Taking a Financial Position in Your Opponent in Litigation*

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Abstract

We explore a model of litigation where the plaintiff can acquire a financial position in the defendant firm. The plaintiff gains a strategic advantage by taking a short financial position in the defendant's stock. First, the plaintiff can turn what would otherwise be a negative expected value claim (even a frivolous one) into a positive expected value claim. Second, the short financial position raises the minimum amount the plaintiff is willing to accept in settlement, thereby increasing the settlement amount. Conversely, taking a long position in the defendant's stock puts the plaintiff at a strategic disadvantage. When the capital market is initially unaware of the lawsuit, the plaintiff can profit both directly and indirectly from its financial position. When the defendant is privately informed of the merit of the case, the plaintiff balances the strategic benefits of short position against the costs of bargaining failure and trial. When credibility is an issue, short selling by the plaintiff can actually benefit both the plaintiff and the defendant by lowering the settlement amount and also reducing the probability of proceeding to costly trial.

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Introduction

In litigation, the party bringing the lawsuit sometimes has an additional financial interest in his or her opponent, an interest that extends beyond the boundaries of the lawsuit itself. In some situations, plaintiffs maintain a "long" financial position. In securities litigation, for instance, the plaintiffs are typically a subset of the firm's current shareholders.[1] In other situations, plaintiffs have "short" financial positions. Recently, a prominent hedge fund manager has brought patent validity challenges against pharmaceutical companies while shorting their stock.[2] Given that the market value of a publicly-traded defendant reacts to new information, when the filing of a lawsuit conveys negative information, the defendant's stock price will decline.[3] If a plaintiff holds a financial interest in the defendant's stock, she will have different litigation incentives than a plaintiff who does not. A plaintiff's financial interest in the defendant can radically change the course of litigation.

This paper explores a model of litigation and settlement when the plaintiff can trade the stock of the defendant firm. Before filing suit, the plaintiff may take either a long or a short position against the defendant. With a long position, the plaintiff would benefit if the defendant's stock price goes up, and with a short position the plaintiff would benefit if the defendant's stock price falls. By selling the stock short, the plaintiff is actively betting against the firm, and will reap higher financial gains when the defendant suffers a greater litigation loss. We show that short selling can make the plaintiff's threat to go to trial more credible. As a consequence, the defendant will have to pay more in settlement to make the plaintiff go away. Thus, the plaintiff can benefit strategically from shorting the defendant's stock.

The basic idea can be demonstrated with a simple example. Suppose the value of the defendant firm is $1,000 without any litigation. If a plaintiff brings suit against the firm, the plaintiff's expected recovery is $50 but the cost of litigation is $60 for the plaintiff and $60 for the defendant firm. Obviously, the lawsuit has a negative expected value and, without additional incentive, the plaintiff will not bring suit. Now suppose, before filing suit, the

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[1] Consider, for example, the class action lawsuit brought by a subset of Facebook's shareholders for an alleged overpricing of the stock issued in the 2012 initial public offering. See, e.g., *In re Facebook, Inc., IPO Securities and Derivative Litigation*, 288 F.R.D. 26 (S.D.N.Y. 2012). If the plaintiffs remain as shareholders, while receiving recovery from the firm, the value of their shares will decrease due to the lawsuit. Other examples include a partner suing the partnership and a beneficiary bringing suit against the trust.

[2] Walker and Copeland (2015) describe the short-and-sue tactics used by hedge-fund manager Kyle Bass against publicly-traded pharmaceutical companies. See also Sidak and Skog (2015). Bass is well known for predicting, and profiting from, the collapse of the subprime mortgage-backed securities market in 2008. By purchasing credit default swaps, Bass was, in essence, "shorting" the subprime bond market.

[3] Many papers have documented the stock price decline in reaction to filing of lawsuits against corporations. See Cutler and Summers (1988), Bhagat et al. (1994), and Bizjak and Coles (1995).

plaintiff takes a short position against the defendant at the initial firm value of v_0, so that, if the firm value later becomes v_1, the plaintiff realizes a financial return of 10% of the valuation difference: $(0.1)(v_0 - v_1)$. Suppose the lawsuit gets filed, and the plaintiff now needs to decide whether to proceed to trial or to drop the case. If she were to drop the case, the firm value becomes \$1,000 and she realizes a financial return of $(0.1)(v_0 - \$1{,}000)$. If she were to proceed to trial, on the other hand, firm value becomes \$890 and she realizes $(\$50 - \$60) + (0.1)(v_0 - \$890)$. Comparing the two returns, by proceeding to trial, she realizes an additional financial return of $(0.1)(\$1{,}000 - \$890)$, which is enough to make up for the loss of \$10 from trial.[4] By shorting the defendant's stock, the plaintiff has turned a non-credible threat of lawsuit into a credible one. This, in turn, will allow her to extract a positive settlement from the defendant.[5]

We begin by analyzing a benchmark model with symmetric information, where the plaintiff and the defendant know the relevant parameters of the model. As shown in the numerical example, by taking a short position in the defendant's stock, the plaintiff can transform what would otherwise be a negative expected value claim into a positive expected value one. This, in turn, implies that more cases will be filed ex ante. While some of these claims may be meritorious and socially valuable, others may not be. Indeed, through a sufficiently short position, the plaintiff can credibly threaten to bring any suit to trial, even an entirely frivolous one where everyone agrees that the plaintiff's chances of prevailing in litigation are (near) zero. Short selling improves the plaintiff's bargaining power for positive expected value claims as well, leading to larger settlement payments by the defendant.[6] Conversely, when taking a long position in the defendant's stock, the plaintiff's threat to go to trial and bargaining position are compromised.

After presenting the basic results, we consider several extensions of the symmetric information model. First, we show that a loser-pays-the-costs (the English fee-shifting) rule can function as an effective screening device that keeps plaintiffs from accumulating financial positions to file frivolous claims. Second, we show that our results hold when there are differential litigation stakes, where the defendant has more to lose from the lawsuit than the plaintiff stands to gain. This may be particularly relevant for cases, such as patent validity

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[4] She will proceed to trial rather than drop the case if $(\$50 - \$60) + (0.1)(v_0 - \$890) \geq (0.1)(v_0 - \$1{,}000)$, which produces $(\$50 - \$60) + (0.1)(\$1{,}000 - \$890) \geq 0$.

[5] The plaintiff and defendant would mutually prefer to settle for, say, \$50 than go to trial. If the financial market does not know about the existence of the lawsuit, and does not anticipate a future settlement, then the stock value of the firm would be $v_0 = \$1{,}000$ and the plaintiff would earn a financial return of $(0.1)(\$1{,}000 - \$950) = \$5$ in addition the \$50 from the settlement.

[6] The most that the defendant is willing to pay in settlement reflects the amount that the defendant expects to lose, on average, if the case goes to trial (expected damages plus the defendant's litigation costs).

lawsuits, where prevailing at litigation brings no direct recovery for the plaintiff. Third, we show that our results continue to hold when litigation costs are endogenous, and are chosen in a non-cooperative rent-seeking game. Fourth, we show that our results are attenuated by the presence of transactions costs of short selling or plaintiff risk aversion. Finally, we show that our results hold when the capital market is strong-form efficient, so that the plaintiff realizes no financial return in equilibrium.[7] Although the plaintiff cannot capture any direct return from the short financial position, she nonetheless benefits indirectly through the effects on the credibility of suit and the enhanced bargaining power.

We then extend the model to allow the defendant to be privately informed about the likely outcome at trial. In a screening protocol of Bebchuk (1984) and Nalebuff (1987) where the plaintiff makes a single take-it-or-leave-it offer, we show that the plaintiff's financial position has two basic effects. First, when credibility is not a concern, taking a short (long) position makes the plaintiff more (less) aggressive in his settlement offer. With a short position, for instance, a larger settlement produces an additional financial return. Thus, a short position will lead to more trials and fewer settlements. Second, when credibility is a concern, as in Nalebuff (1987), the plaintiff's financial position will change the plaintiff's interim incentive to drop the case. A short financial position relaxes the credibility constraint. Interestingly, this allows the plaintiff to become less aggressive and lower the settlement offer. Thus, the plaintiff's short position may actually benefit the defendant and lower the equilibrium rate of litigation.

We also examine the signaling protocol of Reinganum and Wilde (1987) where the informed defendant makes a take-it-or-leave-it settlement offer to the plaintiff. In the fully separating perfect Bayesian equilibrium, the defendant's settlement offer perfectly reveals the defendant's type and the plaintiff randomizes between accepting the offer and going to trial. The plaintiff's financial position has two basic effects. By taking a short position, the plaintiff induces the defendant to make a more generous settlement offer. However, the short position also decreases the likelihood that the plaintiff will accept the defendant's offer to settle at the interim stage. Compared to a world that prohibits financial investing (taking a short position, in particular), the defendant is worse off and the litigation rate is higher.

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[7] More precisely, when the plaintiff takes a financial position in the market, the market incorporates all relevant information about the impending litigation into the price through the plaintiff's short sell order and the plaintiff's private information (about the impending litigation) gets fully revealed. Since the market is inferring the plaintiff's private information based on the plaintiff's trading behavior (which is public information), this is technically weaker than strong form efficiency. According to Sidak and Skog (2015), while the first few challenges by Bass produced statistically significant negative returns (compared to either the S&P 500 index or NYSE pharmaceutical index), later challenges did not. The latter finding is consistent with the market incorporating the litigation-related information well before the challenges were actually filed.

As mentioned earlier, the possibility that plaintiffs may short the rivals' stock is relevant in current litigation practice. The America Invents Act went into effect in September 2012.[8] Among other things, the Act provides a streamlined procedure under which just about anyone can challenge the validity of a patent by filing an inter partes review (IPR) petition before the United States Patent and Trademark Office.[9] One of the many IPR petitioners is hedge fund manager Kyle Bass.[10] Through one venture, the Coalition for Affordable Drugs, Mr. Bass has been challenging pharmaceutical patents in an arguably noble attempt to bring down prescription drug prices.[11] His critics maintain that Mr. Bass' motives are mercenary, and that Bass has been "betting against, or shorting, the shares of drug makers and biotechs whose patents he maintains are spurious."[12] At least one pharmaceutical company, Celgene, has argued that Mr. Bass' IPR petitions should be dismissed as a sanction for misconduct, suggesting that he is using "the IPR process for the purpose of affecting the value of public companies. This is not the purpose for which the IPR process was designed."[13]

This paper contributes to the literature on the economics of litigation in several ways.[14] We provide a new explanation for nuisance litigation, where unscrupulous plaintiffs extort money from otherwise blameless defendants by threatening them with litigation. At first blush, it might appear that a plaintiff with a negative expected value (NEV) claim could not possibly succeed in extracting a settlement offer: since a rational plaintiff would drop the NEV case before trial, a savvy defendant should rebuff the plaintiff's demands. Bebchuk (1988) and Katz (1990) argue that when the plaintiff is privately informed about the strength of his or her case, then extortion may succeed. In a complete information environment,

[8] The Act is also called Leahy-Smith America Invents Act after the lead sponsors, Senator Patrick Leahy and Representative Lamar Smith. The Act was signed into law by President Obama on September 16, 2011.
[9] See Sidak and Skog (2015). An inter partes review is a trial proceeding conducted before the U.S. Patent and Trademark Office (PTO) by the Patent Trial and Appeal Board (PTAB) to review the issues of patentability and the validity of patent. See 35 U.S.C. §§ 311–319.
[10] See Walker and Copeland (2015).
[11] According to Sidak and Skog (2015), as of August 2015, Coalition for Affordable Drugs has brought 21 IPR challenges against 12 companies, whose market capitalizations range from $126 million to $229.8 billion.
[12] See Silverman (2015). A closely related example is hedge fund manager Bill Ackman's Pershing Square shorting Herbalife shares while seeking an enforcement action (or investigation) against Herbalife by the Securities and Exchange Commission. Although there is no litigation (or trial), Herbalife can "defend" its business practices to the SEC, and both parties can "settle," where Pershing Square drops its request and Herbalife makes monetary payment to Pershing Square or changes its business practices.
[13] Celgene's email correspondence with the PTAB on June 3, 2015. See Case IPR2015-01092 (Patent 6,045,501); Case IPR2015-01096 (Patent 6,315,720); Case IPR2015-01102 (Patent 6,315,720); and Case IPR2015-01103 (Patent 6,315,720). Celgene also argues that Bass is "abusing the process" and the suit must be dismissed. As of September 2015, PTAB has denied Celgene's motion to sanction Bass, stating that "profit is at the heart of nearly every patent and nearly every inter partes review…[and] economic motive for challenging a patent claim does not itself raise abuse of process issues." See Sidak and Skog (2015).
[14] Early papers in this literature include Landes (1971), Posner (1973), and Gould (1973). See Cooter and Rubinfeld (1989), Daughety (2000), Daughety and Reinganum (2005), and Spier (2007) for surveys.

Bebchuk (1996) shows that NEV claims may succeed if the costs are borne gradually over time and negotiations can take place after some but not all of the costs are sunk.[15] None of these papers recognize that financial transactions and short selling can transform a NEV claim into a positive expected value one.

Several papers in the law and economics literature explore how contracts with third parties can strengthen a litigant's bargaining position, leading to a more advantageous settlement. Meurer (1992) argues that an insurance contract can make a defendant tougher in settlement negotiations, and may induce the plaintiff to lower the settlement demand. Spier and Sykes (1998) show that financial leverage can be an advantage to a corporate defendant in a "bet-the-firm" litigation. While small judgments will be borne by the shareholders, a very large judgment might ultimately be borne by debt-holders in the resulting bankruptcy. Similarly, contingent fees can potentially make plaintiffs tougher in negotiations. By paying the lawyer the same contingent percentage whether the case settles or goes to trial, a plaintiff may be able to raise his or her minimum willingness to accept in settlement. This is because the lawyer is bearing the costs of litigation, not the plaintiff, making trial relatively more attractive (Choi, 2003; Bebchuk and Guzman, 1996). Spier (2003a, 2003b) and Daughety and Reinganum (2004) show how most favored nations clauses with early litigants can be a strategic advantage in negotiating with later ones.

A small number of papers, primarily in the industrial organization and finance literatures, have examined the possibility of taking a financial position in one's competitors. Gilo (2000) and Gilo, Moshe, and Spiegel (2006) argue that firms taking long financial positions in competitors in the same industry will have a decreased incentive to engage in vigorous competition and an increased incentive to engage in price collusion. Hansen and Lott (1995) argue that an incumbent firm's short position against a potential entrant will allow the incumbent to more successfully engage in costly predation should entry occur. Tookes (2008) shows how informed financial traders have an incentive to make information-based trades in the stocks of competitors and empirically shows an increase in intra-day transactions over competitors when one company makes an earnings announcement.[16] In a paper more directly related to ours, Kobayashi and Ribstein (2006) present a simple model where a plaintiff's lawyer can short the stock of the defendant and argue that allowing the lawyer, who

[15] Rosenberg and Shavell (1985) show that negative expected value (NEV) cases may succeed if the defendant must spend money on his or her defense in order to avoid an adverse summary judgment.

