Keeping Society in the Dark:
On the Admissibility of Pretrial Negotiations as Evidence in Court*

by

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ABSTRACT

We model the settlement and litigation process, allowing for incomplete information about the level of damages (incurred by the plaintiff) on the part of both the defendant and the court, and use the model to examine the effect of making (currently inadmissible) settlement demands admissible as evidence in court should a case proceed to trial. Two conclusions emerge. First, admissibility rules have efficiency consequences: making a pretrial demand admissible would increase the expected number of cases that go to trial. Second, such rules have distributional consequences and need not benefit all parties to a controversy. As an example, in product liability cases consumers are likely to favor inadmissibility, while corporations will favor the reverse.

1. **Introduction**.

Many real world examples of bargaining and negotiation involve a considerable amount of secrecy, secrecy not only between the parties, but between the society at large and the parties to the settlement. This is especially true of settlement negotiations that involve potential recourse to the judicial system. For example, in many civil proceedings[1], pretrial negotiations are not admissible as evidence in court.[2] If Smith injures Jones and Jones sues for damages, even if there is no question about Smith's liability (just its extent), demands and offers made by one party of and to the other party are supposed to be left at the bargaining table, and not brought into court as part of the evidence presented in a trial. In other words, society purposely chooses to keep the pretrial settlement negotiations out of the trial record: society encourages such material to be kept secret.[3] This paper focuses on the issue of making (currently) inadmissible settlement demands admissible in court, both as an interesting question in its own right, and as an example of the larger issue of analyzing institutional rules that restrict the flow of information.

Why might society choose to restrict the flow of information? Specifically, why might it be sensible to make pretrial negotiations inadmissible? One argument, referred to by Brazil [1988] as the "irrelevance rationale", is that, historically, courts often viewed a settlement offer as evidence only of a party's desire to terminate litigation, and that no "reliable inference about the merits of the claim or the amount of damages"

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[1] In the criminal justice area, there may also be seemingly relevant information that is not admissible, such as a defendant's past record; see Schrag and Scotchmer [1991].

[2] Brazil [1988] provides an extensive discussion of the confidentiality of settlement negotiations. "Federal Rule of Evidence 408 provides: Evidence of (1) furnishing or offering or promising to furnish, or (2) accepting or offering or promising to accept, a valuable consideration in compromising or attempting to compromise a claim which was disputed as to either validity or amount, is not admissible to prove liability for or invalidity of the claim or its amount." (p. 955).

[3] A related example is the outcome wherein the nature and details of a settlement are themselves kept secret.

could be drawn from an offer to settle (Brazil [1988], p. 958). Federal Rule of Evidence 408 (see footnote 2) made uniform such protection and extended confidentiality to various other aspects of the negotiation process.[4] This was based on the rationale that it was "in the public interest, and in the interest of individual litigants, to encourage consensual resolution of disputes" (see Brazil [1988], p.958). Thus, if settlement negotiations were admissible as evidence, then parties to a dispute might choose not to negotiate, or they might only make extreme demands (essentially, play to the judge who will eventually make an award to the injured party), resulting in more trials and greater costs.[5] This argument becomes somewhat less clear, however, if one views the court as a participant in the process: if making negotiations admissible as evidence might initially have the above affect (for example, of making parties take more extreme positions) then judges would surely understand this, and might compensate for it. Moreover, it is not clear that all parties to the litigation benefit by keeping negotiations confidential in this sense; perhaps defendants or plaintiffs might actually benefit by having settlement demands be admissible as evidence at trial.

More succinctly, if we view the pretrial negotiations as involving signaling by an informed plaintiff (the sender) to an uninformed defendant (the receiver), making the judge an active participant in the game whose actions can affect both parties may mean that making the pretrial negotiations admissible (thereby making the judge a second receiver of the signal sent by the plaintiff) may have some unexpected consequences for both the likelihood of trial and the average settlement achieved.

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[4] Strictly speaking, this paper is limited to admissibility considerations in Federal courts. In general, however, many state systems have similar rules.

[5] Of course, more trials, in and of itself, may not be so bad if it would lead to greater care being taken when care otherwise would be socially inadequate; see Polinsky and Rubinfeld [1988].

We model the settlement and litigation process, allowing for incomplete information about the level of damages (incurred by the plaintiff) on the part of both the defendant and the court, and use the model to examine the effect of making settlement demands admissible as evidence in court should a case proceed to trial. We find that making pretrial negotiations admissible discourages consensual resolution of disputes. However, it also affects the relative bargaining strengths of the parties. This is because making settlement demands admissible affects both the distribution of the demands and the expected award in court. In particular, we find that while making a pretrial demand admissible would increase the expected number of cases that go to trial and the range of demands made, defendants would ex-ante (i.e., before damage occurs) prefer to have such demands be admissible while plaintiffs would ex-ante prefer to have such demands remain inadmissible. While our model generates results which are potentially consistent with the public interest portion of the consensual resolution rationale, we find little support that maintaining confidentiality is in the interest of all, or even most, of the litigants. Alternatively, to the degree that society chooses to design rules that will be unanimously supported by all parties, it must simultaneously bias the judge away from awarding purely compensatory damages.

Technically, this paper employs a two-receiver model: the plaintiff is the sender and the defendant and the judge are the receivers. Under a policy wherein pretrial negotiations are admissible, the judge receives the same signal as the defendant, while under inadmissibility he receives a much coarser signal (that the case did not settle and has come to court). We employ an extension of Cho-Kreps' [1987] equilibrium refinement D1, which we discuss in the Appendix, to eliminate implausible equilibria.[6]

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[6] Other papers that have employed two-receiver models include Dewatripont [1986, Ch 2.], Gertner, Gibbons and Scharfstein [1988] and Farrell and Gibbons [1989]; the associated refinements employed are extensions of, respectively, the intuitive criterion, perfect sequential equilibrium and neologism-proofness.

The paper proceeds as follows. In the next section we provide a rough outline of the game and the notation that we will use in the rest of the paper. Section 3 examines the inadmissible case while Section 4 considers the admissible case. In both cases we assume that the defendant is liable and the only issue is the extent of damage. In both cases the plaintiff is informed about the level of damages and the defendant is not. In both cases there is an exogenously specified probability that the trial does not reveal the level of damages, and thus that the judge is informed only by the admissible pretrial actions of the parties. In Section 3 this means that the judge only observes the fact that a case came to trial, thus inferring that the defendant rejected the plaintiff's demand. By making the pretrial settlement demands admissible in Section 4, the judge becomes a second receiver of the signal sent by the plaintiff. Section 5 compares the results of Sections 3 and 4, and allows us to characterize the implications of making such negotiations admissible. Section 5 also contains some discussion of potential extensions as well as the conclusions. Proofs and a discussion of the equilibrium refinement used are contained in the Appendix.

2. **General Features of the Model**.

The purpose of this section is to provide the basic details of the model we will use. Since the two analyses to follow involve considerable common elements and notation, we will discuss the common elements here and postpone case-specific issues until the appropriate section.

The defendant, denoted D, is liable for damages incurred by the plaintiff, P. The level of damages, δ, is known by P but not by D; the level of damages is called P's type. D views the level of damages as a random variable, , which is distributed according to the strictly increasing cumulative distribution function F on [$\underline{\delta}$,]. Thus, $F(\delta)$ is the probability that the random variable is less than or equal to δ (i.e., $F(\delta) = Pr\{ \leq \delta\}$)

with $F(\underline{\delta}) = 0$ and $F() = 1$. The analysis in the paper will normally employ this general distribution, but will occasionally use the uniform distribution (that is, $F(\delta) = (\delta-\underline{\delta})/(-\underline{\delta})$); we will alert the reader at these points.

The sequence[7] of actions is as follows: P makes a settlement demand of D, who then responds by accepting or rejecting the demand based upon his updated beliefs about the damages. If the demand is accepted then a transfer (equal to the settlement demand) from D to P occurs. If the demand is rejected then the parties proceed to court; P incurs a court cost k_P while D incurs a court cost k_D. For the purposes of this analysis we assume that even the least-damaged plaintiff would find going to trial rational[8] should settlement negotiations fail; that is, $\underline{\delta} > k_P$. Since we will need to refer to aggregate court costs, let $K \equiv k_P + k_D$. The judge, denoted J, makes a final decision on the transfer that will occur from D to P; we assume that J awards his best guess about the damages given <u>all admissible evidence</u>.

Many authors have addressed the issue of settlement negotiations between a plaintiff and a defendant, but in all of these the trial outcome acts as a fixed outside option. That is, the trial outcome is <u>not influenced</u> by the actions taken during the bargaining phase. Usually, this is because it is assumed (either explicitly or implicitly) that the court has access to any private information one of the litigating parties might have possessed during the bargaining phase. Examples include P'ng [1983], Samuelson [1983], Bebchuk [1984], Salant [1984], Reinganum and Wilde [1986], Nalebuff [1987], Schweizer

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[7] In Daughety and Reinganum [1993] we have examined the issue of allowing parties to sequence themselves rather than artificially restricting the sequence of moves. We showed that, for the case when the plaintiff is informed and the defendant is not, although both parties would choose to make settlement proposals (rather than either choose to wait), the outcome was the same as one wherein the plaintiff made a demand and the defendant responded by accepting or rejecting. Thus, we will employ this simpler structure in this paper.

