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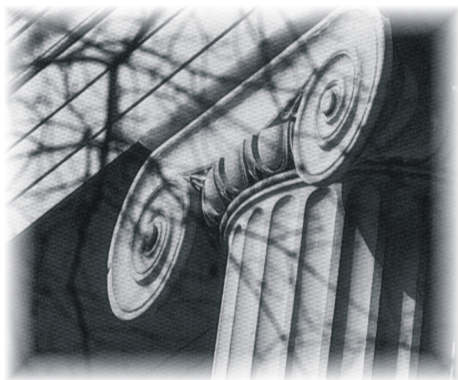

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PRETRIAL BARGAINING WITH ASYMMETRIC INFORMATION AND ENDOGENOUS EXPENDITURE AT TRIAL

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Abstract

We develop a model with asymmetric information, where the uninformed party makes the offer. When parties proceed to trial, their endogenous expenditures partially determine the outcome. The endogenous spending at trial can either strengthen or weaken the bargaining position of the uninformed party with the player types who settle. When the bargaining position is strengthened, some standard results on information transmission prior to trial may be overturned. The recipient of the offer with a weak case may make a costly voluntary disclosure. In addition, the party making the offer may refuse costless discovery. Both of these results contrast with the standard results in the literature derived from models in which spending at trial is treated as exogenous.

1. Introduction

There is a very large literature demonstrating how asymmetric information can lead to bargaining failure and result in costly trials. There is a smaller literature which models endogenous expenditure at trial. However, with a handful of exceptions, these models have not been combined. In this paper, we develop a model where pretrial bargaining may fail as a result of asymmetric information, and where parties proceeding to trial influence the outcome via their endogenous spending decisions. The endogenous spending decisions at trial influence pretrial bargaining in important ways. The interaction between the endogenous spending at trial and pretrial bargaining also leads to some novel results concerning the conditions under which information transmission will occur prior to trial.

Our central example is a two type model in which a plaintiff can either have a claim to a large or a small judgment in the event she prevails at trial. The defendant does not know the plaintiff's type. As is standard in such models, we may have a sorting equilibrium in which the defendant makes a low settlement offer which is only accepted by plaintiffs with a weak case. Since only strong plaintiff types proceed to trial, the defendant's expenditure at trial is high relative to what he would spend against a weak plaintiff in a full information game. This gives the defendant an advantage in pretrial bargaining with the weak plaintiff. If she rejects the offer and proceeds to trial, she will be believed to be a strong plaintiff, and will face high spending by the defendant as a result. Since this high spending reduces the weak plaintiff's payoff at trial, it reduces the offer the defendant needs to make to her to induce settlement. As a result, the weak plaintiff receives a lower payoff than she would in a full information game.

The effect on bargaining discussed above leads to some new results regarding the circumstances under which information transmission will take place prior to trial. When expenditure at trial is exogenous, the plaintiff in a screening game would never make a costly voluntary disclosure, because in the asymmetric information game she always does at least as well as she would in the full information game. If it were costless, then disclosures may be made by plaintiffs with stronger cases while weaker plaintiffs remain silent. In our model, not only might the plaintiff be willing to make a costly disclosure, but it is the weak plaintiff type who may do so. This occurs because the strategic effect of asymmetric information and endogenous expenditure at trial is to disadvantage these players relative to the full information game.

In the standard model, the uninformed defendant in the screening game would always invoke a costless discovery procedure. This allows the defendant to avoid costly trials, while tailoring offers precisely to each plaintiff's type. This allows the defendant to obtain all of the joint surplus from settlement. In our model, the defendant may still want to invoke costless discovery in order to avoid costly trial, but there are parameter values under which he will refuse to do so. In particular, if most plaintiffs are the weak type, the defendant may do better by not knowing the plaintiff's type. This is due to the bargaining advantage the defendant enjoys against weak plaintiffs, relative to the full information game.

We use the intuition developed from the game described above to informally discuss the extent to which the model results are robust to some alternative specifications of the game. Among other things, we discuss how the results would translate to a model in which the asymmetric information concerned the merits of the case, rather than the size of the judgment in the event of a plaintiff victory.[1]

[1] As we model it, the merits of the case will affect the probability of a plaintiff victory, but not the size of the award in the event the plaintiff prevails.

2. Background

The model of endogenous expenditure at trial is related to the literature on contests, which begins with Tullock (1975, 1980) and is surveyed by Nitzan (1994). The literature on contests is treated at book length by Konrad (2009). Of particular relevance to our work is the literature on rent-seeking contests in the presence of asymmetric information. This strand of the literature includes Hurley and Shogren (1998), Wärneryd (2003) and Fey (2008). Several authors have applied contest theory to litigation spending. Katz (1988) provides a micro foundation for the use of a contest success function by modeling the way both sides to a dispute produce arguments. Braeutigam, Owen and Panzar (1984), Plott (1987), and Farmer and Pecorino (1999) address the issues of how fee shifting affects expenditure at trial and the incentive to file meritorious suits. Froeb and Kobayashi (1998) are concerned with the effects of jury bias and with whether or not endogenous spending at trial can eliminate an initial jury bias.[2] Hirshleifer and Osborne (2001) are concerned with how endogenous expenditure at trial affects the relationship between the equilibrium outcome and the just outcome based on the merits of the suit.

