Reverse Game Theory in Case Evaluation with Differential Information*

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Abstract

This paper provides an example showing the benefit of mechanism design in a nonbinding arbitration procedure called case evaluation or mediation that is widely employed in U.S courts. Under the current system, a party who rejects the mediation award is penalized, unless the trial verdict is more favorable to her than the mediation award. This penalty is designed to minimize the frequency of trial, by inducing both parties to accept the award. We provide procedures that motivate the parties to disclose their private information to the mediator. In the example, under the proposed new rules of the game, the mediation award is likely to be more accurate, and the parties are more likely to accept it, thereby reducing the frequency of trial, while providing an ex ante gain for both parties.

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*"Mechanism design (sometimes called reverse game theory)..".Wikipedia.

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1. Introduction

This paper analyzes a procedure called case evaluation or court-annexed mediation, which is a form of nonbinding arbitration widely employed in the U.S., in both State and federal courts. In the courts that have mandatory programs, the plaintiff must submit her claim to nonbinding arbitration (hereinafter called "mediation") before she can request a trial. Typically the mediation hearing is much briefer and more informal than a trial; the usual rules of evidence do not apply, and the formalities of civil procedure are not observed. After the hearing the mediator proposes an award; each party must then submit its response (accept or reject) to the mediation award without knowing the response of the other party. If both parties accept, the case is resolved, and the defendant pays the plaintiff the amount of the award. If, however, either party rejects, the case proceeds on toward trial. In reality, even if the mediation award is not accepted, the case may still be, and often is, settled before trial. For simplicity we ignore this possibility.

Although there is variation across different courts, the usual practice is that a penalty is imposed on a party who rejects the mediation award, if the party does not do better at trial than she would have done by accepting the award. In State courts in Michigan, for example, a party who rejects the mediation award is liable for the post-mediation expenses of the opposing party, unless the trial verdict is more favorable to the rejecting party by a margin of more than ten percent.[1] The idea is that a party's rejection of the mediation award is unjustified unless the trial's verdict is substantially better than the mediation award. Therefore, the rejecting party should bear the full social costs of her decision.

Our first result is that even if the mediator has no private information, but each party does,

[1] The verdict is considered "more favorable" to a plaintiff who rejects if it is more than ten percent above the mediation award, and more favorable to a defendant who rejects if it is more than ten percent below the mediation award. MCL 600.4921(2) (2003).

the mediation process reduces the number of cases that go to trial. The assumption that the mediator has no private information is based on what we believe are the realities of most civil litigation in the federal or state courts. To be sure there are situations where the assumption that an arbitrator or mediator has private information is viable.[2] It can happen that a mediator is more familiar with the applicable law, or industry custom, than the parties, especially if the parties are not represented by lawyers. Thus our model, in which the mediator has no private information, is best suited to civil litigation in which the stakes are substantial and each side is represented by lawyers, the usual situation in the federal courts or state courts of general jurisdiction. Indeed, if the mediator actually had private information, that would normally be grounds for disqualification.[3]

Our new rule of the game is motivated by the idea that the cost of litigation can be minimized if the parties, each of whom usually has private information, are given incentives to provide accurate information to the mediator. Under these conditions the mediation award is more likely to be an accurate evaluation of the claim, and is therefore less likely to be rejected. First, we analyze the equilibrium strategy of the players under the current system and calculate the frequency of trial. Then, we consider it as a mechanism design and look for new rules of the game that give the parties an incentive to submit accurate information. In the current system, the plaintiff and the defendant play a pooling equilibrium. Namely, they report to the mediator as if their case is strong (the plaintiff reporting high damages and the defendant reporting no liability). In the new rules of the game that we propose, we focus on implementation of a simple mechanism and not additional complications required to achieve truth-telling and the revelation principle (see further discussion in the conclusion).

[2] In final-offer arbitration, it is quite reasonable to assume the arbitrator knows more about his own preferences than the parties do. In labor disputes, intermediaries are often chosen because of their knowledge of the industry.

[3] See, e.g., Michigan Compiled Laws 600.4905(4).

The Reverse System

In the new rules of the game (hereafter "the reverse system"), each party's statement to the mediator about the value of the claim must be summarized as a monetary value (i.e., dollar amount). Under this procedure, a penalty is imposed on a party, i.e., she is required to pay the trial expenses of the other party, if (1) she accepts the mediation award, and (2) her report of the claim's value to the mediator is farther from the trial verdict than the report of the other party.[4] This system can be implemented as a clerical function similar to the current system (it is like a reverse of the current system).

The rationale for the reverse system is that under the current system, a party who succeeds in misleading the mediator will certainly accept the mediation award biased in her favor. This would not be the case under our reverse system. Under our reverse system, a party plays a mixed strategy (sometimes reporting falsely and sometimes accurately). In the case where she reports falsely, and from the report of the other party or the mediation award she suspects there is a good chance the case will go to trial, she is better off rejecting the mediation award to avoid the penalty. This rejection reduces her incentive to make a false report in the first place, and this consequence drives our results. If both parties have an incentive to make an accurate report, namely play a mixed strategy between the pooling strategy and the separating one, the mediation award will be accurate and both parties will accept it.

In comparing the two alternatives – the current system and the reverse alternatives – note that the punishment is the same in each one. The reverse systems only change the rule as to when the punishment is imposed. The two systems depend on the accepting or rejecting the mediation award, and a "twist" on the monetary distance from the trial verdict.

[4] There is one other condition: a party must also pay the penalty if his behavior is inconsistent. Thus the defendant is penalized if he first offers more than the mediation award, and then rejects the award. Similarly, the penalty is imposed on the plaintiff if she proposes less than the mediation award and then rejects the award.

2. The Literature

The idea that a mediator or arbitrator could obtain information about the ideal settlement from the parties' offers is not new. A major contribution was made by Stevens (1966) who proposed a procedure called final-offer arbitration.[5] In this procedure each party simultaneously makes a formal offer, and the arbitrator must choose one of the offers as the settlement. The idea is that each party, knowing that the arbitrator will choose the offer that is closer to the arbitrator's ideal settlement value, has an incentive to make an offer close to that value. Thus the gap between the parties' offers will be reduced, and the arbitrator will gain information about the ideal settlement from those offers. It should, however, be noted that other work suggests that the parties' offers may not be close approximations of their view of the median of the arbitrator's preferences. Brams and Merrill (1983) focused on the degree of convergence of the offers of the two parties under different assumptions about the arbitrator's preferences, i.e. different probability distributions. They found that when there are Nash equilibria in pure strategies, the parties' offers are, for most common distributions, symmetric around the median, but separated from one another by two or more standard deviations. Chatterjee (1981) also found a tendency for the parties' offers to diverge under final-offer arbitration, under certain assumptions about the distribution of the arbitrator's preferences.

Farber (1980) and Chatterjee (1981) independently developed models of final-offer arbitration, positing a two-person game of incomplete information in which the parties know the probability distribution of the arbitrator's view of a fair settlement. In these models the arbitrator's views concerning a fair settlement are not affected by the parties' offers.[6]

[5] This idea had, however, been discussed informally before Stevens' paper was published. Stern et al. (1975), at 113, n.7.

[6] Crawford (1982) subsequently showed that some of the findings in Farber's (1980) paper were incorrect.

Gibbons (1988) develops a model that extends the work of Farber (1980) to include learning. The arbitrator's objective is to minimize the difference between the actual settlement and the true settlement value. The arbitrator receives a noisy signal about the true value, and another noisy signal is received by both parties, i.e., each party receives the same signal. The arbitrator is able to infer the parties' private information perfectly from their offers, and can use this information together with his own signal to compute a posterior belief about the true settlement value. He then chooses the offer that is closer to this value.

Zeng (2003) proposed a change in the rules of final-offer arbitration, in which the mechanism of second-price auctions gives the two parties an incentive to submit correct information to the arbitrator, who has a prior notion of a fair settlement: if the offers diverge, the arbitration settlement is determined by the loser's offer.

Samuelson (1991) also analyzes final-offer arbitration, but in his model each disputant has private information - information unavailable to the other side or the arbitrator. In equilibrium, the arbitrator learns from the final offers of the disputants. Samuelson considers how well final-offer arbitration does in arriving at the true value, relative to the benchmark of complete information.

Models with two-sided informational uncertainty are generally considered less tractable than those with one-sided uncertainty, Farmer and Pecorino (2003), but there are some results on the choice between settlement and litigation. See Schweizer (1989) and Daughety and Reinganum (1994).

Bernstein (1993) points out that a party may deliberately present a weak case in order to avoid sanctions for rejecting the ADR award. If, for example, a defendant makes a half-hearted presentation to the mediator, the mediation award will be high, and it will not be difficult for the defendant to do better at trial.

