Discussion Paper Series

2009 – 11

Department of Economics
Royal Holloway College
University of London
Egham TW20 0EX

Signaling, Learning and Screening Prior to Trial: A Theory of Preliminary Injunctions*

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June 23, 2009

Abstract

The decision to request a preliminary injunction—a court order that bans a party from certain behavior until its lawfulness is 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, settlement

JEL classifications: D8, K21, K41, K42

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 for the period 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, as well as is labor and contract law.

A few particularly prominent cases in which preliminary injunctions played a role include a 1997 trademark case brought against Microsoft by Sun Microsystems alleging that MS distributed Internet Explorer 4.0 using the Java Compatible Logo without having passed all compatibility tests—several preliminary injunctions 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 Donatelli 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 Associations 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 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. And 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 prior to a final ruling.

When a plaintiff requests a PI the court weighs four factors in determining how to rule on the motion: (1) the probability that 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 degree to which the plaintiff must establish a likelihood of success at trial, traditionally the threshold for granting a preliminary injunction 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."[2] Moreover, rather than a sequential testing of the four factors, many courts determine the relevant threshold on the merits of the case only in conjunction with the balance of harm (the third criterion). Thus, if the expected damages from an erroneous denial outweigh the expected damages from an erroneous grant, the balance

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

[2]Cf. 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.

tips in favor of granting the request.[3]

Irreparable harm is immediate if, for example, the plaintiff is at risk of going bankrupt or the defendant may become judgement 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, confusion in the market place, or the encouragement of others to infringe.[4] 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; see also Lichtman, 2003).

The most important issue concerning the public interest is upholding the law, which is addressed in the first criterion (see, e.g., Cunningham, 1995).[5] Hence the fourth criterion generally addresses how nonparties are affected by the PI. Indeed, some argue that the fourth and third criteria be merged to assess the overall effect of a ruling on potential harm (see, e.g., Lewis, 1993/94). In the areas of interest to us, however, the public interest rarely determines a ruling on the PI.[6]

While corporate litigation is recognized as an important tool in strategic competition,[7] despite the importance and frequent use of preliminary injunctions in court proceedings, the analysis of preliminary injunctions as an integral part of a plaintiff's

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[3]This 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."

[4]See 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).

[5]For instance, in the Plavix case mentioned earlier 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."

[6]Cases 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).

[7]See, 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.

strategy at trial has by-and-large been eschewed in the economics literature on litigation. A notable exception to this is Lanjouw and Learner's (2001) study on patent infringement litigation. While they acknowledge the important informational roles of PIs,[8] 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 preliminary injunction 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 analysis of 252 patent infringement suits.[9]

Outside of the economics literature 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 in passing 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 preliminary injunctions, as both move into other directions.[10]

We consider the informational implications of preliminary injunctions when there

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[8]They 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).

[9]Another study is Boyce and Hollis (2007), who model how preliminary injunctions in patent cases can be used to take advantage of damage rules when there is no uncertainty about player's payoffs.

[10]Lichtman considers how a particular form of uncertainty about damage levels affects normative implications of the Learned Hand 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.

is uncertainty about the plaintiff's damages and the litigants are unsure about the case strength. Specifically, a plaintiff's request for a PI reveals information about the plaintiff; and the hearing and subsequent ruling on the request reveal information about the merits of the case. 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.[11] 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. If the plaintiff accepts the given settlement offer, the case ends, otherwise it proceeds to trial.

The plaintiff's motion for a PI prior to trial plays several informational roles. First, in Section 3, it is demonstrated that the filing for a PI reveals information about the damage level suffered by the plaintiff, which has an impact on settlement offers. We find that the plaintiff is more inclined to move for a PI with this informational aspect considered compared to the case without such consideration. There always exists such plaintiff types, who would have not filed for a PI without the defendant's learning about the plaintiff's decision of whether or not he moved for a PI, yet now chooses to file for a PI, because by doing so he is offered a higher settlement offer from the defendant. This reveals a *signalling* 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. Interestingly, we show that due to this strategic use of PIs the number of cases that are settled out of

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[11]There 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 the size of those who do not file in terms of cash and equivalents and other measures. (Hence, some practitioners caution against the use of PIs due to their costs (see, e.g., Johnson, 2002).)

court increases, which may result in substantial savings of litigation and court costs.[12]

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. 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 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.