[16] Ayres and Choi (2002) call this type of behavior as "outsider trading" and propose giving right to the traded firm to decide whether to allow such outsider trading.

receives a fraction of the recovery, to short the defendant's stock can mitigate the (litigation effort) incentive problem between the lawyer and the plaintiff.[17]

The paper is organized as follows. Part 1 presents the benchmark model. We present a game with two players (a plaintiff and a defendant) and analyze the case of symmetric information, exploring the effects of financial position (long or short) on the credibility of suit and the outcome of bargaining, and characterizing the plaintiff's optimal short financial position. Part 2 extends the basic symmetric information model to consider alternative rules for allocating the costs of litigation, differential litigation stakes, endogenous litigation spending, transactions costs of short selling, risk aversion, and a strong-form efficient capital market. Parts 3 and 4 allow the defendant to be privately informed of the strength of the case (i.e., the probability of losing at trial) and analyze the plaintiff's optimal financial position. Part 3 considers the screening protocol where the plaintiff makes a take-it-or-leave-it settlement offer to the defendant. Part 4 considers the signaling protocol where the defendant makes a take-it-or-leave-it settlement offer to the plaintiff. The last part concludes. Proofs that are omitted from the text are presented in the Appendix.

1. The Benchmark Model

Consider a simple benchmark model with two risk-neutral players: a plaintiff (p) and a firm-defendant (d). The plaintiff has a legal claim against the firm-defendant. If the case goes to trial, the court finds in favor of the plaintiff and awards damages of $D > 0$ with probability $\pi \in [0,1]$, and the plaintiff and the defendant bear the litigation costs of $c_p > 0$ and $c_d > 0$, respectively. The firm owns and controls a set of assets that will generate a gross cash flow $R > 0$ where R is fixed and is sufficient to cover the damages award and the litigation cost, $R - D - c_d \geq 0$.[18] So, bankruptcy is not a consideration. We assume that these parameters are known by both the plaintiff and the firm-defendant.

The firm-defendant is capitalized with one class of stock (e.g., common stock) and there is a capital market at which the firm's stock trades. The firm's equity market capitalization at the beginning of a given period t is represented by v_t. Note that v_t

[17] In their model, all the legal decisions are made by the lawyer. They assume a weaker version of market efficiency so that the lawyer realizes a positive return from the financial position. They also do not consider the issues of credibility or asymmetric information. See also the informal discussion in Yahya (2006).

[18] Although we assume that the gross valuation R is fixed, in reality, this will be in expectation so that the stock price can move not only due to litigation but for other reasons. In that setting, a risk-neutral plaintiff will attempt to maximize the expected return. For a risk-averse plaintiff, the stock price variation will impose additional loss. See section 2.5 below. The plaintiff can also engage in various hedging strategy to reduce or eliminate stock price movement that is unrelated to the litigation.

represents the firm's total equity market capitalization rather than its stock price.[19] We assume that the firm's debt and other financial obligations are all netted out from the analysis. We assume that the stock market is sufficiently liquid and the volume of trade is sufficiently large so that the plaintiff can fine-tune its financial position in the firm-defendant. There are four periods in the game with no time discounting: $t \in \{0,1,2,3\}$.

At $t = 0$, the plaintiff takes a financial position in the firm-defendant that is equivalent to acquiring a proportion Δ of the firm-defendant's equity at price v_0.[20] For the time being, we assume that the capital market is initially unaware of the lawsuit and the firm's market valuation is fixed at $v_0 = R$. The plaintiff's position can be either long ($\Delta > 0$) or short ($\Delta < 0$) and will be held until the end of the game ($t = 3$).[21] There may be limits on the position that the plaintiff can take: $\Delta_L \leq \Delta \leq \Delta_H$ where $\Delta_H \in (0, \infty)$ and $\Delta_L \in (-\infty, 0)$. If the plaintiff is indifferent between $\Delta = 0$ and other positions, we break indifference by assuming that the plaintiff chooses the neutral position $\Delta = 0$.

Our assumption that the capital market is initially unaware of the lawsuit when the plaintiff takes a financial position at $t = 0$ is both analytically simple and empirically relevant. In practice, potential plaintiffs may be able to trade anonymously without the financial market immediately observing this or realizing its implications.[22] In the next section, we check the robustness of our model by considering a strong-form efficient capital market. There, we assume that the stock market is fully aware of both the potential lawsuit and the plaintiff's financial position at $t = 0$ and that the stock price v_0 adjusts instantaneously to reflect the market's rational expectations. Although the plaintiff will not enjoy a direct return on its investment activities in this case, the plaintiff will capture the same strategic benefits as in the current benchmark.

At $t = 1$, the plaintiff files suit and approach the defendant in an attempt to negotiate an out-of-court settlement. At this point in time, the details of the lawsuit—including the plaintiff's financial position Δ—are observed by the defendant and the capital market. All negotiations take place under complete information. We adopt the Nash bargaining solution

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[19] For instance, if there are 10,000 shares of common stock outstanding, each share will be worth $v_t/10{,}000$ at t.

[20] If the equity market capitalization of the firm is quite large, it may be difficult for the plaintiff to take a sizable financial position on the firm. This issue is, at least partially, addressed through the cost of taking a short position in section 2.4.

[21] We assume that, prior to $t = 0$, the plaintiff has no financial position in the defendant. We can also allow the plaintiff to take derivative positions. Instead of short selling, the plaintiff can also purchase put options. Similarly, the plaintiff can purchase a call option for a long position. Allowing derivative positions will expand the range of feasible financial positions.

[22] Indeed, the plaintiff would benefit by trading surreptitiously, without the market knowing.

concept where $\theta \in (0,1)$ denotes the defendant's relative bargaining strength, conditional on the plaintiff having a credible lawsuit. That is, θ is the share of the bargaining surplus that is captured by the defendant, when the plaintiff is willing to proceed to trial upon breakdown of settlement negotiations. As θ becomes higher (lower), the settlement amount (s) will tend to move in the defendant's (plaintiff's) favor.[23] If the settlement negotiations break down, the plaintiff has the option to drop the case and avoid going to trial.

If the parties fail to settle at $t = 1$ and the plaintiff does not drop the case, the case goes to trial at $t = 2$. With probability $\pi \in [0,1]$ the court finds in favor of the plaintiff and awards damages of D, and the respective litigation costs of c_p and c_d are borne. Thus, in expectation, the defendant would lose $\pi D + c_d$ and the plaintiff would gain $\pi D - c_p$ (which may be either negative or positive) from the trial.

At $t = 3$, the plaintiff covers its short position (or liquidates its long position) by purchasing (selling) shares at price v_3.[24] Since the capital market observes the progress of the lawsuit in the preceding periods—in particular whether the case was dropped, settled, or litigated—the final market capitalization of the firm v_3 fully reflects the case disposition. If the case was dropped then $v_3 = R$; if the case was settled then $v_3 = R - s$ where s is the settlement amount; and if the case went to trial then $v_3 = R - D - c_d$ if the defendant lost the case and $v_3 = R - c_d$ if the defendant won the case (with an expected value of $R - \pi D - c_d$). The plaintiff's net return from the financial position is $(v_3 - v_0)\Delta$.[25]

The plaintiff seeks to maximize its aggregate payoff, which includes any settlement or damages award from litigation and the net return from the financial investment. As is standard in the literature, and in keeping with the fiduciary obligations under the corporate law, the firm seeks to maximize firm profits or, equivalently, its market valuation. The solution concept is subgame-perfect Nash equilibrium, and we will solve this model by backward induction.

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[23] Equivalently, we can (1) interpret θ as the probability that the defendant makes a take-it-or-leave-it offer to the plaintiff and $1 - \theta$ as the probability that the plaintiff makes such an offer; and (2) structure the negotiation process as one party making the offer and, if the offer is not accepted, the plaintiff can decide whether to drop the case. In that setting, when the plaintiff does not have a credible case, the defendant will offer to settle at zero and will refuse to accept any plaintiff's offer unless the offer is zero.

[24] The assumption that the plaintiff always settles its financial position at $t = 3$ (regardless of the case disposition) streamlines the exposition but is not critical to the results.

[25] To see why this is true, suppose that the plaintiff took a long position ($\Delta > 0$) in the defendant's stock at $t = 0$, paying $v_0\Delta$ for a proportion Δ of the defendant's equity. If the market valuation changes to v_3, the plaintiff nets $(v_3 - v_0)\Delta$. Now suppose instead that the plaintiff took a short position in the defendant's stock ($\Delta < 0$), borrowing proportion $|\Delta|$ of the firm's equity, sells the borrowed stake for $v_0 \cdot |\Delta|$, and deposits the money in a brokerage account at $t = 0$. The plaintiff is then obligated to return the borrowed shares to the lender in the future. If the future valuation is v_3, the plaintiff nets $v_0 \cdot |\Delta| - v_3 \cdot |\Delta| = (v_3 - v_0)\Delta$.

1.1. The Credibility of Suit

Suppose that the plaintiff and the defendant have reached a bargaining impasse at $t = 1$. Will the case go to trial, or will the plaintiff drop the case? In the standard model of litigation and settlement, the plaintiff has a credible commitment to take a case to trial when the expected damages exceed the litigation cost: $\pi D \geq c_p$. In the current context, the plaintiff's drop decision will also depend on the plaintiff's financial stake in the defendant's stock, Δ.

Suppose that the plaintiff acquired the position Δ at valuation v_0 at $t = 0$. Since the firm's valuation will be equal to $v_3 = R$ if the plaintiff subsequently drops the case, the plaintiff's payoff from dropping the case is $(v_3 - v_0)\Delta = (R - v_0)\Delta$. If the plaintiff takes the firm-defendant to trial instead, the expected value of the firm's stock will be equal to $v_2 = R - \pi D - c_d$, and so the plaintiff's expected payoff from trial is $\pi D - c_p + (R - \pi D - c_d - v_0)\Delta$. Comparing these two expressions, the plaintiff will choose to go to trial rather than drop the case when

$$\pi D - \Delta\,(\pi D + c_d) \geq c_p \tag{1}$$

The plaintiff has a credible case when the expected damage award plus any financial gain from the decline in the defendant's stock value is greater than the plaintiff's cost of litigation. Note that this condition does not depend on the firm's initial valuation, v_0, nor the firm's gross cash flow, R. The value v_0 is irrelevant since the plaintiff's financial transactions at $t = 0$ are sunk at the time that the plaintiff is making its drop decision at $t = 1$.[26] Firm's gross cash flow R is irrelevant since credibility is determined by the change in the firm's valuation, which stems from the expected loss from litigation ($\pi D + c_d$). Rearranging terms gives the following result.

Lemma 1. *The plaintiff has a credible threat to go to trial if and only if the plaintiff's financial position is* $\Delta \leq \tilde{\Delta}$ *where:*

$$\tilde{\Delta} = \frac{\pi D - c_p}{\pi D + c_d} < 1 \tag{2}$$

From the expression, we can see that, conditional on $\tilde{\Delta}$, litigation credibility is weakened when the plaintiff takes a long position. If $\Delta = 1$, for instance, so the plaintiff's

[26] The credibility of the threat does not depend on R because we assumed that the firm's asset value is sufficient to cover any possible adverse judgment at trial (no bankruptcy).

financial payoff reflects 100% of the firm's equity, the plaintiff would never want to bring the case to court: the lawsuit will have no credibility. By suing the defendant, the plaintiff would essentially be transferring money from one pocket to the other, while wasting money on litigation costs. Credibility is enhanced, however, when the plaintiff takes a short position against the defendant firm. By shorting the defendant's stock, the plaintiff can augment the damages award with the gain from the reduction in the defendant firm's stock value. Even if the lawsuit itself has a negative expected value, i.e., $\pi D - c_p < 0$, the plaintiff can gain credibility by taking a sufficiently large short position: $\Delta \leq \tilde{\Delta} < 0$. As an extreme case, even when the plaintiff has no chance of winning whatsoever (so $\pi = 0$), the plaintiff can establish credibility by setting $\Delta \leq \tilde{\Delta} = -c_p/c_d$. Any lawsuit—even a completely frivolous one with $\pi = 0$—can become credible if the plaintiff takes a sufficiently large short position in the defendant's stock.[27]

1.2. The Bargaining Outcome

Suppose that $\Delta \leq \tilde{\Delta}$ as defined in Lemma 1, so the plaintiff has a credible threat to bring the case to trial. This will in turn allow the plaintiff to extract a positive settlement offer from the defendant. The firm-defendant, seeking to maximize shareholder value, would be willing to accept a settlement offer s that satisfies $R - s \geq R - \pi D - c_d$. Thus, the most that the defendant is willing to pay, $\overline{s}$, is the expected damage award plus the defendant's litigation cost:

$$\overline{s} = \pi D + c_d \tag{3}$$

This expression is familiar from standard settlement models and does not depend on the plaintiff's financial position.

Now consider the plaintiff. If the case goes to trial, the plaintiff's expected payoff is $\pi D - c_p + (R - \pi D - c_d - v_0)\Delta$, the expected damage award minus the litigation cost plus the plaintiff's net expected profit from the financial investment. If the case settles for s then the plaintiff's payoff is $s + (R - s - v_0)\Delta$. Setting these expressions equal to each other and rearranging terms, the least the plaintiff is willing to accept is:

[27] If the defendant has the losses from litigation, both D and c_d, fully insured, the plaintiff will no longer be able to enhance credibility (or bargaining leverage) by shorting the defendant's stock. Insurance may not be available for all lawsuits, however. In Kyle Bass's story, for instance, loss of patent protection and market share is not something that can be insured.

$$\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) \tag{4}$$

Note that this lower bound does not depend on the initial stock price, v_0, since the cost of the financial transaction is sunk by the time of settlement negotiation.

The plaintiff's bargaining position depends critically on the plaintiff's financial stake, Δ. If the plaintiff takes a neutral financial position in the firm, $\Delta = 0$, then the minimum the plaintiff must receive to settle the case is $\pi D - c_p$ as in the standard model of settlement of litigation. When the financial position is negative ($\Delta < 0$) then $\underline{s}(\Delta)$ rises above $\pi D - c_p$ and the plaintiff's bargaining power is enhanced. The reason for this is straightforward. With a short position on the defendant, by going to trial, the plaintiff not only gets the recovery from judgment but also additional financial return from the short position. The stronger the short position, the more the plaintiff must receive to settle. In the limit, as Δ approaches negative infinity (when $\Delta_L \rightarrow -\infty$), the least that the plaintiff is willing to accept in settlement converges to $\pi D + c_d$, which is the most that the defendant is willing to pay.

Comparing (3) and (4) we see that $\underline{s}(\Delta) < \overline{s}$, so a positive bargaining range always exists. Recalling that parameter $\theta \in (0,1)$ is the bargaining power of the defendant, we find that so long as $\Delta \leq \tilde{\Delta}$ the case would settle for $s(\Delta) = (1 - \theta)\overline{s} + \theta \underline{s}(\Delta)$. We have the following result.

Proposition 1. *Suppose the plaintiff takes financial position Δ at $t = 0$. If $\Delta > \tilde{\Delta}$, the case is dropped. If $\Delta \leq \tilde{\Delta}$, the case settles out of court for $s(\Delta) = \pi D + c_d - \theta\left(\frac{c_p + c_d}{1-\Delta}\right) > 0$ where $s'(\Delta) < 0$ and $\lim_{\Delta \to -\infty} s(\Delta) = \pi D + c_d$.*

We have just seen that taking a short position is strategically valuable to the plaintiff. First, it can turn a negative expected value case into a positive expected value one. This allows the plaintiff to credibly threaten the firm that it will take the case to trial, and thereby allows the plaintiff to extract a positive settlement offer. Second, short selling can shift the bargaining outcome in the plaintiff's favor by increasing the minimum that the plaintiff is willing to accept in settlement. This forces the defendant to pay more to the plaintiff to settle the case. Since $s'(\Delta) < 0$, the plaintiff is better off and the defendant is worse off when the plaintiff takes a shorter financial position.

