Managing a Conflict: Optimal Alternative Dispute Resolution*

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September 3, 2020

Abstract

We study optimal methods for Alternative Dispute Resolution (ADR), a technique to achieve settlement and avoid costly adversarial hearings. Participation is voluntary. Disputants are privately informed about their marginal cost of evidence provision. If ADR fails to engender settlement, the disputants can use the information obtained during ADR to determine what evidence to provide in an adversarial hearing. Optimal ADR induces an asymmetric information structure but makes the learning report-independent. It is ex-ante fair and decreases the disputants' expenditures, even if they fail to settle. We highlight the importance of real-world mediation techniques, such as caucusing, for implementing optimal ADR.

*We thank the editor, Kathy Spier, and three anonymous referees for detailed suggestions that improved the article significantly. Further, we thank Andreas Engert, Willie Fuchs, Daniel Garrett, Johannes Hörner, João Correia-da-Silva, Alon Klement, Dan Klerman, Nenad Kos, Aditya Kuvalekar, Yassine Lefouili, Antoine Loeper, Volker Nocke, Martin Peitz, Christoph Wolf, and audiences in numerous places for their comments. Johannes Schneider gratefully acknowledges support from the Ministerio Economia y Competitividad, Maria de Maeztu grant (MDM 2014-0431), and Comunidad de Madrid, MadEco-CM (S2015/HUM-3444).

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1 Introduction

Alternative Dispute Resolution (ADR) has been fully established within the legal system.[1] Stienstra (2011) reports a lower bound of fifteen percent of federal district courts civil cases being referred to ADR.[2] ADR is a large industry. According to their website the American Arbitration Association alone was involved in settling 216,533 cases from January to July 2020. One reason for ADR's success is that disputants appreciate ADR even when it fails to achieve settlement.[3] A second reason is its flexibility. ADR is an umbrella term and can take many forms: according to the ADR Act of 1998, "any process or procedure, other than an adjudication by a presiding judge, in which a neutral third party participates to assist in the resolution of issues in controversy" qualifies as ADR. The most prominent forms are binding arbitration and non-binding mediation. However, even within each form, the third party conducting ADR can manage the case flexibly.

The proponents of ADR argue that a correct interpretation of this flexibility is key to ADR's success (Shavell, 1995; Mnookin, 1998). The details in the design of ADR, such as managing the exchange of information, are crucial (Carver and Vondra, 1994; Ayres and Nalebuff, 1996). Still, a designer of ADR faces two basic constraints. First, she cannot circumvent the rule of law, as ADR operates in the shadow of the law. Second, disputants may be reluctant to reveal certain relevant but private information. ADR thus must provide incentives for parties to share their information.

In this article, we evaluate which ADR mechanism—only subject to the above basic constraints—achieves the highest early settlement rates. To answer this question, we characterize the key institutional properties of optimal ADR. We show that actual mediation protocols used in practice can implement optimal ADR.

We use a systematic mechanism-design approach to characterize the settlement-maximizing ADR mechanism. A basic sketch of the model structure is in Figure 1. Two disputants, a plaintiff and a defendant, hold private information about their cost of evidence provision. If both disputants agree to ADR, they enact the following mechanism. First, the parties report in private to a neutral third party. Based on these reports, the third party either (i) settles the dispute by ruling on the share of damages the defendant is deemed liable for or (ii) refers the parties to an evidentiary hearing. The hearing is an exogenous legal contest that determines the liability of the defendant. Both parties make their cases by investing in evidence provision, taking into account their marginal costs. If, instead, the case settles early, no evidentiary hearing takes place and the parties' private information is irrelevant.

Managing the information flow between parties is of first-order importance when

[1]The ADR Act of 1998 states that "Each district court shall provide litigants in all civil cases with at least one alternative dispute resolution process".

[2]Stienstra (2011) notes: "Many civil cases are [formally] not [...] eligible for ADR. Thus, the true rate of referral is higher, by an unknown amount, than the fifteen percent suggested by the referral numbers."

[3]The US District Court's Northern District of California reported in its *ADR Program Report Fiscal Year 2019* (2020) that 88% of all participants in ADR state that the benefits of participating outweighed the cost. More than 90% considered ADR fair, although the settlement rate is only around 60%. Genn (1998) documents similar results for London, UK.

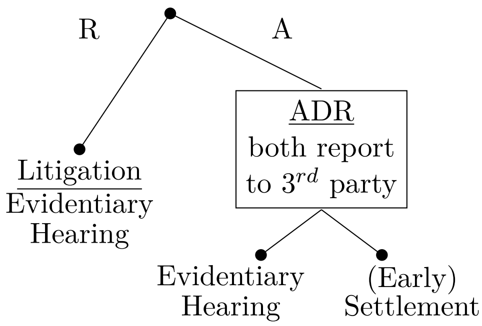


Figure 1: **Sketch of an ADR mechanism.** A third party offers an ADR mechanism. If both disputants accept ADR (A), then any communication, the terms of the (potential) settlement, and the (potential) hearing all happen thorugh the third party. If at least one disputant rejects ADR (R), the case goes to court directly.

designing ADR. Indeed, we characterize ADR by the information structure it induces on the equilibrium path. We identify three key properties. First, optimal ADR induces asymmetries between the parties. The more asymmetric the parties are, the lower their expected legal expenditure in an adversarial process. A low-cost defendant who knows that she faces a high-cost plaintiff saves on legal expenditure—she expects to outperform the plaintiff even at lower levels of evidence. Likewise, a high-cost plaintiff who knows that she faces a low-cost defendant also saves on legal expenditure—she expects that the defendant's evidence would outperform hers regardless. Saving on legal expenditures incentivizes parties to join ADR in the first place.