The papers above assume that cases proceed to trial without allowing for a period of pretrial bargaining. In the absence of asymmetric information, pretrial bargaining would lead to settlement prior to trial. The literature on pretrial bargaining in the presence of asymmetric information has mostly assumed that expenditure at trial is exogenous. Two key early contributions to this literature are Bebchuk (1984) and Reinganum and Wilde (1986). Bebchuk develops a screening model in which the uninformed party to the dispute makes an offer to the informed party. Reinganum and Wilde develop a signaling model in which the informed party makes the offer.[3]

[2] This issue is also addressed by Farmer and Pecorino (2000).
[3] Spier (2007) offers an excellent survey of this literature.

Along with the literature on asymmetric information, there has developed a literature on information transmission prior to trial. This includes voluntary disclosures and use of the discovery procedure. Shavell (1989) considers costless voluntary disclosures, and finds that these can lead to an equilibrium in which all cases settle. In this equilibrium, information is revealed by players with stronger cases, while players with weak cases remain silent. Sobel (1989) shows that the recipient of the offer will not make a costly voluntary disclosure. This party does at least as well under asymmetric information as they would under full information, and can avoid the disclosure cost by remaining silent. Farmer and Pecorino (2005) consider discovery and disclosure in the same model and do this for both the screening and signaling game. They find these procedures to be complementary in the sense that voluntary disclosures may be made in the signaling game, but not the screening game, while discovery may be invoked in the screening game, but will not be invoked in the signaling game.[4]

More recently, there have been models that combine asymmetric information in pretrial bargaining with endogenous expenditure at trial. Gong and McAfee (2000) represents one such model. One focus of their paper is the way in which fee shifting affects the relationship between the settlement a player obtains and the fair settlement based on the merits. A key difference between our paper and theirs is that in their paper, asymmetric information is revealed before spending decisions at trial are made. Thus, while asymmetric information can cause bargaining breakdown, trial expenditure takes place in an environment with symmetric information.

Choné and Linnemer (2010) combine endogenous expenditure with asymmetric information. The spending in question is pretrial case preparation, which they assume is

[4] While they do not model discovery per se, both Daughety and Reinganum (1993) and Watts (1994) develop models of information acquisition prior to trial. Analytically, this is similar to discovery. Other contributions to the literature on discovery include Cooter and Rubinfeld (1994), Hay (1994), Mnookin and Wilson (1998), Schrag (1999), and Schwartz and Wickelgren (2009).

observable. A high level of case preparation (e.g., hiring a prominent law firm) can potentially signal the strength of the case, which is private information. While the pretrial preparation may influence trial costs, there are no additional spending decisions in their model, once the case reaches trial.

Fu (2008) is the paper most closely related to our work. Fu analyzes a signaling game where the informed party makes the offer, while we analyze a screening game in which the uninformed party makes the offer.[5] In Fu's paper, as in ours, it is assumed that the informational asymmetry persists up through the point where the endogenous spending decision is made. Fu does not consider voluntary disclosures or discovery in the pretrial phase. We find that these institutions interact in interesting ways with the endogenous expenditure decisions at trial.

3. Full Information Expenditure

In the next section we will consider the model with asymmetric information, and derive results relating to costly voluntary disclosure and discovery. As a backdrop for these results, it is necessary to derive the results in the full information model. These results are completely standard in the literature.[6]

Both parties to the dispute are risk neutral. Let the judgment at trial be denoted J^i, where $i = H, L$ and $J^H \geq J^L$. Let the merits of the case be denote by $a^k > 0$, where $k = S, W$ and $a^S \leq a^W$. A lower value of a implies a stronger case for the defendant. Furthermore, when $a > 1$, the objective merits favor the plaintiff and when $a < 1$, the objective merits favor the defendant. The plaintiff's expenditure at trial is denote by X, and the defendant's expenditure is denoted by Y. The plaintiff is awarded the judgment J^i with probability p, where

[5] Though unlike the standard screening games, the addition of endogenous expenditure at trial does add a signaling element to the model.
[6] See, for example, Farmer and Pecorino (1999).

$$p = \frac{a^k X}{a^k X + Y} J^i . \quad (1)$$

The defendant prevails at trial with probability *1-p*. Under full information, the plaintiff's problem is to choose *X* to maximize the expected payoff in (2), while the defendant chooses *Y* to minimizes the expected cost in (3).

$$\Pi = \frac{a^k X}{a^k X + Y} J^i - X , \quad (2)$$

$$C = \frac{a^k X}{a^k X + Y} J^i + Y . \quad (3)$$

The reaction functions from the optimization of (2) and (3) are as follows:

$$X = \sqrt{Y J^i / a^k} - (1/a^k) Y, \quad (4)$$

$$Y = \sqrt{a^k X J^i} - a^k X. \quad (5)$$

These reaction functions are presented for future reference. The solutions for the full information legal expenditure game are

$$X = Y = \frac{a^k J^i}{(1 + a^k)^2} . \quad (6)$$

When information is complete, expenditure is equal for both parties and is increasing in the judgment. It is straightforward to show that spending is increasing in a^k for $a^k < 1$, decreasing in a^k for $a^k > 1$ and maximized at $a^k = 1$. Thus, spending is higher in cases which are closer based on the objective merits.[7]

The equilibrium expected payoff to the plaintiff and the expected cost to the defendant under full information are as follows:

[7] See Gradstein (1995).

$$\Pi = \frac{(a^k)^2}{(1+a^k)^2} J^i, \tag{7}$$

$$C = \frac{a^k(2+a^k)}{(1+a^k)^2} J^i. \tag{8}$$

These full information payoffs will prove useful in the analysis which follows.