1.3. The Plaintiff's Choice of Financial Position

At $t = 0$, the plaintiff chooses its financial position Δ to maximize its total expected payoff, which includes the anticipated settlement value, $s(\Delta)$, plus any net return from the financial transaction. We have already proven that taking a shorter position will lead to a higher settlement for the plaintiff (since $s'(\Delta) < 0$). In addition to this strategic benefit, the plaintiff can also capture a direct financial benefit when the defendant's stock price falls.

Recall the basic assumptions of our benchmark model. Since the capital market is unaware of the lawsuit at $t = 0$ before the lawsuit is filed, the initial market value of the firm $v_0 = R$. Later, the case is filed and subsequently is settled for $s(\Delta)$, and this is observed by the capital market. When the plaintiff monetizes its financial position at the end of the game, the stock is trading at $v_3 = R - s(\Delta)$ and so the plaintiff's net financial return is $(v_3 - v_0)\Delta = (R - s(\Delta) - R)\Delta = -s(\Delta)\Delta$. Notice that the plaintiff's net return is positive if the financial position is short ($\Delta < 0$) and is negative if the financial position is long ($\Delta > 0$). More generally, the plaintiff's net return is a decreasing function of Δ.

Proposition 2. *Suppose* $\Delta_L \leq \tilde{\Delta} < 1$. *In equilibrium, the plaintiff takes as large a short position as possible against the defendant* $(\Delta = \Delta_L < 0)$ *and the case settles out of court for* $s(\Delta_L) > 0$. *If* $\Delta_L > \tilde{\Delta}$*, the plaintiff chooses a neutral position* $(\Delta = 0)$ *and the lawsuit is not filed.*

Proof of Proposition 2. If $\Delta > \tilde{\Delta}$ then the plaintiff does not have a credible threat to take the case to trial (Lemma 1) and would therefore not file the lawsuit. Therefore, $v_0 = v_3 = R$ and the plaintiff's payoff is equal to zero. If $\Delta \leq \tilde{\Delta}$, then the plaintiff has a credible threat to take the case to trial and the case settles for $s(\Delta)$ defined in Proposition 1. The plaintiff's net payoff is $s(\Delta) + (v_3 - v_0)\Delta = s(\Delta)(1 - \Delta)$. Since $s'(\Delta) < 0$ from Proposition 1, and $(1 - \Delta)$ is a decreasing function as well, the plaintiff will take as short a position as it possibly can. When the plaintiff takes position $\Delta_L \leq \tilde{\Delta}$, the lawsuit is credible and the case settles for $s(\Delta_L)$.

■

Finally, note that the defendant cannot improve its own bargaining position by taking a long financial position in its own stock. To see why, suppose that the defendant took position γ at the beginning of the game. If the defendant were to settle, the defendant's payoff would be $R - s + (R - s - v_0)\gamma$. If the defendant were to proceed to trial, the payoff would be $R - \pi D - c_d + (R - \pi D - c_d - v_0)\gamma$. Comparing these two expressions, the defendant would prefer to settle when $s \leq \pi D + c_d$, which is independent of financial position γ. Hence, taking a long financial position in its own stock cannot benefit the defendant. Why does the financial position create asymmetric effects on the litigants? This is coming from the fact that while the plaintiff earns $\pi D - c_p$ directly from litigation, the plaintiff's financial return from litigation depends on the defendant's loss, $\Delta(\pi D + c_d)$. Therefore, if the defendant wanted to neutralize or mitigate the financial effect, the defendant would need to take a financial position in the plaintiff's stock, if possible.[28]

2. Symmetric Information: Extensions

This section explores several extensions of the symmetric information model: (1) cost-shifting rule (the English rule) which requires the loser to pay the litigation cost of the winner; (2) differential litigation stakes, where the recovery from litigation that the plaintiff differs from the damages that the defendant has to pay; (3) endogenous litigation costs, where the amount of resources spent by the litigants depend on the litigation stakes; (4) transactions cost of short selling, where it is costly to take and maintain a short position; (5) plaintiff risk aversion; and (6) a strong-form efficient capital market, where the firm value immediately reflects the information about the lawsuit when the plaintiff takes the financial position.

2.1. The Loser-Pays Rule for Allocating Legal Costs

The previous sections assumed that each side in litigation bears its own litigation cost, regardless of the trial outcome (the American Rule). In this section, we explore how the analysis changes with the English Rule, where the loser of litigation must pay for its own costs as well as the costs of the winner. With the English Rule, the plaintiff's expected return from trial is $\pi D - (1-\pi)(c_p + c_d)$ while the expected loss for the defendant is $\pi D + \pi(c_p + c_d)$.

The plaintiff would prefer to go to trial rather than drop the case when the payoff from litigation, $\pi D - (1-\pi)(c_p + c_d) + [R - \pi(D + c_p + c_d) - v_0]\Delta$, is larger than the plaintiff's payoff from dropping, $(R - v_0)\Delta$, or

[28] Even if the defendant were to take a financial position against the plaintiff's stock (assuming that this is possible), the plaintiff enjoys the first mover advantage and the defendant may not want to take too strong a position to eliminate the possibility of settlement. The plaintiff's reservation settlement value is $\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right)$, which converges to $\pi D + c_d$ as $\Delta \rightarrow -\infty$. When the defendant takes a financial position of γ against the plaintiff's stock, the maximum settlement offer the defendant would be willing to make can be written as $\overline{s}(\gamma) = \pi D - c_p + \left(\frac{c_p + c_d}{1-\gamma}\right)$, which converges to $\pi D - c_p$ as $\gamma \rightarrow -\infty$. Clearly, when γ gets too small, we get $\overline{s}(\gamma) < \underline{s}(\Delta)$, settlement breaks down, and the defendant expects to lose $\pi D + c_d$ at trial.

$$\Delta \leq \tilde{\Delta}(\pi) = \frac{\pi D - (1-\pi)(c_p + c_d)}{\pi D + \pi(c_p + c_d)} \tag{5}$$

This credibility threshold, $\tilde{\Delta}(\pi)$, may be either larger or smaller than the threshold under the American Rule. When $\pi > c_d/(c_p + c_d)$ then credibility is easier to achieve under the English Rule than the American Rule, and when $\pi < c_d/(c_p + c_d)$ then credibility is more difficult to achieve.[29] Note that if the case is entirely frivolous (in the sense that $\pi = 0$) then $\tilde{\Delta}(\pi)$ does not exist. There is no amount of short selling that can make the lawsuit credible.

Suppose the plaintiff has a credible threat to go to trial, $\Delta \leq \tilde{\Delta}(\pi)$. The most the firm is willing to pay to settle the case is $\overline{s}(\Delta;\pi) = \pi D + \pi(c_p + c_d)$ and the least that the plaintiff is willing to accept is

$$\underline{s}(\Delta;\pi) = \pi D + \pi(c_p + c_d) - \frac{c_p + c_d}{1-\Delta} \tag{6}$$

One can easily show that the bounds on the bargaining range, $\overline{s}(\Delta;\pi)$ and $\underline{s}(\Delta;\pi)$, are smaller under the English Rule than the American Rule if and only if $\pi < c_d/(c_p + c_d)$. Furthermore, by shorting the defendant's stock, the plaintiff can increase $\underline{s}(\Delta;\pi)$, thereby improving its bargaining position. In the limit as Δ approaches negative infinity, $\underline{s}(\Delta;\pi)$ converges to $\overline{s}(\Delta;\pi)$ and the plaintiff extracts all the bargaining surplus from the defendant.

We have just shown that when the plaintiff's case is weak (in the sense that $\pi < c_d/(c_p + c_d)$), the credibility will require a more significant short position under the English Rule than the American Rule and the most that the plaintiff can hope to gain in settlement is smaller. When the case is totally frivolous ($\pi = 0$), since the firm will not incur any loss through trial under the English Rule, the firm valuation will remain constant throughout at R. This implies that the plaintiff cannot make any financial return by shorting the defendant's stock and cannot successfully extract a settlement offer. Thus, fee-shifting may be an effective policy instrument in preventing frivolous claims from going forward through financial maneuvering and limiting the amount of the settlements.

2.2. Differential Litigation Stakes

The analysis has so far assumed that the plaintiff and the defendant have the same fundamental stakes in litigation. If the court awards damages of D, then this amount is paid by the defendant and received by the plaintiff. In practice, the defendant firm's stakes may

[29] See Rosenberg and Shavell (1985) for related results in models without financial investing.

differ from the stakes of the plaintiff. For example, the benefit to a plaintiff from winning injunctive relief may be outweighed by the cost of the injunction to the defendant. Revisiting the example from the introduction, the benefit to a single plaintiff from succeeding with an inter partes review (IPR) in a patent challenge may be greatly outweighed by the losses to the firm when the floodgates open following the loss of patent protection. Indeed, if the plaintiff owns no competing patent, getting the defendant's patent to be declared invalid may produce no direct recovery for the plaintiff even though the invalidity declaration may be quite costly for the defendant.

Suppose that if the plaintiff wins the case, the plaintiff receives fraction $\lambda \in [0,1)$ of the damages borne by the defendant, D. Extending our previous analysis, the plaintiff has a credible threat to go to trial when the plaintiff's payoff from trial, $\lambda\pi D - c_p + (R - \pi D - c_d - v_0)\Delta$, exceeds the payoff from dropping the case, $(R - v_0)\Delta$, or

$$\Delta \leq \tilde{\Delta}(\lambda) = \frac{\lambda\pi D - c_p}{\pi D + c_d} \tag{7}$$

Note that the credibility threshold $\tilde{\Delta}(\lambda)$ is increasing in λ, so credibility is easier (harder) to achieve when the plaintiff's direct stake in litigation is larger (smaller).

Now suppose that the plaintiff takes a position $\Delta \leq \tilde{\Delta}(\lambda)$ so that the plaintiff has a credible case. The most the defendant is willing to pay is $\overline{s}(\Delta;\lambda) = \pi D + c_d$ as before, but the least the plaintiff is willing to accept is now:[30]

$$\underline{s}(\Delta;\lambda) = \pi D + c_d - \left(\frac{1}{1-\Delta}\right)[(1-\lambda)\pi D + (c_p + c_d)] \tag{8}$$

When $\lambda < 1$, then plaintiff is in a weaker bargaining position vis-à-vis the defendant. However, in the limit as Δ approaches negative infinity, the lower bound $\underline{s}(\Delta;\lambda)$ converges to the upper bound, $\overline{s}(\Delta;\lambda) = \pi D + c_d$.

We have just seen that short selling is particularly valuable in environments where the plaintiff has little to gain from litigation but the defendant has a significant amount to lose. Strikingly, with short selling, the plaintiff can extract the full value $\pi D + c_d$ from the defendant in settlement even when the plaintiff's private litigation stake is zero ($\lambda = 0$). This illustrates how a hedge fund might successfully challenge the validity of a defendant's patent

[30] If the plaintiff accepts the firm's settlement offer then the plaintiff's payoff is $S + (R - S - v_0)\Delta$. The plaintiff's payoff from going to trial is $\lambda\pi D - c_p + (R - \pi D - c_d - v_0)\Delta$.

even when the capital market is efficient and the expected direct recovery from the litigation is negligible.

2.3. Endogenous Litigation Costs

We now extend the model to consider endogenous litigation costs using a standard Tullock (1980) contest framework.[31] Suppose that the costs of litigation c_p and c_d are choice variables for the parties at trial and are chosen simultaneously and non-cooperatively. The probability that the plaintiff wins at trial is

$$\pi(c_p, c_d) = \frac{c_p^r}{c_p^r + c_d^r} \tag{9}$$

where $0 < r \leq 1$.[32] When $r = 1$, this contest is a so-called "lottery contest," where the likelihood that the plaintiff wins, $c_p/(c_p + c_d)$, corresponds to his or her share of the total dollars spent.

Conditional on financial position Δ, the plaintiff chooses c_p to maximize the net return from litigation and the financial investment, $\pi(c_p, c_d)D - c_p + [R - \pi(c_p, c_d)D - c_d - v_0]\Delta$, taking the defendant's expenditure c_d as fixed. The plaintiff's optimization problem is equivalent to $\max_{c_p} \pi(c_p, c_d)(1 - \Delta)D - c_p$. The defendant chooses c_d to maximize $R - \pi(c_p, c_d)D - c_d$, taking c_p as fixed, or equivalently $\max_{c_d} [1 - \pi(c_p, c_d)]D - c_d$. This standard contest model with asymmetric stakes has the following solution:[33]

$$c_p^* = \frac{(1-\Delta)^{1+r}}{[1+(1-\Delta)^r]^2} rD,\ c_d^* = \frac{(1-\Delta)^r}{[1+(1-\Delta)^r]^2} rD, \text{ and } \pi(c_p^*, c_d^*) = \frac{(1-\Delta)^r}{1+(1-\Delta)^r} \tag{10}$$

In equilibrium, $c_p^* = c_d^*(1 - \Delta)$. When the plaintiff takes the neutral financial position, $\Delta = 0$, then the plaintiff and defendant spend the same amount and the plaintiff wins half the time, $\pi(c_p^*, c_d^*) = 1/2$. The plaintiff and defendant are on a level playing field in this special case. When the plaintiff takes a short position ($\Delta < 0$), the plaintiff has more to gain from litigation than the firm has to lose, since the plaintiff would gain the financial return from the

[31] Others have also used contest models to study litigation: Posner (1973, appendix), Katz (1988), Farmer and Pecorino (1999), Parisi (2002), Bernardo et al. (2000), Prescott et al. (2014), and Rosenberg and Spier (2014).

[32] The assumption that $r \leq 1$ is a sufficient condition for the existence and uniqueness of a pure strategy Nash equilibrium for all values of Δ. See the Nti (1999 at 423).

[33] The equilibrium is characterized in the survey of Konrad (2009), page 45. Letting the plaintiff be contestant 1 and the defendant be contestant 2, c_p and c_d correspond to expenditures x_1 and x_2, respectively, and $\pi(c_p, c_d)$ and $1 - \pi(c_p, c_d)$ correspond to $p_1(x_1, x_2)$ and $p_2(x_1, x_2)$ in the standard notation. The stakes for the plaintiff and defendant, $(1 - \Delta)D$ and D correspond to v_1 and v_2 (in the standard notation).

short sale as well as from the litigation expenditure. The probability that the plaintiff wins exceeds one half with short selling. In the limit as Δ approaches negative infinity, the probability that the plaintiff will prevail at trial $\pi(c_p^*, c_d^*)$ approaches one.

An analysis of this equilibrium, which may be found in the appendix, establishes the following. In this model with fully variable litigation expenditures, without any fixed costs, the plaintiff has a credible threat to take the defendant to trial for all values $\Delta < 1$. Nevertheless, through short selling, the plaintiff can gain a significant strategic advantage in this game. When Δ is negative and becomes larger in magnitude, the plaintiff's incentive to spend money increases since the plaintiff's stakes are larger than before. Facing a stronger opponent, the defendant will find itself on the backward bending part of the reaction curve, and will reduce its litigation expenditures in retreat. This will of course lead to a higher chance that the plaintiff will win the litigation. With a better expected outcome from trial, the plaintiff will be able to extract a better settlement outcome. In the limit as the short position approaches negative infinity, the defendant's expenditures approach zero and the plaintiff extracts D in settlement.