Research on fee shifting rules has been done by Spier (1994). She first analyzes a sequential game with one-sided private information: the plaintiff knows the value of his claim, and the uninformed defendant makes one offer to the plaintiff before trial, on a take-it-or-leave-it basis. Spier determines the conditions under which Rule 68[7] increases the probability of settlement, compared to the American rule. She also uses the revelation principle to derive a payoff mechanism that maximizes the settlement rate.

3. The Example

3.1. Player, information and payoff.

Consider a three player game. The first player is the plaintiff (P) who brings an action for damages caused by negligence of the second player, the defendant (D). However, there is uncertainty both about the amount of damages and liability. This uncertainty is described by a probability space (Ω, p) where Ω is a set of a finite number of states of nature and p is a probability measure on Ω. Once the state of nature is realized, the amount of damages is determined by the mapping $v : \Omega \to R^+$ Namely, if $\omega_j \in \Omega$ is the true state of nature then the damage is $v(\omega_j)$ in monetary value. Before going to trial, P and D appear before the third player, the mediator (M), in an attempt to settle the case without incurring the cost of a trial.

We consider a game in which players P and D hold private information regarding damages and liability. The value of the claim depends on the state of nature and the private information of player $i \in \{P, D\}$ represented as a partition Π_i of Ω. If $\omega_j \in \Omega$ is the true state of nature, then player i will observe $\pi_i \in \Pi_i$ which contains ω_j.

[7] Rule 68 of the Federal Rules of Civil Procedure provides that if a defendant makes a formal settlement offer to the plaintiff, which the plaintiff refuses, the plaintiff must pay the costs incurred after the offer was made unless the judgment at trial is more favorable than the offer.

The alternative approach suggested by Harsanyi (1967). Harsanyi represents agents' private information by a set of types, and takes the set of states of nature to be the cross product of the sets of agents' types. These two approaches have been shown to be equivalent, (see, for example, Jackson (1993)) and are the standard in information economics.

Our example has three states of nature, since this is the minimum number of states that is required to enable either P or D to have differential information. We consider a "symmetric" case. In a "non-symmetric" case, the mediator is biased toward one party which seems anomalous. *This simple example enables us to show that the current system increases the players' incentives to misrepresent the truth, so that more cases go to trial than necessary.*

The simplest example

$$\begin{aligned} \Omega &\equiv \{\omega_1, \omega_2, \omega_3\}, \quad P \equiv (1/3, \quad 1/3, \quad 1/3) \\ v(\omega_1) &= 0, \quad v(\omega_2) = 5 \quad \text{and} \quad v(\omega_3) = 10 \end{aligned}$$

meaning that there are three states of nature with equal probability. Also, if the true state is $\omega_{1,}$ then the defendant is not liable (i.e. $v(\omega_1) = 0$). If the true state is ω_2, damages equal 5 ; this can be interpreted as a case where the defendant is liable, but damages are relatively low. Finally, if the true state is ω_3 then the damages are 10. This can be interpreted as a case in which the defendant is liable, and damages are relatively high. The example can be extended to an arbitrary value, but will require tedious calculations.

Let the partition of the plaintiff be represented by

$$\Pi_P = \{(\omega_1, \omega_2)(\omega_3)\}$$

which means that P cannot distinguish between the two states of nature ω_1, ω_2 (i.e., the plaintiff cannot determine whether the defendant is liable if the damages are not large). If the true state is ω_3 then P observes $\pi_P(\omega_3)$, which means that P can distinguish between ω_3 and (ω_1, ω_2). In this case the plaintiff knows the defendant is liable for 10.

Let player D's partition be represented by

$$\Pi_D = \{(\omega_1)(\omega_2, \omega_3)\}$$

thus the defendant knows whether he is liable, but cannot determine the exact amount of damages that are imposed on P.[8]

3.2. The Order of Moves

1) In the first stage, Nature selects the state ω_o and P and D observe their partition that contains ω_o. As mentioned previously, the mediator M has no independent information, but knows the structure of (Ω, p), Π_P and Π_D.

Namely, the mediator is an expert in the field and knows the partition of the players and the probability distribution, but has no private information.

2) In the second stage P and D simultaneously and independently make their first report to M as a function of their partition π_i, $i \in \{P, D\}$. This statement is summarized by a monetary value. Let S_i^1 be the first statement of $i \in \{P, D\}$, $S_i^1 : \Pi_i \rightarrow R^+$.

3) In the third stage the mediator announces his award A_M in monetary value. Let A_M be a function from the statements of P and D to $M's$ award, i.e., $A_M : S_P^1 \times S_D^1 \rightarrow R^+$.

4) In the fourth stage P and D each make their second decision, whether to accept A_M, simultaneously and independently. Let $S_P^2 : \Pi_P \times S_P^1 \times S_D^1 \times A_M \rightarrow \{Y, N\}$ be P's second decision where Y accepts A_M and N rejects it, given that P has heard D's first statement

[8] The Harsanyi alternative way to formulate this example would be with different types. The plaintiff would have private information represented by two types - high damages or low damages. The defendant would also have private information represented by two types - liable or not liable. The types would be correlated, resulting in three states of nature rather than four. This assumption seems more challenging to model but also more realistic than an assumption of independence, since it is relatively unlikely that the plaintiff had information of high damages and the defendant of no liability. Use of this setup would not change our results in any way.

in the second stage. S_P^1 is not redundant and has a major role in the procedure we consider, especially as P and D play mixed strategies. Let $S_D^2 : \Pi_D \times S_P^1 \times S_D^1 \times A_M \rightarrow \{Y, N\}$ be the equivalent for player D.

If both P and D accept A_M, the game ends and P receives A_M from D. In this case M benefits from having solved the case; we represent this as a payoff of 1. Therefore, the payoffs of P, D and M can be represented as $(A_M, -A_M, 1)$. If either or both P and D respond with $S_i^2 = N$ the game moves to the fifth stage.

5) In the fifth stage P and D go to trial. We assume that the court can identify the true state of nature ω_o and will award damages of $v(\omega_o)$. Similar results could be obtained if there were only a high probability that the court could determine the true state. However going to trial will involve a cost C (filing fees, attorney fees, etc.) for both P and D. Let $C = 1$ for each player. Let us consider the case where C is small relative to $v(\omega_2) = 5$, since if C is large P or D might decide to avoid trial for fear of a negative return, in the event the recovery were less than the trial costs of both parties. In the case where C is small, P or D will not have this concern, and the only motive that would induce the parties to settle, rather than go to trial, is to save the costs of trial.

The main objective of this paper is to analyze how different allocation schemes for trial costs affect the outcome of this game. Let C_P and C_D be the allocation of the cost between P and D respectively. We restrict G_i to be $C_i \in \{0, 1, 2), i \in \{P, D\}$, and to cover the costs we require that $C_P + C_D = 2$. This setup means that either each litigant covers his own cost, or one of them covers the cost for both. Player M's payoff at this stage is 0. Thus the payoffs at this stage are $(v(\omega_o) - C_P,\ -v(\omega_o) - C_{D,}\ 0)$. The values of C_P and C_D will be determined by equations 4.1, and 5.3 below, for the current system, and the reverse system respectively.

We can interpret the expected payoff of M as the probability of avoiding trial. Thus M maximizes utility by minimizing the likelihood of trial. M is trying to maintain a reputation as an effective mediator.

Sections 4 and 5 analyze the equilibrium strategy and the trial probability for the current system and the reverse system. In section 6, we compare the equilibrium payoffs of P and D for each system.

4. The Current System

Under the current system, one party (P or D) bears all the costs of trial only if he both rejects A_M and fails to do better at trial than he would have by accepting A_M.[9] Otherwise, each player bears his own trial costs, namely $C = 1$. Formally, let $C_P(A_M \times S_P^2 \times S_2^2 \times v(\omega_o))$ be the allocation C_P under the current system. (Remember that the court identifies the true state of nature ω_o).

$$C_P(A_M \times S_P^2 \times S_D^2 \times v(\omega_o)) = \left\{ \begin{array}{ll} 2 & : S_P^2 = N \ , \ S_D^2 = Y \ \text{ and } \ A_M \geq v(\omega_o) \\ 0 & : S_P^2 = Y \ , \ S_D^2 = N \ \text{ and } \ A_M \leq v(\omega_o) \\ 1 & : \text{ otherwise} \end{array} \right\} \tag{4.1}$$

This will determine $C_D(A_M \times S_P^2 \times S_D^2 \times v(\omega_o))$ as $C_P + C_D = 2$.

Let us next consider the strategies of P, D and M.