[8] For a model wherein this need not hold, see Nalebuff [1987].

[1989], Shavell [1989], Spulber [1990], Daughety and Reinganum [1991] and Spier [1992]. In a recent paper, Rubinfeld and Sappington [1987] describe a court which draws inferences from a defendant's behavior during trial. However, in this model there is no settlement phase, only a trial phase, so it is still a two-player game. Finally, Gay et. al. [1989] describe a model in which a defendant with private information regarding his guilt or innocence can choose between a bench and jury trial, and both the judge and the jury can draw inferences from the defendant's choice. Technically, this is not a two-receiver game such as ours because it is only the response of the receiver who is chosen which matters; that is, it is a choice among one-receiver games.

We view the court as being (possibly) imperfectly informed at the end of the trial. More precisely, there is an exogenous probability $0 \leq \varepsilon < 1$, that the trial itself does not reveal the true value of , and thus J has no exogenous source of information (for ease of exposition we will refer to this as "the uninformed judge"), while with probability $1 - \varepsilon$ the trial perfectly reveals the value of δ to J ("the informed judge").

In the event of trial, J makes an award to the plaintiff equal to the judge's expected value of the damages incurred by P (not including k_P) based upon beliefs updated by the evidence available.[9] Thus, with probability $1 - \varepsilon$, J chooses an award equal to the true level of damages, while with probability ε, J uses his updated beliefs to construct an expected level of damage. The game form, $F(\bullet)$, $\underline{\delta}$, , k_P, k_D, and ε are common knowledge to P, D and J.

Finally, we will assume that if the settlement proposal <u>is</u> admissible in court, then it will, in fact, be made available to the court. In other words,

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[9] Note that we consider only actual damages, not punitive damages, and that each party is expected to bear his or her own legal fees (consistent with the American rule).

we do not consider the further variation that some evidence is admissible, but not part of the case the judge considers.[10]

3. **Analysis of the Inadmissible Evidence Case**

Basic Notation

In this case D observes the settlement demand made by P, but this demand is inadmissible in court: J does not observe the settlement demand. Let $s(\delta)$ be P's settlement demand rule which associates a settlement demand $s \in [0,\infty)$ with a level of damages $\delta \in [\underline{\delta},]$. Upon observing s, D will try to infer the type of plaintiff that would send such a signal (i.e., make such a demand). Let $b_D(s) = \{\delta \in [\underline{\delta},] \mid$ D believes a P of type δ would demand s$\}$ and let $\mu_D(\delta|s)$ be D's posterior distribution function over , given s. Furthermore, let r(s) be D's probability of rejecting P's demand, which associates a value in [0,1] with each possible demand $s \in [0,\infty)$.

Recall that the informed judge always learns the true damage level and hence always awards δ to the plaintiff. The uninformed judge observes that a case has come to trial and thus that the plaintiff has made a demand which the defendant has rejected. Let a represent the award made by the uninformed judge. J's objective function is to $\min_a \{E_J(a-)^2 \mid a \in [\underline{\delta},]\}$, where the expectation reflects J's beliefs. This objective function implements the notion that the uninformed judge wishes to provide an award which is as close as possible to the true level of damage. The possibility that accuracy may conflict with social efficiency will be discussed in Section 5.

J's beliefs reflect the set of types consistent with the case going to trial and a probability distribution over that set. Unlike D, J's beliefs are uninfluenced by the settlement demand s. Thus, let $b_J = \{\delta \in [\underline{\delta},] \mid$ J believes δ

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[10] Shavell [1989] considers the problem of voluntary disclosure.

could end up at trial} and let $\mu_J(\delta)$ be J's posterior distribution function over given that the case has gone to trial. Thus, J wants to choose an award a that minimizes $\int(a - \delta)^2 d\mu_J(\delta)$, and therefore $a = E_J() \equiv \int \delta d\mu_J(\delta)$, where both integrals are evaluated over b_J. The award a is taken as given by P and D.

For convenience in what follows let the <u>two-receiver belief vector</u>, which provides the complete specification of beliefs for D and J, be $(b(s), \mu(\delta|s)) \equiv (b_D(s), b_J, \mu_D(\delta|s), \mu_J(\delta))$. While this notation is somewhat cumbersome, it allows us to be precise later in our specification of various expectations. Note that, because the judge's optimal decision rule is completely characterized by b_J and μ_J, we will economize on notation by suppressing the judge's strategy (a) as an argument in the the other players' objective functions and in the statements of various definitions and theorems. Finally, let π_P and π_D be the expected payoffs to P and D respectively.

Analysis

The payoff function for the defendant who rejects the demand s with probability r, given the beliefs $(b(s),\mu(\delta|s))$, can be written as:

$$\pi_D(r,s;b(s),\mu(\bullet|s)) = r[(1-\varepsilon)E_D(|s) + \varepsilon a + k_D] + (1-r)s,$$

where

$$E_D(|s) = \int_{b_D(s)} \delta d\mu_D(\delta|s) \quad \text{and} \quad a = E_J() = \int_{b_J} \delta d\mu_J(\delta).$$

Thus, the defendant's payoff is r times the expected cost of going to trial plus (1-r) times the settlement demand. The expected cost of going to trial is comprised of three parts: 1) the expected cost if the case is heard by an informed judge, namely $(1-\varepsilon)$ times the expected damage level; 2) the expected cost if the case is heard by an uninformed judge, namely εa; and 3) the

defendant's court costs k_D. Note that the defendant's beliefs enter into the first part via the inferred level of damages the plaintiff has incurred, based on the signal received by the defendant from the plaintiff in the form of the settlement demand made by the plaintiff. The judge's beliefs (or, more accurately, the defendant's correct construction of the judge's beliefs[11]) enter into the second part since the judge must choose the award level a. Since the defendant wishes to minimize this payoff, the defendant's choice problem is to choose an $r \in [0,1]$ for each $s \in [0,\infty)$ so as to minimize $\pi_D(r,s;b(s),\mu(\bullet|s))$, yielding a probability of rejection function r(s).

Given the probability of rejection function r(s) and the beliefs $(b(s),\mu(\delta|s))$, the plaintiff of type δ who demands s can expect a payoff of:

$$\pi_P(s,r(s);b(s),\mu(\delta|s),\delta) = r(s)[(1-\varepsilon)\delta + \varepsilon a - k_P] + (1-r(s))s.$$

Thus, given r(s), the plaintiff's payoff is comprised of the expected return from court and the expected return from settling, each term weighted by the probability of the defendant rejecting or accepting the settlement demand. The expected cost of going to trial has three parts, each analogous to the equivalent term for the defendant, again reflecting the nature (informed versus uninformed) of the judge. (Note, however, that in this case the plaintiff knows precisely what an informed judge would award, since an informed judge would award the true level of damages by definition.) Thus, each type δ of plaintiff wishes to choose a demand $s \in [0,\infty)$ so as to maximize $\pi_P(s,r(s);b(s),\mu(\delta|s),\delta)$, yielding a settlement demand function $s(\delta)$.

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[11] This is where one could readily incorporate some uncertainty about the judge (on the part of the parties to the action). Doing so would only complicate the model without adding anything to the analysis of the impact of making settlement demands admissible, since such a policy decision presumably would not affect the uncertainty surrounding a judge's beliefs. Thus, we have chosen not to pursue this issue here.

We will consider only pure strategies for the plaintiff; that is, we will be characterizing equilibria in which $s(\delta)$ is single-valued. Our basic notion of equilibrium is that of perfect Bayesian equilibrium (Fudenberg and Tirole [1991]) which we adapt to the current problem via the following definition.

Definition 1. A Perfect Bayesian Equilibrium (PBE) for the case of inadmissible settlement demands is a tuple $(s^*(\bullet), r^*(\bullet), b^*(\bullet), \mu^*(\bullet|\bullet))$ such that:

(i) $\pi_P(s^*(\delta), r^*(s^*(\delta)); b^*(s^*(\delta)), \mu^*(\delta|s^*(\delta)), \delta) \geq$

$\pi_P(s, r^*(s); b^*(s), \mu^*(\delta|s), \delta)$ for all $s \in [0,\infty)$ and for all $\delta \in [\underline{\delta},$];

(ii) $\pi_D(r^*(s), s; b^*(s), \mu^*(\bullet|s)) \leq \pi_D(r, s; b^*(s), \mu^*(\bullet|s))$ for all $r \in [0,1]$ and for all $s \in [0,\infty)$;

(iii) $b(s) = \{\delta \in [\underline{\delta},] \,|\, s^*(\delta) = s\}$ and, for $\delta \in b(s)$,

$$d\mu(\delta|s) = dF(\delta) / \int_{b(s)} dF(\sigma).$$

(iv) $b = \{\delta \in [\underline{\delta},] \,|\, r^*(s^*(\delta)) > 0\}$ and, for $\delta \in b$,

$$d\mu(\delta) = r^*(s^*(\delta))\, dF(\delta) / \int_{b} r^*(s^*(\sigma))\, dF(\sigma).$$

Conditions (i) and (ii), respectively, require that the plaintiff choose a payoff-maximizing settlement demand function which anticipates the defendant's choice of rejection function and that the defendant choose a payoff-minimizing probability of rejection function. Condition (iii) specifies the defendant's beliefs as being able to properly rationalize the offer made (which is possible since the defendant can also construct the

settlement demand function). Finally, condition (iv) reflects the fact that the judge does not observe the demand made, but does observe that the case came to trial, which would have occurred only if the defendant had rejected the demand made by the plaintiff.