2.4. Transactions Costs of Short Selling

Until this point, we have ignored any transactions costs of establishing and holding a short financial position. We will now extend the model to include transactions costs of taking a short position. Specifically, suppose the plaintiff's cost of taking a short position is proportional to the magnitude of the short and is given by:

$$-\Delta k v_0 > 0$$

where $k > 0$ is a constant and $\Delta < 0$. These costs can include the foregone opportunity of funds when the plaintiff must hold money in a margin account.[34] Importantly, in this simple framework, it is more costly for the plaintiff to sell short 1% of a firm-defendant that has a large market capitalization than 1% of a firm-defendant with a small market capitalization. As shown earlier, the plaintiff's ex ante benefit of taking a sufficiently short position $\Delta \leq \tilde{\Delta}$ is $s(\Delta)(1 - \Delta)$. Since $s(\Delta) = \pi D + c_d - \theta\left(\frac{c_p + c_d}{1-\Delta}\right)$ from Proposition 1, we have that the gross benefit of the short position is $(\pi D + c_d)(1 - \Delta) - \theta(c_p + c_d)$. The plaintiff will find it

[34] Although we take a reduced form approach on the transaction cost of shorting, there are several components to the cost: (1) cost of locating an investor who is willing to lend the shares (issues of liquidity); (2) having to pay the "rebate rate" for borrowing the shares; (3) having to post collateral if the price of the shorted stock rises; and (4) being subject to recall by the lender. See Jones and Lamont (2002).

profitable to adopt a short-and-sue strategy descried in Proposition 2 if and only if the marginal benefit of taking a shorter position, $\pi D + c_d$, is larger than the marginal cost, kv_0.

This extension is very simple and abstracts away from the costs that would naturally accrue over time and from any nonlinearities in the cost structure. Nevertheless, it gives us the empirical prediction—one that should be robust to more complex environments—that plaintiffs are more likely to strategically establish short financial positions in their opponents when the expected stock price reaction from a trial is large relative to the firm-defendant's market capitalization. Thus, holding all else equal, plaintiffs should be more likely to bring patent challenges against smaller companies rather than against pharmaceutical behemoths since the relative stock-price impact is larger when the target is small.

2.5. Plaintiff Risk Aversion

The previous sections assumed that the plaintiff was risk neutral, and evaluated the plaintiff's different options (drop, litigate, settle) at their expected value. We now relax that assumption, and show how plaintiff risk aversion will dampen the plaintiff's incentive to bring suit will reduce the plaintiff's bargaining power. We will also illustrate how risk aversion may reduce the benefits of a sue-and-short strategy, and may actually lead the plaintiff to take a long position in the defendant's stock.

To illustrate these ideas, suppose that the plaintiff's utility has a simple mean-variance form. Given financial position Δ, the plaintiff's certainty equivalent of going to trial is $\pi D - c_p + (R - \pi D - c_d - v_0)\Delta - (1-\Delta)^2\rho$, where ρ is the plaintiff's risk premium from going to trial with a neutral financial position ($\Delta = 0$).[35] Note when $\rho > 0$, then the plaintiff's risk premium is larger when the plaintiff's position is shorter, and taking a long position reduces the risk premium. The plaintiff has a credible threat to go to trial when this expression is larger than $(R - v_0)\Delta$, or

$$\pi D - \Delta\,(\pi D + c_d) - (1-\Delta)^2\rho \geq c_p$$

Comparing this expression to equation (1), it is obvious that credibility is harder to achieve than before. The risk premium makes going to trial less attractive for the plaintiff. Note also that when the plaintiff is very risk averse (ρ is large), then there may exist no financial position that achieves credibility. Thus, risk aversion may thwart a sue-and-short strategy.

[35] Letting a be the coefficient of absolute risk aversion, we have $\rho = (a/2)D^2\pi(1-\pi)$. See the binary model and discussion in Prescott et al. (2014).

Even if the plaintiff does have a credible threat to bring the lawsuit to trial, risk aversion will tend to weaken the plaintiff's bargaining position. The least the plaintiff is willing to accept makes the plaintiff indifferent between going to trial (which has an associated risk premium of $(1-\Delta)^2\rho$) and settling out of court (which is safe). Comparing the alternatives, one can easily show that the least the plaintiff is willing to accept is

$$\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right) - (1-\Delta)\rho$$

Comparing this expression to equation (4), we see that $\underline{s}(\Delta)$ is lower that it was before, reflecting the riskiness of trial. It follows that when the bargaining parameter $\theta > 0,$ the plaintiff will extract less in settlement than before. Finally, in contrast to our analysis without risk aversion, taking a shorter position is not always better for the plaintiff. There is a tradeoff: taking a shorter position makes the plaintiff tougher through the channel identified earlier, but also weakens the plaintiff through the risk premium. As a consequence, the optimal financial position will tend to be less short and, when the plaintiff is sufficiently risk averse, the optimal position may in fact be long.

2.6. An Informationally Efficient Capital Market

In the benchmark case, the capital market was initially unaware of the potential lawsuit at $t = 0$, and so the plaintiff could surreptitiously take a short (or a long) position in the defendant at a fixed price $v_0 = R$. This allowed the plaintiff to capture a direct financial benefit from driving down the stock price of the defendant, in addition to the indirect strategic benefit of raising the settlement amount.

We now assume that the capital market is fully aware of the lawsuit and the plaintiff's financial position before the case is filed. Specifically, we adopt the strong form of the efficient market hypothesis and assume that the firm's valuation v_0 instantaneously adjusts to reflect the market's rational expectations about the continuation game and the future disposition of the lawsuit when the plaintiff takes a financial position Δ.[36] Since the capital market accurately forecasts the future outcome of any continuation game, and the stock price adjusts to reflect this, the plaintiff cannot capture a direct financial return from its short position. The plaintiff will, however, be able to extract more money in settlement from the defendant as before.

[36] See Sidak and Skog (2015), who find that while the first few IPR challenges by Bass produced statistically significant negative returns (compared to the S&P 500 or NYSE pharmaceutical indices), the later challenges did not. The latter finding is consistent with the financial market incorporating the litigation-related information well before lawsuits are actually filed.

To see this formally, suppose that the plaintiff takes a position Δ at $t = 0$. Since the market valuation will depend critically on the plaintiff's financial position, we'll adopt the notation $v_0(\Delta)$. As described in Proposition 1, there are two cases to consider. First, if $\Delta > \tilde{\Delta}$, then the plaintiff does not have a credible threat to go to trial, and will therefore drop (or not file) the case. The capital market, being aware and forward looking, realizes that the case will be dropped and so $v_0(\Delta) = v_3 = R$. The plaintiff cannot earn a positive profit in this case. Second, if $\Delta \leq \tilde{\Delta}$, the case is credible and will settle for $s(\Delta) > 0$. The capital market foresees this when the plaintiff takes the position Δ, and so $v_0(\Delta) = v_3 = R - s(\Delta)$. Since $v_0(\Delta) \equiv v_3$ for all possible values of Δ, the plaintiff's net financial return is identically zero, $(v_3 - v_0(\Delta))\Delta \equiv 0$. With a strong-form efficient capital market, the plaintiff cannot capture a positive financial return from the short position.

The plaintiff may capture indirect strategic benefits from a short financial position, however. First, as in Lemma 1, the short position can turn a negative expected value case into a positive expected value one. This allows the plaintiff to credibly threaten the firm that it will take the case to trial, and thereby allows the plaintiff to extract a positive settlement offer. Second, as in Proposition 1, short selling can shift the bargaining outcome in the plaintiff's favor by increasing the minimum that the plaintiff is willing to accept in settlement. This forces the defendant to pay more to the plaintiff to settle the case.

As in the benchmark case, if $\Delta_L \leq \tilde{\Delta}$ then the plaintiff takes the shortest possible position Δ_L at $t = 0$. Because the stock market is fully rational and forward-looking, the market foresees that the parties will subsequently settle the case for $s(\Delta_L)$, and so the firm's market valuation immediately adjusts to $v_0(\Delta_L) = R - s(\Delta_L)$ and stays at that level along the equilibrium path. When the plaintiff liquidates its position at $t = 3$, since the market valuation hasn't changed, the plaintiff makes no positive return from the financial position. Since a stronger short position increases the plaintiff's gross return from going to trial and getting a judgment, the defendant has to pay more to settle the case with the plaintiff. In equilibrium, therefore, all the additional return the plaintiff gets comes from the increase in bargaining power vis-à-vis the defendant through the financial position.

3. Asymmetric Information: Screening

So far, we have assumed the plaintiff and defendant are symmetrically informed of all relevant aspects of the litigation. We now relax this assumption and let the defendant privately observe the probability of being held liable, π, which is drawn from a probability density function $f(\pi)$. We assume that $f(\pi)$ is continuously differentiable and strictly positive on its support $[0,1]$. Let $F(\pi)$ be the cumulative distribution function. As is standard in the literature, we also assume that the hazard rate is monotone: $\frac{\partial}{\partial \pi}\left(\frac{f(\pi)}{1-F(\pi)}\right) > 0$.[37] The value of π is not directly observed by the plaintiff or by the capital market.

As in the benchmark model, the plaintiff takes a financial positon Δ in the firm-defendant at $t = 0$ when the stock is trading at $v_0 = R$. At $t = 1$, the plaintiff can file suit and the existence of the lawsuit and the plaintiff's financial position become known to the defendant and the capital market. We follow the standard screening protocol of Bebchuk (1984) and Nalebuff (1987) and assume that the uninformed plaintiff makes a single take-it-or-leave-it offer to the informed defendant at $t = 1$. If the defendant accepts the offer, the game proceeds to $t = 3$. If the defendant rejects the offer, the plaintiff can either drop the case or proceed to trial (at $t = 2$). The financial market is rational and adjusts the firm valuation based on the new information, if any, that is revealed through settlement bargaining. Our solution concept is Perfect Bayesian Equilibrium.

As is typical in screening models, defendants who believe that they are likely to lose at trial are more likely to accept the plaintiff's settlement offer. Thus, after a settlement offer is rejected, the plaintiff faces a truncated sample of defendant types, namely those types who are more likely to win at trial. For ease of notation, define $m(\pi) \equiv E(q \mid q \leq \pi) = \int_0^{\pi} q \frac{f(q)}{F(\pi)} dq$. In words, $m(\pi)$ is the expected mean probability that the plaintiff will win the case given that the distribution of defendant types $f(\cdot)$ is truncated above at π.

3.1. Bebchuk (1984)

We begin by solving the continuation game after the plaintiff files suit at $t = 1$ under the strong assumption that the plaintiff is committed to never drop the case, and takes any defendant who rejects the settlement offer to trial. This extends the insights of Bebchuk (1984) to include financial positioning by the plaintiff, and serves as a building block for the more general analysis in section 3.2. We will show that by taking a short (long) position, the plaintiff becomes more (less) aggressive in the settlement demand. When the plaintiff's financial position is shorter (Δ is smaller), the plaintiff demands more in settlement, the settlement rate falls, and more cases go to trial.

Suppose that the plaintiff took a financial stake Δ at price v_0 at $t = 0$. The plaintiff's problem at $t = 1$ is to choose a threshold $\hat{\pi}$ and a corresponding settlement offer $\hat{s} = \hat{\pi}D + c_d$

[37] This is true of many standard distributions, including uniform, normal, and exponential distributions.

where defendant types below the threshold ($\pi < \hat{\pi}$) reject the settlement offer and defendant types above this threshold ($\pi \geq \hat{\pi}$) accept the offer.[38] Given Δ, the plaintiff's expected payoff is given by:

$$W^p(\hat{\pi}, \Delta) \equiv \int_0^{\hat{\pi}} [\pi D - c_p + (R - \pi D - c_d - v_0)\Delta] f(\pi) d\pi + \int_{\hat{\pi}}^1 [\hat{\pi} D + c_d + (R - \hat{\pi} D - c_d - v_0)\Delta] f(\pi) d\pi \tag{11}$$

The first part of this expression is the plaintiff's expected payoff from those defendant types $\pi \in [0, \hat{\pi})$ who reject the settlement offer and go to trial. For these types, the final market value v_3 will be either $R - D - c_d$ or $R - c_d$, depending on whether the plaintiff wins or loses at trial. Conditional on the defendant's type π, the expected market value if the case goes to trial is $R - \pi D - c_d$. The second part is the plaintiff's payoff from those defendant types who accept the settlement offer $\hat{s} = \hat{\pi} D + c_d$. For types $\pi \in [\hat{\pi}, 1]$, the expected market value is $R - \hat{\pi} D - c_d$.

At $t = 1$, the plaintiff chooses $\hat{\pi} \in [0, 1]$ to maximize $W^p(\hat{\pi}, \Delta)$. Taking the derivative of the interim payoff function with respect to $\hat{\pi}$, the slope is given by:

$$\frac{\partial W^p(\hat{\pi}, \Delta)}{\partial \hat{\pi}} = -(c_p + c_d) f(\hat{\pi}) + (1 - \Delta) D [1 - F(\hat{\pi})] \tag{12}$$

This expression may be understood intuitively. When the plaintiff raises the threshold $\hat{\pi}$ and corresponding settlement offer $\hat{s}$ slightly, fewer defendant types will accept the settlement offer. The first term represents the additional litigation costs associated with the additional cases that go to court. The second term represents the benefit to the plaintiff of raising the threshold, since the infra-marginal defendant types below the threshold $\hat{\pi}$ will accept the higher settlement offer. The plaintiff benefits directly through the higher settlement received and, when $\Delta < 0$, the plaintiff benefits indirectly because the stock value is lower in light of the higher settlement amount.

The optimal threshold may be an interior solution, $\hat{\pi}(\Delta) \in (0, 1)$, or a corner solution where the plaintiff settles with all defendant types, $\hat{\pi}(\Delta) = 0$.[39] An interior solution, if one exists, is where the slope $\partial W^p(\hat{\pi}, \Delta)/\partial \hat{\pi}$ equals zero:

[38] Without loss of generality, we assume that when indifferent, the defendant accepts the plaintiff's settlement offer instead of rejecting it. When the plaintiff offers to settle at $\hat{s} = \hat{\pi} D + c_d$, it is optimal for defendant type $\pi < \hat{\pi}$ to reject the offer and proceed to trial (expecting to lose $\pi D + c_d$ which is strictly smaller than $\hat{s}$) while it is (at least weakly) optimal for defendant type $\pi \geq \hat{\pi}$ to accept the offer.

$$\frac{(1-\Delta)D}{c_p+c_d}=\frac{f(\hat{\pi}(\Delta))}{1-F(\hat{\pi}(\Delta))} \tag{13}$$

The monotone hazard rate assumption implies that the right-hand side is strictly increasing with respect to $\hat{\pi}(\Delta)$, so an interior solution (if one exists) is unique. The monotone hazard rate also implies that $\hat{\pi}'(\Delta) < 0$. When Δ falls (so the position becomes shorter), the left hand side rises and so $\hat{\pi}(\Delta)$, and the settlement offer $\hat{s}(\Delta)$, must rise as well: the plaintiff becomes more aggressive by raising the settlement offer when the position is shorter. At the same time, when Δ is sufficiently positive, we can get $\partial W^p(\hat{\pi},\Delta)/\partial\hat{\pi} < 0$ for all $\hat{\pi} \in [0,1]$. In that case, we get the corner solution of $\hat{\pi}(\Delta) = 0$. To allow for both possibilities, we let $\Delta_0 \in (-\infty, 1)$ to be the value where

$$\frac{(1-\Delta_0)D}{c_p+c_d}=f(0) \tag{14}$$

We now state the following result. A full proof is given in the appendix.