Since the partitions of P contain only two elements (recall that $\Pi_P = \{(\omega_1, \omega_2)(\omega_3)\}$), without loss of generality, let $S_P^1 : \Pi_P \rightarrow \{h, l\}$ where h represents high and l low damages. Players P can use mixed strategies. Consider the following strategy for P.

$$\begin{aligned} S_P^1(\pi_P(\omega_1, \omega_2)) &= \left\{ \begin{array}{ll} l & : \alpha \\ h & : 1 - \alpha \end{array} \right\} \\ S_P^1(\pi_P(\omega_3)) &= h \end{aligned} \tag{4.2}$$

[9] In some jurisdictions the player must do more than 10% better than the mediation award. This is the rule, for example, in Michigan. M.C.L. 600.4919 (see Spurr (2000)). For the rules in other States, see Bernstein (1993), at 2294. For simplicity we model the current system as imposing a penalty unless the rejecting party does better than the mediation award.

where $\alpha \in [0, 1]$. We will interpret these strategies as follows: if P's partition is $\pi_P(\omega_1, \omega_2)$, he will report l with probability α, and h with probability $1 - \alpha$. Note that reporting l is in effect reporting $\pi_P(\omega_1, \omega_2)$ (accurate information), and reporting h is in effect reporting $\pi_P(\omega_3)$ (false information). Finally, the strategy $S_P^1(\pi_P(\omega_3)) = h$ weakly dominates the strategy $S_P^1(\pi_P(\omega_3)) = l$ if the mediation award is weakly monotonically increasing with respect to S_P^1.

As for player D, his partition is $\Pi_D = \{(\omega_1)(\omega_2, \omega_3)\}$. Let $S_D^1 : \Pi_D \to \{d, a\}$ where d represents denying liability and a represents admitting liability. The set of his strategies is following:

$$S_D^1(\pi_2(\omega_1)) = d \tag{4.3}$$
$$S_D^1(\pi_2(\omega_{2,}\omega_3)) = \left\{ \begin{array}{cc} d & : \beta \\ a & : 1 - \beta \end{array} \right\}$$

where $\beta \in [0, 1]$. The restriction on $S_D^1(\pi_2(\omega_1))$ will not change the result.[10]

We assume that $M's$ decision rule is determined as follows: if the information provided by P and D enables M to determine the most likely state of nature, he will award that amount. If, on the other hand, the most likely state cannot be determined from that information, M will choose the alternative that minimizes the probability of trial.

Lemma 1. *If the mediator chooses the state of nature with the highest probability, then*

$$A_M(S_P^1 = h, S_D^1 = a) = 10 \tag{4.4}$$

$$A_M(S_P^1 = l, S_D^1 = a) = 5 \tag{4.5}$$

$$A_M(S_P^1 = l, S_D^1 = d) = 0 \tag{4.6}$$

[10] An alternative model could assume that, even if the mediation award is rejected by one or both parties, the case would go to trial only if P elected to pursue it. In such a model D might be inclined to overstate damages, to inflate the mediation award. D's motive for doing so would be to ensure that he would do substantially better than the mediation award at trial, and thereby avoid the penalty of paying $P's$ trial costs. See Bernstein (1993).

proof: see appendix.

A mediator who desires to maintain his reputation, by choosing the most likely state of nature, would follow these principles. For an intuitive explanation, consider (4.4). For P, reporting h is equivalent to reporting damages of 10, and he can distinguish between damages of 10 and 5, while D admits liability (a), but he cannot distinguish between damages of 5 and 10. Thus M should accept P's report and award 10. For 4.6, the intuitive explanation is similar: P asks for l, but he cannot distinguish between 0 and 5 while D declares d (which is equivalent to 0) and can distinguish between 5 and 0. As for 4.5, this statement is equivalent to a report of 5 by each player. Therefore M should award 5.

Lemma 2. *If the statements made by the parties to the mediator are $S_P^1 = h, S_D^1 = d$, then he cannot determine the state of nature with the highest probability without knowing α and β.*

proof: see appendix .

Here it must be true that one of the players has misrepresented his information. To determine the state of nature with the highest probability, M must know the ratio of α to $1 - \beta$ (the truthfulness of the plaintiff relative to the defendant). If P makes false reports with higher probability than D, so that $\alpha < 1 - \beta$, then M will realize that ω_1 is the state of nature with the highest probability and award 0. However, this will give D a greater incentive to make a false report, and vice versa for P. Therefore, there is no way we can sensibly restrict the strategy of M in this case before calculating the equilibrium of this game. Hence, we will compare all three possible pure strategies of M in this case.[11]

[11] To reduce the dimensionality of the problem, we rule out mixed strategies for M. Also, in our setup M can only award the value of one of the states of nature; he cannot award, for example, 7.5. It appears that this restriction reduces the probability that the parties go to trial. A formal proof is not provided. But the motivation is that if the true state of nature is ω_3 and M awards, say, 7.5, then P will certainly reject (since he can recognize

Theorem 4.1. *Under the current system if the mediator's award is* $A_M(S_P^1 = h, S_D^1 = d) = 5$ *then the only equilibrium has the following properties:*

1) The plaintiff's first report is h regardless of his partition (equivalent to $\alpha = 0$).

2) The defendant's first report is d regardless of his partition (equivalent to $1 - \beta = 0$).

3) The plaintiff accepts the mediator's award iff his partition is $\pi_P(\omega_1, \omega_2)$.

4) The defendant accepts the mediator's award iff his partition is $\pi_D(\omega_2, \omega_3)$.

5) The probability of trial is 2/3

proof: see appendix .

We will find that in equilibrium $A_M(S_P^1 = h, S_D^1 = d) = 5$, i.e., M will award the intermediate value.

Lemma 3. *Under the current system, if* $A_M(S_P^1 = h, S_D^1 = d) = 0$ *then the only equilibrium has the following properties :*

1) The defendant's first report is d regardless of his partition (equivalent to $1 - \beta = 0$).

2) The plaintiff's first report is irrelevant, as the mediator's award is always 0.

3) The plaintiff never accepts the mediator's award, so the probability of trial is 1.

The proof is similar to the proof of Theorem 4.1 and omitted . Intuitively, as M "believes" D and awards $A_M(S_P^1 = \cdot, S_D^1 = d) = 0$, D has an incentive to report $S_D^1 = d$. Therefore, the result of the mediation process is 0. P has a positive expected profit from rejecting A_M even when his partition is $\pi_P(\omega_1, \omega_2)$. P's expected profit is $0.5(0 - 2) + 0.5(5 - 1) > 0$. Therefore the case always goes to trial.

that the state is ω_3) and so the case will go to trial. If the state is not ω_3, P will not take the case to trial, but then D is better off doing so.

Similarly, if $A_M(S_P^1 = h, S_D^1 = d) = 10$, then the only equilibrium has the following properties: 1) The plaintiff's first report is h regardless of his partition (equivalent to $\alpha = 0$). 2) The defendant's first report is irrelevant as $A_M(S_P^1 = h, S_D^1 = \cdot) = 10$. 3) The defendant never accepts the mediator's award, so the probability of trial is 1.

Corollary 1. *Regardless of the strategy of M, and regardless of their private information, P and D will report high damages and no liability, respectively.*

Namely, P and Dwill play a pooling equilibrium and will never reveal their private information.

Corollary 2. *A mediator whose objective is to minimize the probability of trial should choose $A_M(S_P^1 = H, S_D^1 = d) = 5$. This policy will lead to a 2/3 chance that the case goes to trial.*

Since the parties are already in court and have reached the stage of mediation, we will assume they have exhausted all their opportunities for out-of-court settlement; thus we assume that without mediation the probability of trial is 1. Consequently the mediation process reduces the number of cases that go to court even under the current system.

It is important to note that although M has no private information, the parties would not be able to achieve these rates of settlement without him. Suppose, for example, that without mediation a plaintiff whose information set is $\pi_P(\omega_1, \omega_2)$ offered a value of 5 to D. If D's information set were $\pi_D(\omega_2, \omega_3)$ this would reveal to him that the state is not ω_3. This information is valuable to D, so P is better off not making the offer. Also with a mediator, there is a penalty for refusing the award.

5. The Reverse System

Under the reverse system, each party's statement to M must be summarized in monetary value. Therefore, the adjustment strategies are

$$
\begin{aligned}
S^1_P(\pi_P(\omega_1,\omega_2)) &= \left\{ \begin{array}{cc} 5 & : \alpha \\ 10 & : 1-\alpha \end{array} \right\} \\
S^1_P(\pi_P(\omega_3))) &= 5
\end{aligned} \tag{5.1}
$$

and

$$
\begin{aligned}
S^1_D(\pi_2(\omega_1)) &= 0 \\
S^1_D(\pi_2(\omega_{2,}\omega_3)) &= \left\{ \begin{array}{cc} 0 & : \beta \\ 5 & : 1-\beta \end{array} \right\}
\end{aligned} \tag{5.2}
$$

Lemmas 1 and 2 can be similarly adjusted.

