixed point giving the equilibrium is unique. \square

Proof of Theorem 1 Note that (16) can be rearranged to yield

$$\hat{x} = \frac{c_{PI}}{\gamma\tau} - \frac{\nu(1-\tau)}{\gamma\tau}(x^{PI} - \hat{x}) < \frac{c_{PI}}{\gamma\tau} = \hat{x}_B, \quad (17)$$

implying that plaintiffs of type $x \in [\hat{x}, \hat{x}_B)$ use the filing for a PI as a means to signal to the defendant that they do not have low damages. \square

Proof of Theorem 3 The MHRC on the distribution of damage levels implies that $x^G \leq x^D$, as can be seen when substituting ν^G and ν^D for ν in (6). Hence plaintiff types with damages $x \in [x^G, x^D]$ settle only upon having their PI request denied compared to when a PI is granted. \square

Proof of Proposition 2 The method of proof is as before. In determining the threshold plaintiff type who is indifferent between requesting a PI and proceeding straight to trial, the relevant payoff used to determine the filing decision is given by the expectation across (14) and (15), as the filing decision necessarily precedes the court's ruling on the PI. Consequently, noting that $\gamma\nu^G = \nu(1-\alpha)$ and $(1-\gamma)\nu^D = \nu\alpha$ from (12),

$$E[V^{PI,S}] = \Pi_p - c_{PI} - (1-\gamma)\tau x - c_p - (1-\tau)(x - \nu((1-\alpha)x^G(\hat{x}^c) + \alpha x^D(\hat{x}^c))). \quad (18)$$

After setting $V^{N,T}(\theta) = E[V^{PI,S}(\theta|\hat{x}^c)]$, the remainder of the proof follows the proof of Proposition 1 *mutatis mutandis*. \square

Proof of Theorem 4 We prove the theorem using the case of uniformly distributed damages, but the result also applies to other distributions. Recall from (17) that for the case without learning

$$\hat{x} = \frac{c_{PI}}{\gamma\tau} - \frac{\nu(1-\tau)}{\gamma\tau}(x^{PI} - \hat{x}).$$

In contrast, when there is learning, \hat{x}' is implied by (8) and (18). Specifically, $V^{N,T}(\hat{x}') = E[V^{PI,S}(\hat{x}'|\hat{x}')]$, yields

$$\hat{x}' = \frac{c_{PI}}{\gamma\tau} - \frac{\nu(1-\tau)}{\gamma\tau}((1-\alpha)x^G + \alpha x^D - \hat{x}'). \quad (19)$$

From (6) the cut-off for out-of-court settlement given a uniform distribution of damages is of the same form independent of learning and is given by

$$x^H = \frac{1}{2} \left(y + \frac{\nu^H b + c_d + c_p}{\nu^H(1-\tau)} \right); \quad y \in \{\hat{x}, \hat{x}'\}. \quad (20)$$

Thus, using (12),

$$\begin{aligned} (1-\alpha)x^G + \alpha x^D &= \frac{1}{2} \left(\hat{x}' + (1-\alpha) \frac{\nu^G b + c_d + c_p}{\nu^G(1-\tau)} + \alpha \frac{\nu^D b + c_d + c_p}{\nu^D(1-\tau)} \right) \\ &= \frac{1}{2} \left(\hat{x}' + \gamma \frac{\nu b + c_d + c_p}{\nu(1-\tau)} + (1-\gamma) \frac{\nu b + c_d + c_p}{\nu(1-\tau)} \right); \end{aligned} \quad (21)$$

and by substituting back into (19) and comparing to (17), it follows that $\hat{x} = \hat{x}'$. \square

Proof of Theorem 5 For the uniform distribution the *ex ante* likelihood of out-of-court settlement after filing is directly proportional to x^H . For the case with learning the expected probability of an out-of-court settlement after filing is therefore proportional to $\gamma x^G + (1-\gamma)x^D$; whereas it is similarly proportional to x^{PI} for the case without learning. Now notice that starting from (20) and using the fact that $\hat{x} = \hat{x}'$, from Theorem 4

$$\begin{aligned}
& \gamma x^G + (1 - \gamma)x^D > x^{PI} \\
\iff & \frac{\gamma}{\nu^G} + \frac{1-\gamma}{\nu^D} > \frac{1}{\nu} \\
\iff & \frac{\gamma^2}{1-\alpha} + \frac{(1-\gamma)^2}{\alpha} > 1 \\
\iff & \gamma^2\alpha + (1 - \gamma)^2(1 - \alpha) > (1 - \alpha)\alpha \\
\iff & (1 - (\gamma + \alpha))^2 > 0,
\end{aligned}$$