Many equilibria might satisfy Definition 1. Separating equilibria involve each type making a different settlement demand so that the defendant can correctly infer the type from the demand; that is, $b(s^*(\delta)) = \delta$ for all $\delta \in [\underline{\delta},]$. Pooling equilibria involve all types making the same settlement demand; in such a case the defendant cannot infer the type. Semi-pooling equilibria involve some types separating and some types pooling. While any particular set of model parameter values may result in the simultaneous existence of one or more of the above types of equilibria, we will employ an equilibrium refinement (an extension of the standard Cho-Kreps D1 refinement, as discussed in the Appendix) to focus discussion on outcomes of particular interest.

In this section we will focus on the separating equilibrium; in the Appendix we show that this is the unique refined PBE. Clearly, there are demands that the defendant should definitely accept: any demand $s < \underline{s} \equiv (1-\varepsilon)\underline{\delta} + \varepsilon a^* + k_D$, which is the expected cost to the defendant of going to trial against the least-damaged plaintiff. Similarly, there are demands that the defendant should certainly reject: any demand $s > \equiv (1-\varepsilon) + \varepsilon a^* + k_D$, which is the expected cost to the defendant of going to trial against the most-damaged plaintiff. For demands in between, the defendant will follow a mixed strategy, with a higher likelihood of rejection associated with a higher demand. This mixed strategy reflects indifference on D's part between accepting the demand s or proceeding to trial, and thus $s = (1-\varepsilon)E_D(|s) + \varepsilon a + k_D$. In order for this to be an equilibrium, s must also maximize P's payoff $\pi_P(s,r(s);b(s),\mu(\delta|s),\delta)$. Thus, s must solve P's first order condition:

$r'(s)[(1-\varepsilon)\delta + \varepsilon a - k_P - s] + 1 - r(s) = 0$. Finally, separation means that $E_D(\delta \mid s^*(\delta)) = \delta$; that is, when the equilibrium demand function $s^*(\delta)$ is used, it reveals the plaintiff's true damage level δ. Combining these three equations yields an ordinary differential equation for $r^*(s)$: $r^{*\prime}(s)(-K) + 1 - r^*(s) = 0$. Finally, if the defendant were to reject the demand $\underline{s}$ with positive probability, the plaintiff making this demand could reduce it by a trivial amount and assure acceptance. Thus, the boundary condition is that $r^*(\underline{s}) = 0$. These results are summarized below in Theorem 1.

Theorem 1. The unique refined PBE for the case of inadmissible demands is a separating equilibrium given by:

(i) $s^*(\delta) = (1-\varepsilon)\delta + \varepsilon a^* + k_D$, for $\delta \in [\underline{\delta},]$.

(ii) $r^*(s) = \begin{cases} 1 & s > \\ 1 - e^{-(s-\underline{s})/K} & s \in [\underline{s},]. \\ 0 & s < \underline{s} \end{cases}$

(iii) $b(s) = \begin{cases} & s > \\ (s-\varepsilon a^*-k_D)/(1-\varepsilon) & s \in [\underline{s},]. \\ \underline{\delta} & s < \underline{s} \end{cases}$

(iv) $b = (\underline{\delta},]$ and, for $\delta \in (\underline{\delta},]$,

$$d\mu(\delta) = [1 - e^{-(1-\varepsilon)(\delta-\underline{\delta})/K}]dF(\delta) / [\int_b (1 - e^{-(1-\varepsilon)(\sigma-\underline{\delta})/K})dF(\sigma)].$$

A few observations are in order. First, note that the settlement demand function is comprised of the defendant's court costs plus a weighted combination of the true level of damage and the expected award a*, where the weight used reflects the exogenous probability ε that the judge is uninformed.

Second, note that the probability of rejection function is increasing in s (and has a jump to the right of s =); that is, higher demands are more

likely to be rejected. Further, D is able to correctly infer P's type; this can be seen by substituting (i) into (iii) above. On the other hand, since J does not observe s (J observes only that a case reaches the court), J cannot be as precise. Part (iv) shows what J does: he knows that the cases do not include type $\underline{\delta}$ (since D would not, in equilibrium, reject the demand for that type), and that the probability of going to trial should be monotonically increasing in δ.

Since the equilibrium probability of trial ($r^*(s^*(\delta))$) is an increasing function of the level of damages, the settlement process acts as a "filter" on the prior F, resulting in a posterior that involves a smaller proportion of low damage cases and a greater proportion of high damage cases. This results in a* being upward-biased relative to the mean of F (i.e., $a^* > E_F()$, where the F subscript indicates that the expectation is taken with respect to the prior distribution $F(\bullet)$). This property of a* is proved in the Appendix.[12]

Let $_D(\delta) \equiv \pi_D(r^*(s^*(\delta)),s^*(\delta);b^*(s^*(\delta)),\mu^*(\bullet|s^*(\delta)))$ and let $_P(\delta) \equiv \pi_P(s^*(\delta),r^*(s^*(\delta));b^*(s^*(\delta)),\mu^*(\bullet|s^*(\delta)),\delta)$. These are <u>interim equilibrium payoffs</u>, which are computed after the random variable has been realized and after the plaintiff has made his settlement demand. After some simplification, these expressions are given by

$$_D(\delta) = (1-\varepsilon)\delta + \varepsilon a^* + k_D$$

and

$$_P(\delta) = (1-\varepsilon)\delta + \varepsilon a^* + k_D - (\delta)K,$$

where (δ) is the equilibrium probability of trial; that is, $(\delta) = r^*(s^*(\delta)) = 1-\exp\{-(1-\varepsilon)(\delta-\underline{\delta})/K\}$.

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[12] We thank Joel Horowitz for suggesting this proof.

On an ex ante basis (i.e., prior to the realization of), the expected payoffs for D and P are denoted, respectively, $E_{FD}()$ and $E_{FP}()$. Performing this calculation yields the following:

$$E_{FD}() = (1-\varepsilon)E_F() + \varepsilon a^* + k_D$$

and

$$E_{FP}() = (1-\varepsilon)E_F() + \varepsilon a^* + k_D - KE_F().$$

Notice that $E_{FD}() > E_F() + k_D$, again reflecting the skewed nature of cases that come to trial. Note that this is worse for the defendant than if he could have precommitted to rejecting all demands, thus eliminating the signaling aspect of rejection and yielding an expected award of $E_F()$. This means that the defendant bears a cost of being better informed than the judge. This cost is of the same nature as that which any informed agent bears when signaling his type to an uninformed agent in a standard signaling game, because when D chooses to reject P's demand, D is aware of P's type (since this is a separating equilibrium). Thus, D is informed and J is uninformed, and by rejecting the settlement demand D is "signaling" (in a crude fashion) something to J.

4. **Analysis of the Admissible Evidence Case**

Basic Notation

In this case both D and J observe the settlement demand made by P. To help the reader keep this case separate from the inadmissible case, we shall use upper-case letters and adjust the foregoing notation to reflect J's changed information. Let $S(\delta)$ be P's settlement demand rule which associates a settlement demand $S \in [0,\infty)$ with a level of damages $\delta \in [\underline{\delta},]$. Upon observing S, D will try to infer the type of plaintiff that would send such a signal (i.e., make such a demand). Let $B_D(S) = \{\delta \in [\underline{\delta},] \mid$ D believes a P of type δ would demand S$\}$ and let $M_D(\delta|S)$ be D's posterior distribution function over , given S. Furthermore, let R(S) be D's probability of rejecting P's

demand, which associates a value in [0,1] with each possible demand S ∈ [0,∞).

The uninformed judge observes not only that a case has come to trial, he observes S, too. Let A represent the award made by the uninformed judge (the informed judge always awards δ). J's objective function is to $\min_A \{E_J(A-)^2 \mid A \in [\underline{\delta},]\}$, where the expectation reflects J's beliefs. Now J's beliefs are contingent on the settlement demand S. Thus, let $B_J(S) = \{\delta \in [\underline{\delta},] \mid$ J believes δ could end up at trial given that P demanded S} and let $M_J(\delta|S)$ be J's posterior distribution function over given S. Thus, J wants to choose an award A that minimizes $\int (A - \delta)^2 dM_J(\delta|S)$ (integrated over $B_J(S)$), yielding a function A(S) as S is varied. Thus $A(S) = E_J(|S) \equiv \int \delta dM_J(\delta|S)$, where this integral is also evaluated over $B_J(S)$. The award is taken as given by D; P recognizes that the award is influenced by S and accounts for this in his decision problem.

Again, for convenience in what follows let the belief vector, which provides the complete specification of beliefs for D and J, be $(B(S), M(\delta|S)) \equiv (B_D(S), B_J(S), M_D(\delta|S), M_J(\delta|S))$. Finally, let Π_P and Π_D be the expected payoffs to P and D, respectively, for this case.