Lemma 2. *Suppose the plaintiff takes financial position Δ at $t = 0$, can make a take-it-or-leave-it offer to the privately informed defendant, and is committed to never drop the case. Then there exists a unique threshold $\hat{\pi}(\Delta)$ that maximizes the plaintiff's interim expected payoff. If $\Delta \geq \Delta_0$, then $\hat{\pi}(\Delta) = 0$. If $\Delta < \Delta_0$, then $\hat{\pi}(\Delta) > 0$, where $\hat{\pi}'(\Delta) < 0$ and $\lim_{\Delta\to-\infty} \hat{\pi}(\Delta) = 1$. The case settles out of court if and only if $\pi \geq \hat{\pi}(\Delta)$.*

Lemma 2 has several interesting implications. First, when the plaintiff's financial position is above a threshold, $\Delta \geq \Delta_0$, then $\hat{\pi}(\Delta) = 0$. The plaintiff is "soft" and offers to settle with the defendant for the litigation costs only: $\hat{s}(\Delta) = c_d$. All defendant types, even the defendant with $\pi = 0$, will accept this offer. Second, when the financial position is below the threshold, $\Delta < \Delta_0$, then $\hat{\pi}(\Delta) > 0$. Defendant types with strong cases ($\pi < \hat{\pi}(\Delta)$) reject the settlement offer and go to trial while those with weak cases ($\pi \geq \hat{\pi}(\Delta)$) accept the settlement offer. Third, and importantly, note that $\hat{\pi}'(\Delta) < 0$. When Δ becomes smaller—so the plaintiff's financial position is shorter—the threshold $\hat{\pi}(\Delta)$ rises. Indeed, in the limit as Δ approaches $-\infty$, the threshold type $\hat{\pi}(\Delta)$ rises and approaches 1 and the settlement rate approaches 0. Taking a short position in the defendant's stock makes the plaintiff more aggressive in its settlement demands. Thus, when the plaintiff (with full commitment to

[39] It is never optimal for the plaintiff to choose $\hat{\pi} = 1$ and litigate with all defendant types, since, with $\hat{\pi} = 1$, we get $-(c_p + c_d)f(1) + (1-\Delta)D[1-F(1)] < 0$. In short, $\hat{\pi}(\Delta) \in [0,1)$ and whenever $\hat{\pi}(\Delta) > 0$, $\hat{\pi}'(\Delta) < 0$.

proceed to trial) takes a shorter position, the settlement rate falls and the rate of litigation rises.

3.2. Nalebuff (1987)

Our analysis in the last subsection deliberately sidestepped the issue of credibility. As argued by Nalebuff (1987) in a model without financial position, the plaintiff may not have a credible threat to take the defendant to trial following the rejection of a settlement offer. The plaintiff may prefer to drop the case rather than litigate against defendant types who reject the offer. In order to maintain a credible threat to go to trial, Nalebuff (1987) argued that the plaintiff might need to raise the settlement offer to a higher value than in Bebchuk (1984). We now extend the analysis in section 3.1 to give the plaintiff the opportunity to drop the case following the rejection of the settlement offer.

We begin by defining a key piece of new notation. Let $\bar{\pi}(\Delta) \in [0,1]$ be such that if the distribution of defendant types $f(\pi)$ were truncated to the range $[0, \bar{\pi}(\Delta)]$, then the plaintiff would be indifferent between dropping the case and going to trial. Specifically, $\bar{\pi}(\Delta)$ is the implicit solution to

$$m(\bar{\pi}(\Delta))D + \ c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) = 0 \tag{15}$$

Note that the threshold $\bar{\pi}(\Delta)$ does not necessarily exist. When $\Delta < -\frac{c_p}{c_d}$, the left-hand side is strictly positive even if $\bar{\pi}(\Delta) = 0$. In this case, the plaintiff has a credible threat to go to trial regardless of its beliefs about the defendant's type. If $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$, the left-hand side is negative even if $\bar{\pi}(\Delta) = 1$. In this case, the plaintiff would strictly prefer to drop the case even when facing the entire distribution of defendant types. The threshold $\bar{\pi}(\Delta)$ is only defined when Δ is in limited range:

$$\Delta \in \Omega \equiv \left[-\frac{c_p}{c_d}, \frac{m(1)D - c_p}{m(1)D + c_d}\right] \tag{16}$$

The next lemma describes the properties of this threshold $\bar{\pi}(\Delta)$.

Lemma 3. *When $\Delta \in \Omega$ then $\bar{\pi}(\Delta) \in [0,1]$ exists, is unique, and has the following properties: $\bar{\pi}\left(-\frac{c_p}{c_d}\right) = 0, \bar{\pi}\left(\frac{m(1)D - c_p}{m(1)D + c_d}\right) = 1$, and $\bar{\pi}'(\Delta) > 0$.*

By the definition of $\bar{\pi}(\Delta)$, if the defendant's type were drawn from the truncated distribution on the interval $[0, \bar{\pi}(\Delta)]$, the plaintiff would be just indifferent between dropping the case and going to trial. If the plaintiff faced a larger interval of defendant types, $[0, \bar{\bar{\pi}}(\Delta)]$ where $\bar{\bar{\pi}}(\Delta) > \bar{\pi}(\Delta)$, then the plaintiff would strictly prefer to go to trial. If the plaintiff faced a smaller interval with $\bar{\bar{\pi}}(\Delta) < \bar{\pi}(\Delta)$ then the plaintiff would strictly prefer to drop the case. According to Lemma 3, $\overline{\pi}'(\Delta) > 0$. This implies that as the plaintiff's position becomes longer (shorter), the incentive of the plaintiff to take the defendant to trial following the rejection of a settlement offer gets weaker (stronger).

The threshold $\bar{\pi}(\Delta)$, and the corresponding settlement offer $\bar{s}(\Delta) = \bar{\pi}(\Delta)D + c_d$, will be critical for understanding plaintiff's optimal settlement strategy at $t = 1$. To see why, let's compare the threshold from the last section, $\hat{\pi}(\Delta)$, to our new threshold, $\bar{\pi}(\Delta)$. First, suppose that $\hat{\pi}(\Delta) > \bar{\pi}(\Delta)$. If the plaintiff offered $\hat{s}(\Delta) = \hat{\pi}(\Delta)D + c_d$ and if defendants with types $\pi \in [0, \hat{\pi}(\Delta))$ rejected the offer, then we would have $m(\hat{\pi}(\Delta)) > m(\bar{\pi}(\Delta))$. The plaintiff's threat to go to trial is credible in this case, and there would be no need for the plaintiff to distort the settlement offer. Next, suppose that $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$. Since $m(\hat{\pi}(\Delta)) < m(\bar{\pi}(\Delta))$ in this case, the plaintiff would rather drop the suit than litigate against defendants on the truncated distribution on $[0, \hat{\pi}(\Delta))$. So it is no longer a continuation equilibrium for the defendant to reject the offer if and only if $\pi < \hat{\pi}(\Delta)$.[40] Credibility will impose a binding constraint on the plaintiff in this case and, as in Nalebuff (1987), the plaintiff would raise the settlement offer to $\bar{s}(\Delta) = \bar{\pi}(\Delta)D + c_d$ in order to maintain credibility.

The next proposition, which is proven in the appendix, fully characterizes the equilibrium of the continuation game at time $t = 1$ conditional on Δ. This characterization is facilitated by the fact that $\overline{\pi}(\Delta)$ is an increasing function and $\hat{\pi}(\Delta)$ is a decreasing function of Δ. Specifically, there is a unique value $\Delta^* \in \Omega$ that satisfies $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. When $\Delta \leq \Delta^*$ then $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$ and the credibility constraint does not bind and the plaintiff offers $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$ as in the benchmark case with full commitment. When $\Delta > \Delta^*$ then $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and the credibility constraint does bind. In this case, the plaintiff offers to settle for $s^*(\Delta) = \bar{\pi}(\Delta)D + c_d$. If the financial stake Δ is sufficiently large, the plaintiff will simply drop the case.

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[40] As shown in the proof of Proposition 3 in the appendix, the plaintiff will use a mixed strategy of either proceeding to trial or dropping the case in equilibrium.

Proposition 3. *Suppose the plaintiff has taken a financial position Δ at $t = 0$ and can make a take-it-or-leave-it offer to the privately informed defendant. There exists a $\Delta^* \in \Omega$ such that $\hat{\pi}(\Delta^*) = \overline{\pi}(\Delta^*)$. For $\Delta \in \Omega$, if $\Delta \leq \Delta^*$, then $\hat{\pi}(\Delta) \geq \overline{\pi}(\Delta)$ and if $\Delta > \Delta^*$, then $\hat{\pi}(\Delta) < \overline{\pi}(\Delta)$.*

1. *If $\Delta \leq \Delta^*$, the plaintiff offers to settle for $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$. The defendant accepts if and only if $\pi \geq \hat{\pi}(\Delta)$. If the offer is rejected, the case goes to trial.*
2. *If $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right]$, the plaintiff offers to settle for $s^*(\Delta) = \overline{\pi}(\Delta)D + c_d$. The defendant accepts if and only if $\pi \geq \overline{\pi}(\Delta)$. If the offer is rejected, the case goes to trial.*
3. *If $\Delta > \frac{m(1)D-c_p}{m(1)D+c_d}$, the defendant rejects any positive offer and the plaintiff drops the case.*

This proposition has a number of interesting and important implications. First, when $\Delta \leq \Delta^*$, the plaintiff offers to settle for $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$. Since $\hat{\pi}'(\Delta) < 0$ by Lemma 2, a shorter financial position leads to a higher settlement offer, a lower settlement rate and higher rate of litigation rate. Thus, in this range, short-and-sue tactics harm defendants and increase the costs of litigation. When $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right]$, however, the plaintiff offers $s^*(\Delta) = \overline{\pi}(\Delta)D + c_d$. Since $\overline{\pi}'(\Delta) > 0$ by Lemma 3, the comparative statics are reversed. When the plaintiff takes a slightly shorter financial position, the settlement offer falls, the settlement rate rises, and the litigation rate falls. In this range, taking a shorter position relaxes the (binding) credibility constraint, and allows the plaintiff lower its settlement offer. Thus, the defendant can actually be made better off, and more litigation costs are averted, when the plaintiff takes a shorter financial position in the defendant's stock. The results from Proposition 3 are illustrated in the following numerical example.

Numerical Example. Suppose that π is uniformly distributed on the unit interval, so that $f(\pi) = 1$ and $F(\pi) = \pi$, and $D = 100$ and $c_p = c_d = 30$. The set $\Omega = \left[-\frac{c_p}{c_d}, \frac{m(1)D-c_p}{m(1)D+c_d}\right] = [-1,\ 1/4]$, and the two threshold functions are:

$$\hat{\pi}(\Delta) = \frac{0.4 - \Delta}{1 - \Delta} \quad \text{and} \quad \overline{\pi}(\Delta) = \frac{0.6(1 + \Delta)}{1 - \Delta} \tag{17}$$

as shown in Figure 1 below. Per Proposition 3, when $\Delta \leq \Delta^* = -1/8$, the plaintiff offers to settle for $100\hat{\pi}(\Delta) + 30$; when $\Delta \in (-1/8, 1/4]$ the plaintiff offers to settle for $100\overline{\pi}(\Delta) + 30$; when $\Delta > 1/4$ then the plaintiff drops (or does not file) the case.

Suppose $\Delta = 0$, so that $\hat{\pi}(0) = 2/5$ and $\overline{\pi}(0) = 3/5$. If the plaintiff were committed to going to trial following the rejection of an offer, the plaintiff would choose $\hat{s}(0) = \hat{\pi}(0)D + c_d = 40 + 30 = 70$ and defendants with types below $\hat{\pi}(0) = 2/5$ would reject and go to trial. However, since $m(0.4)D - c_p = 20 - 30 = -10$, the plaintiff's threat to go to trial is not credible. According to Proposition 3, the plaintiff would raise the offer to $\overline{s}(0) = \overline{\pi}(0)D + c_d = 60 + 30 = 90$. The plaintiff now has a credible threat to go to trial following rejection since $m(0.6)D - c_p = 30 - 30 = 0$. Suppose instead that the plaintiff takes a short position $\Delta^* = -1/8$, the value where $\hat{\pi}(\Delta^*) = \overline{\pi}(\Delta^*) = 7/15$. With $\Delta^* = -1/8$, the plaintiff offers $s^*(\Delta^*) = \hat{\pi}(\Delta^*)D + c_d \approx 47 + 30 = 77$. Since the settlement offer is lower with the short position, the defendant is better off on average. When $\Delta \leq \Delta^* = -1/8$ and the position becomes shorter (as Δ decreases), the settlement offer rises and the defendant becomes worse off.

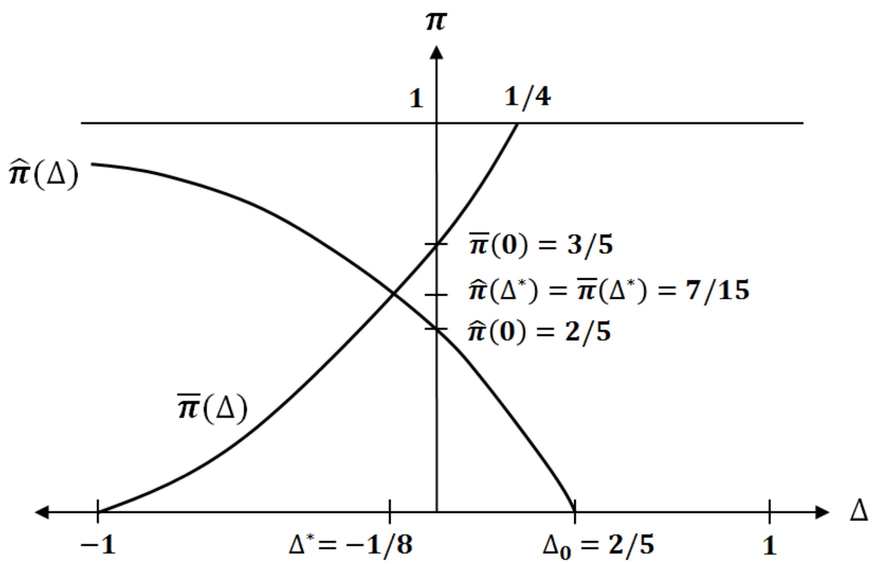

Figure 1: $\pi \sim U[0,1]$, $D = 100$, $c_p = c_d = 30$

3.3. The Plaintiff's Choice of Financial Position

With the preceding analysis, we can characterize the plaintiff's optimal financial position Δ at $t = 0$. When the financial market does not initially expect the future lawsuit by the plaintiff, so that $v_0 = R$, the plaintiff's ex ante expected return is maximized by taking the largest possible short position. We can consider two separate cases. First, suppose credibility is not an issue and the settlement offer is set at $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$. In that case, when deciding on Δ, given that the subsequent settlement offer is set at an unconstrained optimum, the plaintiff can ignore the effect a change in financial position will have on the settlement offer and focus only on the direct, financial effect. Since taking a larger short position produces a bigger financial return, the plaintiff is strictly better off with a larger short position. Second, when credibility is an issue and the settlement offer is set at $s^*(\Delta) = \bar{\pi}(\Delta)D + c_d$, taking a stronger short position not only improves the direct financial return, but also relaxes the credibility constraint and produces a positive strategic effect ($\bar{\pi}'(\Delta) > 0$). In both cases, the plaintiff's expected return is maximized by taking on the largest possible short position. This result is summarized in the following proposition, with the formal proof in the appendix.