Formally, let $C^*_P(A_M \times S^2_P \times S^2_D \times v(\omega_o))$ be the allocation of the trial's costs C_P under the reverse system.

$$
C^*_P(S^1_P \times S^1_D \times S^2_P \times S^2_D \times v(\omega_o)) = \left\{ \begin{array}{ll} 2 & : S^2_P = Y \text{ and } S^1_P - V(\omega_o) > V(\omega_o) - S^1_D \\ 0 & : S^2_D = Y \text{ and } V(\omega_o) - S^1_D > S^1_P - V(\omega_o) \\ 2 & : S^1_P \leq A_M \text{ and } S^2_P = N \text{ and } S^2_D = Y \\ 0 & : S^1_D \geq A_M \text{ and } S^2_D = N \text{ and } S^2_P = Y \\ 1 & : \text{otherwise} \end{array} \right\} \tag{5.3}
$$

The first two rules of 5.3 are the basic rules of the reverse system. The next two rules is the adjustment of the reverse system to Bermsten (1993)'s result (see the literature review). Those rules will prevent a party from manipulating the system by rejecting a mediation award that is more favorable to him than the amount he proposed.

This will determine $C^*_D(S^1_P \times S^1_D \times S^2_P \times S^2_D \times v(\omega_o))$ as $C^*_P + C^*_D = 2$.

As before, we consider only the case where $A_M(S^1_P = H, S^1_D = d) = 5$.

Theorem 5.1. *If $A_M(S^1_P = H, S^1_D = d) = 5$ then the only equilibrium has the following properties:*

1) The plaintiff's first report is $S_P^1(\pi_P(\omega_1, \omega_2)) = 5$ with probability $\frac{10-2}{10}$.

2) The defendant's first report is $S_D^1(\pi_D(\omega_2, \omega_3)) = 5$ with probability $\frac{10-2}{10}$.

3) The probability of trial is $\left(\frac{2}{3} \cdot \frac{10^2+2*10+2}{10^2+4*10}\right) = \left(\frac{2}{3} \cdot \frac{122}{140}\right)$.

The proof is in the appendix.

In the reverse system, P and D play mixed strategies and are each reporting truthfully $\frac{10-2}{10}$ of the time and falsely $\frac{2}{10}$ of the time. The probability of trial falls from $\frac{2}{3}$ under the current system to 0.5809 in the reverse system.

6. P and D Payoffs In The Two Systems

Since the objective of the legal system is not just to minimize the number of cases going to trial, we should also compare the payoffs to the parties under the two systems.

Theorem 6.1. *The expected payoff of the plaintiff given his partition $\pi_P(\omega_3)$ is $10 - 1$ under the current system compared to an expected payoff of $10 - \frac{10^2+4}{10(10+4)}$ under the reverse system. The expected payoff of the plaintiff given his partition $\pi_P(\omega_1, \omega_2)$ is $\frac{1}{4}10 - \frac{1}{2}$ under the two systems.*

proof: see appendix.

Theorem 6.2. *The expected payoff of the defendant given his partition $\pi_D(\omega_1)$ is -1 under the current system compared to an expected payoff of $-\frac{10^2+4}{10(10+4)}$ under the reverse system. The expected payoff of the defendant given his partition $\pi_D(\omega_2, \omega_3)$ is $\left(-\frac{3}{4}10 - \frac{1}{2}\right) = -8$ under the two systems.*

The proof of theorem 5.2 is symmetric to that of theorem 5.1.

It should be noted that the entire welfare improvement of going from the current system to either one of the reverse system is captured by the party who has better private information of the true state, or equivalently who has the stronger case. That is, the party whose position is stronger has a higher expected payoff under reverse system; P is strongly better off if the state of nature is ω_3, while D is strongly better off if the state is ω_1.

7. Conclusion

We have analyzed a sequential game in which each party has private information, and the mediator must acquire all his information from the parties. In this game the mediator is a player whose objective is to choose the state that is most likely, but if he cannot determine that he will minimize the frequency of trial. All players maximize expected utility at each stage of the game. In our model the types are not independent (for example, if the plaintiff knows that the state is w_3, he knows the defendant is liable) a feature that makes the game harder to solve but may be more realistic.

In the simplest example that we consider, there is a lower frequency of trial under the reverse system that provides incentives for truthfulness than under the current system, that rewards acceptance of the mediation award. Under the current system, the equilibrium probability of trial is $\frac{2}{3}$, while it is $\left(\frac{2}{3} \cdot \frac{122}{140} \sim 0.58\right)$ under the reverse system. These results show the importance of mechanism design (reverse game theory) compared to the current system that imposes a penalty directly on the action, rejecting the mediation award. Also, each party stands to gain by replacing the current system with the reverse one.

The results are driven by the fact that the current system is myopic. It turns out that the best way to ensure that both parties accept the mediation award is, not to penalize them for rejecting it, but instead to give them an incentive to give accurate information to the mediator in the first place. When the mediation award is more accurate, the parties have less to gain from a trial, and will be deterred from doing so by the costs of trial, even if, as here, those costs are low relative to the value of claims.

We hope that this note will open the discussion about the current system. There are a bundle of systems that can put the emphasis on truth telling. There is a trade-off between the complexity of implementing these systems with the percentage of truth telling. In our reverse system, the truth telling is 80%, but implementing is quite easy.

8. Appendix

8.1. Proof of Lemma 1

If $S_P^1 = h, S_D^1 = a$ then by Bayes' Rule the posterior probabilities that M assigns to the state of nature given the strategies S_P^1 and S_D^1 described in 4.2 and 4.3 are $P(\omega_1|S_P^1 = h, S_D^1 = a) = 0$, $P(\omega_2|S_P^1 = h, S_D^1 = a) = \frac{1-\alpha}{2-\alpha}$ and $P(\omega_3|S_P^1 = h, S_D^1 = a) = \frac{1}{2-\alpha}$. Therefore ω_3 is the state with the higher probability, which implies an award of $A_M(S_P^1 = h, S_D^1 = a) = 10$.

Secondly, consider $S_P^1 = l, S_D^1 = a$. By Bayes' Rule, $P(\omega_1|S_P^1 = h, S_D^1 = a) = 0$, $P(\omega_2|S_P^1 = h, S_D^1 = a) = 1$ and $P(\omega_3|S_P^1 = h, S_D^1 = a) = 0$. Therefore ω_2 is the state with the highest probability, and M should award $A_M(S_P^1 = l, S_D^1 = a) = 5$.

Finally, consider $S_P^1 = l, S_D^1 = d$. By Bayes' Rule the posterior probabilities are $P(\omega_1|S_P^1 = l, S_D^1 = d) = \frac{1}{1+\beta}$, $P(\omega_2|S_P^1 = l, S_D^1 = d) = \frac{\beta}{1+\beta}$, and $P(\omega_3|S_P^1 = l, S_D^1 = d) = 0$ Therefore ω_1 is the state with the highest probability, and M should award $A_M(S_P^1 = l, S_D^1 = d) = 0$. ■

8.2. Proof of Lemma 2

Using Bayes' Rule we see that $P(\omega_1|S_P^1 = h, S_D^1 = d) = \frac{1-\alpha}{1-\alpha+2\beta-\alpha\beta}$, $P(\omega_2|S_P^1 = h, S_D^1 = d) = \frac{\beta-\alpha\beta}{1-\alpha+2\beta-\alpha\beta}$ and $P(\omega_3|S_P^1 = h, S_D^1 = d) = \frac{\beta}{1-\alpha+2\beta-\alpha\beta}$. In order to determine the state of nature with the highest probability, M must know the ratio of α to $1-\beta$. ■

8.3. Proof of Theorem 4.1 (the Current System)

We will analyze this game by backward induction (it is not a subgame refinement as in this game there is no subgame, but backward induction will make the analysis easier). The structure of the proof is as follows: we begin by examining the response of P and D to the mediation award; this analysis is carried out in claims 1. In claims 2 and 3 we show how the mixed-strategy equilibrium is eliminated. Claim 4 shows that the pure strategy honest equilibrium is eliminated. Claim 6 shows that a pure strategy deceptive equilibrium exists.

Let us then start with $S_P^2 : \Pi_P \times S_P^1 \times S_D^1 \times A_M \rightarrow \{Y, N\}$. This is P's response to A_M, observe that

$$S_P^2(\cdot,\cdot,\cdot,A_M = 10) = Y \tag{8.1}$$

$$S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l,\ S_D^1 = a,\ A_M = 5) = Y \tag{8.2}$$

$$S_P^2(\pi_P(\omega_3), S_P^1 = h, S_D^1 = d, A_M = 5) = N \tag{8.3}$$

$$S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = h, S_D^1 = d, A_M = 5) = Y \tag{8.4}$$

Observe that (8.1) is a dominant strategy as P cannot get more than 10 and $S_P^2(\cdot,\cdot,\cdot,A_M = 10) = N$ guarantees that P's payoff will not exceed $10 - 1$.

For (8.2) by Bayes' Rule, we can conclude that P's posterior probability for ω_2 is $P_P(\omega_2|\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = a) = 1$. If he accepts the award, P is guaranteed a payoff of 5. If , however, P rejects the award, he will receive at most $5 - 1$, therefore it is Y.