Analysis

The payoff function for the defendant who rejects the demand S with probability R, given the beliefs $(B(S),M(\delta|S))$, can be written:

$$\Pi_D(R,S;B(S),M(\bullet|S)) = R[(1-\varepsilon)E_D(|S) + \varepsilon A(S) + k_D] + (1-R)S,$$

where

$$E_D(|S) = \int_{B_D(S)} \delta dM_D(\delta|S) \quad \text{and} \quad A(S) = E_J() = \int_{B_J(S)} \delta dM_J(\delta|S).$$

Thus, once again, the defendant's payoff is R times the expected cost of going to trial plus (1–R) times the settlement demand. Note that, as before, the defendant's beliefs enter into expected trial cost via the inferred level of damages the plaintiff has incurred, based on the signal received by the defendant from the plaintiff in the form of the settlement demand made by the plaintiff. The judge's beliefs, which also depend upon S, enter into the second part of the expected trial cost since the judge must choose the award level A(S). Since the defendant wishes to minimize this payoff, the defendant's choice problem is to choose an $R \in [0,1]$ for each $S \in [0,\infty)$ so as to minimize $\Pi_D(R,S;B(S),M(\bullet|S))$, yielding a probability of rejection function R(S).

Given the probability of rejection function R(S) and the beliefs $(B(S),M(\delta|S))$, the plaintiff of type δ who demands S can expect a payoff of:

$$\Pi_P(S,R(S);B(S),M(\delta|S),\delta) = R(S)[(1-\varepsilon)\delta + \varepsilon A(S) - k_P] + (1-R(S))S.$$

Thus, given R(S), the plaintiff's payoff is comprised of the expected return from court and the expected return from settling, each term weighted by the probability of the defendant rejecting or accepting the settlement demand. Thus, each type δ of plaintiff wishes to choose a demand $S \in [0,\infty)$ so as to maximize $\Pi_P(S,R(S);B(S),M(\delta|S),\delta)$, yielding a settlement demand function $S(\delta)$.

Again, we consider only pure strategies for the plaintiff. It is straight-forward to adapt the previous definition of a PBE to this case, allowing for the restriction that the beliefs of D and J must be the same in equilibrium.

As will become clear shortly, the exogenous probability $1 - \varepsilon$ that the trial perfectly reveals the true level of δ now has a substantial impact on the type of equilibria that we will characterize. In particular, for low

values of ε there will be a unique refined PBE which involves separation. However, for higher values of ε, only semi-pooling or pooling equilibria will exist.

Analysis of the Separating Equilibrium Case

Once again we will focus on the separating equilibrium; this is the unique refined PBE if $\varepsilon \in [0,\varepsilon^1)$, where ε^1 is the minimal solution of:

$$\varepsilon^1 = e^{-(\ -\ \underline{\delta})(1\ -\ \varepsilon\ )^1/K}\ .$$

It is shown in the Appendix that ε^1 always exists and is less than or equal to 1. (When $\varepsilon > \varepsilon^1$, some degree of pooling occurs; this will be discussed in the next sub-section.) The defendant should accept any demand $S < \underline{S} \equiv \underline{\delta} + k_D$, and should reject any demand $S >\ \equiv\ + k_D$. For demands in between, the defendant again will follow a mixed strategy which reflects indifference on D's part between accepting the demand S or proceeding to trial, and thus $S = (1-\varepsilon)E_D(|S) + \varepsilon A(S) + k_D$. In order for this to be an equilibrium, S must also maximize P's payoff $\Pi_P(S,R(S);B(S),M(\delta|S),\delta)$. Thus, S must solve P's first order condition: $R'(S)[(1-\varepsilon)\delta + \varepsilon A(S) - k_P - S] + \varepsilon R(S)A'(S) + 1 - R(S) = 0$. Furthermore, separation means that $E_I(|S^*(\delta)) = \delta$, I = D, J. Thus, $S^*(\delta) = \delta + k_D$ and $A^*(S) = S - k_D$. Combining these results gives a differential equation for $R^*(S)$: $R^{*\prime}(S)(-K) + 1 - (1 - \varepsilon)R^*(s) = 0$. Finally, if the defendant were to reject the demand $\underline{S}$ with positive probability, the plaintiff making this demand could reduce it by a trivial amount and assure acceptance. Thus, the boundary condition is that $R^*(\underline{S}) = 0$. These results are summarized below in Theorem 2.

Theorem 2. Assume that $\varepsilon \in [0,\varepsilon^1)$. Then the unique refined PBE for the case of admissible demands is a separating equilibrium, given by:

(i) $S^*(\delta) = \delta + k_D$, for $\delta \in [\underline{\delta},]$,

(ii) $$R^*(S) = \begin{cases} 1 & S > \\ (1 - e^{-(S-\underline{S})(1-\varepsilon)/K})/(1 - \varepsilon) & S \in [\underline{S},] \\ 0 & S < \underline{S}, \end{cases}$$

(iii) $$B(S) = \begin{cases} & S > \\ S - k_D & S \in [\underline{S},] \\ \underline{\delta} & S < \underline{S}, \end{cases}$$

where I = D, J.

Again, some observations are in order. First, it should now be clear why the restriction on ε is necessary: observe that when $\varepsilon = \varepsilon^1$, $R^*() = 1$. Since the rejection probability must be bounded from above by one, for ε in excess of ε^1, there exists a subinterval of $[\underline{S},]$ such that all demands in that subinterval are rejected with probability one, leading to a pooling result for all types belonging to that subinterval. It is straight-forward to show that $d\varepsilon^1/d((-\underline{\delta})/K) < 0$. Intuitively, $(-\underline{\delta})/K$ reflects the incentive for low damage types to mimic high damage types. Thus, as cases are more subject to this incentive, the range of ε wherein the theorem will hold (and thus full separation will be the unique equilibrium) shrinks. We shall return to this shortly when we consider semi-pooling equilibria. For now, however, the restriction in the theorem is necessary (and sufficient) to provide fully separating equilibria.

Since J receives the same message as D, and since this is a separating equilibrium, the award at court will be precisely the damages incurred. Thus, the settlement demand function becomes $\delta + k_D$. The probability of rejection

function R*(S) is similar in shape to that provided in Section 3, and also has a jump at the upper end (i.e., at).

Analysis of the Semi-Pooling and Pooling Equilibrium Cases

Unlike the case of inadmissible evidence, semi-pooling equilibria play an important role in the case of admissible evidence. This is because when $\varepsilon > \varepsilon^1$, separating equilibria fail to exist. The reason is straight-forward: when $\varepsilon > \varepsilon^1$, there is an interval of settlement demands (the highest ones) which would be rejected with probability one. In this case, since the types associated with those demands are certain of proceeding to trial, they have no reason to stick with their separating equilibrium demands. This means that the entire interval of types making demands that would now yield R* = 1 could pool. Of course types sufficiently below this interval could still find it optimal to reveal their true damage levels. An equilibrium that involved low types separating and high types pooling would be a semi-pooling equilibrium. Finally observe that in any such equilibrium, the defendant's probability of rejection function would again need to have a jump in it so as to create a "marginal" type that was just indifferent between separating and pooling. This means that, in equilibrium, the interval of pooling types is larger than the interval described above (i.e., that associated with R* = 1). This occurs because court costs are positive.

In some sense, a semi-pooling equilibrium characterizes a vast range of possible values of ε. To see this, return to the definition of ε^1:

$$\varepsilon^1 = e^{-(- \underline{\delta})(1 - \varepsilon)^1/K} .$$

Clearly, ε^1 is a function of $(-\underline{\delta})/K$; for convenience let us denote this ratio as T. Thus, for examples, when T = 1, 2, 3 and 4, we find that ε^1 = 1, 0.2, 0.05, and 0.02, respectively. While it is not particularly useful to

speculate about the likely true value of ε, as well as whether or not this completely and properly models the "real world", the above values do suggest that an investigation of equilibrium behavior when $\varepsilon > \varepsilon^1$ is in order.

Two further definitions will be useful. First, for each possible value of ε, we need to find the marginal type, which we denote as $\delta(\varepsilon)$: this is the type of plaintiff who is just indifferent between separating and pooling. In the equilibrium, all types in $[\underline{\delta},\delta(\varepsilon))$ will separate while all types in $[\delta(\varepsilon),]$ will pool. For convenience let $(\delta) \equiv R^*(S^*(\delta))$. In the remainder of this section we employ the uniform distribution (for F) so as to simplify the exposition.

If type $\delta(\varepsilon)$ chooses to follow the separating strategy his expected payoff is:

$$(\delta(e))[(1-\varepsilon)\delta(\varepsilon) + \varepsilon\delta(\varepsilon) - k_P] + (1 - (\delta(e)))[\delta(\varepsilon) + k_D].$$

On the other hand, if type $\delta(\varepsilon)$ joins the pool and makes the pooling demand (i.e., demands something in excess of $\delta(\varepsilon) + k_D$) then the court cannot distinguish amongst the types in the pool, leading it to award the plaintiff the expected damage of the pool members (i.e., $(\delta(\varepsilon)+)/2$). Thus, in this case his expected payoff is $(1-\varepsilon)\delta(\varepsilon) + \varepsilon(\delta(\varepsilon)+)/2 - k_P$. For type $\delta(\varepsilon)$ to be the marginal type, these two payoffs must be equal for this type. If we let $\phi(\delta,\varepsilon) = 1 - (\delta) - \varepsilon(- \delta)/K$, then the condition that the two payoffs be equal for the marginal type reduces to the requirement that $\phi(\delta(\varepsilon),\varepsilon) = 0$. In the Appendix we show that, for $\varepsilon \leq 2K/(- \underline{\delta})$, this equation has a unique solution $\delta(\varepsilon)$.