Proposition 4. *Suppose the plaintiff makes a take-it-or-leave-it offer to a privately informed defendant and the financial market is initially unaware of the lawsuit so that* $v_0 = R$. *If* $\Delta_L \leq \frac{m(1)D - c_p}{m(1)D + c_d}$*, the plaintiff's ex ante payoff is maximized by taking as short a financial position as possible,* $\Delta = \Delta_L$. *If* $\Delta_L > \frac{m(1)D - c_p}{m(1)D + c_d}$ *the plaintiff's threat to go to trial cannot be made credible and so the plaintiff will take a neutral financial position.*

If, on the other hand, that the financial market is informationally efficient, the plaintiff would no longer want to take on the maximal possible short position. Because the plaintiff can no longer receive a direct, financial benefit from taking a short position, the only reason for the plaintiff to take any short (or long) position against the defendant is to acquire a strategic advantage. When credibility is not an issue, taking a short position will only distort the settlement offer (by making the plaintiff more aggressive) and the plaintiff would want to take no financial position against the defendant. When credibility is an issue, on the other hand, the plaintiff will want to take a moderate short position so as to relax the constraint, but the short position will be just large enough so that the credibility constraint is satisfied but not strictly binding. The following proposition formalizes this, with the proof in the appendix.

Proposition 5. *Suppose the plaintiff makes a take-it-or-leave-it offer to a privately informed defendant and the financial market is informationally efficient. When* $\Delta^* \geq 0$*, the plaintiff's ex ante expected return is maximized by not investing in the defendant's stock* ($\Delta = 0$). *When* $\Delta^* < 0$*, the plaintiff's ex ante expected return is maximized by taking the short position* $\Delta^* < 0$ *such that* $\hat{\pi}(0) < \bar{\pi}(\Delta^*) = \hat{\pi}(\Delta^*) < \bar{\pi}(0)$. *The probability of litigation is lower and the plaintiff and defendant are better off when the plaintiff can short the defendant's stock.*

From the uniform distribution example above, when the financial market is informationally efficient, the plaintiff's optimal financial position is $\Delta = \Delta^* = -1/8$, just large enough to relax the credibility constraint. It is worth re-emphasizing that, when $\Delta^* < 0$, with an informationally efficient financial market, both the plaintiff and the defendant are strictly better off in expectation when the plaintiff can short the stock of the defendant. With $\Delta^* < 0$, shorting the stock allows the plaintiff to relax its own incentive compatibility constraint, which leads to a lower settlement offer than would be obtained otherwise: $s^*(\Delta^*) < \bar{s}(0)$. The defendants with types $\pi \in [\bar{\pi}(0), 1]$ benefit from this, since they pay less in settlement when $\Delta = \Delta^*$ than they would if $\Delta = 0$. The defendants with types $\pi \in (\bar{\pi}(\Delta^*), \bar{\pi}(0))$ benefit as well, since these types settle when $\Delta = \Delta^*$ but would have gone to trial if $\Delta = 0$. Note also that the litigation rate is lower as a consequence of short selling, and so the expected litigation costs are lower as well. So, in this admittedly limited sense, social welfare rises when the plaintiff shorts the defendant's stock.

4. Asymmetric Information: Signaling

In this section, we adopt a bargaining protocol where the informed defendant makes a single take-it-or-leave-it offer to the uninformed plaintiff. The model closely follows the signaling model of Reinganum and Wilde (1986).[41] We characterize the fully-separating Perfect Bayesian Equilibrium where the offer fully reveals the defendant's type and makes the plaintiff indifferent between accepting the offer and rejecting the offer and going to trial. The plaintiff subsequently randomizes between accepting the offer and going to trial.[42] As in Reinganum and Wilde (1986), we assume that all cases have positive expected value (absent short selling by the defendant). Specifically, we assume that $f(\pi)$ is distributed on support $[\underline{\pi}, 1]$ where $\underline{\pi}D - c_p > 0$. Although short selling is not necessary for credibility, it will improve the terms of settlement offered by the defendant.

Before analyzing the signaling model, let us briefly revisit the case of *symmetric information* where the defendant could make a take-it-or-leave-it offer to the plaintiff ($\theta = 1$). Since $\pi D - c_p > 0$ for all $\pi \in [\underline{\pi}, 1]$, the plaintiff has a credible threat to litigate absent short selling. If $\Delta = 0$, then the defendant would offer $s(0) = \pi D - c_p$ and the plaintiff would accept. With short selling, the defendant would need to raise the settlement offer to get the plaintiff to accept. In the limit as $\Delta \to -\infty$, the defendant's settlement offer would converge to $\pi D + c_d$. With *asymmetric information*, the same basic force is at play. By taking a short position in the defendant's stock, the plaintiff can induce the defendant to make a more generous settlement offer. At the same time, short selling will distort the plaintiff's interim

[41] In Reinganum and Wilde (1986), the plaintiff was privately informed and made an offer to the uninformed defendant.
[42] Pooling equilibria are eliminated with the D1 refinement of Cho and Kreps (1987).

incentives, making it more likely that the plaintiff will reject the defendant's offer, and therefore more litigation will occur in equilibrium.

4.1. The Bargaining Outcome

Let the settlement offer made by the defendant of type π to a plaintiff with financial position Δ be denoted by $\sigma(\pi;\Delta)$. In a fully-separating equilibrium, the plaintiff infers the defendant's type from the offer and is indifferent between accepting the offer and going to trial. Thus, the settlement offer must be exactly the same as the lower bound of the settlement range characterized earlier:

$$\sigma(\pi;\Delta) \equiv \underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right) \tag{18}$$

Note that this settlement offer is increasing in π, so higher offers correspond to higher defendant types. It is also decreasing in Δ, so shorter financial positions induce higher offers. Our earlier assumption that $\underline{\pi}D - c_p > 0$ guarantees that the settlement offer $\sigma(\pi;\Delta)$ is strictly positive when $\Delta \leq 0$. In the limit as $\Delta \to -\infty$, the entire schedule of offers converges to $\pi D + c_d$.

Let $p(\pi;\Delta)$ denote the equilibrium probability that the plaintiff accepts the offer $\sigma(\pi;\Delta)$. To construct a closed form solution for this probability, suppose the defendant is of type π and makes a settlement offer corresponding to type $\tilde{\pi}$ in the fully-separating equilibrium. After receiving an offer to settle for $\sigma(\tilde{\pi};\Delta)$, the plaintiff believes that the defendant is type $\tilde{\pi}$ and mixes with probability $p(\tilde{\pi};\Delta)$, giving the type π defendant an expected payment of

$$p(\tilde{\pi};\Delta)\left[\tilde{\pi}D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right)\right] + \big(1 - p(\tilde{\pi};\Delta)\big)[\pi D + c_d] \tag{19}$$

The first term represents the payments made by the defendant if the settlement offer is accepted; the second term represents the payments made if the case goes to trial.

Incentive compatibility requires that a defendant of type π would not want to misrepresent himself and pretend to be type $\tilde{\pi} \neq \pi$. Taking the derivative of (19) with respect to $\tilde{\pi}$ and setting the slope equal to zero when $\tilde{\pi} = \pi$ gives:

$$p(\pi;\Delta)D - \frac{\partial p(\pi;\Delta)}{\partial \Delta}\left(\frac{c_p + c_d}{1-\Delta}\right) = 0 \tag{20}$$

This is a first-order differential equation with general solution $p(\pi;\Delta) = \beta e^{\frac{\pi(1-\Delta)D}{c_p+c_d}}$ where β is an arbitrary constant. When $\beta > 0$ this function is increasing in π, so higher defendant types are more likely to accept. It must be the case that $p(1;\Delta) = 1$, so the defendant with the highest type has his offer accepted for sure. If this were not true, i.e., $p(1;\Delta) < 1$, the defendant could raise his offer slightly and the plaintiff would accept regardless of the beliefs held about the defendant's true type. Using this boundary condition of $p(1;\Delta) = 1$, we establish the value for the constant $\beta = e^{\frac{-(1-\Delta)D}{c_p+c_d}}$ and we have the following result.

Proposition 6. *Suppose the informed defendant makes a take-it-or-leave-it offer to the uninformed plaintiff who has taken financial position Δ at time $t = 0$. In the fully-separating Perfect Bayesian Equilibrium, the defendant offers $\sigma(\pi;\Delta)$ where $\frac{\partial\sigma(\pi;\Delta)}{\partial\Delta} < 0$ and $\lim_{\Delta\to-\infty} \sigma(\pi;\Delta) = \pi D + c_d$. The plaintiff accepts with probability*

$$p(\pi;\Delta) = e^{\frac{-(1-\pi)(1-\Delta)D}{c_p+c_d}} \tag{21}$$

and goes to trial otherwise. $p(\pi;\Delta) > 0$, $p(1;\Delta) = 1$, $\frac{\partial p(\pi;\Delta)}{\partial\pi} > 0$, $\frac{\partial p(\pi;\Delta)}{\partial\Delta} > 0$, *and* $\lim_{\Delta\to-\infty} p(\pi;\Delta) = 0\ \forall\pi \in [\underline{\pi}, 1)$.

Several observations are in order. First, the defendant's settlement offer $\sigma(\pi;\Delta)$ and the plaintiff's probability of acceptance $p(\pi;\Delta)$ are both increasing in the defendant's type π. To provide the incentive for the defendant to truthfully reveal his type, the plaintiff must be more likely to accept higher settlement offers than lower ones. Second, the settlement offer $\sigma(\pi;\Delta)$ is decreasing, and the probability of acceptance $p(\pi;\Delta)$ is increasing, in the plaintiff's financial position Δ. Thus, when Δ becomes smaller, the settlement offer gets larger and the plaintiff is more likely to reject the settlement offer and go to trial. Short selling by the plaintiff will increase the equilibrium rate of litigation.

4.2. The Plaintiff's Choice of Financial Position

With the continuation equilibrium, we can now explore the plaintiff's optimal choice of Δ at $t = 0$. To do this, we first construct the plaintiff's ex ante expected payoff from the game. Initially, suppose the financial market is unaware of the lawsuit so that the plaintiff can take a financial position Δ at $v_0 = R$. When the defendant makes a settlement offer of $\sigma(\pi;\Delta)$ and the plaintiff accepts, we get $v_3 = R - \sigma(\pi;\Delta)$. If the plaintiff rejects the offer, the expected value of the company, conditional on π at $t = 3$ is $R - \pi D - c_d$. In the former case, the plaintiff will make a financial return of $\Delta(R - \sigma(\pi;\Delta) - R) = -\Delta\sigma(\pi;\Delta)$, whereas in the latter case, the plaintiff expects to make a financial return of $\Delta(R - \pi D - c_d - R) = -\Delta(\pi D + c_d)$. When we combine the financial returns with the returns from litigation, the plaintiff's expected return as of $t = 0$ becomes:

$$\int_{\underline{\pi}}^{1} p(\pi;\Delta)\sigma(\pi;\Delta)(1-\Delta)f(\pi)d\pi + \int_{\underline{\pi}}^{1}\big(1-p(\pi;\Delta)\big)\Big(\big(\pi D - c_p\big) - \Delta(\pi D + c_d)\Big)f(\pi)d\pi \tag{22}$$

The first part of this expression represents the plaintiff's return from accepting the settlement offer of $\sigma(\pi;\Delta)$ which happens with probability $p(\pi;\Delta)$. The second part of this expression represents the expected return from rejecting the settlement offer and proceeding to trial. Using the expressions for $\sigma(\pi;\Delta)$ and $p(\pi;\Delta)$ in equations (18) and (21) above, we can rewrite the plaintiff's ex ante payoff as:

$$V^p(\Delta) = (1-\Delta)\int_{\underline{\pi}}^{1}\left(\pi D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right)\right)f(\pi)d\pi = (1-\Delta)\int_{\underline{\pi}}^{1}\sigma(\pi;\Delta)\,f(\pi)d\pi \tag{23}$$

This is intuitive since the defendant's settlement offer to the plaintiff makes the plaintiff indifferent, in terms of aggregate return, between accepting and rejecting. When we take the derivative with respect to Δ, we see that $V^p(\Delta)$ is strictly decreasing in Δ:

$$\frac{\partial V^p(\Delta)}{\partial \Delta} = \int_{\underline{\pi}}^{1} -(\pi D + c_d)f(\pi)d\pi \, < 0$$

This leads to the following result:

Proposition 7. *Suppose the informed defendant makes a take-it-or-leave-it offer to the uninformed plaintiff and the financial market is initially unaware of the lawsuit, so that $v_0 = R$. The plaintiff's ex ante payoff is maximized by taking as short a financial position as possible, $\Delta = \Delta_L$.*

When the financial market is strong form efficient, however, it may no longer make sense for the plaintiff to take the largest possible short position. With an informationally efficient capital market, the ex ante market value $v_0(\Delta)$ is equal to the expected future market value of the firm. As a consequence, the plaintiff cannot earn any direct return from its financial investing activities—the plaintiff will just break even on the short selling of the defendant's stock. The plaintiff may benefit from the short position indirectly, however, through its impact on the bargaining outcome.

Since the plaintiff's ex ante return from the financial investment is zero, the plaintiff's expected ex ante payoff simply becomes:

$$\int_{\underline{\pi}}^{1} p(\pi;\Delta)\sigma(\pi;\Delta)f(\pi)d\pi \ + \int_{\underline{\pi}}^{1}(1-p(\pi;\Delta))(\pi D - c_p)f(\pi)d\pi \tag{24}$$

Note that, compared to (22), a financial position affects the plaintiff's return only by affecting the settlement offer $\sigma(\pi;\Delta)$ and the probability of acceptance $p(\pi;\Delta)$. Using the expressions for $\sigma(\pi;\Delta)$ and $p(\pi;\Delta)$, we can rewrite the plaintiff's ex ante payoff as:

$$V^p(\Delta) = \int_{\underline{\pi}}^{1}(\pi D - c_p)f(\pi)d\pi \ - \left(\tfrac{\Delta}{1-\Delta}\right)(c_p + c_d)\int_{\underline{\pi}}^{1} e^{\frac{-(1-\pi)(1-\Delta)D}{c_p+c_d}} f(\pi)d\pi \tag{25}$$

Suppose that $\Delta = 0$ so the plaintiff takes no financial position. In this case, the second term is zero and the defendant will offer to settle for $\sigma(\pi;0) = \pi D - c_p$. The plaintiff's payoff, therefore, is exactly what it would be if the plaintiff went to trial against all defendant types. Suppose instead that the plaintiff takes a long position in the defendant's stock, $\Delta > 0$. In that case, the second term in expression (25) is negative. Knowing that the plaintiff is in a weak bargaining position, the defendant would offer to settle for $\sigma(\pi;\Delta) < \pi D - c_p$ and the plaintiff is worse off ex ante. It is clear from (25) that the plaintiff is strictly better off if he shorts the defendant's stock at time $t = 0$. When $\Delta < 0$, the second term is strictly positive. By taking a short position, the plaintiff induces the defendant to make a settlement offer $\sigma(\pi;\Delta) > \pi D - c_p$. At the same time, the probability of accepting the offer $p(\pi;\Delta)$ decreases as Δ falls, thereby making the plaintiff more likely to realize $\pi D - c_p$. When we take these two effects into account, we have the following result.