4. Asymmetric Information Regarding the Judgment

In this section we assume that the merits of the case are common knowledge, so that $a^S = a^W = a$, but that there is asymmetric information over the judgment. A type H plaintiff will receive J^H if she prevails at trial while a type L plaintiff will receive J^L, where $J^H > J^L$. The stages of the game are as follows:

0. Nature determines the plaintiff's type. The plaintiff is type H with probability q and type L with probability 1-q. The plaintiff knows her type, but the defendant knows only the distribution of types that he faces.
1. a. The plaintiff decides whether to disclose her private information at the cost v. If she discloses her private information, her type becomes known to the defendant with certainty.

   b. The defendant decides whether or not to invoke discovery at the cost d. If discovery is invoked, the defendant learns the plaintiff's type with certainty.
2. The defendant makes a take it or leave it offer O^D to the plaintiff. If the plaintiff accepts the offer, the game ends with the plaintiff receiving a payoff of O^D and the defendant incurring of cost of O^D. If the plaintiff rejects the offer, the players proceed to trial.
3. Players simultaneously choose their level of expenditures where plaintiff spending is denoted X and defendant spending is denoted Y. Trial occurs and the plaintiff of type i wins J^i with

probability $p = \frac{aX}{aX+Y}$. The plaintiff's payoff is J^i - X if she wins at trial and $-X$ if she loses.

The defendant's cost is $J^i + Y$ if the plaintiff wins at trial and Y if she loses.

If a voluntary disclosure or discovery does not take place, then at the point where the spending decision is made, the defendant does not directly observe the plaintiff's type. The model will have a perfect Bayesian equilibrium, so the defendant's beliefs at this point will be mathematically consistent with the equilibrium actions of the plaintiff. We will first analyze the game without voluntary disclosure or discovery (steps 1a and 1b) and then analyze the model when these steps are individually added to the model.

4.1. The Model Without Disclosure or Discovery

Before proceeding, we make the following parameter restriction:

$$\sqrt{J^H} < (1+a)\sqrt{J^L} \ . \qquad (9)$$

While $J^H > J^L$, this restriction puts a limit on how much greater J^H can be. This restriction guarantees that if the type L plaintiff deviates from the sorting equilibrium below, she will spend a positive amount at trial. If the restriction were violated, she would spend 0 if she deviated and proceeded to trial. We have analyzed this case, and the results are quite similar to what follows. Thus, in the interests of space, we will omit this analysis from the paper.

The model described by steps 0, 2 and 3 above can either have a pooling equilibrium under which in stage 2 a high offer is made and accepted by both plaintiff types or a sorting equilibrium under which a low offer is made. This low offer is accepted by type L plaintiffs and rejected by type H plaintiffs. All other offers are dominated by these two possibilities. Given that the defendant has two distinct strategies in making his stage 2 offer, we will first analyze the outcome of each of these possible strategies, and then state the condition under which each is predicted to occur as equilibrium of the game.

4.1.1. The Pooling Equilibrium

Under a pooling equilibrium, the defendant makes an offer designed to be accepted by both plaintiff types. While the type *L* plaintiff will strictly prefer to accept the equilibrium offer, this offer is designed to make the type *H* plaintiff indifferent between acceptance and rejection. Consider the following candidate for a pooling offer:

$$O^D = \frac{a^2}{(1+a)^2} J^H . \tag{10}$$

The offer in (10) equals what the type *H* plaintiff earns in the full information game.[8] While both plaintiff types settle in equilibrium, the acceptability of the offer in (10) to a type *H* plaintiff depends upon what she would earn if she deviated from equilibrium and proceeded to trial. This depends upon the defendant's out of equilibrium action, which is his level of trial expenditure *Y*. This action, in turn, needs to be supported by the defendant's out of equilibrium belief. Let ϕ be the defendant's out of equilibrium belief that a plaintiff is type *H*, conditional on her having rejected the offer in (10). Our solution concept is the perfect Bayesian equilibrium which offers some latitude in specifying out of equilibrium beliefs. Since type *H* plaintiffs are indifferent between accepting and rejecting the offer in equilibrium and type L plaintiffs strictly prefer this offer to trial, $\phi = 1$ seems a plausible specification of this belief.[9] With $\phi = 1$, out of equilibrium expenditure at trial by the defendant and the type *H* plaintiff is the same as in the Nash equilibrium of the full information game:

[8] This can be calculated from (7), where $a^k = a$ and $J^i = J^H$.