The paper ends with some discussions and extensions of the model in Section 5, where we consider corner solutions in settlement negotiations, the option of dropping the case, the effect of legal remedies, the British rule of cost compensation, and biases in beliefs about the case strength. This is followed by some general concluding remarks in Section 6.

2   The Basic Model

The legal conflict under consideration involves a plaintiff firm and a defendant firm, both of whom are risk neutral. Absent the legal dispute firms earn a constant discounted profit stream denoted by Π_i; where $i \in \{p, d\}$, with p and d being mnemonics for the plaintiff and defendant. The conflict begins when the defendant is about to embark on allegedly unlawful actions that adversely affect the plaintiff firm, e.g., a purported patent-, copyright-, trademark-infringement, or actions in violation of civil anti-trust or labor laws, or a breach of contract. Due to the actions of the defendant, the plaintiff suffers unverifiable damages of x. The extent of the damages are pri-

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[12]These findings echo those of Posey (1998), who studies the signalling value of hiring an attorney in insurance claims cases and Choné and Linnemer (2008), who consider signaling through pretrial investment in case preparation, which results in augmented expected damage awards by a fixed factor.

vate information of the plaintiff; the defendant knows only the distribution of possible damages, denoted by $F(x)$ with differentiable density $f(x)$ on $[\underline{x}, \overline{x}]$, where $F(x)$ is non-atomistic and satisfies the monotone hazard rate condition (MHRC). The distribution $F(\cdot)$ may either reflect *a priori* damages, or can be the result of remaining uncertainty after previous unsuccessful settlement negotiations. In contrast, the defendant's overall benefit from the action taken, denoted by b, is assumed to be common knowledge.[13]

We consider a three period interaction between the litigants. Litigation takes place in the first two periods: a pre-trial phase and the actual trial (which commences should settlement not be reached during the pre-trial phase) followed by the post-trial phase. For simplicity, we assume that no damages (benefits) occur during the pre-trial phase, as these would be sunk in any event and therefore not affect the litigants' strategies. However, in the pre-trial phase the plaintiff firm may request a preliminary injunction (PI) to enjoin the defendant firm, in which case the plaintiff incurs a cost for legal proceedings of c_{PI}. A portion $\tau \in (0,1)$ of the total damages (benefits) from the action accrue during the main trial phase and are thus subject to the PI, whereas the remainder $1 - \tau$ proportion of damages (benefits) accrue in the final period and are thus the subject of the possible final litigation.[14]

The court's judgment in response to the filing is immediate. That is, injunctive relief is either temporarily granted or denied instantaneously. 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. If the plaintiff accepts the given settlement offer, the game ends with an out-of-court settlement.[15] Otherwise the second phase is

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[13]This assumption is made for simplicity and does not carry any implications for our analysis, since the size of b has no direct bearing on the strategic use of the PI for informational purposes.

[14]For expositional ease and without loss of generality we assume that no costs are incurred by the defendant firm in the course of a PI hearing. Also, it need not be the case that τ applies equally to x and b, that is, the proportion of damages that accrue in the trial phase may be greater for one or the other. However, as the main insights of the analysis are unaffected by such a differentiation we let τ apply uniformly across parties.

[15]Indeed, it is not unusual for a trial to be agreed to be stayed after a PI ruling specifically in order to give the litigants a chance to come to 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.

entered during which 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. The court rules either in favor of the plaintiff by permanently enjoining the defendant firm, or it rules in favor of the defendant, thereby determining the allocation of the final portion of $1 - \tau$ of damages and benefits.[16] Figure 1 summarizes the timing and the structure of the legal proceedings that we consider.
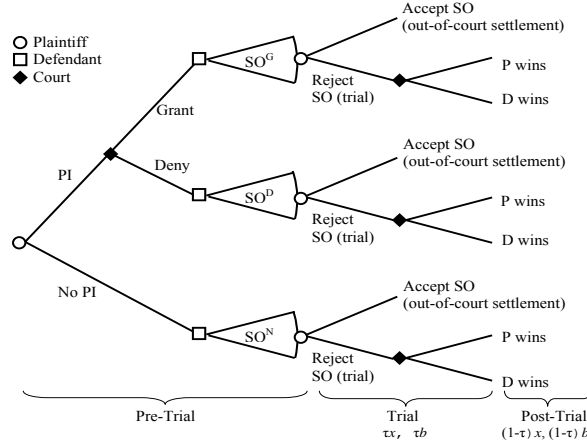