Second, if settlement fails, the information a disputant obtains in ADR is independent of her own report to the designer. This property removes incentives for strategic misreporting to extract information. In general, observing that settlement failed may be informative to both parties. Each uses her knowledge about her own report within ADR, as well as the resulting outcome of ADR, to conjecture about the opponent's report. Using equilibrium reasoning, she infers information about her opponent's cost. Anticipating such inference, both parties have an incentive to use ADR strategically. In particular, they may provide false information within ADR to extract more information about the opponent or to misdirect the opponent's own reasoning. If, however, the information the plaintiff obtains does not depend on her own report, these incentives disappear.

Third, ADR provides no guarantees. The plaintiff is never sure about the defendant's cost or vice versa. Because an evidentiary hearing happens with positive probability for any report profile, 'no guarantees' reduces the signaling value of an evidentiary hearing. If evidentiary hearings were reserved for strong disputants, enforcing a hearing would serve as an overly strong signal. By providing no guarantees, no disputant can unambiguously signal her type by enforcing a hearing.

We provide a mediation protocol in the spirit of Klerman and Klerman (2015) that implements the optimal mechanism. Most importantly, the mediator communicates with each disputant separately to elicit their private reservation values. Based on these caucus sessions, she then provides each disputant with a closing offer. In doing so, she takes into account how much information about each disputant's opponent that offer reveals. In other words, the mediator acts as an information gatekeeper. Indeed, compared to alternative settlement mechanisms such as (unmediated) bilateral negotiations, the main advantage of third-party-run ADR is that ADR manages the information flow between disputants (see e.g. Brown and Ayres, 1994; Ayres and Nalebuff, 1996). Information is relevant for continuation strategies so disputants are reluctant to share it. A neutral (and committed) third party promises the disputants contingencies on which she passes on information. If the disputants are wary about sharing information, the gatekeeper's role is of first-order importance. Other aspects, such as the disputants' commitment to accept rulings, are less important. Thus, even our non-binding mediation protocol can implement the optimal mechanism.

We also address a set of additional questions: (i) What are the welfare consequences of a failed ADR attempt? (ii) Is ADR ex-ante fair? (iii) What changes if ADR aims at maximizing disputants' joint surplus? First, we find that disputants benefit from ADR even when it fails to settle: legal expenditures after a failed settlement attempt are lower than in a world without ADR. Second, ADR is ex-ante fair despite the induced asymmetry. Parties that are disadvantaged in hearings expect favorable settlement outcomes and vice versa. Third, we address the case in which ADR maximizes disputants' joint expected surplus instead of the settlement rate. Our qualitative characterization of optimal ADR remains, but closed-form solutions do not exist. Numerical results show that the asymmetry increases compared to settlement-maximizing ADR.

Related Literature. The law and economics literature studying settlement under asymmetric information is extensive.[4] Most models focus on bilateral bargaining following early models by Bebchuk (1984), Reinganum and Wilde (1986), and Spier (1992). Schweizer (1989) introduces two-sided private information into these models. We too consider two-sided private information, but allow for a flexible ADR mechanism administered by a third party.[5]

A small literature in law and economics studies dispute resolution from a mechanism-design perspective. Spier (1994) and Klement and Neeman (2005) are closest to our approach within that literature. The key difference is that information revelation does not affect parties' behavior within litigation in both Spier (1994) and Klement and Neeman (2005). Instead, it determines incentives to (re-)negotiate. Translated to our setting, both models implicitly assume that a disputant's optimal strategy in a hearing does not depend on information about her opponent. Thus, information revealed within the mechanism has no effect on behavior.

[4]Spier (2007) and Daughety and Reinganum (2017) provide excellent overviews of the literature. Each also discusses the degree of the disputants' optimism as another friction to settlement. A recent example in that complementary strand is Vasserman and Yildiz (2019).

[5]For an empirical study of court-annexed arbitration see the analysis of New York's summary jury trial program by Prescott and Spier (2016). Their study also illustrates the degree of flexibility a designer of ADR has.

Different from Klement and Neeman (2013) but similar to Spier (1994) and Klement and Neeman (2005), we assume that a monopolist designer offers the ADR mechanism. Yet under certain restrictions, our mechanism can arise in a competitive market for ADR services too (see Section 5 for details). Following Klement and Neeman (2005), we assume that no disputant is forced to participate in ADR and can unilaterally enforce litigation.

In terms of modeling techniques, the closest approach to our article is Hörner, Morelli, and Squintani (2015), who study peace negotiations in the shadow of war. Different from us, they assume that information does not affect behavior in wars. Their main result is that arbitration and mediation are equally effective. We show that their result extends to settings where information does affect subsequent behavior. However, the properties of our optimal mechanism are fundamentally different from theirs. We discuss the relation to Hörner, Morelli, and Squintani (2015) in detail in Section 5.[6]

In Balzer and Schneider (2019) we consider a different class of games ('conflicts') that follow a resolution attempt. There, our aim is to draw connections to the information-design literature characterizing when and how a designer can alleviate her problem by sending additional signals to the agents. Our result on additional information revelation, Proposition 4, builds on the findings in Balzer and Schneider (2019). Thus, whereas Balzer and Schneider (2019) considers abstract and hard-to-interpret game forms to provide a methodological insight, the present article characterizes the optimal ADR mechanism and provides a connection to real-world mechanisms.