The other definition that we will need is the value of ε such that semi-pooling fails: for ε at this value and above <u>all</u> types pool. This obviously

occurs when the marginal type is $\delta(\varepsilon) = \underline{\delta}$. Thus, let ε^2 be defined by this requirement, i.e., $\phi(\underline{\delta},\varepsilon^2) = 0$. A little algebra yields the result that $\varepsilon^2 = 2K/(- \underline{\delta})$.[13] Thus, semi-pooling occurs for $\varepsilon \in [\varepsilon^1,\varepsilon^2)$: higher ε results in pure pooling equilibria. We may now state the semi-pooling result.

Theorem 3. Assume that $\varepsilon \in [\varepsilon^1, \varepsilon^2)$. Then the unique family of refined PBEs is the family of (maximally separating) semi-pooling equilibria, indexed by $\in [(\delta(\varepsilon)+)/2 + k_D, \infty)$, given by:

(i) $S^*(\delta) = \delta + k_D$ for $\delta \in [\underline{\delta},\delta(\varepsilon))$; and $S^*(\delta) =$ for $\delta \in [\delta(\varepsilon),]$,

$$\text{(ii)}\quad R^*(S) = \begin{cases} 1 & S \geq \delta(\varepsilon)+k_D \\ (1 - e^{-(S-\underline{S})(1-\varepsilon)/K})/(1 - \varepsilon) & S \in [\underline{S},\ \delta(\varepsilon)+k_D) \\ 0 & S < \underline{S}, \end{cases}$$

$$\text{(iii)}\quad B(S) = \begin{cases} [\delta(\varepsilon),\ ] & S = \\ S - k_D & S \in [\underline{S},\delta(\varepsilon)+k_D) \\ \delta(\varepsilon) & S\neq\ ,\ S \in [\delta(\varepsilon)+k_D,\infty) \\ \underline{\delta} & S < \underline{S}, \end{cases}$$

where I = D, J.

Note that $A^*(S) = S - k_D$ for revealing demands, while $A^*() = (\delta(\varepsilon)+)/2$ for a pooling demand.

While the above theorem appears complex, the interpretation is reasonably straight-forward. First, observe that (for each value of ε in the indicated interval) there is a continuum of semi-pooling equilibria, with one such equilibrium associated with each possible pooling demand . As discussed earlier, some types separate and some types pool. In particular, a "low" type (i.e., one with $\delta < \delta(\varepsilon)$) makes the appropriate separating settlement demand,

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[13] Thus, for T = 1,2,3 and 4 we get $\varepsilon^2 = 2,1,2/3$ and 1/2 respectively.

thereby revealing type, while a "high" type (i.e., $\delta \geq \delta(\varepsilon)$) pools and demands . Since the high types know that they will go to trial, any sufficiently high demand will do. Thus, they abandon the negotiations and "play to the judge." Note that the pooling portion of the equilibrium is enforced by the belief that any demand in excess of $\delta(\varepsilon) + k_D$ will be taken to have been made by type $\delta(\varepsilon)$.

Finally, the greater the value of ε, the more types that pool. As indicated earlier, when $\varepsilon \geq \varepsilon^2$, all the types are pooling. All the cases go to trial, all the plaintiffs pool at , and J must form the equilibrium award based purely on the prior, resulting in an award of ($\underline{\delta}$ +)/2.

5. **Comparisons and Conclusions**

We are now in a position to compare the results of Section 3 with those of Section 4, yielding an analysis of the effect of making (currently) inadmissible settlement demands admissible as evidence at trial. In what follows we only compare the separating equilibria. This turns out to be the most conservative comparison; a comparison of the separating equilibrium in the inadmissible evidence case with either the semi-pooling or pooling equilibria in the admissible evidence case would only further reinforce our findings. Thus, though technically what follows is a comparison assuming $\varepsilon \in [0,\varepsilon^1)$, the qualitative implications that we shall obtain hold for all $\varepsilon \in [0,1)$.

In Section 3 we found the <u>interim</u> and <u>ex-ante</u> payoffs for the plaintiff and the defendant in the inadmissible evidence case to be as follows:

$$_P(\delta) = \delta + k_D - K(\delta) + \varepsilon(a^* - \delta),$$

$$_D(\delta) = \delta + k_D + \varepsilon(a^* - \delta),$$

$$E_{FP}() = E_F() + k_D - KE_F() + \varepsilon(a^* - E_F())$$

and

$$E_{FD}() = E_F() + k_D + \varepsilon(a^* - E_F()).$$

Using Theorem 2, the interim and ex-ante payoffs for the plaintiff and the defendant in the admissible evidence case can be shown to be as follows:

$$_P(\delta) = \delta + k_D - K(\delta),$$

$$_D(\delta) = \delta + k_D,$$

$$E_{FP}() = E_F() + k_D - KE_F()$$

and

$$E_{FD}() = E_F() + k_D.$$

Finally, from the definitions of and , it follows that $(\delta) = (\delta)/(1-\varepsilon)$.

Thus (assuming $\varepsilon > 0$) we can make the following observations. First, $(\delta) > (\delta)$ and hence admissibility implies an increase in the expected number of trials. Admissibility encourages mimicry, since the opportunity to influence the judge's beliefs provides a further incentive to inflate the settlement demand. In order to counteract this incentive, the defendant must reject more often. Second, $\underline{S} < \underline{s}$ and $ > $: the range of settlement demands under admissibility is greater than the range when evidence is not admissible. Observe that under inadmissibility, high types suffer a negative externality generated by the low types via the calculation of a*: they are undercompensated should they proceed to trial. Similarly, low types enjoy a positive externality generated by the high types: they are overcompensated should they proceed to trial. Under admissibility trial promises accurate compensation, meaning that high types can demand more and low types must demand less. Third, for $\varepsilon \in (\varepsilon^1, \varepsilon^2)$, the types associated with the highest damage levels "play to the judge" -- they make very high demands, well aware that the defendant will reject these for sure. Fourth, since a* is upward-biased, $E_{FD}() < E_{FD}()$. On an ex-ante basis, defendants prefer that settlement demands be admissible as evidence at trial. Fifth, again, since a* is upward-

biased, $E_{FP}() < E_{FP}()$. Thus, on an ex-ante basis, plaintiffs prefer that settlement demands be inadmissible as evidence at trial, where this preference is further strengthened by the lower probability of trial under inadmissibility. Sixth, for $\delta \in [\underline{\delta}, a^*]$, $_P(\delta) > _P(\delta)$: on an interim basis, upward-biasedness of a* means that all types $\delta \leq a^*$ prefer settlement demands to be inadmissible. Numerical examples (using the uniform distribution for F) can be constructed in which some of the types in the upper portion of the distribution will prefer that settlement demands be admissible.

With these observations in mind, let us return to the "consensual resolution" rationale described in Section 1. The first three observations might be thought of as related to public interest considerations, inasmuch as an increase in the expected number of trials means an increased amount of resources devoted to court costs, and greater congestion of a scarce resource.[14] The last three observations reflect private interest considerations, akin to Brazil's reference to the "interest of individual litigants." Thus, we can conclude that while keeping settlement demands inadmissible as evidence may contribute to the public interest, such a policy can not be construed as contributing to the (private) interests of all the individual litigants.

The fourth and fifth observations refer to ex-ante payoffs; that is, expectations of payoffs constructed before any damage occurs, but after the agent's role is known (whether one is a plaintiff or a defendant). Some naturally-occurring situations have well-defined assignments of plaintiffs and defendants (agents know their roles); a good example is in the area of product liability. Here corporations are likely to be defendants and consumers are likely to be plaintiffs. This assignment therefore suggests a clear alignment

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[14] Again, some caution is due here since, as discussed earlier in footnote 5, anticipation of such increased costs should lead to greater care being taken, and thus possibly fewer trials and less aggregate damage in equilibrium.

of preferences about the admissibility of settlement demands as evidence in court: consumers will prefer inadmissibility and corporations will prefer admissibility. Thus, in such a context, a rule making settlement demands inadmissible in court would appear to be to the advantage of one group of potential litigants over another. Note that, under a complete "veil of ignorance" (i.e., if one is equally likely to be either party) inadmissibility is preferred to admissibility.

Notice that judges can make more accurate assessments under admissibility than under inadmissibility when ε is low. When ε is high and demands are admissible, the "filtering value" of pretrial negotiations is nil, presenting the court with no added information. Moreover, accuracy leads to a conflict of preferences regarding admissibility. Since inadmissibility is more efficient than admissibility (in the limited context of the expected number of trials), there are gains to be split amongst the parties that will ensure that a socially efficient rule is adopted in conjunction with an objective for judges that does not reflect accuracy alone. For example, by adjusting damage awards <u>downward</u> from the least squares estimate, one might achieve unanimity on this issue.