Figure 1: *Structure of the Game*

There are two possible underlying states concerning the case in question. In the "valid" state, the plaintiff wins if it comes to a final ruling at trial; whereas in the "invalid" state the court—when called upon—finds in favor of the defendant. Let ν denote the prior probability that both parties commonly hold that the case will prove to be valid if the case proceeds through to a final finding at trial, so the litigants' expected probabilities of prevailing in court are ν and $1 - \nu$, respectively.

If called upon to rule on a requested PI, the court weighs the relevant factors discussed in the introduction. Each party expects that a request for a PI is granted with probability γ, which need not coincide with ν. Initially we assume that the

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[16]Thus, we are considering equitable, rather than legal relief. Explicitly considering legal remedies in our setting can be done, but comes at the modeling expense of increasing the notational burden without altering the main insights; and while assuming legal relief in addition to equitable relief comes closer to some settings of interest, in the data considered in Bizjak and Coles (1995), for instance, only thirty percent of cases are brought with a request for monetary damages.

hearing and the ruling on the PI does not generate information that is relevant beyond the request itself—that is, the beliefs about the validity of the case are unaffected by the court's ruling on a PI. This assumption is dropped in Section 4, where it is assumed that the hearing and the court's ruling on the PI allow the 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 a final ruling at trial.

We conclude with a final assumption that assures that litigation is a credible option for both parties. For the plaintiff this is the case regardless of his damage-level x, provided that he seeks to establish a tough reputation vis-à-vis other potential infringers. For the defendant litigation is credible whenever the cost of litigation is smaller than his potential gain from his actions weighted by the probability that he prevails in court.

Before presenting informational concerns that arise in filing for a preliminary injunction we briefly consider the plaintiff's basic (i.e., 'defensive') motivation for filing for a PI.[17] 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 preliminary injunction whenever

$$\Pi_p - c_{PI} - (1 - \gamma)\tau x > \Pi_p - \tau x$$

$$\Longleftrightarrow \qquad c_{PI} < \gamma\tau x. \tag{1}$$

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

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[17]The defensive use of PIs concern exclusively the attempt at preventing current damages. This is in contrast to the 'offensive' use, in which the request is designed to harm the defendant. The model by Lanjouw and Learner (2001), for example, concerns the latter use of PIs.

sought, the benchmark motivation for filing for a PI is given by

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

where PI designates that a request is filed, whereas N identifies the case in which no PI is sought, and $\hat{x}_B$ denotes the threshold (benchmark) level of damages above which a PI is sought. 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 Signalling 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 required to request a preliminary injunction, 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. And because filing for a PI affects the possible terms of a settlement, the plaintiff 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 given the assumption 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 the following monotonicity assumption, which is verified in equilibrium.

Assumption 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 the trial. At this stage the proportion τ of damages (benefits) are sunk so that proposed settlement offers concern the remaining $(1 - \tau)$ proportion of damages (benefits) that are yet to accrue.

In order 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 a settlement offer of SO his payoff is the amount of the settlement offer diminished by the future losses incurred due to the continued actions of the defendant firm, i.e., $V^S = \Pi_p + SO - (1 - \tau)x$, where the superscript S denotes the out-of-court settlement.

In contrast, if the plaintiff proceeds to trial his payoff consists of the costs of litigation and the costs associated with a possible ruling against him at court. 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

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

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

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 his benefit of $(1 - \tau)b$, yielding a payoff of $\Pi_d - SO + (1 - \tau)b$. If settlement is not reached, the defendant incurs litigation costs, but stands a chance to prevail at trial so that the defendant's payoff is $\Pi_d - c_d + (1 - \nu)(1 - \tau)b$.