Roadmap. We set up an abstract model in Section 2 and analyze it in Section 3. In Section 4 we show how our findings map to actual ADR mechanisms. Section 5 discusses the key assumptions of the model and extends our setting. Section 6 concludes.

2 Model

Environment. There are two risk-neutral disputants, Plaintiff (P) and Defendant (D). Plaintiff has incurred damages $W > 0$. According to the commonly known facts, parties agree that Defendant is liable for damages $S \in [0, W)$. However, parties dispute over the liability for the remainder $X \equiv W - S > 0$.[7] A third party, e.g. a judge or an arbitrator, may rule on the liability of X based on evidence provided by the disputants. This evidence, however, is yet to be produced through witness testimonies, documents produced by expert witnesses, private investigators, etc. Evidence provision is costly, and each party has private information about her cost of evidence provision. Cost captures access to witnesses, data that can be submitted to the expert witness, rates of the investigators, etc.

[6]Other articles studying peace negotiations make similar assumptions (Bester and Wärneryd, 2006; Fey and Ramsay, 2011; Meirowitz et al., 2019; Zheng, 2019). Zheng and Kamranzadeh (2018) discuss take-it-or-leave-it settlement offers in an environment isomorphic to ours.

[7]Liability for S is uncontested. This assumption can be relaxed by, e.g., a small fixed cost of providing convincing evidence (the 'facts') on S. Plaintiff would provide it in any hearing. The expected utility in hearings reduces by a constant in an otherwise identical model. The 'facts' on X, in turn, are unclear.

Let $i \in \{P, D\}$. Disputant i's marginal cost of evidence provision, $\theta_i \in \{1, K\}$ with $K > 1$, is constant and binary. We say a disputant is *strong* when she has a low cost, $\theta_i = 1$, and *weak* when she has a high cost, $\theta_i = K$. Each disputant draws her cost independently from the same distribution represented by p, the probability that $\theta_i = 1$.[8]

There are two basic ways to solve the dispute. Parties can either *settle* or solve the dispute by means of an *evidentiary hearing*; we denote the event of a hearing by L. Settlement includes any agreement about the liability of X. It comes without any additional evidence provision. An evidentiary hearing, in contrast, is an adversarial process that determines who is liable for X after the disputants present evidence.[9]

The disputants can unanimously decide to opt into a given ADR mechanism defined below. If either party refuses to join ADR, an evidentiary hearing—litigation—follows. Once the disputants unanimously agree to ADR, they commit to obey any ruling coming from ADR. Importantly, the ADR designer can also rule to hold an evidentiary hearing. In the analysis, we drop the constants W and S for notational clarity and focus on the contested part X.

For all our qualitative results we do not have to impose any restrictions on the parameter space. However, to provide a (closed-form) characterization of optimal ADR (Proposition 1 below) and to facilitate the algebra we make the following assumption on the parameters (p, K).

Assumption 1. $K > 2$ and $p \in [\underline{p}, \overline{p})$ where $\underline{p} := (2(K-1) - \sqrt{8 - 4K + K^2})/(2 + 3K)$ and $\overline{p} := (K-2)/(2(K-1))$.

The assumption on the lower bound $\underline{p}$ ensures a closed-form solution. The upper bound $\overline{p}$ rules out trivial cases in which full settlement is achieved by the simple proposal to split the burden of X equally. Conversely, if $p < \overline{p}$ no full-settlement mechanism (no matter how sophisticated) exists. Assuming $K > 2$ is equivalent to assuming $\overline{p} > 0$.[10]

Evidentiary Hearing. For simplicity, we assume that evidentiary hearings inside ADR and litigation, a hearing outside ADR, are identical with respect to the marginal cost of evidence provision. Further, we assume that the outcome of an evidentiary hearing has an *all-or-nothing* structure with respect to the contested component X. If D's evidence is more convincing, she is ruled to be liable only for S. If P's evidence is more convincing, D is ruled to be liable for all of W. An evidentiary hearing is a legal contest where disputants compete in providing evidence to an authority (see Rubinfeld and Sappington, 1987; Katz,

[8] The symmetry assumption is entirely driven by the ease of exposition. Including asymmetries in the cost distributions does not affect the qualitative results. In fact, the asymmetry is reversed: suppose P is ex-ante stronger, then D becomes stronger in any on-path hearing.

[9] The information in our model is about the time, cost, and effort it takes to improve the legal argument on the intensive margin. Relaxing this assumption by, e.g., introducing a maximum evidence level complicates the model substantially, yet the basic intuition remains.

[10] Observe that $\overline{p} < 1/2$ as it is increasing in K and converges to $1/2$ as $K \to \infty$. In addition, because $K > 2$, $\underline{p} < \overline{p}$ and $\underline{p} \in (0, 1/3]$. We provide a computer program on our websites to compute (numerical) solutions for $p < \underline{p}$.