Obviously, the foregoing conclusions are based on a specific extensive game form. It is quite possible that altering the sequence of play, the informational endowments, the certainty of liability and other aspects of the model could alter some of our conclusions (e.g., distributional consequences). On the other hand, our procedure has involved picking a plausible game form and then varying the basic policy issue (admissibility) within that form. Our results suggest that rules on such matters as the inadmissibility of pretrial negotiations are likely to have distributional consequences, when judged from the perspective of a court system designed to accurately compensate plaintiffs. This also suggests that the conflict between social efficiency and judicial accuracy will also be robust, a problem in judicial system design that is beyond the focus of this paper.

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APPENDIX

Proof of Theorem 1. Given the settlement demand function $s^*(\delta)$ and the beliefs $(b^*(\bullet),\mu^*(\bullet|\bullet))$ as in Theorem 1, D is indifferent about accepting versus rejecting any demand $s \in [\underline{s},]$ and hence is willing to randomize as specified. For $s >$, it is optimal to reject s with probability 1 (independent of beliefs), while for $s < \underline{s}$, it is optimal to reject s with probability 0 (independent of beliefs).

Given $r^*(\bullet)$ and the beliefs $(b^*(\bullet),\mu^*(\bullet|\bullet))$ as in Theorem 1, $s = \underline{s}$ is strictly preferred by all plaintiff types to $s < \underline{s}$, while $s =$ is strictly preferred by all types to $s >$. Thus the optimal demand for each type δ belongs to $[\underline{s},]$ and solves:

$$\max \pi_P(s,r^*(s);b^*(s),\mu^*(\delta|s),\delta) = r^*(s)[(1-\varepsilon)\delta + \varepsilon a^* - k_P] + (1-r^*(s))s.$$

This function is differentiable with

$$d\pi_P/ds = r^{*\prime}(s)[(1-\varepsilon)\delta + \varepsilon a^* - k_P - s] + 1 - r^*(s).$$

The equation $d\pi_P/ds = 0$ has the unique solution $s^*(\delta) = (1-\varepsilon)\delta + \varepsilon a^* + k_D$. The second derivative of π_P with respect to s, evaluated at $s^*(\delta)$, is given by

$$d^2\pi_P/ds^2 = r^{*\prime\prime}(s^*(\delta))(-K) - 2r^{*\prime}(s^*(\delta)) = -(1/K)\exp\{-(1-\varepsilon)(s^*(\delta)-\underline{s})/K\} < 0,$$

indicating that $s^*(\delta)$ as defined above provides (at least) a local maximum. But in fact, it must provide the global maximum for if there were another local maximum, there would need to be an interior local minimum between the two. But this is impossible since $d\pi_P/ds = 0$ has the unique solution $s^*(\delta)$.

The beliefs $b(s)$ are clearly consistent, since $b(s) \in [\underline{\delta},]$ for all s and $b(s^*(\delta)) = \delta$ for all $\delta \in [\underline{\delta},]$. Finally, $b = (\underline{\delta},]$ since $r^*(s^*(\delta)) > 0$ for all $\delta \in (\underline{\delta},]$ and

$$d\mu(\delta) = r^*(s^*(\delta))dF(\delta)/\int_{\underline{\delta}} r^*(s^*(\sigma))dF(\sigma).$$

Uniqueness of the separating sequential equilibrium follows by appropriate modification of the uniqueness proof in Reinganum and Wilde [1986].

Pooling and Semi-Pooling Considerations: A Two-Receiver Refinement

There may also exist pure pooling and semi-pooling equilibria for this model. However, we will eliminate all but the separating equilibrium given in Theorem 1 by using the following two-receiver version of Cho and Kreps' (1987) equilibrium refinement criterion D1. Let (s^0, r^0, b^0, μ^0) be a sequential equilibrium with associated equilibrium payoff for P denoted (δ) and let s be an out-of-equilibrium demand. Let

$$D(\delta,s) \equiv \{(r,a) \in [0,1]x[\underline{\delta},] \,|\, r[(1-\varepsilon)\delta + \varepsilon a - k_p] + (1-r)s > {}_p(\delta)\}$$

and let

$$D^\circ(\delta,s) \equiv \{(r,a) \in [0,1]x[\underline{\delta},] \,|\, r[(1-\varepsilon)\delta + \varepsilon a - k_p] + (1-r)s = {}_p(\delta)\}.$$

The set $D(\delta,s)$ is the set of potential responses (r,a) on the part of D and J (the two receivers) for which the plaintiff of type δ would strictly prefer to defect from $s^0(\delta)$ to s. (Note that any $(r,a) \in [0,1]x[\underline{\delta},]$ could be a best response for D and J for some beliefs, where we allow D and J to have arbitrary, unrelated out-of-equilibrium beliefs). Similarly, the set $D^\circ(\delta,s)$ is the set of potential responses (r,a) on the part of D and J (the two receivers) for which the plaintiff of type δ would be indifferent between defecting to s and remaining at $s^0(\delta)$.

Definition A1. Specify a sequential equilibrium $(s^0(\bullet), r^0(\bullet), b^0(\bullet), \mu^0(\bullet|\bullet))$. Now consider an out-of-equilibrium demand s. If

(i) whenever $D(\delta,s) \cup D^\circ(\delta,s) \neq \varnothing$, there exists another type δ' such that

$$D(\delta,s) \cup D^\circ(\delta,s) \subset D(\delta',s),$$

then (δ,s) can be pruned from the tree (i.e., assigned probability 0 in the posterior beliefs $\mu^0(\bullet|\bullet)$). Alternatively put, if whenever type δ would be

willing to defect to s, type δ' strictly prefers this defection, then an observation of s should not be attributed to δ. If there exists any out-of-equilibrium demand s and types δ and δ' satisfying (i) for which $d\mu(\delta|s) > 0$, then we will say that the equilibrium $(s^0(\bullet), r^0(\bullet), b^0(\bullet), \mu^0(\bullet|\bullet))$ does not survive two-receiver D1.

Continuation of Proof of Theorem 1. To verify that the separating equilibrium is the unique refined sequential equilibrium, we need to show that pure pooling and semi-pooling equilibria do not survive two-receiver D1. First consider pure pooling equilibria. Note that there cannot be a pure pooling equilibrium in which the defendant rejects the pooled offer with probability 1. To see why, note that this would yield an equilibrium payoff of $(1-\varepsilon)\delta + \varepsilon E_F() - k_P$ to a plaintiff of type δ, where $E_F()$ is the anticipated court award in a pooling equilibrium. Yet in this case it is always optimal for the defendant to accept with probability 1 any demand less than $(1-\varepsilon)\underline{\delta} + \varepsilon E_F() + k_D$. Thus sufficiently low-damaged plaintiffs (in particular, type $\underline{\delta}$) will prefer to defect from the pooled demand. Thus low-damaged plaintiffs cannot be induced to pool at any demand which will be rejected with probability 1 by the defendant.

A family of pure pooling equilibria in which the defendant accepts the pooled offer with probability 1 exists in this model whenever $- E_F() \leq K/(1-\varepsilon)$. To see this, notice that the defendant will accept a pooled offer of if and only if $\leq (1-\varepsilon)E_F() + \varepsilon a + k_D$, where a is the anticipated award at trial (this a may take on any value in $[\underline{\delta},\ ]$ since trial is an out-of-equilibrium event in this equilibrium); moreover, the plaintiff of type δ will be willing to demand any $\geq (1-\varepsilon)\delta + \varepsilon a - k_P$. A value satisfying these two inequalities for all $\delta \in [\underline{\delta},\ ]$ exists whenever $- E_F() \leq K/(1-\varepsilon)$. Thus a pure pooling

equilibrium involves all plaintiff types demanding $< = (1-\varepsilon) + \varepsilon a + k_D$; the defendant accepts but must reject $s >$ with sufficiently high probability as to make demanding $s >$ unattractive for all plaintiff types; this requires a strictly positive probability of rejection for $s > .$ Now consider an out-of-equilibrium demand $s \in (,)$. All plaintiff types would strictly prefer to defect to $s >$ if it were to be accepted; thus $D(\delta,s) \neq \varnothing$, since $\{r = 0, a \in [\underline{\delta},]\} \subset D(\delta,s)$ for all $\delta \in [\underline{\delta},]$. But $D(\delta,s) \cup D^{\circ}(\delta,s) \subset D(,s)$ for all $\delta < ,$ since for $r > 0$, $r[(1-\varepsilon)\delta + \varepsilon a - k_P] + (1-r)s \geq$ implies $r[(1-\varepsilon) + \varepsilon a - k_P] + (1-r)s > .$ Thus $b(s) =$ (and $d\mu_D(\delta|s) = 0$ for all $\delta <);$ that is, an observation of $s \in (,)$ must be attributed to type ; but then the defendant should accept $s \in (,)$ with probability 1, which is a contradiction. Thus, such a pooling equilibrium fails our refinement.