In light of the defendant's uncertainty about the plaintiff's damages, the defendant must estimate the likelihood that a given settlement offer is accepted in order to determine the optimal offer. Given Assumption 1, the defendant updates his beliefs about

the damage level suffered by the plaintiff upon observing the plaintiff's decision on whether or not 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

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

Give these beliefs, the (subjective) probability that a plaintiff accepts a given settlement offer SO is thus given by $F^H\left(x^S\right)$, yielding the defendant's (history dependent) expected payoff from making a settlement offer SO;

$$\Pi_d + F^H\left(x^S\right)\left(-SO + (1-\tau)b\right) + \left(1 - F^H\left(x^S\right)\right)\left(-c_d + (1-\nu)(1-\tau)b\right). \tag{5}$$

It is worth noting that if the defendant's benefits are very large, his strategy is to simply buy off the plaintiff. Also, if his benefits are very low, he will not make any settlement offer to a plaintiff who has revealed relatively high damages by filing for a preliminary injunction. 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 he will propose. 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

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

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

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

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

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

Proof. 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 his 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. ∎

Lemma 1 shows how a defendant's optimal settlement offer is affected by his 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 his 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, the plaintiff 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,

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

where the superscript S at the end 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. If on the other hand 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 $x \le x^{PI}$. Hence, letting V^{PI} denote the plaintiff's expected continuation payoff when requesting a PI,

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

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

3.3 Signalling Equilibrium

Having derived the litigants' incentives, we now consider the equilibrium and demonstrate the existence and uniqueness of a signalling 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 $\tilde{\tau}$ such that whenever $\tau > \tilde{\tau}$, there exists a unique sequential equilibrium.*

Proof. (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 $\min\left\{x^N(\hat{x}^c), \hat{x}^c\right\} = x^N(\hat{x}^c)$. 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, any 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, i.e., at the threshold $V^{N,T}(\hat{x}) = V^{PI,S}(\hat{x})$.

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., Assumption 1 is verified). Hence, for any belief $\hat{x}^c$ there exists a function that determines the threshold type $\hat{x}$, call this function $\hat{x} = \theta(\hat{x}^c) : [\underline{x}, \overline{x}] \to [\underline{x}, \overline{x}]$, which is implied by $V^{N,T}(\theta) = V^{PI,S}(\theta|\hat{x}^c)$, i.e.,

$$\hat{x} \equiv \theta(\hat{x}^c) = \frac{c_{PI} - \nu(1-\tau)x^{PI}(\hat{x}^c)}{\gamma\tau - \nu(1-\tau)}, \tag{10}$$

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

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

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, $\frac{dx^{PI}}{d\hat{x}^c} = -\frac{X_{\hat{x}^c}}{X_{x^{PI}}}$ 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 $\frac{f(\hat{x}^c)}{f(x^{PI})} > 0$. Hence $\theta(\cdot)$ is downward sloping and thus the fixed point giving the equilibrium is unique. ∎

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 order to prevent 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

$$\text{Filing and Settlement Decisions:} \quad \begin{cases} PI & \begin{cases} T & \text{for } x \in \left(x^{PI}, \overline{x}\right], \\ S & \text{for } x \in \left(\hat{x}, x^{PI}\right]; \end{cases} \\ N & \begin{cases} T & \text{for } x \in \left[x^N, \hat{x}\right], \\ S & \text{for } x \in \left[\underline{x}, x^N\right). \end{cases} \end{cases}$$
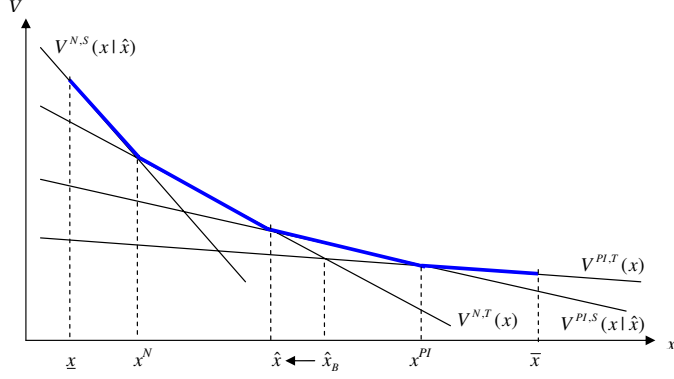
Figure 2: *Plaintiff's Payoff:* $V(x) = \max\left\{V^{N,S}(x|\hat{x}), V^{N,T}(x), V^{PI,S}(x|\hat{x}), V^{PI,T}(x)\right\}$

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.