and the result follows. \square

References

- [1] Bebchuk, L., 1984, “Litigation and Settlement under Imperfect Information,” *RAND Journal of Economics*, 15, 404–415.
- [2] Bizjak, J. M. and Coles, J. L., 1995, “The Effect of Private Antitrust Litigation on the Stock-Market Valuation of the Firm,” *American Economic Review*, 85(3), 436–461.
- [3] Boyce, J. R. and Hollis, A., 2007, “Preliminary Injunctions and Damage Rules in Patent Law,” *Journal of Economics & Management Strategy*, 16(2), 385–405.
- [4] Briggs, H. C., Huryn, K. D. and McBride, M. E., 1996, “Treble damages and the incentive to sue and settle,” *RAND Journal of Economics*, 27(4), 770–786.
- [5] Brooks, R. R. W. and Schwartz, W. F., 2005, “Legal Uncertainty, Economic Efficiency, and the Preliminary Injunction Doctrine,” *Stanford Law Review*, 58(2), 381–409.
- [6] Choi, J. P., 1998, “Patent Litigation as an Information-Transmission Mechanism,” *American Economic Review*, 88(5), 1249–1263.
- [7] Choné, P. and Linnemer, L., 2010, “Optimal Litigation Strategies with Observable Case Preparation,” *Games and Economic Behavior*, 70(2), 271–288.
- [8] Cunningham, M. A., 1995, “Preliminary Injunctive Relief in Patent Litigation,” *IDEA: The Journal of Law and Technology*, 213–237.
- [9] Daughety, A. F. and Reinganum, J. F., 2002, “Informational Externalities in Settlement Bargaining: Confidentiality and Correlated Culpability,” *RAND Journal of Economics*, 33(4), 587–604.

- [10] Daughety, A. F. and Reinganum, J. F., 2008, “Settlement,” to appear in: C. W. Sanchirico [ed.], *Encyclopedia of Law and Economics*, Vol. 10, Edward Elgar, forthcoming.
- [11] Farrell, J. and Merges, R. P., 2004, “Incentives to Challenge and Defend Patents: Why Litigation Won’t Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help,” *Berkeley Technology Law Journal*, 19(3), 943–970.
- [12] Grossman, G. M. and Katz, M. L., 1983, “Plea Bargaining and Social Welfare,” *American Economic Review*, 73(4), 749–57.
- [13] Johnson, R. M., 2002, “An Alternative Approach to Seeking a Preliminary Injunction in a Patent Infringement Action,” Ladas & Parry, New York.
- [14] Lanjouw, J. O. and Lerner, J., 2001, “Tilting The Table? The Use of Preliminary Injunctions,” *Journal of Law and Economics*, 44, 573–603.
- [15] Lemley, M. A. and Shapiro, C., 2005, “Probabilistic Patents,” *Journal of Economic Perspectives*, 19(2), 75–98.
- [16] Lewis, O. H., 1993/94, “ ‘The Wild Card That Is the Public Interest:’ Putting a New Face on the Fourth Preliminary Injunction Factor,” *Texas Law Review*, 72, 849–892.
- [17] Leubsdorf, J., 1978, “The Standard for Preliminary Injunctions,” *Harvard Law Review*, 91, 525–566.
- [18] Leubsdorf, J., 2007, “Preliminary Injunctions: In Defense of the Merits,” *Fordham Law Review*, 76, 33–47.
- [19] Lichtman, D., 2003, “Uncertainty and the Standard for Preliminary Relief,” *University of Chicago Law Review*, 70(1), 197–214.
- [20] Meurer, M. J., 1989, “The settlement of patent litigation,” *RAND Journal of Economics*, 20, 77–91.
- [21] Nalebuff, B., 1987, “Credible Pretrial Negotiation,” *RAND Journal of Economics*, 18, 198–210.
- [22] P’ng, I., 1983, “Strategic Behavior in Suit, Settlement, and Trial,” *Bell Journal of Economics*, 14, 539–550.

- [23] Posey, L. L., 1998, “The Plaintiff’s Attorney in the Liability Insurance Claims Settlement Process: A Game Theoretic Approach,” *Journal of Insurance Issues*, 21(2), 119–137.
- [24] Reinganum, J. and Wilde, L., 1986, “Settlement, Litigation, and the Allocation of Legal Costs,” *RAND Journal of Economics*, 17, 557–566.
- [25] Samuelson, P. and Bebenek, K., 2009, “Why Plaintiffs Should Have to Prove Irreparable Harm in Copyright Preliminary Injunction Cases,” *Journal of Law & Policy for the Information Society*, Vol. 5.
- [26] Shapiro, S. E., 1993, “Preliminary Injunction Motions in Patent Litigation,” *IDEA: The Intellectual Property Law Review*, 33(2), 323–348.
- [27] Shehaded, R. and Stewart, M. B., 2001, “An Economic Approach to the ‘Balance of Hardships’ and ‘Public Interest’ Tests for Preliminary Injunction Motions in Patent Infringement Cases,” *Journal of the Patent and Trademark Office Society*, 83, 341–357.
- [28] Spier, K. E., 1992, “The Dynamics of Pretrial Negotiation,” *Review of Economic Studies* 59(1), 93–108.
- [29] Spier, K. E., 2007, “Litigation,” in: A. M. Polinsky and S. Shavell [eds.], *Handbook of Law and Economics*, Vol. 1, Elsevier.