Proposition 8. *Suppose the informed defendant makes a take-it-or-leave-it offer to the uninformed plaintiff and the financial market is informationally efficient. There exists a* $\Delta^{**} \in (-\infty, 0)$ *that maximizes* $V^p(\Delta)$ *in (25). The probability of litigation is higher, the plaintiff is better off, the defendant is worse off, and the litigation rate is higher when the plaintiff takes the short position (*$\Delta^{**} < 0$*) than when he does not* ($\Delta = 0$).

Proof of Proposition 8. From (25), we see that $V^p(0) = \int_{\underline{\pi}}^{1}(\pi D - c_p)f(\pi)d\pi$. When we differentiate (25) with respect to Δ, we get

$$\frac{\partial V^p(\Delta)}{\partial \Delta} = -\frac{c_p + c_d}{1-\Delta}\int_{\underline{\pi}}^{1}\left(\frac{2-\Delta}{1-\Delta}p(\pi;\Delta) + \Delta\frac{\partial p(\pi;\Delta)}{\partial \Delta}\right)f(\pi)d\pi \tag{26}$$

where $\frac{\partial p(\pi;\Delta)}{\partial \Delta} = p(\pi;\Delta)\frac{(1-\pi)D}{c_p+c_d} > 0\ \forall \pi \in [0,1)$. From (26), we see that $\frac{\partial V^p(\Delta)}{\partial \Delta} < 0\ \forall \Delta \in [0,1)$. From (18), we know that the plaintiff will not want to take a financial position of $\Delta \geq 1$. Also, from (25), as $\Delta \to -\infty$, $V^p(\Delta) \to \int_{\underline{\pi}}^{1}(\pi D - c_p)f(\pi)d\pi$ since $-\frac{\Delta}{1-\Delta} \to 1$ while $p(\pi;\Delta) \to 0\ \forall \pi \in [0,1)$. Hence, there exists a $\Delta^{**} \in (-\infty, 0)$ where $V^p(\Delta)$ is maximized. Since $(\pi;\Delta^{**}) < p(\pi;0)\ \forall \pi \in [\underline{\pi}, 1)$, the litigation rate is strictly higher for all defendant types except for type 1. Combined with the higher litigation rate, because $(\pi;\Delta^{**}) > \sigma(\pi;0)$ $\forall \pi \in [\underline{\pi}, 1)$, all defendant types (except for type 1) are strictly worse off. ■

With a strong form efficient financial market, the plaintiff does not realize a direct financial gain. With respect to the strategic benefit, there are two effects to consider. First, as Δ gets smaller, the schedule of settlement offers $\sigma(\pi;\Delta)$ increases and converges to $\pi D + c_d$. However, to maintain incentive compatibility, the plaintiff has to accept the offer with lower probability: $p(\pi;\Delta)$ falls as Δ gets smaller. In the limit as $\Delta \to -\infty$, the probability $p(\pi;\Delta)$ approaches zero for all $\pi < 1$. (When $\pi = 1$, $p(1;\Delta) = 1$ for all Δ.) The upshot is that while taking a very short position on the defendant's stock has the advantage of raising the defendant's offer, the reduced probability of acceptance at the interim stage mitigates the plaintiff's gain from the ex ante perspective. The plaintiff will, therefore, take a short position ($\Delta^{**} \in (-\infty, 0)$) that optimally balances these two effects.

5. Conclusion

This paper has analyzed a model of litigation where the plaintiff has or can acquire a financial position in the defendant. This issue has become quite salient recently when a prominent hedge fund manager brought numerous patent challenges against pharmaceutical companies while shorting their stock. The analysis has shown that the plaintiff gains a strategic advantage by taking a short position in the defendant's stock. This is true even with a fully forward-looking financial market, so that the plaintiff makes no positive return from the financial position. Such strategic advantages are two-fold. First, when the lawsuit itself has a negative expected value, taking a short position against the defendant allows the plaintiff to turn the lawsuit into a positive expected value one. Second, the short position raises the minimum amount of settlement that the plaintiff is willing to accept, thereby improving the settlement return for the plaintiff. When the defendant is privately informed about the probability of winning at trial, the plaintiff balances the benefits of relaxing the credibility constraint against the costs of bargaining failure. When credibility is an issue, the paper has shown that short selling can actually benefit both the plaintiff and the defendant by making the plaintiff less aggressive in settlement demands and lowering the probability of going to a costly trial.

By analyzing the plaintiff's financial and litigation strategy, the paper contributes to the literature on litigation, particularly that on negative expected value suits and gaining strategic advantage through third-party contracts. The paper also contributes to the literature that examines the effect of a financial position on non-financial actions, for instance, on how long positions among competitors in the same market can facilitate collusion while a short position by an incumbent can make predation against an entrant credible. One type of non-financial behavior that has received much less attention is government lobbying. The recent case of a prominent hedge fund, Pershing Square, lobbying the Federal Trade Commission (FTC) and the Securities and Exchange Commission (SEC) to investigate and to bring an enforcement action against Herbalife, while maintaining a short position on the company, is illustrative. While the Herbalife case did not involve a lawsuit and is not directly addressed by the paper, analyzing how financial position affects government lobbying and vice versa is an important topic left for further research.

Appendix: Proofs

Analysis of Endogenous Litigation Costs. This section presents a more detailed analysis of the Tullock contest. The plaintiff has a credible threat to go to trial for all $\Delta < 1$ by revealed preference. Given c_d^*, the plaintiff could would achieve the same payoff as dropping the case by spending $c_p = 0$. By spending more than zero, the plaintiff does strictly better. Given Δ, the most the firm is willing to pay in settlement is:

$$\overline{s}(\Delta) = \pi(c_p^*, c_d^*)D + \; c_d^* \; \leq D \tag{A1}$$

The defendant's reservation value is now a function of Δ since the equilibrium litigation expenditures, c_p^* and c_d^*, depend on Δ. The property that $\overline{s}(\Delta) \leq D$ follows from revealed preference. Since the defendant can guarantee itself an exposure of D by spending nothing at all, the most the defendant is willing to pay is capped at this level.

Consider the equilibrium characterization of the expenditures in the text. Multiplying the numerators and denominators of expressions for c_p^* and c_d^* by $(1-\Delta)^{-2r}$, we can rewrite the expressions for the equilibrium litigation expenditures as:

$$c_p^* = \frac{(1-\Delta)^{1-r}}{\left[\frac{1}{(1-\Delta)^r}+1\right]^2} rD \qquad \text{and} \qquad c_d^* = \frac{(1-\Delta)^{-r}}{\left[\frac{1}{(1-\Delta)^r}+1\right]^2} rD$$

In the limit as Δ approaches negative infinity, the denominators of these two expressions converge to one. Since the exponent in the numerator of the first expression is positive, $1 - r > 0$, c_p^* grows without bound. Since the exponent in the second expression is negative, c_d^* approaches zero. Note however that c_d^* is not monotonic in Δ. Specifically, c_d^* is an increasing function of Δ when $\Delta < 0$ and an increasing function of Δ when $\Delta > 0$. When $\Delta = 1$ then $c_d^* = 0$. The plaintiff's litigation spending c_p^* rises without bound as Δ becomes more and more negative and the defendant's litigation spending c_d^* converges to zero.

We will now prove that $\overline{s}(\Delta)$ is a decreasing function using the envelope theorem. Since the defendant chooses its litigation expenditure c_d^* optimally given its belief about the plaintiff's choice c_p^*, we need only consider the effect of Δ on $\overline{s}(\Delta)$ through the plaintiff's equilibrium expenditure, c_p^*. Specifically, since $\pi(c_p^*, c_d^*)$ is an increasing function of c_p^*, an increase in Δ would lower $\pi(c_p^*, c_d^*)$ as well. Since $c_p^*(\Delta) = \frac{(1-\Delta)^{1+r}}{[1+(1-\Delta)^r]^2} rD$, we have:

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{-[1+(1-\Delta)^r]^2(1+r)(1-\Delta)^r + (1-\Delta)^{1+r}2[1+(1-\Delta)^r]r(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^4} rD$$

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r](1-\Delta)^r}{[1+(1-\Delta)^r]^4} \{-[1+(1-\Delta)^r](1+r) + 2r(1-\Delta)^r\}rD$$

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r](1-\Delta)^r}{[1+(1-\Delta)^r]^4}\{-(1+r)-(1-r)(1-\Delta)^r\}rD < 0 \quad \text{(A2)}$$

The fraction is positive and the second term in curly brackets is negative for all $\Delta < 1$ and $r \in (0,1)$. Thus, $c_p^*(\Delta)$ is a decreasing function of Δ. So, an increase in Δ reduces the most that the defendant is willing to pay in settlement.

Given Δ, the least that the that the plaintiff is willing to accept is

$$\underline{s}(\Delta) = \pi(c_p^*, c_d^*)D + c_d^* - \left(\frac{c_p^* + c_d^*}{1-\Delta}\right)$$

Since $c_p^* = c_d^*(1-\Delta)$, this becomes

$$\underline{s}(\Delta) = \pi(c_p^*, c_d^*)D - \left(\frac{c_d^*}{1-\Delta}\right) \quad \text{(A3)}$$

We will now prove that $\underline{s}(\Delta)$ is a decreasing function of Δ. Our argument will proceed in two parts. First, we will show that $\pi(c_p^*, c_d^*)$ is decreasing in Δ. Then, we will show that $-c_d^*/(1-\Delta)$ is also decreasing in Δ. Abusing notation slightly, let $\pi(\Delta) = \pi(c_p^*, c_d^*) = \frac{(1-\Delta)^r}{1+(1-\Delta)^r}$. Taking the derivative, we have

$$\frac{\partial \pi(\Delta)}{\partial \Delta} = \frac{-[1+(1-\Delta)^r]r(1-\Delta)^{r-1} + (1-\Delta)^r r(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^2} = \frac{-r(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^2} < 0$$

Next, let us define

$$\varphi(\Delta) \equiv \frac{-c_d^*(\Delta)}{1-\Delta} = \frac{-(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^2}\, rD \quad \text{(A4)}$$

Taking the derivative, we get:

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r]^2(r-1)(1-\Delta)^{r-2} - (1-\Delta)^{r-1}2[1+(1-\Delta)^r]r(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^4}\, rD$$

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r](1-\Delta)^{r-2}}{[1+(1-\Delta)^r]^4}\{[1+(1-\Delta)^r](r-1) - 2r(1-\Delta)^r\}\, rD$$

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r](1-\Delta)^{r-2}}{[1+(1-\Delta)^r]^4}\{-(1-r)-(1+r)(1-\Delta)^r\}\, rD < 0 \quad \text{(A5)}$$

This last inequality follows from the fact that $\Delta < 1$ and $r \in (0,1)$. This concludes the demonstration that $\underline{s}(\Delta)$ is a decreasing function of Δ.

Comparing the upper and lower bounds of the settlement range, it is clear that $\overline{s}(\Delta) > \underline{s}(\Delta)$ for $\Delta < 1$. Thus, the bargaining range is nonempty for all values of Δ. The Nash bargaining solution gives $s(\Delta) = (1-\theta)s(\Delta) + \theta\underline{s}(\Delta)$. Since both terms are decreasing functions of Δ, we know that $s(\Delta)$ is also decreasing in Δ. By taking a very short position, the plaintiff will be able to extract a settlement arbitrarily cost to D. As we saw above, in the limit as $\Delta \to -\infty$, $\pi(c_p^*, c_d^*) \to 1$ and $c_d^* \to 0$. Therefore, as $\Delta \to -\infty$, $\overline{s}(\Delta) \to D$ and $\underline{s}(\Delta) \to D$. ■

Proof of Lemma 2. Taking the derivative of (11) with respect to $\hat{\pi}$ gives the slope:

$$\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} \equiv \left[\hat{\pi}D - c_p + (R - \hat{\pi}D - c_d)\Delta\right]f(\hat{\pi}) \\ -[\hat{\pi}D + c_d + (R - \hat{\pi}D - c_d)\Delta]f(\hat{\pi}) + \int_{\hat{\pi}}^{1} D(1-\Delta)f(\pi)d\pi \tag{A6}$$

Canceling terms, this slope may be rewritten as

$$\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} \equiv -(c_p + c_d)f(\hat{\pi}) + (1-\Delta)D[1 - F(\hat{\pi})] \tag{A7}$$

Since $(\pi) > 0$ $\forall \pi \in [0,1]$, this slope is negative when $\hat{\pi} \to 1$. Therefore, the optimal $\hat{\pi} < 1$. Dividing by $1 - F(\hat{\pi})$, the slope is negative (positive) if and only if

$$\frac{(1-\Delta)D}{c_p + c_d} < (>) \frac{f(\hat{\pi})}{1 - F(\hat{\pi})}. \tag{A8}$$

The monotone hazard rate condition implies that the right-hand side strictly is increasing in $\hat{\pi} \in (0,1)$. It is equal to $f(0)$ when $\hat{\pi} = 0$ and approaches positive infinity as $\hat{\pi}$ approaches 1.

Define Δ_0 to be where $\frac{(1-\Delta_0)D}{c_p+c_d} = f(0)$. Suppose $\Delta \geq \Delta_0$. Using the monotone hazard rate condition, $\frac{(1-\Delta)D}{c_p+c_d} \leq \frac{(1-\Delta_0)D}{c_p+c_d} = f(0) < \frac{f(\hat{\pi})}{1-F(\hat{\pi})}$ for all $\hat{\pi} \in (0,1)$. This implies that $\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} < 0$ for all $\hat{\pi} \in (0,1)$ and a corner solution is obtained at $\hat{\pi}(\Delta) = 0$.

Now suppose instead that $\Delta < \Delta_0$. In this case, $\frac{(1-\Delta)D}{c_p+c_d} > \frac{(1-\Delta_0)D}{c_p+c_d} = f(0)$. So $\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} > 0$ when $\hat{\pi} = 0$ and an interior solution $\hat{\pi}(\Delta) \in (0,1)$ is obtained. Finally, we will show that $\hat{\pi}'(\Delta) < 0$ when an interior solution exists. Letting $\varphi(\hat{\pi}) \equiv \frac{f(\hat{\pi})}{1-F(\hat{\pi})}$ be the monotone likelihood ratio, we can write the first order condition as $\frac{(1-\Delta)D}{c_p+c_d} = \varphi(\hat{\pi})$. Totally differentiating, we have $\frac{-D}{c_p+c_d}(d\Delta) = \varphi'(\hat{\pi})(d\hat{\pi})$, and so the slope $\hat{\pi}'(\Delta) = \frac{d\hat{\pi}}{d\Delta} = \frac{-D}{(c_p+c_d)\varphi'(\hat{\pi})} < 0$ and we are done. ■

Proof of Proposition 3. First, we show that there exists a unique fixed point $\Delta^* \in \Omega$ such that $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. Lemma 2 implies that $\hat{\pi}(\Delta)$ exists, is continuous, and $\hat{\pi}'(\Delta) \leq 0$ for all $\Delta \in \Omega$. Since $\bar{\pi}\left(\frac{-c_p}{c_d}\right) = 0$, $\bar{\pi}\left(\frac{m(1)D-c_p}{m(1)D+c_d}\right) = 1$, and $\bar{\pi}'(\Delta) > 0$ from Lemma 3, there must be a fixed point $\Delta^* \in \Omega$ where $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. Further, since $\hat{\pi}'(\Delta) \leq 0 < \bar{\pi}'(\Delta)$ for all $\Delta^* \in \Omega$, we have that if $\Delta < \Delta^*$ then $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$ and if $\Delta > \Delta^*$ then $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$.