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

Proof. Note that (10) can be rearranged to yield

$$\hat{x} = \frac{c_{PI}}{\gamma\tau} - \frac{\nu(1-\tau)}{\gamma\tau}(x^{PI} - \hat{x}) < \frac{c_{PI}}{\gamma\tau} = \hat{x}_B, \tag{11}$$

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. ∎

The intuition behind the signalling aspect of the equilibrium is that filing for a PI separates the plaintiff types into two groups. The group that incurred the cost of filing for a PI are offered better settlement terms. 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 order to obtain 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 $x \in [\hat{x}_B, x^{PI}]$

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file for a PI and then subsequently settle, these are not engaged in signalling, as they would have incurred the cost of filing for a PI even absent any potential settlement. In sum, whenever $\hat{x} \leq x < \hat{x}_B$ the plaintiff incurs the cost associated with requesting a preliminary injunction, not in order to ward off current harm due to the action of the defendant, but rather as a means of obtaining more favorable settlement terms from the defendant in the pre-trial phase, as the costly filing decision is a credible way to signal that the plaintiff's damages are not low.

A concern encountered in all signalling models are potential welfare losses implied by costly signalling. Due to the important defensive role of PIs in the non-signalling ranges of damages, eliminating the option of PIs in order to prevent potentially costly signalling associated with the possibility of filing for a PI is not an appropriate benchmark consideration for welfare implications of the strategic (i.e., signalling) use of filing for PIs. However, in order to ascertain welfare implications of signalling it is worth considering how the case plays out when litigants are myopic and are unaware of the potential strategic signalling use of filing for a PI. Remarkably, such a comparison reveals that the overall welfare effects of the signalling use of filing for a PI may be positive.

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

$$\frac{F\left(\hat{x}_B\right) - \max\left\{F\left(\hat{x}\right), F\left(x^N\right)\right\}}{F\left(x_B^{PI}\right) - F\left(x^{PI}\right)} > 1, \tag{12}$$

where x_B^{PI} 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 in the signalling equilibrium the threshold for filing is lower than in the non-signalling benchmark. On the one hand this has the effect of lowering the settlement offer to plaintiff types that file. As a result of this out-of-court settlement becomes less likely among those who file for a PI 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 signalling 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 $x \in \left[\max\left\{x^N, \hat{x}\right\}, \hat{x}_B\right]$ settle only in the signalling equilibrium, whereas in the benchmark they proceed to trial. Whenever the mass of (intermediate-damage) plaintiff types who end up settling (solely) due to signalling (i.e., the numerator of (12)) outweighs the mass of (high-damage) plaintiff types who no longer are made an acceptable settlement offer (i.e., the denominator of (12)), the overall welfare effects of signalling are positive, as signalling increases the likelihood of out-of-court settlement and, thus, reduces the costs associated with proceeding to trial.[18] The incidence of increased settlement due to signalling is illustrated in the following example.

Example of Welfare Increase Consider a uniform distribution of damages, i.e., $F(x) = \frac{x - \underline{x}}{\overline{x} - \underline{x}}$ and suppose that $\tau > \tilde{\tau}$. Then $x_B^{PI} = \frac{1}{2}\left(b + \hat{x}_B + (c_p + c_d)/\nu(1-\tau)\right)$ and $x^{PI} = \frac{1}{2}\left(b + \hat{x} + (c_p + c_d)/\nu(1-\tau)\right)$ so the welfare losses associated with high damage plaintiff types who no longer settle out-of-court are proportional to $F\left(x_B^{PI}\right) - F\left(x^{PI}\right) = \frac{x_B^{PI} - x^{PI}}{\overline{x} - \underline{x}} = \frac{1/2(\hat{x}_B - \hat{x})}{\overline{x} - \underline{x}}$. Moreover, a sufficient condition for there to be an increase in welfare is that $\hat{x} > x^N$,[19] since then the gains for intermediate range plaintiff types who now settle are proportional to $F\left(\hat{x}_B\right) - F\left(\hat{x}\right) = \frac{\hat{x}_B - \hat{x}}{\overline{x} - \underline{x}}$, yielding a net welfare gain that is proportional to $\frac{1/2(\hat{x}_B - \hat{x})}{\overline{x} - \underline{x}} > 0$.