1988, for early related models). Whichever party provides the highest quality of evidence wins.[11]

Disputant i chooses the quality level of the evidence she provides, $a_i \in [0, \infty)$. Increasing the quality of evidence is costly and, given evidence profile (a_i, a_{-i}), type θ_i obtains ex-post utility

$$u(a_i; a_{-i}, \theta_i) = \begin{cases} X - \theta_i a_i & \text{if } a_i > a_{-i} \\ -\theta_i a_i & \text{if } a_i < a_{-i} \\ X/2 - \theta_i a_i & \text{if } a_i = a_{-i}. \end{cases}$$

ADR. We use a mechanism-design approach and assume that ADR is designed ex-ante by a neutral third party with full commitment power—the designer. For now, we focus on direct revelation mechanisms. ADR is thus a mechanism in which disputants report their types by sending a private message $m_i \in \{1, K\}$ to the designer. ADR results in one of two outcomes: settlement or evidentiary hearing. Settlement directly awards a share $x_i(m_i, m_{-i}) \in [0, X]$ to disputant i. ADR cannot increase the overall surplus, $x_P(m_P, m_D) + x_D(m_D, m_P) \leq X$. At the optimum, whenever there is settlement, ADR distributes the entire surplus X among participants. Therefore, assuming $x_P(m_P, m_D) + x_D(m_D, m_P) = X$ does neither alter the analysis nor the results.

Formally, ADR is a mapping $(m_P, m_D) \mapsto (x_P, x_D, \gamma)$, where $\gamma(\cdot, \cdot) \in [0, 1]$ is the *likelihood* that ADR invokes an evidentiary hearing.[12] ADR is incentive compatible if disputants truthfully report their type in equilibrium.

Timing. The timing of the game is as follows.

1. ADR is publicly announced and disputants learn their types privately.
2. Disputants decide whether to participate in ADR.
3. One of the following two events occurs.
   (a) If either disputant rejects to participate in ADR, ADR is void and the parties move to litigation—an evidentiary hearing. The disputants update their beliefs, choose their strategies a_i in the hearing, and realize payoffs $u_i(a_i; a_{-i}, \theta_i)$. *The game ends.*
   (b) If neither disputant rejects to participate in ADR, each sends a message m_i in private to ADR, and each party is committed to the outcome of ADR. The game moves to 4.
4. One of the following two events occurs.
   (a) With probability $1 - \gamma(m_P, m_D)$ the disputants settle and realize payoffs equal to their share $x_i(m_i, m_{-i})$. *The game ends.*
   (b) With probability $\gamma(m_P, m_D)$ ADR moves to an evidentiary hearing. The

[11] We choose this all-or-nothing structure for simplicity. It is the limiting case of a Tullock contest, where awards smoothly depend on both disputants' evidence levels. Moreover, introducing differences between litigation and within-ADR hearings has no qualitative effects on the outcomes.

[12] We use the convention that for any i the corresponding $\gamma_i(\theta_i, \theta_{-i}) \equiv \gamma(\theta_P, \theta_D)$ to shorten notation.

disputants update their beliefs, choose their strategies a_i in the hearing, and realize payoffs $u_i(a_i; a_{-i}, \theta_i)$. *The game ends.*

Define

$$V^{\theta_i} := \max_{a_i} \mathbb{E}_{a_{-i}}[u(a_i; a_{-i}, \theta_i)|i \textit{ rejects ADR}], \text{ and}$$
$$U_i(m_i; \theta_i) := \max_{a_i} \mathbb{E}_{a_{-i}}[u(a_i; a_{-i}, \theta_i)|m_i].$$

That is, V^{θ_i} is the ex-ante expected payoff for a hearing in stage 3(a) and $U_i(m_i; \theta_i)$ is θ_i's ex-ante expected payoff for a hearing in stage 4(b) after report m_i. Notice that both expectations are conditional on disputants' own behavior prior to the hearing.[13] The expected payoff from participating in ADR and reporting m_i is

$$\Pi_i(m_i; \theta_i) := \overbrace{p(1-\gamma_i(m_i, 1))x_i(mi, 1) + (1-p)(1-\gamma_i(m_i, K))x_i(m_i, K)}^{:=z_i(m_i),\ \textit{the settlement value}}$$
$$+ \underbrace{\Big(p\gamma_i(m_i, 1) + (1-p)\gamma_i(m_i, K)\Big)}_{:=\gamma_i(m_i)} U_i(m_i; \theta_i).$$

Solution Concept and Objective. Our solution concept is perfect Bayesian equilibrium. Our objective is to find the ADR mechanism that maximizes the *settlement rate*, i.e. the ex-ante likelihood of settlement. The most direct way to map our abstract model to reality is to assume that ADR is court-annexed. That is, Plaintiff has filed a lawsuit and the court proposes a specific court-sponsored ADR mechanism to settle the dispute outside litigation. Judges and legal clerks are mainly interested in reducing the burden on the court system by achieving early settlement. We provide further discussion and an alternative objective in Section 5.

3 Optimal ADR

In this section we present our main findings. We start at the end of the game and analyze the continuation game of the evidentiary hearing.

3.1 Evidentiary Hearing

Evidentiary hearings serve as the continuation game in two cases: (i) if one of the disputants rejects participating in ADR, or (ii) if ADR does not result in a settlement. In either case, the parties use the information they obtain to update their beliefs about their opponent's cost. In the first case, parties receive information on who refused to participate. In the second case, the parties update their strategies based on their knowledge of the ADR protocol and the history of play up to this point of the game. Plaintiff computes a *posterior*

[13] The reason is that disputants' strategies within the evidentiary hearing depend on their updated beliefs (and that of their opponent). These beliefs, in turn, are affected by their previous behavior.