Case 1: We consider two subcases. Suppose $\frac{-c_p}{c_d} \leq \Delta \leq \Delta^*$. We just showed that $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$. Suppose the plaintiff offers $\hat{\pi}(\Delta)D + c_d$ and the defendant accepts if and only if $\pi \geq \hat{\pi}(\Delta)$. Following the rejection of the offer, the plaintiff believes that $\pi < \hat{\pi}(\Delta)$. Given these updated beliefs, it is credible for the plaintiff to bring the defendant to trial following the rejection of the offer if:

$$m\big(\hat{\pi}(\Delta)\big)D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right) \geq 0 \tag{A9}$$

Recall that $\bar{\pi}(\Delta)$ is defined by $m(\bar{\pi}(\Delta))D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) = 0$. Since $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$, we have that $m(\hat{\pi}(\Delta)) \geq m(\bar{\pi}(\Delta))$ and so the credibility constraint does not bind. Suppose $\Delta < \frac{-c_p}{c_d}$. The plaintiff has a credible threat to litigate even when he believes he is facing the very lowest defendant type with $\pi = 0$. So the credibility constraint is not binding and the plaintiff chooses settlement offer $\hat{s}(\Delta)$ with threshold $\hat{\pi}(\Delta)$.

Case 2: Suppose $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right]$. We proved above that $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and so $m\big(\hat{\pi}(\Delta)\big) < m\big(\bar{\pi}(\Delta)\big)$. We will now show that it is optimal for the plaintiff to offer $\bar{\pi}(\Delta)D + c_d$. To do this, we first prove the following claim.

> ***Claim 1.*** *Suppose $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right)$ and the plaintiff offers $\tilde{s} = \tilde{\pi}D + c_d$ where $\tilde{\pi} < \bar{\pi}(\Delta)$. In equilibrium, the defendant types $\pi < \bar{\pi}(\Delta)$ reject the settlement offer and the plaintiff proceeds to trial with probability $\sigma(\tilde{\pi}) = \frac{\tilde{\pi}D+c_d}{\bar{\pi}(\Delta)D+c_d}$.*
>
> ***Proof of Claim 1.*** The proof follows the analysis in Nalebuff (1987) closely. Since $\Delta > \Delta^*$ (as we are in case 2), we have $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and so $m\big(\hat{\pi}(\Delta)\big)D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) < 0$. We cannot have a continuation equilibrium where the plaintiff always proceeds to trial following the rejection of $\tilde{s} = \tilde{\pi}D + c_d$. If that were true, then $m(\tilde{\pi})D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) < 0$ and the plaintiff would drop the case, a contradiction. We cannot have a continuation equilibrium where the plaintiff always drops the case following rejection of the offer, $\tilde{s} = \tilde{\pi}D + c_d$. If that were true, then no defendant

type would accept the offer. If all defendant types rejected, then since $\Delta < \frac{m(1)D - c_p}{m(1)D + c_d}$, we have $m(1)D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right) > 0$ and so the plaintiff would go to trial rather than drop the case (a contradiction). The equilibrium, therefore, will involve a mixed strategy. For the plaintiff to be indifferent between proceeding to trial and dropping the case after the rejection of settlement offer of $\tilde{\pi} < \bar{\pi}(\Delta)$, it must be that all defendants with types $\pi < \bar{\pi}(\Delta)$ reject the offer, so that, conditional on rejection, we have $m(\bar{\pi}(\Delta))D + c_d - \left(\frac{c_p + c_d}{1-\Delta}\right) = 0$. Let $\sigma(\tilde{\pi})$ be the probability that the plaintiff proceeds to trial upon rejection of $\tilde{\pi} < \bar{\pi}(\Delta)$. To make the defendant type $\bar{\pi}(\Delta)$ indifferent between accepting and rejecting the settlement offer $\tilde{\pi}D + c_d$ we need $\sigma(\tilde{\pi})(\bar{\pi}(\Delta)D + c_d) = \tilde{\pi}D + c_d$, from which we get $\sigma(\tilde{\pi}) = \frac{\tilde{\pi}D + c_d}{\bar{\pi}(\Delta)D + c_d}$. This concludes the proof of Claim 1. ■

Coming back to the proof for case 2, now, we can show that the plaintiff's expected return is maximized by offering $\bar{\pi}(\Delta)D + c_d$. If the plaintiff chooses $\tilde{\pi} \le \bar{\pi}(\Delta)$, the plaintiff's expected return can be written as:

$$\int_0^{\bar{\pi}(\Delta)} R\Delta f(\pi)d\pi + \int_{\bar{\pi}(\Delta)}^1 [\tilde{\pi}D + c_d + (R - \tilde{\pi}D - c_d)\Delta]f(\pi)d\pi \ - v_0(\Delta)\Delta \tag{A10}$$

The first term in this expression results from the plaintiff's indifference between going to trial and dropping the case following the rejection of the offer. Differentiating with respect to $\tilde{\pi}$, we get

$$D(1-\Delta)\left(1 - F\left(\bar{\pi}(\Delta)\right)\right) > 0 \tag{A11}$$

So the plaintiff would want to raise $\tilde{\pi}$ all the way up to $\bar{\pi}(\Delta)$. Now suppose instead that $\tilde{\pi} > \bar{\pi}(\Delta) > \hat{\pi}(\Delta)$. The plaintiff has a credible threat to litigate following the rejection of the settlement offer, and the plaintiff's payoff is $W^p(\tilde{\pi}, \Delta)$. Since $\tilde{\pi} > \hat{\pi}(\Delta)$, $W^p(\tilde{\pi}, \Delta)$ is decreasing in $\tilde{\pi}$. So the plaintiff would lower $\tilde{\pi}$ all the way down to $\bar{\pi}(\Delta)$.

Case 3: We now show that when $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$ the plaintiff will never take the defendant to trial. Suppose that this was not true, and that the plaintiff offers $\tilde{\pi}D + c_d$ and takes the defendant to trial with probability $\tilde{\sigma}$ if the offer is rejected. In this case, the defendant would reject the offer if $\tilde{\pi}D + c_d > \tilde{\sigma}(\pi D + c_d)$. Rearranging terms, the defendant rejects the offer if $\pi \in \left[0, \frac{\tilde{\pi}D + c_d(1-\tilde{\sigma})}{\tilde{\sigma}D}\right)$. The expected value of π on this interval is certainly smaller than $m(1)$. Therefore, since $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$, the plaintiff's threat to go to trial is never credible. Therefore the plaintiff cannot succeed in extracting a settlement offer. ■

Proof of Proposition 4. When the financial market does not anticipate the lawsuit, we have $v_0 = R$. Foremost, when $\Delta_L > \frac{m(1)D-c_p}{m(1)D+c_d}$, from Proposition 3, even with the largest possible short position, the plaintiff does not have a credible case against the defendant. Hence, the plaintiff takes the neutral position against the defendant and does not bring suit. Now, suppose $\Delta_L \leq \frac{m(1)D-c_p}{m(1)D+c_d}$. Let's consider two separate cases: (1) when $\Delta \leq \Delta^*$; and (2) when $\Delta > \Delta^*$.

Case 1: Suppose that $\Delta \leq \Delta^*$. Using Proposition 3, the plaintiff's settlement offer is $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$, so that (11) becomes:

$$W^p(\hat{\pi}(\Delta),\Delta)$$
$$= \int_0^{\hat{\pi}(\Delta)} \left[\pi D - c_p - (\pi D + c_d)\Delta\right] f(\pi) d\pi + \int_{\hat{\pi}(\Delta)}^{1} [\hat{\pi}(\Delta)D + c_d - (\hat{\pi}(\Delta)D + c_d)\Delta] f(\pi) d\pi$$

When $\Delta \leq \Delta^*$, since $\hat{\pi}$ is chosen optimally to maximize $W^p(\hat{\pi},\Delta)$ given Δ, the envelope theorem implies that we can ignore the effect of a change in Δ has on $W^p(\hat{\pi}(\Delta),\Delta)$ through $\hat{\pi}$. Hence, when we get

$$\frac{\partial W^p(\hat{\pi}(\Delta),\Delta)}{\partial \Delta} = -\int_0^{\hat{\pi}(\Delta)} (\pi D + c_d) f(\pi) d\pi - \int_{\hat{\pi}(\Delta)}^{1} (\hat{\pi}(\Delta)D + c_d)\, f(\pi) d\pi < 0$$

Therefore, the plaintiff's ex ante expected return is maximized by taking the largest possible short position: $\Delta = \Delta_L$.

Case 2: Now, suppose that $\Delta > \Delta^*$. From Proposition 3, the plaintiff's settlement offer is $s^*(\Delta) = \bar{\pi}(\Delta)D + c_d$ and the plaintiff's expected return becomes $W^p(\bar{\pi}(\Delta),\Delta)$. When we differentiate $W^p(\bar{\pi}(\Delta),\Delta)$ with respect to Δ, we get

$$\frac{\partial W^p(\bar{\pi}(\Delta),\Delta)}{\partial \Delta} = \bar{\pi}'(\Delta)\left\{-\left(c_p + c_d\right) f\left(\bar{\pi}(\Delta)\right) + (1-\Delta)D\left(1 - F\left(\bar{\pi}(\Delta)\right)\right)\right\}$$
$$- \int_0^{\bar{\pi}(\Delta)} (\pi D + c_d) f(\pi) d\pi - \int_{\bar{\pi}(\Delta)}^{1} (\bar{\pi}(\Delta)D + c_d)\, f(\pi) d\pi$$

First, from Lemma 3, we know that $\bar{\pi}'(\Delta) > 0$. Second, since $\bar{\pi}(\Delta) > \hat{\pi}(\Delta)$, and with the monotone likelihood ratio property, we have $-\left(c_p + c_d\right) f\left(\bar{\pi}(\Delta)\right) + (1-\Delta)D\left(1 - F\left(\bar{\pi}(\Delta)\right)\right) < 0$. Therefore, $\frac{\partial W^p(\bar{\pi}(\Delta),\Delta)}{\partial \Delta} < 0$ and the plaintiff's expected return is maximized with the largest possible short position: $\Delta = \Delta_L$. ■

Proof of Proposition 5. With an informationally efficient market, at $t = 0$, the firm value is given by:

$$v_0(\Delta) = \int_0^{\pi^*(\Delta)} (R - \pi D - c_d) f(\pi) d\pi + \int_{\pi^*(\Delta)}^1 (R - \pi^*(\Delta) D - c_d)\, f(\pi) d\pi$$

where $\pi^*(\Delta) = \hat{\pi}(\Delta)$ when $\Delta \leq \Delta^*$ and $\pi^*(\Delta) = \bar{\pi}(\Delta)$ when $\Delta > \Delta^*$. This, in turn, produces the plaintiff's expected payoff of:

$$W^p(\pi^*(\Delta), \Delta) \; = \int_0^{\pi^*(\Delta)} \left[\pi D - c_p\right] f(\pi) d\pi + \int_{\pi^*(\Delta)}^1 [\pi^*(\Delta) D + c_d] f(\pi) d\pi$$

Taking the derivative of the plaintiff's ex ante payoff function with respect to Δ, we find that the slope is

$$\frac{dW_p(\pi^*(\Delta), \Delta)}{d\Delta} = \left[-(c_p + c_d) f(\pi^*(\Delta)) + \; D(1 - F(\pi^*(\Delta))\right] \frac{d\pi^*(\Delta)}{d\Delta} \tag{A12}$$

Notice the similarity between the expression in brackets and the slope of the interim payoff function in the text. The only difference is that in the interim payoff function, the financial position Δ has a direct impact on the slope while here it does not.

Case 1: $0 < \Delta^*$. Since $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) > 0$, we have that $0 < \Delta^* < \Delta_0$. The plaintiff would choose threshold $\pi^*(\Delta) = \hat{\pi}(\Delta)$ for all $\Delta < \Delta^*$ and by Lemma 2 $\hat{\pi}(\Delta) \in (0,1)$ and $\frac{d\hat{\pi}(\Delta)}{d\Delta} < 0$. For $\Delta < \Delta^* < \Delta_0$ the threshold $\hat{\pi}(\Delta)$ satisfies

$$-(c_p + c_d) f(\hat{\pi}(\Delta)) + \; (1 - \Delta) D[1 - F(\hat{\pi}(\Delta))] = 0 \tag{A13}$$

which implies

$$-(c_p + c_d) f(\hat{\pi}(\Delta)) + \; D[1 - F(\hat{\pi}(\Delta))] = \Delta D[1 - F(\hat{\pi}(\Delta))] \tag{A14}$$

Substituting above, we see that $\frac{dW_p(\cdot)}{d\Delta}$ has the same sign as $\Delta \frac{d\hat{\pi}(\Delta)}{d\Delta}$ which has the same sign as $-\Delta$. When $\Delta < 0$ then the plaintiff is better off raising Δ and when $\Delta > 0$ the plaintiff is better off lowering it. So the best Δ for the plaintiff is $\Delta = 0$.

Case 2: $\Delta^* = -\frac{c_p}{c_d} < 0$. Since $\bar{\pi}\left(-\frac{c_p}{c_d}\right) = 0$, we have a corner solution with $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) = 0$. Since $\frac{d\hat{\pi}(\Delta)}{d\Delta} \leq 0$ we must have $\hat{\pi}(\Delta) = 0$ for all $\Delta > \Delta^*$ so $\hat{\pi}(0) = 0$. In other words, if the plaintiff could commit to a strategy, they would make an offer that all defendant types accept and then take anyone who rejects to trial. This is not credible when $\Delta = 0$, since $\bar{\pi}(0) > 0$, but it is credible when $\Delta = \Delta^*$, since by proposition 4 the plaintiff will choose $\pi^*(\Delta^*) = 0$. The plaintiff is weakly worse off choosing $\Delta < \Delta^*$, since $\pi^*(\Delta) = \hat{\pi}(\Delta) \geq 0$ in this range. The plaintiff is strictly worse off with $\Delta \in \left(\Delta^*, \frac{m(1)D - c_p}{m(1)D + c_d}\right)$ since $\pi^*(\Delta) = \bar{\pi}(\Delta) > 0$

in this range. Since $\frac{d\bar{\pi}(\Delta)}{d\Delta} > 0$ for all $\Delta \in \left(\Delta^*, \frac{m(1)D - c_p}{m(1)D + c_d}\right)$, we know that the plaintiff's payoff is falling as Δ rises. Therefore $\Delta = \Delta^*$ maximizes the plaintiff's expected ex ante payoff.

Case 3: $\Delta^* \in \left(-\frac{c_p}{c_d}, 0\right)$. Note that $\pi^*(\Delta^*) = \hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) > 0$. Since $\hat{\pi}(\Delta^*) > 0$, we have that $\frac{d\hat{\pi}(\Delta^*)}{d\Delta} < 0$ and so $\hat{\pi}(\Delta^*) > \hat{\pi}(0)$. If the plaintiff chooses $\Delta < \Delta^*$, then by Proposition 4 and since $\frac{d\hat{\pi}(\Delta^*)}{d\Delta} < 0$ we have $\pi^*(\Delta) = \hat{\pi}(\Delta) > \pi^*(\Delta^*)$. If the plaintiff chooses $\Delta > \Delta^*$ then since $\frac{d\bar{\pi}(\Delta)}{d\Delta} > 0$ we have $\pi^*(\Delta) = \bar{\pi}(\Delta) > \pi^*(\Delta^*)$. By choosing $\Delta = \Delta^*$, the plaintiff gets the outcome closer to $\hat{\pi}(0)$. ■

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