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[18]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 signalling has the added beneficial effect of shifting settlement towards lower-damage cases, with a greater number of high-damage cases obtaining a final ruling in the court.

[19]The necessary and sufficient condition is that $\frac{1}{2}\left(\hat{x}_B + \hat{x}\right) > x^N$.

4 The Extended Model: Learning

Thus far it has been assumed that a hearing on a PI 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's ruling is generally regarded as being indicative of the final ruling that the court makes if the case proceeds to trail. Nevertheless, as the court does not yet have full information concerning the underlying facts of the case and their legal implications as these are to be fully developed in the course of further discovery, the ruling on preliminary injunctive relief cannot be a prefect predictor of the final finding. The court's ruling on the PI may in hindsight be considered erroneous if the ruling on the PI differs from the final adjudication. In this sense we speak of court errors,[20] which we formalize by considering two possible types of errors on the PI ruling. Injunctive relief is preliminarily denied with probability $\alpha \, (\geq 0)$, even when the true state is valid. That is, the court mistakenly denies the requested preliminary injunction with probability α, even though the court would rule in favor of the plaintiff upon further consideration at trial. Another type of error is that the preliminary injunction is granted with probability $\beta \, (\geq 0)$, even though the true state is invalid so that the court will eventually not enjoin the defendant firm.[21] Table 1 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 possible court errors in the ruling on a PI, the probability that a PI is

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[20]This language is in keeping with the Leubsdorf-Posner balancing rule for granting PIs.

[21]The first type or error is referred to as Type-I error, false positive or α error, while the second one is called a Type-II error, false negative, or β error. Our notation reflects the third convention.

granted when it is filed is

$$\gamma := \nu(1 - \alpha) + (1 - \nu)\beta. \tag{13}$$

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 (instantaneous) ruling on the injunction 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

$$\nu^H = \begin{cases} \frac{(1-\alpha)\nu}{\nu(1-\alpha)+(1-\nu)\beta} = \frac{1-\alpha}{\gamma}\nu, & \text{for } H = G, \\[2mm] \frac{\alpha\nu}{\nu\alpha+(1-\nu)(1-\beta)} = \frac{\alpha}{1-\gamma}\nu, & \text{for } H = D, \\[2mm] \nu & \text{for } H = N. \end{cases} \tag{14}$$

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 implies that the joint error rates must be less than one, i.e., $\alpha + \beta < 1$.

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.[22] If no PI is sought, no learning takes place concerning the case strength and the analytics of the previous section continue to hold. Thus, given beliefs about the threshold for filing, the settlement offer derived previously for the case when no PI is sough remains the same (cf. Lemma 1).

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[22]Again, we assume at this point that a monotone equilibrium filing decision exists—an assumption that is verified subsequently.

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

$$SO^{PI}(\hat{x}^c) = \begin{cases} SO^G(\hat{x}^c) := \nu^G(1-\tau)x^G(\hat{x}^c) - c_p, \\ SO^D(\hat{x}^c) := \nu^D(1-\tau)x^D(\hat{x}^c) - c_p, \end{cases} \qquad (15)$$

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

The impact of the these settlement offers on the likelihood of the case proceeding to trial are captured 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.*

Proof. 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 $x \in \left[x^G, x^D\right]$ settle only upon having their PI request denied compared to when a PI is granted. ∎

To understand Theorem 3, note that the plaintiff faces two altered circumstances once the court has ruled on a request for a preliminary injunction. First, a plaintiff who is denied the PI is less optimistic about winning the case than a plaintiff who is granted the motion (i.e., $\nu^D < \nu^G$)—this suggests that he is less likely to reject any given settlement offer. Second, however, as a result of this, the unsuccessful plaintiff obtains a lower settlement offer compared to the successful plaintiff—leading to a decreased incentive to settle. In both cases—denial and grant—the former effect dominates the latter, so that $x^G \leq x^D$, and settlement becomes more likely after a PI is denied.