Next (8.3), Note that P will be awarded 10 at trial, so in the worst case his payoff will be $10-1$. If, on the other hand, P accepts A_M, he is certain to receive 5 since, as we will see below (8.9), D will accept A_M.

For (8.4), under the current system, the plaintiff cannot be punished for accepting the mediation award, and he knows he cannot do better at trial.

Claim 1 If D plays $S_D^1(\pi_2(\omega_2,\omega_3)) = d$ (see 4.3) with $\beta = \frac{2}{5-1}$ then $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)$ is a mixed strategy. If $\beta > \frac{2}{5-1}$ then $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0) = N$. if $\beta < \frac{2}{5-1}$ then $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0) = Y$.

proof of claim 1 Let $EU_P[S_P^2 = Y \mid (\pi_P(\omega_1,\omega_2)), S_P^1 = l, S_D^1 = d, A_M = 0)]$ be P's expected payoff if he accepts $A_M = 0$. Obviously D will accept A_M. Therefore, $EU_P[S_P^2 = Y \mid (\pi_P(\omega_1,\omega_2)), S_P^1 = l, S_D^1 = d, A_M = 0] = 0$

The alternative strategy for P is to reject A_M, which yields an expected payoff of

$$\begin{aligned} EU_P[S_P^2 &= N| \ \pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)] = \qquad (8.5) \\ P_P(\omega_1|\pi_P(\omega_1,\omega_2), S_D^1 &= d)(0-2) + P_P(\omega_2|\pi_P(\omega_1,\omega_2)), S_D^1 = d)(5-1) \end{aligned}$$

In the event of ω_1 P receives 0 and must pay 2, the trial cost of both sides. In the event of ω_2 he will receive 5 and pay only his cost of 1 (as his rejection of A_M was justified). By Bayes' Rule and 4.3 , $P_P(\omega_1|\pi_P(\omega_1,\omega_2), S_D^1 = d) = \frac{1}{1+\beta}$ and $P_P(\omega_2|\pi_P(\omega_1,\omega_2)), S_D^1 = d) = \frac{\beta}{1+\beta}$. Hence:

$$EU_P[S_P^2 = N| \ (\pi_P(\omega_1,\omega_2)), S_P^1 = l, S_D^1 = d, A_M = 0)] = \frac{1}{1+\beta}[\beta(5-1)-2] \qquad (8.6)$$

For $\beta = 0$ (which means that D always reports truthfully) P is better off accepting A_M. But for $\beta = 1$ (which means that D always reports falsely) P is better off rejecting A_M. P will be indifferent and play a mixed strategy only if $EU_P[S_P^2 = N| \ (\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)] = EU_P[S_P^2 = Y \mid (\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)])$ which leads to

$$\frac{1}{1+\beta}[\beta(5-1)-2] = 0 \Longrightarrow \beta = \frac{2}{5-1} \qquad (8.7)$$

We do not claim that D plays a mixed strategy with $\beta = \frac{2}{5-1}$. We also do not claim that $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)$ is a mixed strategy. We claim only that if D plays $S_D^1(\pi_2(\omega_{2,}\omega_3)) = d$ with $\beta = \frac{2}{5-1}$, then P adopts a mixed strategy for $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0)$. Let α_1 be the probability that $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0) = Y$.

However, we will show that D will always report falsely, so that $S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = l, S_D^1 = d, A_M = 0) = N$. This exercise will eliminate the mixed strategy equilibrium. ■

Next let us analyze $S_D^2 : \Pi_D \times S_P^1 \times S_D^1 \times A_M \rightarrow \{Y, N\}$. Observe first that

$$
\begin{aligned}
S_D^2(\bullet, \bullet, \bullet, A_M &= 0) = Y && (8.8)\\
S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 &= l,\ S_D^1 = a,\ A_M = 5) = Y && (8.9)\\
S_D^2(\pi_D(\omega_1), S_P^1 &= h, S_D^1 = d, A_M = 5) = N && (8.10)\\
S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 &= h, S_D^1 = d, A_M = 5) = Y && (8.11)
\end{aligned}
$$

The argument is similar to those of 8.1, 8.2, 8.3 and 8.4.

Claim 2 If P employs $S_P^1(\pi_P(\omega_1, \omega_2)) = l$ with $\alpha = \frac{5-3}{5-1}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10)$ is a mixed strategy If $\alpha > \frac{5-3}{5-1}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = Y$,and if $\alpha < \frac{5-3}{5-1}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = N$.

The proof is similar to that of claim 1, as β is equivalent to $1 - \alpha$. (observe that $1 - \alpha = 1 - \frac{5-3}{5-1} = \frac{2}{5-1}$). Now symmetrically to $\alpha_{1,}$ let β_1 be the probability that $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = N$.

Claim 3 P does not play a mixed strategy; he will be deceptive at every opportunity $S_P^1(\pi_P(\omega_1, \omega_2) = h$ (i.e., $\alpha = 0$). Therefore $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = N$.

proof of claim 3 P will play the mixed strategy only if the expected payoff from h is the same as the expected payoff from l, namely $EU_P[S_P^1(\pi_P(\omega_1, \omega_2) = h] = EU_P[S_P^1(\pi_P(\omega_1, \omega_2) = l]$

Let us consider $EU_P[S_P^1(\pi_P(\omega_1, \omega_2)) = h]$. First, if the state of nature is ω_1 then $S_D^1 = d$ (4.3) which leads to $A_M = 5$ (the condition of Theorem 4.1) which leads to $S_P^2(\pi_P(\omega_1, \omega_2), S_P^1 = h$, $S_D^1 = d$, $A_M = 5) = Y$ and $S_D^2(\pi_D(\omega_1), S_P^1 = h$, $S_D^1 = d$, $A_M = 5) = N$ which generates a payoff of $0 - 1$.

Now if the state of nature is ω_2 then $S_D^1 = d$ with probability β and $S_D^1 = a$ with probability $1-\beta$ (4.3). If $S_D^1 = d$ then $A_M = 5$ and both P and D accept A_M. If $S_D^1 = a$ then $A_M = 10$ which P accepts. D accepts $A_M = 10$ with probability β_1 and rejects with probability $1-\beta_1$.

For convenience of exposition, rather than explain the proof verbally as done above, we will now show it with a flow-chart; we will use this method of explanation hereafter.

$$\begin{array}{ll} \text{If } \omega_1 \Rightarrow & S_D^1 = d \Rightarrow A_M = 5 \Rightarrow S_P^2 = Y \text{ and } S_D^2 = N \Rightarrow 0-1 \\ \text{If } \omega_2 \Rightarrow & \left\{ \begin{array}{c} S_D^1 = d : \beta \Rightarrow A_M = 5 \Rightarrow S_D^2 = Y \text{ and } S_P^2 = Y \Rightarrow 5 \\ S_D^1 = a : 1-\beta \Rightarrow A_M = 10 \Rightarrow S_P^2 = Y \text{ and } \left\{ \begin{array}{c} S_D^2 = Y : \beta_1 \Rightarrow 10 \\ S_D^2 = N : 1-\beta_1 \Rightarrow 5-2 \end{array} \right\} \end{array} \right\} \end{array}$$

Therefore

$$\begin{aligned} EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) &= h] = P_P(\omega_1|\pi_P(\omega_1,\omega_2)[0-1] + \\ & P_P(\omega_2|\pi_P(\omega_1,\omega_2))[\beta(5) + (1-\beta)\{\beta_1(10) + (1-\beta_1)(5-1)\}] \end{aligned} \tag{8.12}$$

and since $P_P(\omega_1|\pi_P(\omega_1,\omega_2)) = 0.5$,

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = h] = 0.5[(-2+5+5\beta_1 - 5\beta_1\beta + \beta + \beta_1 - \beta_1\beta)] \tag{8.13}$$

Let us next consider $EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = l]$. It will be efficient to explain the sequence of the parties' actions with a flow-chart:

$$\begin{array}{ll} \text{If } \omega_1 \Rightarrow & S_D^1 = d \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 \Rightarrow 0 \\ S_P^2 = N : 1-\alpha_1 \Rightarrow 0-2 \end{array} \right\} \\ \text{If } \omega_2 \Rightarrow & \left\{ \begin{array}{c} S_D^1 = d : \beta \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 \Rightarrow 0 \\ S_P^2 = N : 1-\alpha_1 \Rightarrow 5-1 \end{array} \right\} \\ S_D^1 = a : 1-\beta \Rightarrow A_M = 5 \Rightarrow S_D^2 = Y \text{ and } S_P^2 = Y \Rightarrow 5 \end{array} \right\} \end{array}$$

Therefore

$$\begin{aligned} EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) &= l] = P_P(\omega_1|\pi_P(\omega_1,\omega_2)[\alpha_1(0) + (1-\alpha_1)(0-2)] + \\ & P_P(\omega_2|\pi_P(\omega_1,\omega_2))[\beta\{\alpha_1(0) + (1-\alpha_1)(5-1)\} + (1-\beta)(5)] \end{aligned} \tag{8.14}$$

8.14 can be reduced to

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = l] = 0.5[(-2+5-5\alpha_1\beta-\beta+2\alpha_1+\beta_1\alpha_1)] \quad (8.15)$$

If $\alpha_1 = 0$, then simple algebra will show that

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = h] > EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = l]$$

If $0 < \alpha_1 < 1$ then $\beta = \frac{2}{5-1}$ (see 8.7). then again, simple algebra will show that for all β_1, $EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = h] > EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = l]$ implying that $\alpha = 0$. Therefore $S_D^2(\pi_D(\omega_2,\omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = N$. If $\alpha_1 = 1$, then D is better off always being deceptive, and therefore P is better off rejecting the offer. ■

Claim 4 D does not play a mixed strategy; he is deceptive all the time. $S_D^1(\pi_D(\omega_2,\omega_3) = d$ namely ($\beta = 0$); therefore $S_P^2(\pi_p(\omega_1,\omega_2), S_P^1 = l, S_D^1 = a, A_M = 0) = N$.