Finally, it is possible to support a pure pooling equilibrium in which the defendant accepts the pooled offer with sufficiently high positive probability r. In this case, trial is an equilibrium event, and therefore $a = E_F()$. The defendant will be indifferent between accepting and rejecting the demand only if $= (1-\varepsilon)E_F() + \varepsilon E_F() + k_D < (1-\varepsilon) + \varepsilon E_F() + k_D$. Again, demands $s \in (,(1-\varepsilon) + \varepsilon E_F() + k_D)$ must be rejected with probability strictly greater than r so as to prevent plaintiffs from defecting from to s. But an argument analogous to the one in the preceding paragraph implies that any demand $s \in (,(1-\varepsilon) + \varepsilon E_F() + k_D)$ must be attributed to the highest-damaged plaintiff, and should thus be accepted by the defendant with probability 1. This contradicts the implication that $s >$ must be rejected with probability greater than r.

Similar arguments can be devised to eliminate semi-pooling equilibria, but this seems too tedious an exercise to include. The upshot is that only the separating equilibrium survives two-receiver D1.

The Upward-Biasedness of a*. Let $w(\delta) \equiv r^*(s^*(\delta))/\int r^*(s^*(\sigma))dF(\sigma)$, where the integral is over $\Delta \equiv [\underline{\delta},]$; thus $\int_\Delta w(\delta)dF(\delta) = 1$. Observe that $w(\underline{\delta}) = 0$, $w() > 1$ and $w(\delta)$ is monotonically increasing and continuous over Δ. Therefore, there exists $\delta^0 \in int(\Delta)$ such that $w(\delta) < 1$ for all $\delta < \delta^0$, $w(\delta) > 1$ for all $\delta > \delta^0$, and $w(\delta^0) = 1$. Then $\int(\delta - \delta^0)(1 - w(\delta))dF(\delta) < 0 < \int(\delta - \delta^0)(1 - w(\delta^0))dF(\delta)$, where the first integral is over $[\underline{\delta}, \delta^0]$ and the second integral is over $[\delta^0,]$. Expansion and collection of terms in these inequalities, along with the fact that $\int_\Delta dF(\delta) = \int_\Delta w(\delta)dF(\delta) = 1$, yields the required result.

Existence and Uniqueness of ε^1. The equation $g(\varepsilon) \equiv \varepsilon - \exp\{-(1-\varepsilon)(-\underline{\delta})/K\} = 0$ has the unique solution $\varepsilon^1 = 1$ if $(-\underline{\delta})/K \leq 1$. If $(-\underline{\delta})/K > 1$ then the equation has two solutions, one at 1 and one, denoted $\varepsilon^1 < 1$.

Proof. Note that $g(0) = -\exp\{-(-\underline{\delta})/K\} < 0$ and $g(1) = 1$. Moreover, $g(\varepsilon)$ is a strictly concave function with $g'(1) = 1 - (-\underline{\delta})/K$. Thus, when $(-\underline{\delta})/K \leq 1$, there is one solution at $\varepsilon = 1$. If $(-\underline{\delta})/K > 1$ then $g'(1) < 0$, and g cuts the axis both at 1 and between 0 and 1.

Proof of Theorem 2. This proof parallels that of Theorem 1 and is ommitted to save space.

Existence and Uniqueness of $\delta(\varepsilon)$ Under the Uniform Distribution. Let $\varepsilon^2 \equiv 2K/(\ - \underline{\delta})$. For $\varepsilon^1 < \varepsilon < \varepsilon^2$, the equation

$$\phi(\delta,\varepsilon) \equiv 1 - R^*(S^*(\delta)) - \varepsilon(-\delta)/2K$$

$$= 1 - [1/(1-\varepsilon)][1 - \exp\{-(1-\varepsilon)(\delta-\underline{\delta})/K\}] - \varepsilon(-\delta)/2K = 0$$

has a unique solution in δ for given ε; that is, there is a unique value $\delta(\varepsilon) \in [\underline{\delta},]$ such that $\phi(\delta(\varepsilon),\varepsilon) = 0$.

Proof. Note that $\phi(\underline{\delta},\varepsilon) = 1 - \varepsilon(-\underline{\delta})/2K > 0$ for all $\varepsilon \in (\varepsilon^1,\varepsilon^2)$. Moreover, $\phi(,\varepsilon) = 1 - [1/(1-\varepsilon)][1 - \exp\{-(1-\varepsilon)(-\underline{\delta})/K\}] < 0$ for all $\varepsilon \in (\varepsilon^1,\varepsilon^2)$. Since $\phi(\delta,\varepsilon)$ is

a strictly concave function of δ, there exists a unique value of $\delta \in (\underline{\delta},)$, denoted $\delta(\varepsilon)$, such that $\phi(\delta(\varepsilon),\varepsilon) = 0$.

Proof of Theorem 3. Given the beliefs $B(\bullet)$ and $B(S)$, and the settlement demand function $S^*(\delta)$ as in Theorem 3, the defendant will (be willing to) reject the pooled offer if and only if $\geq (\delta(\varepsilon)+)/2 + k_D$. Any demand $S \in [\delta(\varepsilon)+k_D,\infty)$, but not equal to , is believed to come from the plaintiff of type $\delta(\varepsilon)$. It is a best response for the defendant to reject any such demand since D expects to pay $\delta(\varepsilon) + k_D$ at trial. Finally, any $S \in [\underline{S},\delta(\varepsilon)+k_D)$ is believed to come from the plaintiff of type $S - k_D$; in this case, the defendant is indifferent about accepting or rejecting the demand S, and is therefore willing to randomize as specified in Theorem 3. Independent of out-of-equilibrium beliefs, it is optimal for D to reject with probability 1 any $S >$ and to accept with probability 1 any $S < \underline{S}$. Thus the defendant's behavior is a best response, given the beliefs.

Given the beliefs and the probability of rejection function $R^*(S)$, the plaintiff of type δ chooses S so as to maximize

$$\max \Pi_P(S,R^*(S);B^*(S),M^*(\delta|S),\delta) = R^*(S)[(1-\varepsilon)\delta + \varepsilon A^*(S) - k_P] + (1-R^*(S))S.$$

Note that $S = \underline{S}$ is strictly preferred by all types to $S < \underline{S}$.

Consider first plaintiff types $\delta \in [\underline{\delta},\delta(\varepsilon))$. For $S \in [\underline{S},\delta(\varepsilon)+k_D)$, the function Π_P is differentiable in S with

$$d\Pi_P/dS = R^{*\prime}(S)[(1-\varepsilon)\delta + \varepsilon A^*(S) - k_P - S] + 1 - R^*(S)(1 - \varepsilon A^{*\prime}(S)).$$

The equation $d\Pi_P/dS = 0$ has the unique solution $S^*(\delta) = \delta + k_D$. The second derivative of Π_P with respect to S, evaluated at $S^*(\delta)$, is given by

$$\begin{aligned} d^2\Pi_P/dS^2 &= R^{*\prime\prime}(S^*(\delta))(-K) - 2R^{*\prime}(S^*(\delta))(1 - \varepsilon) \\ &= -[(1-\varepsilon)/K]\exp\{-(1-\varepsilon)(S^*(\delta)-\underline{S})/K\} < 0, \end{aligned}$$

indicating that $S^*(\delta)$ as defined above provides (at least) a local maximum. But in fact, it must provide the global maximum on $[\underline{S}, \delta(\varepsilon)+k_D)$ for if there were another local maximum, there would need to be an interior local minimum between the two. But this is impossible since $d\Pi_P/dS = 0$ has the unique solution $S^*(\delta)$. It remains to prove that type $\delta \in [\underline{\delta}, \delta(\varepsilon))$ (at least weakly) prefers $S^*(\delta)$ to any $S \in [\delta(\varepsilon)+k_D, \infty)$. First note that demanding dominates demanding any other $S \in [\delta(\varepsilon)+k_D, \infty)$ since both are rejected by D and J gives a higher award upon observing . Thus the relevant comparison is between $S^*(\delta)$ and . If δ demands , it is inferred to belong to the pooled group $[\delta(\varepsilon),]$, goes to court and receives $(1-\varepsilon)\delta + \varepsilon(\delta(\varepsilon)+)/2 - k_P$. On the other hand, if δ demands $S^*(\delta)$ (thereby revealing δ), it can expect to receive $\delta)[\delta - k_P] + (1-(\delta))[\delta + k_D] = \delta + k_D - (\delta)K$. The plaintiff of type δ (at least weakly) prefers $S^*(\delta)$ to so long as

$$\delta + k_D - (\delta)K \geq (1-\varepsilon)\delta + \varepsilon(\delta(\varepsilon)+)/2 - k_P;$$

that is, so long as

$$G(\delta,\varepsilon) \equiv 1 - (\delta) - \varepsilon[\delta(\varepsilon)+-2\delta]/2K \geq 0.$$

Collecting terms in $G(\delta,\varepsilon)$ allows us to re-write $G(\delta,\varepsilon) = \phi(\delta,\varepsilon) - \varepsilon[\delta(\varepsilon)-\delta]/2K$. From the definition of $\delta(\varepsilon)$, it follows that $G(\delta(\varepsilon),\varepsilon) = 0$; that is, the plaintiff of type $\delta(\varepsilon)$ is indifferent between revealing its damages and making the pooling demand. Moreover,

$$\partial G/\partial\delta = (\varepsilon - \exp\{-(1-\varepsilon)(\delta-\underline{\delta})/K\})/K = -[(1-\varepsilon)/K][1 - (\delta)].$$

From the definition of $\delta(\varepsilon)$, it follows that $1 - (\delta(\varepsilon)) > 0$; furthermore, since (δ) is an increasing function of δ, it follows that $1 - (\delta) > 0$ for all $\delta < \delta(\varepsilon)$. Thus $G(\delta,\varepsilon)$ is a strictly decreasing function of δ for $\delta < \delta(\varepsilon)$, and

$G(\delta(\varepsilon),\varepsilon) = 0$. Therefore $G(\delta,\varepsilon) > 0$ for $\delta < \delta(\varepsilon)$; that is, all plaintiff types with $\delta < \delta(\varepsilon)$ strictly prefer their revealing demands to pooling at .