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 signalling equilibrium. The equilibrium is derived as was done previously when there were no informational implications of the court ruling. To this end, one must first determine the plaintiff's payoffs.

If no PI is sought, no learning takes place concerning the case strength and the analytics of the previous section continue to hold. Thus, payoffs are the same as before and (8) still 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:

$$
V^{PI,G} = \begin{cases} V^{G,T}(x) := \Pi_p - c_{PI} - (1-\gamma)\tau x - c_p - (1-\tau)\left(1-\nu^G\right)x, & x > x^G(\hat{x}^c); \\ V^{G,S}(x|\hat{x}^c) := \Pi_p - c_{PI} - (1-\gamma)\tau x - c_p - (1-\tau)\left(x - \nu^G x^G(\hat{x}^c)\right), & x < x^G(\hat{x}^c), \end{cases}
$$
(16)

when a PI is granted; whereas

$$
V^{PI,D} = \begin{cases} V^{D,T}(x) := \Pi_p - c_{PI} - (1-\gamma)\tau x - c_p - (1-\tau)\left(1-\nu^D\right)x, & x > x^D(\hat{x}^c); \\ V^{D,S}(x|\hat{x}^c) := \Pi_p - c_{PI} - (1-\gamma)\tau x - c_p - (1-\tau)\left(x - \nu^D x^D(\hat{x}^c)\right), & x < x^D(\hat{x}^c), \end{cases}
$$
(17)

when the PI is denied.

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

Proof. 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

(16) and (17), 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 (14),

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

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

In order 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 3.
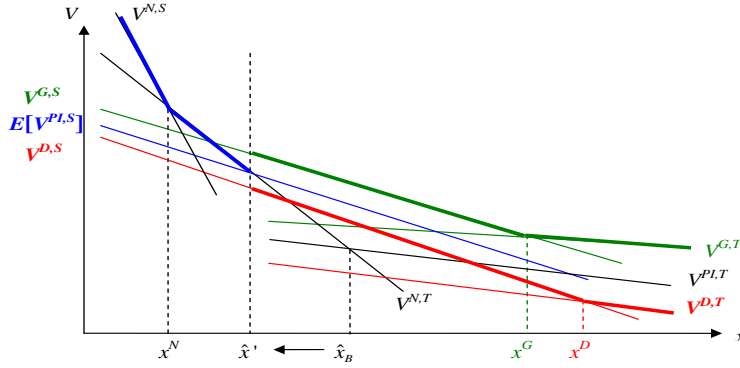

Figure 3: *Plaintiff's Payoffs with Learning depend on the court's ruling for $x \geq \hat{x}'$*

The plaintiff's strategy is given by

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

That is, when not filing for a PI the defendant proposes settlement terms which

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);[23] as these now stand a good chance at obtaining a final ruling in their favor.

Theorem 4 (Signalling 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.*

Proof. We prove the theorem using the case of uniformly distributed damages, but the result also applies to other distributions. Recall from (11) 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, $V^{N,T}(\hat{x}') = E\left[V^{PI,S}(\hat{x}'|\hat{x}')\right]$, yields

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

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

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

---

[23]We address such "corner" settlements in Section 5.

Thus, using (14),

$$(1-\alpha)x^G + \alpha x^D = \frac{1}{2}\left(\hat{x}' + b + (1-\alpha)\frac{c_d + c_p}{\nu^G(1-\tau)} + \alpha\frac{c_d + c_p}{\nu^D(1-\tau)}\right)$$

$$= \frac{1}{2}\left(\hat{x}' + b + \gamma\frac{c_d + c_p}{\nu(1-\tau)} + (1-\gamma)\frac{c_d + c_p}{\nu(1-\tau)}\right); \qquad (21)$$

and by substituting back into (19) and comparing to (11), it follows that $\hat{x} = \hat{x}'$. ∎

Thus, while the plaintiff's payoffs are affected by the court ruling because out-of-court settlement increases upon a denial and decrease upon a granting, this need not affect the incentive to file for a PI in the first place. However, while the incentive to file is unaffected, 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 expected 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.*

Proof. 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 Proposition 4

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

and the result follows. ∎

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 a settlement should be affected by learning. However, the intuition for the result of an increase in the likelihood of out-of-court settlement is straightforward. Information about the case strength is valuable as it allows the litigants to avoid the costs associated with going to trial when they agree to an out-of-court settlement. Thus, despite the fact that a ruling in favor of the plaintiff decreases the likelihood of out-of-court settlement, the finding substantiates Lichtman's (2003) assertion, cited above in the Introduction, that hearings promote settlement.