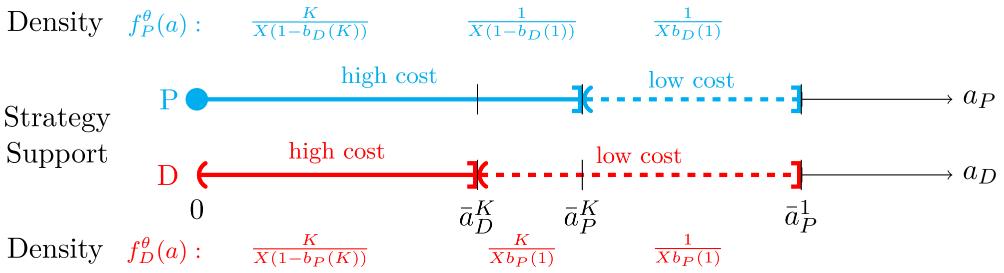


Figure 2: **Equilibrium evidence provision in on-path hearings.** Types uniformly mix over intervals. Solid lines denote the strategy support of $\theta_i{=}K$; dashed lines denote that of $\theta_i{=}1$. Above (below) is the respective density on the interval of P (D). Interval boundaries are $\overline{a}_D^K = \frac{X(1-b_P(K))}{K}$, $\overline{a}_P^K = \overline{a}_D^K + \left(1 - \frac{b_D(1)}{b_P(1)}\right) \frac{Xb_P(K)}{K}$, and $\overline{a}_P^1 = \overline{a}_P^K + Xb_D(1)$.

belief—the (subjective) probability Plaintiff attaches to Defendant having low cost—using Bayes' rule starting from the prior p. Similarly, Defendant computes a posterior belief about Plaintiff. Each one also forms a belief about the opponent's belief formation and so on. On the equilibrium path, all higher-order beliefs are correct.

As we show below in Lemma 2, the mechanism-design approach allows us to restrict attention to cases in which all types participate in ADR on the equilibrium path. Thus, the *post-veto belief* b_i^v that disputant i holds after $-i$'s refusal to participate is *off the equilibrium path* and thus arbitrary. We select an off-path belief $b_i^v = p$: i does not infer anything from observing that $-i$ unexpectedly rejects ADR. It turns out that no other off-path belief yields a higher settlement rate.

The belief that disputant i holds after settlement *within* ADR fails, $b_i(m_i)$, may be both an *on and off equilibrium path* object. This belief depends on the ADR mechanism and the history of play, i.e. how the parties behaved during ADR. In the direct revelation mechanism disputant i does not observe her opponent's type report. Thus, disputant i's history of play only contains her own type report and the fact that no early settlement is found. Therefore, we denote the information of player i conditional on no early settlement by $m_i \in \{1, K\}$. Moreover, on the equilibrium path parties reveal their information truthfully and thus $m_i = \theta_i$.

For the sake of exposition, we focus here on the case in which Defendant appears stronger than Plaintiff *conditional on an (on-path) hearing.*

$$b_P(1) \geq b_D(1) \qquad \text{and} \qquad b_P(K) \geq b_D(K). \tag{1}$$

There are three other potential cases. Beliefs, however, are endogenous to the design of ADR; any potential ADR mechanism that induces $b_i(1) \geq b_{-i}(1)$ also induces $b_i(K) \geq b_{-i}(K)$ (Lemma 3 in Appendix A.1 provides the formal argument). Thus, the only other relevant case is the one in which both *both* inequalities in (1) are flipped. As parties are ex-ante symmetric, this case is redundant.

Using backward induction we solve the evidentiary hearing game for arbitrary beliefs $b_i(m_i)$. Here, we focus on the description of the on-path continuation game. The disputants play mixed strategies and randomize their actions a_i. Figure 2 sketches the equilibrium strategy support. We discuss the off-path counterpart in Appendix A.1. Monotonicity conditions are common to the literature on contests (see Siegel, 2014). In our model, the monotonicity condition is[14]

$$Kb_i(1) > b_i(K) > 1 - K(1 - b_i(1)). \tag{M}$$

Because beliefs are endogenous (M) could be violated under optimal ADR. This turns out not to be the case. In Appendix C.1 we provide the respective arguments. In what follows, we characterize the equilibrium payoffs under conditions (1) and (M). A detailed construction, including expressions of all relevant terms, is provided in Appendix C.2 using the algorithm from Siegel (2014). To characterize optimal ADR, describing the following payoffs is sufficient. By abusing notation slightly we use $U_i(\theta_i)$ as the payoff of type θ_i (given some believes $b_i(\theta_i)$) in a hearing.

Lemma 1. *Under conditions* (1) *and* (M)*, the disputants' expected payoffs in a hearing satisfy* $U_D(1) = U_P(1) > U_D(K) \geq U_P(K)$ *and take the form*

$$\begin{aligned} U_i(1) &= \left(1 - b_D(1) - \frac{1}{K}\Big(1 - \frac{b_P(K)b_D(1)}{b_P(1)}\Big)\right) X, \\ U_D(K) &= \left(b_P(K) - b_D(K) - \frac{1}{K}\Big(1 - \frac{b_D(1)}{b_P(1)}\Big)\frac{b_P(K)(1 - b_D(K))}{1 - b_D(1)}\right) X, \\ U_P(K) &= 0. \end{aligned} \tag{2}$$

After i's veto, the disputants' beliefs are type independent and (M) is trivially satisfied. Applying Lemma 1 under the off-path belief $b^v_{-i} = p$, we obtain the expected continuation payoff of type θ_i who refuses to participate in ADR off the equilibrium path,

$$V^{\theta_i} := \begin{cases} (1-p)\frac{(K-1)}{K}X & \text{if } \theta_i = 1 \\ 0 & \text{if } \theta_i = K. \end{cases}$$

From the formulation of V^{θ_i} it is evident that full settlement is possible if $V^1 < X/2$: the disputants simply split liability. Each receives $x_i(\cdot,\cdot) = X/2$. Such a mechanism is trivially implementable through bilateral bargaining and needs no third party. However, because low cost are sufficiently rare $p < \overline{p}$ such a split cannot be achieved and $V^1 > X/2$.