The proof of claim 6 is similar to the proof of claim 3.

We have proved that there is no equilibrium for a mixed strategy. Next we will prove that there is no equilibrium for a pure truthful strategy.

Claim 5 There is no pure strategy honest equilibrium under the current system.

proof of claim 5 Consider the following strategy for P: $S_P^1(\pi_P(\omega_1,\omega_2)) = l$, $S_P^1(\pi_P(\omega_3)) = h$. Obviously D will not choose to take the case to trial; therefore $S_D^2(\pi_D(\omega_2,\omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = Y$. However given this strategy of D, P is better off deviating to $S_P^1(\pi_P(\omega_1,\omega_2)) = h$, as in the event of ω_2 this strategy generates an outcome of 10 and in the event of ω_1 it generates an outcome of -1. These outcomes may be compared to those of the truthful strategy, which are 5 and 0 , respectively. Since P assigns the same probability to

ω_1 and ω_2, P is better off deviating. Similar arguments will eliminate the truthful strategy for D. ■

Claim 6 There is a pure strategy deceptive equilibrium under the proposed system.

proof of claim 6 Consider the following first-stage strategies for P and D: $S_P^1(\pi_P(\omega_1, \omega_2)) = S_P^1(\pi_P(\omega_3)) = h$, $S_D^1(\pi_2(\omega_1)) = S_D^1(\pi_2(\omega_{2,}\omega_3)) = d$.

Suppose P deviates in the first statement by reporting $S_P^1(\pi_P(\omega_1, \omega_2)) = l$, i.e., he reports low damages if his partition is $\pi_P(\omega_1, \omega_2)$ (the rest of his strategy stays the same)

According to M's strategy, $A_M = 0$. But if $A_M = 0$, P is better off rejecting A_M, since that will give him an expected value of $-1.5 + 0.25 * 10$, compared to 0 if he accepts (claim 2). Therefore, a deviation will yield a payoff of $0.5(0-2) + 0.5(5-1) = -1.5 + 0.25 * 10$ compared to the payoff of $-0.5 + 0.25 * 10$ under the equilibrium strategy. We conclude that P will not deviate from the deceptive strategy. The same analysis applies to D. ■.

To complete the proof of Theorem 4.1 we need to calculate the probability of trial. P and D will report h and d regardless of their partition, so $A_M = 5$ regardless of the state of nature. Now P will reject A_M if the state of nature is ω_3 and D will reject A_M if the state is ω_1. Therefore the only case that will not go to trial is ω_2 and the probability of this state is 1/3. Thus the probability of trial is 2/3. ■

8.4. Proof of Theorem 5.1 (the Reverse System)

The proof is similar to that of Theorem 4.1 so we will just concentrate on the calculation, and on the different rule for sharing trial costs that leads to a different result. Observe that

$$S_P^2(\cdot,\cdot,\cdot,A_M = 10) = Y \tag{8.16}$$

$$S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = 5,\ S_D^1 = 5,\ A_M = 5) = Y \tag{8.17}$$

$$S_P^2(\pi_P(\omega_3), S_P^1 = 10,\ \ S_D^1 = 5,\ \ A_M = 5) = N \tag{8.18}$$

$$S_P^2(\pi_P(\omega_1,\omega_2), S_P^1 = 10, S_D^1 = 0, A_M = 5) = N \tag{8.19}$$

The reasoning is similar to that of equations 8.1, 8.2, 8.3 and 8.4.

Let $EU_P[S_P^2 = Y \mid (\pi_P(\omega_1,\omega_2), S_P^1 = 10, S_D^1 = 0, A_M = 5)]$ be the expected payoff of P if he accepts $A_M = 5$, given his partition $\pi_P(\omega_1,\omega_2)$ and that $S_P^1 = 10, S_D^1 = 0$. Observe that

$$EU_P[S_P^2 = Y|\pi_P(\omega_1,\omega_2), S_P^1 = 10, S_D^1 = 0, A_M = 5] = \tag{8.20}$$

$$P_P(\omega_1|\pi_P(\omega_1,\omega_2), S_D^1 = 0)[(0-2)] + P_P(\omega_2|\pi_P(\omega_1,\omega_2), S_D^1 = 0)[(1-\beta_3)(5) + \beta_3(5-1)]$$

This expected payoff is the sum of the expected outcomes for ω_1 and ω_2. The expected outcome for ω_1 is the probability that P assigns to ω_1 given that he observed $S_D^1 = 0$, multiplied by $(0-2)$, since it is certain that D will reject A_M and the case will go to trial. A similar analysis applies to ω_2 , except that D's probability of rejecting $A_M = 5$ is now $\beta_3 \in [0,1]$. If D accepts A_M, the payoff to P is (5), and if D rejects it is $(5-1)$.

Let $EU_P[S_P^2 = N \mid \pi_P(\omega_1,\omega_2), S_P^1 = 10, S_D^1 = 0, A_M = 5]$ be the expected payoff if $P's$ response is N , so that the case goes to trial with certainty. Observe that

$$EU_P[S_P^2 = N|\ (\pi_P(\omega_1,\omega_2), S_P^1 = 10, S_D^1 = 0, A_M = 5)] = \tag{8.21}$$

$$P_P(\omega_1|\pi_P(\omega_1,\omega_2), S_D^1 = 0)[(0-1)] + P_P(\omega_2|\pi_P(\omega_1,\omega_2), S_D^1 = 0)[(1-\beta_3)(5-1) + \beta_3(5-1)]$$

In this case the payoff depends on whether the outcome is ω_1 or ω_2 , which generate trial verdicts of 0 and 5 respectively, no matter whether D accepts or refuses A_M.

As $\beta_3 \leq 1$ and $P_P(\omega_1|\pi_P(\omega_1,\omega_2),S_D^1=0) \geq 0.5$ then $8.21 \geq 8.20$ therefore $S_P^2(\pi_P(\omega_1,\omega_2),S_1^1=10,S_2^1=0,A_M=5)=N$. ■

claim 5.1 If D plays $S_D^1(\pi_2(\omega_{2,}\omega_3))=0$ (see 4.3) with $\beta=\frac{2}{10}$ then $S_P^2(\pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0)$ is a mixed strategy. If $\beta>\frac{2}{10}$ then $S_P^2(\pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0)=N$. if $\beta<\frac{2}{10}$ then $S_P^2(\pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0)=Y$.

proof of claim 5.1 Let $EU_P[S_P^2=Y \mid \pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0)]$ be the expected payoff for P if he accepts $A_M=0$. Obviously D will accept A_M. Therefore, $EU_P[S_P^2=Y \mid \pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0]=0$.