[9] Given our freedom in specifying this belief, the equilibrium we specify will not be unique, but nothing critical depends upon our focus on this particular equilibrium.

$$Y = X^H = a^2 J^H/(1+a)^2. \qquad (11)$$

The H superscript denotes that this spending by the type H plaintiff. Given the spending levels in (11), the expected payout in trial is the same as in the full information game (equation 7), and a type H plaintiff will accept the offer in (10).[10]

In the pooling equilibrium, the payoffs to the plaintiffs and the cost to the defendant are

$$\Pi^L = \Pi^H = C = \frac{a^2}{(1+a)^2} J^H. \qquad (12)$$

While there are some additional details relative to the game with exogenous expenditure at trial, the pooling equilibrium with endogenous expenditure at trial does not contain any striking new features. As we shall see however, the sorting equilibrium does contain new and interesting features relative to the game with exogenous expenditure at trial.

4.1.2. The Sorting Equilibrium

A sorting offer is designed to be acceptable to type L plaintiffs, but will be rejected by type H plaintiffs. Since only type H plaintiffs proceed to trial in equilibrium, the defendant believes all such players are in fact type H. Thus, in equilibrium, spending at trial by the defendant and type H plaintiff is described by (11). The sorting offer which is acceptable to a type L plaintiff depends upon what she could earn if she deviates from equilibrium and proceeds to trial; this determines the size of the offer the defendant will need to make to induce settlement by type L plaintiffs. Since only type H plaintiffs proceed to trial in equilibrium, any type L plaintiff who deviated from equilibrium and proceeded to trial would be believed to be type H. Given the

[10]From (2), the expected payoff for a type H plaintiff from proceeding to trial is the offer in (10).

defendant's resulting spending in (11), the type L plaintiff's reaction function in (4) dictates that she spend the following:

$$X^L = \frac{J^H}{(1+a)}\left[\frac{\sqrt{J^L}}{\sqrt{J^H}} - \frac{1}{1+a}\right]. \tag{13}$$

The spending in (13) reflects the type *L* plaintiff's optimal action at trial conditional on a deviation from equilibrium. Using (2), (11) and (13), it can be shown that the following offer leaves the type *L* plaintiff indifferent between acceptance and rejection:

$$O^D = \left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)^2. \tag{14}$$

The defendant makes the offer in (14) which is accepted by type *L* plaintiffs and rejected by Type *H* plaintiffs. Trial occurs with probability *q*, the unconditional probability the plaintiff is type *H*. The resulting expected payoffs for the plaintiffs and expected cost for the defendant are

$$\Pi^L = \left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)^2, \tag{15}$$

$$\Pi^H = \frac{a^2}{(1+a)^2} J^H, \text{ and} \tag{16}$$

$$C = (1-q)\left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)^2 + q\frac{a(2+a)}{(1+a)^2} J^H, \tag{17}$$

where the expected payoffs and cost at trial are computed from (7) and (8). The expected cost of the defendant reflects the fact that type *H* and *L* plaintiffs are encountered with probabilities *q* and 1-*q* respectively.

The key feature of the sorting equilibrium is that the type *L* plaintiff receives a lower payoff than she would in the full information game. This can be seen by comparing (15) to (7), where $a^k = a$ and $J^i = J^L$. This would not occur in a model with exogenous spending, where the offer to the type *L* plaintiff under asymmetric information would equal the full information offer. Why does she get less here? The reason is that only type *H* plaintiffs proceed to trial in equilibrium. The defendant spends more against these plaintiffs than he would against a type *L* plaintiff under full information. This lowers the expected payoff that a type *L* plaintiff would receive by deviating from equilibrium and proceeding to trial.

This underscores the importance of the assumption that player type is not observed at the time spending decisions are made. In equilibrium the defendant always faces a type *H* plaintiff in trial, but he infers this, rather than observing it directly. If type were directly observable when spending decisions were made, type *L* plaintiffs deviating to trial would be recognized as such and would not face the higher spending associated with a type *H* plaintiff.

Because the defendant expects to face a strong plaintiff at trial, this strengthens the defendant's bargaining position with type *L* plaintiffs who settle. This is crucially important to our results on voluntary disclosure and discovery which follow. It is also worth noting that if our condition $\sqrt{J^H} < (1+a)\sqrt{J^L}$ were violated, a type *L* plaintiff would spend 0 at trial if she deviated, thereby obtaining a payoff of 0. As a result, this player would receive (and accept) an offer of $O^D = 0$ from the defendant in equilibrium. This is an extreme example of how the bargaining position of the defendant can be strengthened against weak plaintiffs who settle.

4.1.3. Equilibrium Conditions

In the previous subsection, we derived what the defendant expects to pay under a high pooling offer and low sorting offer. Next we state, in the form of a proposition, the conditions under which each offer would be made:

<u>Proposition 1</u>:*For the game described by steps 0, 2 and 3:*

(i) If $q > \dfrac{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a(2+a)J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}$ *there is a pooling equilibrium. The defendant offers* $O^D = \dfrac{a^2}{(1+a)^2} J^H$ *which both plaintiff types accept. The defendant's out of equilibrium belief is that any plaintiff who proceeds to trial is type H with probability 1. The defendant's out of equilibrium action is to spend the amount given by (11) against plaintiffs who proceed to trial. The payoffs for the plaintiff and the cost for the defendant are given by (12).*

(ii) If $q < \dfrac{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a(2+a)J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}$ *there is a sorting equilibrium in which* $O^D = \left(\sqrt{J^L} - \dfrac{\sqrt{J^H}}{1+a)}\right)$*. Type L accepts this offer and type H plaintiffs reject it and proceed to trial. The defendant believes with probability 1 that he faces a type H plaintiff at trial. The plaintiff and defendant expenditure at trial is described by equation (11). The payoffs for the type L and type H plaintiffs and the cost for the defendant are given by (15), (16), and (17).*

Proof: See Appendix.