We want to stress that we also abstract from cases in which parties can contract to waive any form of hearings before they have any sort of private information about their cost of evidence production. As hearings are costly and parties are risk-neutral such contracts imply an outside option of $pV^1 + (1-p)V^K < X/2$. Contracting to share the burden

[14] This condition ensures that low-cost types mix on higher intervals than high-cost types. A high-cost Defendant, for example, is indifferent between any $a \in (0, \bar{a}^K_D]$. Thus, $X(1 - b_D(K))f^K_P(a) = K$ for any such a implying $f^K_P(a) = K/(X(1 - b_D(K)))$. Under (M), a low-cost Defendant's utility increases in $a \in (0, \bar{a}^K_D]$: $X(1 - b_D(1))f^K_P(a) \geq 1 \Leftrightarrow b_D(K) \geq 1 - (1 - b_D(1))$. The left inequality of (M) follows from imposing that a high-cost Defendant's utility decreases in $a > \bar{a}^K_D$.

is always optimal. Instead, in our model ADR is designed at an interim stage when the Plaintiff's damages have already realized.

3.2 Optimal ADR

We characterize optimal ADR in two steps. First, we state the designer's problem. Second, we provide a characterization and interpretation of optimal ADR.

The Designer's Problem

We now describe the designer's problem. We first describe the payoff a disputant expects from participating in ADR. This payoff is a weighted sum of her expected outcome when the case settles early and her expected payoff from the continuation game when the case moves to an evidentiary hearing. Weights are determined by the probabilities of the two events. The probability to move to an evidentiary hearing is

$$\gamma_i(m_i) := p\gamma_i(m_i, 1) + (1-p)\gamma_i(m_i, K).$$

Under early settlement, no evidence is produced, types are irrelevant, but *type reports* determine the outcome. We summarize the part of the payoff coming from early settlement by the *settlement value*:

$$z_i(m_i) := p(1-\gamma_i(m_i, 1))x_i(m_i, 1) + (1-p)(1-\gamma_i(m_i, K))x_i(m_i, K).$$

From Lemma 1 we know that the continuation payoff in an evidentiary hearing depends on the disputants' beliefs. Because ADR is a direct revelation mechanism the disputants report truthfully on the equilibrium path. The belief of disputant i who reports m_i is then

$$b_i(m_i) := \frac{p\gamma_i(m_i, 1)}{\gamma_i(m_i)}.$$

Incentive compatibility means that no disputant has an incentive to misreport her type. That incentive depends on the disputant's continuation payoff, following a misreport in ADR. Deviations are not immediately detected, which creates a situation of *non-common* knowledge: deviators are aware of the deviation, but the non-deviating opponent is not.[15] The opponent is thus expected to follow her equilibrium strategy. The continuation payoff of i after a deviation is

$$U_i(m_i; \theta_i) = \sup_{a_i} F_{-i}(a_i|b_i(m_i)) - a_i\theta_i, \tag{3}$$

where $F_{-i}(a_i|b_i(m_i))$ is the expected probability that $a_i > a_{-i}$, given deviator i's belief $b_i(m_i)$. The function $F_{-i}(a_i|b_i(m_i))$ is an equilibrium object of evidentiary hearing. We

[15] For example, if type $\theta_i = K$ reported $m_i = 1$, she holds the belief $b_i(1)$ whereas her opponent thinks she holds the belief $b_i(K)$.

fully characterize the continuation game after any history in Appendix C.2.

Multiplying $\gamma_i(m_i)U_i(m_i;\theta_i)$ describes the ex-ante value attributed to evidentiary hearings inside ADR. The total expected payoffs from participating in ADR and reporting m_i are thus

$$\Pi_i(m_i;\theta_i) := z_i(m_i) + \gamma_i(m_i)U_i(m_i;\theta_i). \tag{4}$$

The ADR protocol is *incentive compatible* if and only if

$$\forall i, \theta_i, m_i : \Pi_i(\theta_i;\theta_i) \geq \Pi_i(m_i;\theta_i).$$

By a small abuse of notation, we drop the argument m_i whenever it is unambiguous from the context that incentive compatibility holds. Incentive-compatible ADR can be implemented with *full participation* if and only if

$$\Pi_i(\theta_i) \geq V^{\theta_i}.$$

Lemma 2. *There exists an incentive-compatible ADR mechanism with full participation that is optimal.*

This result is a direct implication of the revelation principle. It follows because ADR can replicate any outcome outside ADR by promising an evidentiary hearing inside ADR. Thus, any hearings follow a failed early settlement attempt through the ADR mechanism. We denote the probability of a hearing by $Pr(L)$.