The alternative strategy for P is to reject A_M, which yields an expected payoff of

$$\begin{aligned} EU_P[S_P^2 &= N|\ \pi_P(\omega_1,\omega_2),S_P^1=5,S_D^1=0,A_M=0]= \qquad (8.22)\\ P_P(\omega_1|\pi_P(\omega_1,\omega_2),S_D^1 &= 0)(0-1)+P_P(\omega_2|\pi_P(\omega_1,\omega_2),S_D^1=0)(5) \end{aligned}$$

In the event of ω_1 player P receives 0 and must pay 1. The reason is that P rejects the mediation award; D accepts but $V(\omega_o)=S_D^1$, so each bears his own cost. In the event of ω_2 P will receive 5 and will not pay his trial cost, as D accepts and $V(\omega_o)-S_D^1>S_P^1-V(\omega_o)$. By Bayes' Rule and 4.3 , $P_P(\omega_1|\pi_P(\omega_1,\omega_2),S_D^1=0)=\frac{1}{1-\beta}$ and $P_P(\omega_2|\pi_P(\omega_1,\omega_2),S_D^1=0)=\frac{\beta}{1-\beta}$. Hence:

$$EU_P[S_P^2=N|\ (\pi_P(\omega_1,\omega_2),S_P^1=5,\quad S_D^1=0,A_M=0)]=\frac{1}{1-\beta}[\beta 5-1] \qquad (8.23)$$

For $\beta=0$, which means that D always reports truthfully, P is better off accepting A_M. But for $\beta=1$, which means that D always reports falsely, P is better off rejecting A_M. P will be indifferent and play a mixed strategy only if $EU_P[S_P^2=N|\ \pi_P(\omega_1,\omega_2),S_P^1=l,S_D^1=R,D_M=$

$0] = EU_P[S_P^2 = Y \mid \pi_P(\omega_1, \omega_2), S_P^1 = l, S_D^1 = R, D_M = 0]$, which leads to

$$\frac{1}{1-\beta}[\beta 5 - 1] = 0 \Longrightarrow \beta = \frac{2}{10} \tag{8.24}$$

Let α_1 be the probability that $S_P^2(\pi_P(\omega_1, \omega_2), S_P^1 = 5, S_D^1 = 0, A_M = 0) = Y$ ■

Next let us analyze $S_D^2 : \Pi_D \times S_P^1 \times S_D^1 \times A_M \to \{Y, N\}$. Observe $S_D^2(\cdot, \cdot, \cdot, A_M = 0) = Y$, $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = 5,\ S_D^1 = 5,\ A_M = 5) = Y$, $S_D^2(\pi_D(\omega_1), S_P^1 = 10, S_D^1 = 0, A_M = 5) = N$ and $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = 10,\ S_D^1 = 0,\ A_M = 5) = N$

claim 5.2 If P employs $S_P^1(\pi_P(\omega_1, \omega_2)) = 5$ with $\alpha = \frac{10-2}{10}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = 10, S_D^1 = 5, A_M = 10)$ is a mixed strategy. If $\alpha > \frac{10-2}{10}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = 10, S_D^1 = 5, A_M = 10) = Y$, and if $\alpha < \frac{10-2}{10}$ then $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = 10, S_D^1 = 5, A_M = 10) = N$.

The proof of claim 5.2 is similar to the proof of claim 5.1.

claim 5.3 In equilibrium, P plays a mixed strategy in his first period report; he plays $S_P^1(\pi_P(\omega_1, \omega_2) = 5$ with probability $\alpha = \frac{10-2}{10}$. Therefore D plays $S_D^2(\pi_D(\omega_2, \omega_3), S_P^1 = h, S_D^1 = a, A_M = 10) = Y$ with probability $\beta_1 = \frac{4(10-1)}{(10-2)(10+4)}$.

proof of claim 5.3 P will play the mixed strategy $S_P^1(\pi_P(\omega_1, \omega_2) = 5$ only if $EU_P[S_P^1(\pi_P(\omega_1, \omega_2) = 10] = EU_P[S_P^1(\pi_P(\omega_1, \omega_2) = 5]$

Let us first consider $EU_P[S_P^1(\pi_P(\omega_1, \omega_2)) = 10]$. It is efficient to explain the sequence of the parties' actions with a flow-chart:

$$\begin{array}{lll} \text{If } \omega_1 & \Rightarrow & S_D^1 = 0 \Rightarrow A_M = 5 \Rightarrow S_P^2 = N \text{ and } S_D^2 = N \Rightarrow 0 - 1 \\ \text{If } \omega_2 & \Rightarrow & \left\{ \begin{array}{c} S_D^1 = 0 : \beta \Rightarrow A_M = 5 \Rightarrow S_P^2 = N \text{ and } S_D^2 = N \Rightarrow 5 - 1 \\ S_D^1 = 5 : 1-\beta \Rightarrow A_M = 10 \Rightarrow S_P^2 = Y \text{ and } \left\{ \begin{array}{c} S_D^2 = Y : \beta_1 \Rightarrow 10 \\ S_D^2 = N : 1-\beta_1 \Rightarrow 5 - 2 \end{array} \right\} \end{array} \right\} \end{array}$$

Therefore

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2) \quad = \quad 10] = P_P(\omega_1|\pi_P(\omega_1,\omega_2))[0-1] + \tag{8.25}$$

$$P_P(\omega_2|\pi_P(\omega_1,\omega_2))[\beta(5-1)+(1-\beta)\{\beta_1(10)+(1-\beta_1)(5-2)\}]$$

Consider first the case $0 < \alpha_1 < 1$. Then $\beta = \frac{2}{10}$ and $P_P(\omega_1|\pi_P(\omega_1,\omega_2)) = 0.5$, so we get

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = 10] = -\frac{1}{10} + (\frac{10-2}{4})\beta_1 + \frac{10-2}{4} - \frac{10-2}{10}(1-\beta_1) \tag{8.26}$$

Let us next consider $EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = 5]$.

$$\text{If } \omega_1 \quad \Rightarrow \quad S_D^1 = 0 \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 \Rightarrow 0 \\ S_P^2 = N : 1-\alpha_1 \Rightarrow 0-1 \end{array} \right\}$$

$$\text{If } \omega_2 \quad \Rightarrow \quad \left\{ \begin{array}{c} S_D^1 = 0 : \beta \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 \Rightarrow 0 \\ S_P^2 = N : 1-\alpha_1 \Rightarrow 5 \end{array} \right\} \\ S_D^1 = 5 : 1-\beta \Rightarrow A_M = 5 \Rightarrow S_D^2 = Y \text{ and } S_P^2 = Y \Rightarrow 5 \end{array} \right\}$$

Therefore

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) \quad = \quad 5] = P_P(\omega_1|\pi_P(\omega_1,\omega_2))[\alpha_1(0)+(1-\alpha_1)(0-1)] \tag{8.27}$$

$$P_P(\omega_2|\pi_P(\omega_1,\omega_2))[\beta\{\alpha_1(0)+(1-\alpha_1)(5)\}+(1-\beta)(5)]$$

And since $\beta = \frac{2}{10}$,

$$EU_P[S_P^1(\pi_P(\omega_1,\omega_2)) = 5] = 0.25[10-2] \tag{8.28}$$

implying $EU_P[S_P^1(\pi_P(\omega_1,\omega_2) = h] = EU_P[S_P^1(\pi_P(\omega_1,\omega_2) = l]$ which is equivalent to

$-\frac{1}{10} + (\frac{10-2}{4})\beta_1 + \frac{10-2}{4} - \frac{10-2}{10}(1-\beta_1) = 0.25[10-2]$, which leads to the conclusion that

$$\beta_1 = \frac{4(10-1)}{(10-2)(10+4)} \tag{8.29}$$

Finally, it is easy to see that $\alpha_1 = 0$ and $\alpha_1 = 1$ are the cases that lead to pure strategies; they are discussed in Claim 7.7 and 7.8. ■

claim 5.4 D plays $S^1_D(\pi_D(\omega_2, \omega_3) = 0$ with probability $\beta = \frac{2}{10}$, therefore P plays $S^2_P(\pi_p(\omega_1, \omega_2), S^1_P = 0, S^1_D = 5, A_M = 0) = Y$ with probability $\alpha_1 = \frac{4(10-1)}{(10-2)(10+4)}$.

The proof of claim 5.4 is similar to the proof of claim 5.3.

We have established the existence of a mixed strategy equilibrium. For uniqueness we must prove that pure strategy equilibria do not exist in the Reverse system. This is done in claims 5.5 and 5.6.

claim 5.5 There is no pure strategy honest equilibrium under the Reverse System.

The proof of claim 5.5 is similar to the proof of claim 5.

claim 5.6 There is no pure strategy deceptive equilibrium under the Reverse System.

We will set forth the proof in detail, as it highlights the difference between the current system and the Reverse System.

proof of claim 5.6 Consider the following first strategies for P and D :

$S^1_P(\pi_P(\omega_1, \omega_2)) = S^1_P(\pi_P(\omega_3)) = 10,\ S^1_D(\pi_2(\omega_1)) = S^1_D(\pi_2(\omega_{2,}\omega_3)) = 0.$

Observe next that the second decisions of P are:

$S^2_P(\pi_P(\omega_1, \omega_2), S^1_P = 5,\ S^1_D = 0,\ A_M = 5) = Y$

$S^2_P(\pi_P(\omega_1, \omega_2), S^1_P = 10,\ S^1_D = 0,\ A_M = 5) = N$

$S^2_P(\pi_P(\omega_1, \omega_2), S^1_P = 5, S^1_D = 0, A_M = 0) = N.$

Suppose P deviates in the first statement by reporting $S^1_P(\pi_P(\omega_1, \omega_2)) = 5$, i.e., he reports low damages if his partition is $\pi_P(\omega_1, \omega_2)$ (the rest of his strategy stays the same).