The advantage of a pooling offer is that trials are avoided. The disadvantage is paying more than necessary to type L plaintiffs. When q is large, the first effect dominates, leading to a pooling equilibrium. The key feature of the sorting equilibrium is that the type L plaintiff's payoff in (15) is less than her payoff in the full information game.

4.2. Voluntary Disclosure

The standard result in the literature is that in a screening game, the party receiving the offer will not make a costly voluntary disclosure.[11] If disclosure is costless, we may have an equilibrium in which players with a strong case reveal their type, while players with a weak case remain silent.[12] Incorporating endogenous expenditure at trial can at least partially overturn these standard results.

When in the absence of a disclosure, the game has a pooling equilibrium, the standard results apply. In the pooling equilibrium the type H plaintiff receives exactly what she expects in the full information equilibrium and, therefore, would not make a costly disclosure. The type L plaintiff earns more than she would in the full information equilibrium and would not make a disclosure, even if it were costless. Since these results are standard, we turn our attention to the situation where, in the absence of disclosure, there is a sorting equilibrium.

In the absence of a disclosure, the type H plaintiff's equilibrium payoff in the sorting equilibrium is the same as in the full information equilibrium. Thus, she would not incur a positive cost to reveal her type. However, the type L plaintiff receives less in the sorting equilibrium than in the full information equilibrium. Thus, she does have an incentive to reveal her information if the cost v of doing so is sufficiently low. However, it cannot be a pure strategy equilibrium for the type L plaintiff to reveal her type. If only type H were silent, then the

[11] See, for example, Sobel (1989).
[12] See Shavell (1989).

defendant would treat all silent players as if they were type *H* and make a high offer. In this case type *L* players would deviate from equilibrium, by remaining silent, in order to receive a high offer. Thus, there must be an equilibrium in mixed strategies as summarized in proposition 2.

<u>Proposition 2</u>: If $q < \dfrac{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a(2+a)J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}$ and $v < \dfrac{a^2}{(1+a)^2} J^L - \left(\sqrt{J^L} - \dfrac{\sqrt{J^H}}{1+a)}\right)^2$ *there exists a mixed strategy equilibrium in which type H plaintiffs remain silent, type L plaintiffs reveal their type at cost v with probability* γ*, where*

$$\gamma = 1 - \left(\frac{q}{1-q}\right)\left[\frac{2aJ^H}{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}\right]. \tag{18}$$

Type L plaintiffs who reveal their type receive and accept the offer $O^D = a^2J^L/(1+a)^2$*. The defendant responds to silence on the part of the plaintiff by making a low offer* $O^D = \left(\sqrt{J^L} - \dfrac{\sqrt{J^H}}{1+a)}\right)^2$ *with probability* Ω *and a high offer* $O^D = a^2J^H/(1+a)^2$ *with probability 1-*Ω*, where*

$$\Omega = \frac{a^2(J^H - J^L) + (1+a)^2 v}{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}. \tag{19}$$

Silent type L plaintiffs accept either offer. Type H plaintiffs accept the high offer and reject the low offer. Only type H plaintiffs proceed to trial. The defendant's beliefs at trial and the behavior of both the plaintiff and defendant at trial are the same as in part (ii) of proposition 1. The equilibrium expected payoffs of the type L and type H plaintiffs and the expected cost for the defendant are as follows:

$$\Pi^L = \frac{a^2}{(1+a)^2} J^L - v, \tag{20}$$

$$\Pi^H = \frac{a^2}{(1+a)^2} J^H, \tag{21}$$

$$C = \gamma(1-q)\frac{a^2}{(1+a)^2} J^L + \left[(1-\gamma)(1-q)+q\right]\frac{a^2}{(1+a)^2} J^H. \tag{22}$$

Proof: As in proposition 1, type H plaintiffs are the only type to reach trial in equilibrium. Thus, the beliefs are correct and the actions at trial specified in proposition 1 are optimal. Since $\Omega\left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)^2 + (1-\Omega)\frac{a^2}{(1+a)^2} J^H = \frac{a^2}{(1+a)^2} J^L - v$*, type L plaintiffs are indifferent between revealing their type at the cost v and remaining silent. This is consistent with a mixed strategy on the part of the plaintiff.*

Type H plaintiffs earn $\frac{a^2}{(1+a)^2} J^H$ *if they remain silent and* $\frac{a^2}{(1+a)^2} J^H - v$ *if they reveal their type. Thus, it is consistent with equilibrium for type H plaintiffs to remain silent. Given the probability* γ *with which type L plaintiffs reveal their type, the conditional probability that the plaintiff is type H given that she remains silent is*

$$\Gamma = \frac{q}{(1-\gamma)(1-q)+q} = \frac{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a(2+a)J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}, \tag{23}$$

where the expression after the second equality is obtained by substitution from (18).