To find the optimal ADR mechanism the designer has to solve the following program:

$$\begin{aligned} \min_{(\gamma_i,x_i)} \; & \underbrace{p^2\gamma(1,1) + p(1-p)\gamma(1,K) + (1-p)p\gamma(K,1) + (1-p)^2\gamma(K,K)}_{=:Pr(L)} \\ \text{s.t. } \forall\theta_i, i, m_i : \quad & \Pi_i(\theta_i) \geq \Pi_i(m_i;\theta_i) \text{ and} \\ & \Pi_i(\theta_i) \geq V^{\theta_i}. \end{aligned} \tag{5}$$

Second-Best ADR

We now present the solution to the designer's problem. The most compact way to characterize optimal ADR is through the *information structure* that ADR induces, i.e. the distribution of (θ_P, θ_D) conditional on failed settlement. This characterization also determines the properties of optimal ADR in an intuitive way.

A sufficient statistic for the information structure is the triple $(\rho_P, \rho_D, b_P(1))$. Whereas $b_P(1)$ is the familiar belief defined above, $\rho_i := Prob(\theta_i{=}1|\text{no settlement})$ describes the ex-ante expected probability that disputant i has low cost, conditional on ADR resulting in an evidentiary hearing. Statistically, ρ_i is a marginal probability. It marginalizes out the information about $-i$. Given the marginal probabilities, the belief $b_P(1)$ captures the correlation between beliefs. Thus $(\rho_P, \rho_D, b_P(1))$ describes the information structure. Appendix A provides the technical details. We now characterize optimal ADR.

Proposition 1 (Optimal ADR). *Under Assumption 1 optimal ADR is characterized by inducing an information structure* $b_i(1) = b_i(K) = \rho_{-i} = (1+p)/2$ *and* $b_{-i}(1) = b_{-i}(K) = \rho_i = (1-p)/2$.

Proposition 1 implies that optimal ADR is characterized by the information structure it induces in an evidentiary hearing. Thus, managing the information flow between the disputants is key to the success of ADR. Only to arrive at the closed-form solution of Proposition 1 we need that $p \geq \underline{p}$ and hence Assumption 1. The following corollary to Proposition 1 that describes the main properties of optimal ADR holds also for $p < \underline{p}$.

Corollary 1. *Optimal ADR implies the following features.*

(Induced Asymmetry). *The distribution of types in hearings is asymmetric,* $\rho_P \neq \rho_D$.

(Report-Independent Information). *The information a disputant obtains within ADR is independent of her type report,* $b_i(m_i) = \rho_{-i}$.

(No Guarantees). *Any pair of types,* (θ_P, θ_D)*, fails to settle with positive probability,* $b_i(K) < 1$.

To see the intuition behind Corollary 1, note first why full settlement is not achievable: (i) low-cost types prefer direct litigation to full settlement and (ii) types are irrelevant under settlement. The first property, *induced asymmetry*, addresses (i). The other two properties, *report-independent beliefs* and *no guarantees*, address (ii).

Induced Asymmetry. Asymmetry decreases the expected expenditure on evidence. Any such reduction benefits the parties' aggregate welfare in a hearing. If settlement fails with positive probability, a ceteris paribus increase in aggregate welfare in the hearing implies an increase in the value of participating in ADR. A high value of participation relaxes the participation constraint. The designer can implement a mechanism with a higher settlement rate.

Asymmetry operates through a discouragement effect. If a low-cost type is sure to face a high-cost type and vice versa, both types are reasonably certain about the outcome. The high-cost type has little incentives to invest in evidence provision. She expects to lose with high probability. The low-cost type, too, has little incentives to invest into evidence provision. She expects to win even absent high-quality evidence.

The stronger the asymmetry, however, the larger the settlement share that ADR has to promise the disadvantaged party to compensate her for the worse prospects in the continuation game. That promise is costly to the designer. The trade-off implies an interior level of asymmetry.

Report-Independent Information. The amount of information conveyed to P is independent of the information that P provides herself. The same is true for D. Absent this property, a party that misreports receives an information advantage. If she misreports her type, she manipulates the distribution she faces. Consider, e.g., $\theta_P = K$ who reports $m_P = 1$. Her deviation implies that she holds belief $b_P(1)$ after settlement has failed. The non-deviating D cannot detect the deviation and expects any type $\theta_P = K$ to hold belief $b_P(K)$. That (incorrect) second-order belief implies that the deviator P, being aware of her own deviation, has an information advantage.

The deviator can leverage that information advantage. The non-deviator follows her equilibrium strategy. Recall that the equilibrium is in mixed strategies. If $b_P(1) \neq b_P(K)$, the deviator P optimally chooses a pure strategy. Moreover, and different from on-path equilibrium reasoning, her change in behavior does not influence D's strategy because D *expects* on-path beliefs and thereby on-path behavior. Under report-independent information these considerations are irrelevant. Independent of the report, P holds belief ρ_D about D and optimally follows her on-path mixed strategy, even after a deviation.

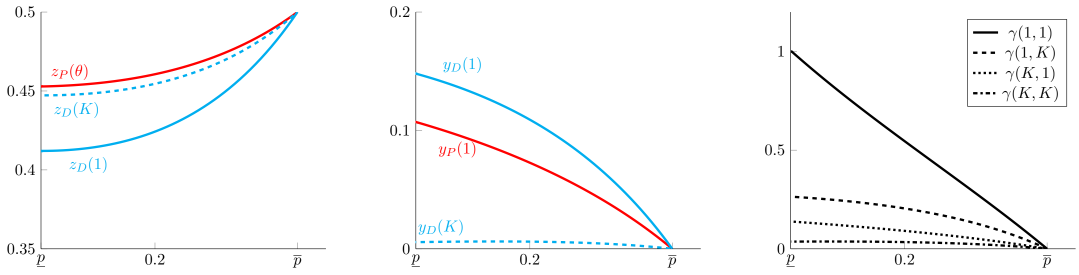
Report-independent information resembles the intuition from a second-price auction. There, to ensure incentive compatibility, the payment conditional on winning is independent of a bidder's type report. Similarly here, to ensure incentive compatibility, the belief conditional on failed settlement is independent of a disputant's type report.