The sequence of events will then be as follows:

$$\text{If } \omega_1 \quad \Rightarrow \quad S_D^1 = 0 \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \ , \ S_P^2 = N \Rightarrow 0 - 1 \tag{8.30}$$

$$\text{If } \omega_2 \quad \Rightarrow \quad S_D^1 = 0 \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \ , \ S_P^2 = N : 1 - \alpha_1 \Rightarrow 5 \tag{8.31}$$

Namely in the event of $\omega_{1,}$ P rejects the mediation award, but $D's$ report was closer to the true state, so each party bears his own cost of 1. In the event of ω_2, if D accepts, he bears all the cost since his report was farther from the true state, i.e., P pays 0 trial costs (if D rejects he also pays all the costs, since M gave him the amount he demanded).

If P does not deviate (so that $S_P^1(\pi_P(\omega_1, \omega_2)) = 10$) then the sequence of events is

$$\text{If } \omega_1 \quad \Rightarrow \quad S_D^1 = 0 \Rightarrow A_M = 5 \Rightarrow S_D^2 = N \ , \ S_P^2 = N \Rightarrow 0 - 1 \tag{8.32}$$

$$\text{If } \omega_2 \quad \Rightarrow \quad S_D^1 = 0 \Rightarrow A_M = 5 \Rightarrow S_D^2 = N \ , \ S_P^2 = N \Rightarrow 5 - 1 \tag{8.33}$$

Namely in the event of ω_1, P rejects the mediation award, but $D's$ report was closer to the true state, so each party bears his own costs . In the event of ω_2, P will reject the mediation award (claim 7.1) so each party bears his own costs (namely 1). Comparison of 8.30 and 8.32 shows that if the state is $\omega_{1,}$ P's payoff is the same, and reference to 8.31 and 8.33 shows that in the event of ω_2, P will deviate from the pure deceptive strategy.

It is easy to see that in the Reverse System P will not adopt the pure strategy $S_P^1(\pi_P(\omega_1, \omega_2)) = 10$. A similar analysis applies to D.

To complete the proof of Theorem 5.1 we must calculate the probability of trial. We will also use the following claim to calculate the expected payoffs for P and D, which are needed for Theorem 6.1 and Theorem 6.2

claim 5.7 The probability of trial is $\frac{2}{3}\frac{10^2+2*10+2}{10^2+4*10}$

proof of claim 5.7 Let us find the expected payoff of each of the three players, given the events ω_1, ω_2 , and ω_3. Since the expected payoff to player M is $1-$ the probability of trial, we determine the probability of trial by finding M's expected payoff.

First consider the case that the true state is ω_1. As stated previously $S_D^1 = 0$ (the items in parentheses represent the payoffs to P, D and M respectively):

$$S_p^1 = 5 : \alpha = \tfrac{10-2}{10} \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 = \frac{4(10-1)}{(10-2)(10+4)} \Rightarrow (0,0,1) \\ S_P^2 = N : 1-\alpha_1 \Rightarrow (-1,-1,0) \end{array} \right\}$$
$$S_P^1 = 10 : 1-\alpha = \tfrac{2}{10} \Rightarrow A_M = 5 \Rightarrow S_D^2 = N \text{ and } S_P^2 = N \Rightarrow (-1,-1,0)$$

Let $EU_i^*(\omega_j)$ be the expected payoff of i given ω_j, where $i \in \{P, D, M\}$, and $j \in \{1,2,3\}$. Therefore,

$$EU_P^*(\omega_1) = EU_D^*(\omega_1) = \frac{10^2+4}{10(10+4)}(-1), \;\; EU_M^*(\omega_1) = 1 - \frac{10^2+4}{10(10+4)} \tag{8.34}$$

From equation 8.34 we determine that the probability of trial in the event of ω_1 is $\frac{10^2+4}{10(10+4)}$.

If the true state is ω_2, both P and D will play mixed strategies.

1) D will play $S_D^1 = 0$ with probability $\frac{2}{10}$ so the sequence of events is:

$$\left\{ \begin{array}{c} S_p^1 = 5 : \alpha = \frac{10-2}{10} \Rightarrow A_M = 0 \Rightarrow S_D^2 = Y \text{ and } \left\{ \begin{array}{c} S_P^2 = Y : \alpha_1 = \frac{4(10-1)}{(10-2)(10+4)} \Rightarrow (0,0,1) \\ S_P^2 = N : 1-\alpha_1 \Rightarrow (5,-5-2,0) \end{array} \right\} \\ S_P^1 = 10 : 1-\alpha = \frac{2}{10} \Rightarrow A_M = 5 \Rightarrow S_D^2 = N \text{ and } S_P^2 = N \Rightarrow (5-1,-5-1,0) \end{array} \right\}$$

2) D will play $S_D^1 = 5$ with probability $\frac{10-2}{10}$ so the sequence of events is:

$$\left\{ \begin{array}{c} S_p^1 = 5 : \alpha = \frac{10-2}{10} \Rightarrow A_M = 5 \Rightarrow S_D^2 = Y \text{ and } S_P^2 = Y \Rightarrow (5,-5,1) \\ S_P^1 = 10 : 1-\alpha = \frac{2}{10} \Rightarrow A_M = 10 \Rightarrow S_P^2 = Y \text{ and } \left\{ \begin{array}{c} S_D^2 = Y : \beta_1 = \frac{4(10-1)}{(10-2)(10+4)} \Rightarrow (10,-10,1) \\ S_D^2 = N : 1-\beta_1 \Rightarrow (5-2,-5,0) \end{array} \right\} \end{array} \right\}$$

Therefore,

$$EU_P^S(\omega_2) = \frac{10}{2} - \frac{4(10-1)}{10(10+4)} \tag{8.35}$$

$$EU_D^S(\omega_2) = -\frac{10}{2} - \frac{4(10-1)}{10(10+4)} \tag{8.36}$$

$$EU_M^S(\omega_2) = 1 - \frac{4(10-1)}{10(10+4)} \tag{8.37}$$

Lastly, consider the case that the true state is ω_3 . As stated above, P will play $S_P^1 = 10$,

$$S_D^1 = 5 : \alpha = \tfrac{10-2}{10} \Rightarrow A_M = 10 \Rightarrow S_P^2 = Y \text{ and } \left\{ \begin{array}{c} S_D^2 = Y : \beta_1 = \frac{4(10-1)}{(10-2)(10+4)} \Rightarrow (10, -10, 1) \\ S_D^2 = N : 1 - \beta_1 \Rightarrow (10-1, -10-1, 0) \end{array} \right\}$$

$$S_D^1 = 0 : 1 - \alpha = \tfrac{2}{10} \Rightarrow A_M = 5 \Rightarrow S_P^2 = N \text{ and } S_D^2 = N \Rightarrow (10-1, -10-1, 0)$$

Therefore after some algebra,

$$EU_P^S(\omega_3) \ = 10 - \frac{10^2 + 4}{10(10+4)} \tag{8.38}$$

$$EU_D^S(\omega_3) \ = -10 - \frac{10^2 + 4}{10(10+4)} \tag{8.39}$$

$$EU_M^S(\omega_3) \ = 1 - \frac{10^2 + 4}{10(10+4)} \tag{8.40}$$

Let $P^S(c)$ be the probability of going to trial in the Reverse System. Thus $P^S(c) = 1 \ -[\sum_{i=1,2,3} P(\omega_i) EU_M^S(\omega_I)]$. As $P(\omega_i) = \frac{1}{3}$, after some calculation,

$$P^S(c) = \frac{2}{3}\left(\frac{10^2 + 2 * 10 + 2}{10(10+4)}\right) \tag{8.41}$$

■

Proof of Theorem 5.1: Comparison of the Payoffs to the Parties Under Each System Let us first consider the case where P's partition is $\pi_P(\omega_3)$:

Under the current system the case always goes to trial and the outcome is 10, but P must pay his trial costs. Therefore P's payoff is $10 - 1$.

Under the Reverse system, P's expected payoff $EU_P^S(\pi_P(\omega_3)) = 10 - \frac{10^2+4}{10(10+4)}$.(see 8.38)

Next consider the case where P's partition is $\pi_P(\omega_1, \omega_2)$:

Under the current system P's payoff is $0.5(-1) + 0.5(5)$. The first term applies to the event ω_1, where the case goes to trial and the verdict is 0 but P must pay his trial costs. The second term applies to the event ω_2 ; in this case both P and D accept $A_M = 5$.

Under the Reverse system P's payoff is $EU_P^S(\pi_P(\omega_1, \omega_2)) = \frac{1}{2}EU_P^S(\omega_1) + \frac{1}{2}EU_P^S(\omega_2)$. From 8.34 and 8.35, we get $EU_P^S(\pi_P(\omega_1, \omega_2)) = \frac{1}{4}10 - \frac{1}{2}$. ■

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