Since , $(1-\Gamma)\left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)^2 + \Gamma\frac{a(2+a)}{(1+a)^2} J^H = \frac{a^2}{(1+a)^2} J^H$*, the defendant is indifferent between making a pooling and sorting offer. This is consistent with the mixed strategy on the part of the defendant.*

In the previous literature on the screening game, the recipient of the offer never makes a costly voluntary disclosure. In addition, when costless disclosures are made it is the party with the strong case who makes the disclosure, while the party with the weak case remains silent. Both of these previous results hold if the condition for a pooling equilibrium is met, but both are overturned when the condition for a sorting equilibrium is met. Costly disclosures will be made if v is not too large and it is the party with the weak case who makes them. Plaintiffs with weaker cases are willing to pay a cost to disclose their type because asymmetric information weakens their bargaining position; if they deviate and proceed to trial, they are mistaken for a type H player and face high trial expenditure by the defendant.

Assuming disclosure occurs, the probability of trial in the sorting equilibrium is $q\Omega < q$, where q is the probability of trial when disclosures are not allowed. The restriction on v stated in the proposition guarantees that $\Omega < 1$. Costly disclosures sometimes occur in the model with endogenous expenditure while they never occur in the model with exogenous expenditure. This in turn lowers the equilibrium dispute rate. Higher values of v are associated with higher values of Ω and therefore with a higher dispute rate $q\Omega$. When the cost of making a disclosure is high, there must be a high probability that silence will be met with a low offer in order to induce type L plaintiffs to reveal their type.

4.3. Discovery

We analyze the process of discovery, assuming that the plaintiff does not have the opportunity for a voluntary disclosure,. In the screening game, the standard result is that the uninformed party will pay to invoke discovery if the cost of doing so is not too high. With exogenous expenditure at trial, the defendant would always invoke costless discovery, because this would allow him to offer each player type exactly her expected payoff at trial, and settle 100% of cases out of court. If, in the absence of the invocation of discovery, there would be a pooling equilibrium, these standard results continue to hold in the model with endogenous expenditure at trial. However, if the conditions for a sorting equilibrium exist, the defendant may not invoke costless discovery. Since this is the interesting result, we will proceed assuming that the cost of discovery $d = 0$.

If the defendant invokes discovery, he pays each plaintiff type their expected payoff from trial. These payoffs, which may be calculated from equations (6) – (8), result in the following expected cost for the defendant.

$$C = (1-q)\left(\frac{a^2}{(1+a)^2}J^L\right) + q\left(\frac{a^2}{(1+a)^2}J^H\right) \tag{24}$$

In the absence of discovery, the defendant's expected cost in a sorting equilibrium is given in (17), and the expected cost associated with a pooling offer is given by (12). The expected cost in (24) is always less than the expected cost in (12). In comparing (24) to (17) note that when discovery is invoked, the defendant pays less against type *H* plaintiffs, because he can settle with these plaintiffs, rather than take them to trial. On the other hand, the defendant pays more to type *L* defendants, because in the sorting equilibrium these plaintiffs receive a lower payoff than in the full information equilibrium. Proposition 3 summarizes the results on the defendant's use of discovery:

<u>Proposition 3</u>*: The defendant will invoke costless discovery if and only if*

$$q > \frac{a^2 J^L - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a^2 J^L + 2aJ^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}. \tag{25}$$

Proof: By comparing (12), (17) and (24), it can seen that the defendant's expected costs under discovery are lower if and only if the condition in (25) holds.

In the model with exogenous expenditure at trial, the defendant always invokes costless discovery. Equation (25) will fail to hold for low values of q. When type H plaintiffs are rare, the expected cost of having to take them to trial in the sorting equilibrium is low. In addition, since a low q implies a higher percentage of type L plaintiffs, the strategic bargaining advantage resulting from asymmetric information looms larger. A comparison of (25) with part (ii) of proposition 1 reveals that the set of values of q for which discovery is not invoked is a subset of the values associated with a sorting equilibrium in the absence of discovery. Thus, if we would otherwise have a pooling equilibrium, discovery is always invoked in stage 1. For some of the values associated with a sorting equilibrium in the absence of discovery, the procedure will again be invoked, and all cases will settle. However, there exist low values of q for which discovery is not invoked, and for which sorting occurs as described by part (ii) of proposition 1.

The reason why costless discovery is sometimes not invoked is the same as the reason why a costly disclosure is sometimes made by type L plaintiffs; in a sorting equilibrium, these plaintiffs do worse than in the full information equilibrium. A comparison of the condition in (25) with the condition stated on v (the cost of a voluntary disclosure) in proposition 2 reveals that costly disclosures will tend to be made and discovery will tend not to be invoked when $\frac{a^2}{(1+a)^2}J^L - \left(\sqrt{J^L} - \frac{\sqrt{J^H}}{1+a)}\right)$ is large. This expression implies a large gap between the full information offer to type L plaintiffs and the sorting offer made in the game with asymmetric information.