5 Discussions and Extensions

5.1 Corner solutions and the option of dropping the case

An immediate implication of learning about the case strength and the resulting shifting 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 $\overline{x}$ may become sufficiently pessimistic about prevailing at trial that he accepts the proposed equilibrium settlement offer, i.e., $\overline{x} \leq x^D$ so the defendant simply buys the plaintiff off. Second, when a PI is granted, the plaintiff's chances at prevailing at trial

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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., $\min \left\{ \overline{x}, x^D(\hat{x}^c) \right\} = \overline{x}$), 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., $\max \left\{ \hat{x}, x^G(\hat{x}) \right\} = \hat{x}$), 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 he is better off ceasing the disputed behavior and thereby ending the case, i.e., $b \leq \frac{c_d}{(1-\tau)(1-\nu^G)}$. 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 in addition to equitable relief

In the current setting we assume only equitable relief (i.e., an injunction is either permanently granted or denied). However, in many relevant settings the winning side may also claim damages (e.g., in patent infringement cases a wrongfully enjoined defendant must be compensated; and a winning plaintiff may collect damages if the PI was denied; also in civil anti-trust cases treble damages are awarded at the conclusion of the trial). As these legal remedies can be considered to be subsumed in in the post-trial payoffs $(1-\tau)x$ and $(1-\tau)b$, an explicit treatment of these damage awards has largely quantitative implications in raising the stakes of litigation. This is especially so in the case of treble damage awards in civil anti-trust cases. However, the qualitative analysis essentially continuous to hold.

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 trial's outcome, which has been assumed throughout our paper. Under the alternative British rule, in contrast, the losing party bears all the litigation costs. It is no wonder

that the 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.

More specifically, a 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 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 $c(1 - 2\nu^H)$ on the expected payoff of going to trial. Interestingly, 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 more likely when a PI is granted, but less likely when it is denied.

5.4 Optimistic- and pessimistic bias

In our models we assume that both parties share the same prior belief about a case, i.e., $\nu = \nu_p = \nu_d$. However, when a party has private information containing some information to infer the distribution of ν differently from the other party, the prior may differ across the agents.[24] In addition, when we consider the optimistic or pessimistic bias toward the quality of a case when a particular message is received through the PI ruling, the posteriors may remain different across agents, despite some discovery having taken place; that is, $\nu_i^H \neq \nu_j^H$ for $i, j = d, p$, $i \neq j$, and $H \in \{G, D\}$. Our model can easily be modified to see how these changes affect the request of PIs, the settlement amount, and litigation decisions, by distinguishing the defendant's beliefs and the plaintiff's beliefs. Of course, this modification yields many additional considerations depending on the relative magnitude of each party's prior. Further research in this direction is surely interesting, though it is obviously beyond the scope of this paper.

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[24]See, e.g., Loewenstein, et al. (1993).

6 Conclusion

Corporate litigation is recognized to be an important tool used in strategic competition and preliminary injunctions are a frequently used pre-trial motion in corporate litigation, such as in civil anti-trust, patent, copyright, trademark, employment and labor relations, and contract cases. 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 a court trial. This motivation is reflected in our model in that plaintiff's 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 uncertainty about the damage level that the plaintiff is subjected to, the motion for a PI reveals information about the damages suffered by the plaintiff. As the revelation of such information affects settlement offers that are entertained by the defendant, the legal motion of filing for a PI takes on an added function of signalling bounds of the damage levels to the defendant. As a result of this, PIs are more readily used when compared to the initial motivation that solely relies on the prevention of current damages. While this strategic use, thus, goes beyond the pure 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 signalling value of the filing decision is actually diminished.

In addition to considering signalling motivations as an underlying incentive to file for a PI, we also consider the informational effects that arise due to the hearing on

the motion and the court's subsequent ruling on the request. Thus, 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.

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 encouraged. 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.

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