Next consider plaintiff types with $\delta \geq \delta(\varepsilon)$. It must be shown that such plaintiffs prefer (at least weakly) the pooled demand to any other demand. Again, demanding dominates any other demand $S \in [\delta(\varepsilon)+k_D, \infty)$ since these are all rejected by D and J makes a higher award upon observing .

The plaintiff of type $\delta \geq \delta(\varepsilon)$ receives an equilibrium payoff of $_P(\delta) = (1-\varepsilon)\delta + \varepsilon(\delta(\varepsilon)+)/2 - k_P$, but would expect upon switching to $S < \delta(\varepsilon)+k_D$ to receive a payoff of $R^*(S)[(1-\varepsilon)\delta + \varepsilon(S-k_D) - k_P] + (1-R^*(S))S$. Thus the plaintiff of type $\delta \geq \delta(e)$ will (at least weakly) prefer the pooled demand to any demand $S < \delta(\varepsilon)+k_D$ so long as the difference between these expressions is non-negative; that is, so long as

$$L(S,\delta) \equiv (1-R^*(S))[(1-\varepsilon)\delta - k_P - S] - \varepsilon R^*(S)(S-k_D) + \varepsilon(\delta(\varepsilon)+)/2 \geq 0$$

for all $S < \delta(\varepsilon)+k_D$. Notice that $L(S,\delta)$ is strictly increasing in δ, so that if $L(S,\delta(\varepsilon)) \geq 0$ for all $S < \delta(\varepsilon)+k_D$, then $L(S,\delta) \geq 0$ for all $S < \delta(\varepsilon)+k_D$ for all $\delta \geq \delta(\varepsilon)$ as well. Thus we will now verify that $L(S,\delta(\varepsilon)) \geq 0$ for all $S < \delta(\varepsilon)+k_D$. Evaluating $L(S,\delta(\varepsilon))$ at $S = \delta(\varepsilon)+k_D$ and simplifying yields

$$L(\delta(\varepsilon)+k_D,\delta(\varepsilon)) = -K[1-(\delta(\varepsilon))] + \varepsilon(-\delta(\varepsilon))/2 = 0$$

by the definition of $\delta(\varepsilon)$. Moreover, differentiating $L(S,\delta(\varepsilon))$ with respect to S and using the fact that $-KR^{*\prime}(S) + 1 - (1-\varepsilon)R^*(S) = 0$ yields

$$\partial L(S,\delta(\varepsilon))/\partial S = -R^{*\prime}(S)(1-\varepsilon)[\delta(\varepsilon) + k_D - S] < 0 \text{ for all } S < \delta(\varepsilon)+k_D.$$

Thus, we have $L(S,\delta(\varepsilon)) \geq 0$ for all $S < \delta(\varepsilon)+k_D$, and consequently that $L(S,\delta) \geq 0$ for all $S < \delta(\varepsilon)+k_D$ and for all $\delta \geq \delta(\varepsilon)$.

We have just shown that $S^*(\delta)$ as given in Theorem 3 provides a best response for all P types. The beliefs B(S) and B(S) are obviously consistent.

Out-of-equilibrium beliefs for demands $S < \underline{S}$ and $S >$ are irrelevant, since D's behavior upon observing such S values does not depend on beliefs.

It remains to be shown that these beliefs survive two-receiver D1. First note that $(R,A) = (1,(\delta(\varepsilon)+)/2) \in D^{\circ}(\delta(\varepsilon),S)$ for all $S \geq \delta(\varepsilon)+k_D$; that is, type $\delta(\varepsilon)$ would be indifferent about defecting from to any out-of-equilibrium $S \geq \delta(\varepsilon)+k_D$ if such a demand were to be rejected by D and awarded $(\delta(\varepsilon)+)/2$ by J with probability ε (since this is exactly what happens in equilibrium). Thus $D(\delta(\varepsilon),S) \cup D^{\circ}(\delta(\varepsilon),S) \neq \emptyset$. However, <u>there does not exist another type δ' such that</u> $D(\delta(\varepsilon),S) \cup D^{\circ}(\delta(\varepsilon),S) \subset D(\delta',S)$. To see this, simply note two things: (1) for $\delta' \in (\delta(\varepsilon),]$, $(R,A) = (1,(\delta(\varepsilon)+)/2) \in D^{\circ}(\delta,S)$ as well; that is, all plaintiff types $\delta' \in (\delta(\varepsilon),]$ are also indifferent between their equilibrium payoffs and being rejected by D and awarded $(\delta(\varepsilon)+)/2$ by J. Thus no such δ' can be used to eliminate $\delta(\varepsilon)$. (2) for $\delta' \in [\underline{\delta},\delta(\varepsilon))$, the plaintiff of type δ' prefers his equilibrium payoff to being rejected by D and awarded $(\delta(\varepsilon)+)/2$ by J with probability ε; we know this because the type δ' plaintiff could already have achieved this latter outcome by joining the pool in demanding , and each $\delta' \in [\underline{\delta},\delta(\varepsilon)))$ prefers his (revealing) equilibrium demand $S^*(\delta')$. Thus no such δ' can be used to eliminate $\delta(\varepsilon)$. Thus the beliefs used in Theorem 3 survive two-receiver D1.

Note that there could be other beliefs which will also support this semi-pooling equilibrium and survive two-receiver D1. An argument is given below to verify that no pooling equilibria (or semi-pooling equilibria involving more pooling) survive two-receiver D1.

<u>Refinement Proof for Theorem 3</u>. Here we verify that no other equilibria which exist under the conditions of Theorem 3 can survive refinement using two-receiver D1. First, note that for $\varepsilon < \varepsilon^2$, there cannot exist a pure pooling equilibrium in which the defendant rejects the pooled demand with probability

1. For if there were, the plaintiff of type δ would receive an equilibrium payoff of $(1-\varepsilon)\delta + \varepsilon(+\underline{\delta})/2 - k_P$. But since the defendant would always accept a demand (just slightly below) $\underline{\delta} + k_D$, the $\underline{\delta}$ type plaintiff would always defect since $\underline{\delta} + k_D > (1-\varepsilon)\underline{\delta} + \varepsilon(+\underline{\delta})/2 - k_P$ so long as $\varepsilon < 2K/(-\underline{\delta}) = \varepsilon^2$.

For all values of ε, there may exist pure pooling equilibria in which the defendant accepts the pooled demand (or less) with probability 1, but rejects any higher demand with sufficiently high probability as to make it unattractive to the plaintiff (a strictly positive probability of rejection is required). In order to be willing to accept the pooled demand , the defendant must expect $\leq (+\underline{\delta})/2 + k_D$, his anticipated trial outcome. Therefore, $<$ $+ k_D$.

Consider now a plaintiff of type δ considering defection to an out-of-equilibrium demand $S \in (,+k_D)$ (no plaintiff would ever defect to $S <$ since is accepted). Define the sets

$$D(\delta,S) \equiv \{(R,A) \in [0,1]x[\underline{\delta},] \,|\, R[(1-\varepsilon)\delta + \varepsilon A - k_P] + (1-R)S > \}$$

and

$$D^{\circ}(\delta,S) \equiv \{(R,A) \in [0,1]x[\underline{\delta},] \,|\, R[(1-\varepsilon)\delta + \varepsilon A - k_P] + (1-r)S = \}.$$

The set $D(\delta,S)$ is the set of potential responses (R,A) on the part of D and J (the two receivers) for which the plaintiff of type δ would strictly prefer to defect from to $S >$. Since, for any $S >$, $D(\delta,S) \cup D^{\circ}(\delta,S) \subset D(,S)$ for all $\delta <$, such an S should be attributed by both receivers (according to two-receiver D1) to the type plaintiff. Such a demand should be accepted with probability 1 (since its rejection will entail a cost of $+ k_D$ to the defendant), rather than rejected with sufficiently high (positive) probability, as required for a pooling equilibrium at . Thus no pure pooling equilibrium involving acceptance by the defendant with probability 1 can survive two-receiver D1. A similar argument can be constructed (along the lines of that in the proof of Theorem 1) to eliminate pooling equilibria with a positive (though less than

1) probability of acceptance. For $\varepsilon \in [\varepsilon^1, \varepsilon^2)$, semi-pooling equilibria which involve more pooling than that of Theorem 3 likewise can be refined away.