The fact that discovery is foregone and disclosure is undertaken under similar circumstances raises the possibility that these will remain complementary institutions in ensuring a high degree of information transmission in the pretrial period.[13] This in turn should ensure a high degree of settlement. It should be noted, however, that the disclosure by type *L* plaintiffs is not a perfect substitute for discovery by the defendant, because it can only be part of a mixed strategy equilibrium. In this mixed strategy equilibrium, some type *L* plaintiffs will remain silent and trials will occur with a positive probability.

4.4. Discussion

The specific solutions we derive from our model clearly depend upon the details of the contest success function, but the nature of the results does not. The results are driven by the fact that the defendant spends more at trial against a type *H* plaintiff than a type *L* plaintiff, and this feature of the model is not sensitive to the choice of the contest success function.[14]

On the other hand, our results are sensitive to our assumption about the party who holds the private information. Suppose the asymmetric information were over the judgment at trial, but this information is known by the defendant while the plaintiff only knows the distribution of defendant types.[15] In this revised model, type *H* defendants are the weak player type, and type *L* defendants are the strong type. In a sorting equilibrium, the plaintiff will make a high demand that is accepted by type *H* defendants and rejected by type *L* defendants who proceed to trial. The plaintiff spends less at trial against type *L* defendants than she would against type *H* defendants

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[13] Recall that in the standard model, discovery tends to be invoked in the information structure under which voluntary disclosures are not made and voluntary disclosures tend to be made under the information structure in which discovery is not invoked.

[14] We have worked out the model using the contest success function $p = aX^r/(aX^r + Y^r)$, where $0 \leq r \leq 2$, and obtained results analogous to those found in Section 4.3. This material is available upon request.

[15] When the asymmetric information is over the judgment, it is typical to assume that the plaintiff knows the information and the defendant does not. Fu (2008) models asymmetric information over the judgment where the true judgment is known by the defendant and not the plaintiff. He cites civil fraud cases, where the defendant knows how much has been stolen, but the plaintiff does not.

in a full information game. Since the sorting offer reflects what the type *H* defendant would pay if he deviated to trial, this offer costs the type *H* defendant less than what he would pay in the full information game. Thus, relative to the game with exogenous spending at trial, the bargaining position of the plaintiff with type *H* defendants who settle is weakened. This is the opposite of the finding in the model we developed earlier in which the bargaining position of the player making the offer is strengthened by the endogenous spending decisions at trial.

In this revised model, the standard informational results would hold. Since, in a sorting equilibrium, the type *H* defendant pays less than he would under full information, he would not make a voluntary disclosure, even if it were costless. Conversely, the plaintiff would certainly be willing to invoke a costless discovery procedure.

5. Asymmetric Information Over the Merits

In this section, we provide a relatively informal analysis of a model in which there is asymmetric information over the merits of the lawsuit. Using the intuition from the previous section, it is fairly easy to see how the results from the earlier model will apply in this new setting.

The relative merits are reflect by the 'a' term in the contest success function. Lower values of a imply a stronger case for the defendant, and $a < 1$ implies that the relative merits favor the defendant. Let a^S be the relative merits when the defendant has a strong case and a^W be the relative merits when he has a weak case, where $a^S < a^W$. We will refer to these as type *S* and type *W* defendants. Consider the following game:

0. Nature determines the defendant's type. The defendant is type *S* with probability z and type *W* with probability 1-z. The defendant knows his type, but the plaintiff knows only the distribution of types that she faces.

1. a. The defendant decides whether to disclose his private information at the cost *v*. If he discloses his private information, his type becomes known to the plaintiff with certainty.

   b. The plaintiff decides whether or not to invoke discovery at the cost *d*. If discovery is invoked, the plaintiff learns the defendant type with certainty.
2. The plaintiff makes a take it or leave it offer O^P to the defendant. If the defendant accepts the offer, the game ends with the plaintiff receiving a payoff of O^P and the defendant incurring of cost of O^P. If the defendant rejects the offer, the players proceed to trial.
3. The players simultaneously choose how much to spend at trial, where plaintiff spending is denoted X and defendant spending is denoted Y. Trial occurs and against a defendant of type k, the plaintiff wins J with probability $p = \frac{a^k X}{a^k X+Y}$. The plaintiff's payoff is $J - X$ if she wins at trial and $-X$ if she loses. The defendant's cost is $J + Y$ if the plaintiff wins at trial and Y if she loses.

As before, behavior in a pooling equilibrium is standard, so all of the discussion below will focus on a sorting equilibrium. If z is sufficiently low, there exists a sorting equilibrium in which the plaintiff makes a high demand. This demand is accepted by type W defendants and rejected by type S defendants. The results generated by the model depend upon the relationship between the plaintiff's spending at trial against a type S defendant and the level of spending that would occur at trial in a full information game with type W defendants.

As stated in Section 3, in the full information game spending is monotonically increasing in a for $a < 1$, monotonically decreasing in a for $a > 1$ and maximized at $a=1$. The nature of the results we obtain depend on the relationship of a^S and a^W to 1, where 1 corresponds to the case where the merits favor neither the defendant nor the plaintiff. If $a^S < 1 < a^W$, we have ambiguous results, but for other configurations of the parameters, the findings are more definitive.[16]

5.1.1.The Merits Favor the Defendant: $a^S < a^W < 1$

When $a < 1$, spending is increasing in a. Since $a^W > a^S$, the plaintiff will spend less at trial against type *S* defendants than she would against type *W* defendants in the full information game. Thus, the expected cost a type *W* defendant would incur by deviating from equilibrium and proceeding to trial is less than what she would incur in the full information game. As a result, the plaintiff's equilibrium offer extracts less from the type *W* defendant than the offer in the full information game. Thus, the strategic effects resulting from endogenous expenditure at trial benefit type *W* defendants who settle. The standard results on information transmission apply in this case. The type *W* defendant would not make a voluntary disclosure, even if it were costless. On the other hand, the plaintiff would invoke costless discovery.

5.1.2. The Merits Favor the Plaintiff: $1 < a^S < a^W$

When $a > 1$, spending is decreasing in a. Since $a^W > a^S$, the plaintiff spends more against the type *S* defendant at trial then she would against the type *W* defendant in the full information game. This increases what a type *W* defendant would expect to pay if he deviated to trial by rejecting the plaintiff's demand.[17] This in turn raises the plaintiff's equilibrium settlement demand relative to what type *W* defendants would pay in the full information game. As a result, the plaintiff earns more against type *W* defendants when information is asymmetric than she would under full information.

Since a type *W* defendant pays more under asymmetric information than he would under full information, the novel results on information transmission derived earlier will apply here. If

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[16] When $a^S < 1 < a^W$, the nature of the results will depend on how far distant a^S and a^W are from 1.

[17] If a type *W* defendant deviated to trial, he would be believed to be type *S*.

the cost of disclosure is sufficiently low, there exists a mixed strategy equilibrium in which type *W* defendants reveal their type with some probability, while type *S* defendants remain silent . Similarly, there will be sufficiently low values of *z* such that the plaintiff would refuse costless discovery.

When information regarding the size of the judgment is asymmetric (as in Section 4), the structure of the game can be altered from a situation in which our novel results on information transmission apply to one in which they do not. This is done by switching the party that has the private information with the party that makes this offer. For the model presented here, this is accomplished by changing the relationship between the parameters representing a strong or weak case for the defendant and the number 1.[18] The intuition behind these results is exactly the same in both sections. What matters is the equilibrium level of spending at trial relative to the amount of spending that would occur under full information against the weak player types who settle.

6. Conclusion

Adding endogenous expenditure at trial to the standard model of pretrial bargaining is an important step towards making these models more realistic. The endogenous expenditure at trial has interesting implications for bargaining against player types who settle. The reason is that the amount these players can obtain in a settlement is a function of what they would obtain by deviating from equilibrium and proceeding to trial. Since this deviation does not occur in equilibrium, they would be mistaken for the stronger player type who does proceed to trial in equilibrium, and they would face a level of trial expenditure associated with this stronger type.

[18] Recall that the number 1 reflects a situation where the merits of the case favor neither the plaintiff nor the defendant.

Depending on the structure of the game, this can either strengthen or weaken their bargaining position relative to the full information game.

If the weak player type who settles faces a weaker bargaining position than in the full information game, we find two novel results regarding the transmission of information prior to trial. In particular, the weak player type may be willing to undertake a costly voluntary disclosure, and the uninformed party may want to forgo costless discovery. In the standard model, the recipient of the offer would never make a costly voluntary disclosure, and only stronger player types would make a costless disclosure. In addition, in the standard game, costless discovery would always be invoked by the uninformed party.

Making expenditure at trial endogenous affects the strategic bargaining environment in important ways. This paper is one step in gaining a fuller understanding of how endogenous spending at trial affects the pretrial bargaining game.

Appendix

Proof of Proposition 1: The defendant's out of equilibrium belief is consistent with a perfect Bayesian equilibrium. This solution concept puts little structure on these beliefs. The out of equilibrium action specified is consistent with the defendant's beliefs and his reaction function in (5), given his belief. The type *H* plaintiff is indifferent between accepting and rejecting the offer in (10). This can be verified using the plaintiff's reaction function in (4) combined with the defendant's specified action and the payoff function in (2). Similarly, it can be verified that the type *L* plaintiff strictly prefers the offer in (10) compared with a deviation to trial with optimally chosen spending.

The defendant's belief in part (ii) is mathematically correct given the equilibrium action of the plaintiff. The actions specified at trial are consistent with their respective reaction functions in (4) and (5). If a type *L* plaintiff deviated to trial, she would spend the amount in (13) which can be verified from her reaction function. Using the payoff function in (7) it can then be verified that the offer in (14) makes her indifferent between acceptance and rejection. Thus, it is consistent with equilibrium to have her accept this offer.

Comparing the defendant's expected cost in (17) with his expected cost in (12), it can be seen that the expected cost of a pooling offer is lower than the expected cost of a sorting offer if and only if $q > \dfrac{a^2 J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}{a(2+a)J^H - \left((1+a)\sqrt{J^L} - \sqrt{J^H}\right)^2}$.

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