No Guarantees. This property implies that no 'easy settlements' exist. Suppose instead that the designer guarantees settlement if both disputants have high cost. Further, assume that both P and D have high cost, but P mimics the low-cost type in ADR. If D observes that settlement fails, she is sure to face a low-cost P. She is pessimistic about her chances of winning in the hearing. The pessimism discourages her from investing in evidence provision. Disputant P can leverage D's pessimism. P has to invest little into evidence to win against D, simply because D *expects* P to have low cost. This, of course, increases P's incentives to misreport. At the optimum, the designer shuts down this channel by sending all type pairs into the hearing with positive probability.

3.3 Implications

We now address the implications of the optimal ADR protocol. We begin by describing payoffs. We then discuss how changes in p affect optimal ADR. Finally, we show how ADR affects legal expenditure and thus welfare, even if it fails to settle the case.

Payoffs. A disputant's ex-ante expected payoff consists of two parts. One is the value she obtains from a settlement solution. The other is the hearing value. Panel (a) and panel (b) in Figure 3 plot these values for different levels of the strong type's ex-ante likelihood, p. Under optimal ADR Plaintiff and Defendant are treated asymmetrically. Indeed, Plaintiff's settlement value does not depend on her type whereas Defendant's settlement value does. Moreover, Plaintiff obtains a larger settlement value than Defendant. The asymmetry is reversed when considering the hearing values in panel (b). A weak Plaintiff obtains no value from a hearing, whereas a weak Defendant's hearing value is positive. In addition, a strong Plaintiff's hearing value is also lower than that of a strong Defendant, as a strong Defendant expects a hearing to occur with larger probability than a strong Plaintiff. The



(a) Settlement Values $z_i(m_i)$

(b) Hearing Values $y_i(\theta_i) := \gamma_i(\theta_i)U_i(\theta_i)$

(c) Failure Rates $\gamma(m_A, m_B)$

Figure 3: **Properties of the optimal mechanism as a function of p (with $K = 3, X = 1$).** Panel (a) depicts the (probability weighted) ex-ante payoff a disputant i expects to obtain through settlement given her type $\theta \in \{1, K\}$. Panel (b) depicts the (probability weighted) ex-ante payoff that she expects to obtain through a hearing. Panel (c) depicts the probability that settlement fails given a specific type profile (θ_P, θ_D).
For $K = 3$, $\underline{p} = (4 - \sqrt{5})/11 \approx 0.16$ and $\overline{p} = 1/4$.

designer, however, only indirectly cares about disputants' payoffs. Her goal is to minimize the failure rate. By doing so, as we can see in panel (c) of Figure 3, she treats all type profiles differently and thereby induces these asymmetries.

Moreover, panel (c) illustrates the differences in failure rates. The probability of failure is largest for two strong disputants and smallest for two weak ones. However, by the no-guarantees property from Corollary 1, the designer induces a positive probability of failure for any type profile (θ_A, θ_B). Specifically, the failure rates are

$$\begin{pmatrix} \gamma(1,1) & \gamma(1,K) \\ \gamma(K,1) & \gamma(K,K) \end{pmatrix} = \alpha \begin{pmatrix} 1 & \frac{p}{1+p} \\ \frac{p(1+p)}{(1-p)^2} & \left(\frac{p}{1-p}\right)^2 \end{pmatrix}, \tag{6}$$

where α is a scalar in $[0, 1]$ given by[16]

$$\alpha = \frac{1-p^2}{4p^2} \frac{2p(1-p)\frac{K-1}{K} - p}{\frac{1}{2}(1+p^2)\frac{K-1}{K} - p}, \tag{7}$$

which implies an ex-ante expected likelihood that settlement fails of

$$Pr(L) = \frac{4p^2}{1-p^2}\alpha = \frac{2p(1-p)\frac{K-1}{K} - p}{\frac{1}{2}(1+p^2)\frac{K-1}{K} - p}.$$

From a disputant's point of view not only the likelihood of failure but also the payoff conditional on the hearing is relevant. This payoff determines both whether the disputant wants to participate in ADR and, if she does so, what type to report. At the optimum, a weak Plaintiff expects to face a (comparatively) strong Defendant once settlement fails. Thus, she expects zero payoffs from hearings. A weak Defendant, in turn, expects to face a weaker Plaintiff and thus expects strictly positive payoffs from hearings. Strong disputants

[16] The computation of α follows from plugging the results below into the designer's (binding) budget constraint, $1 - Pr(L) = \sum_i (pz_i(1) + (1-p)z_i(K))$.

know that their opponent is at most as strong as them and thus receive a strictly positive payoff. To summarize, the on-path payoffs in a hearing are

$$\begin{aligned} U_P(K) &= 0, \\ U_D(K) &= (\rho_D - \rho_P)\frac{K-1}{K}X = p\frac{(K-1)}{K}X, \\ U_i(1) &= (1-\rho_P)\frac{K-1}{K}X = (1+p)\frac{(K-1)}{K}\frac{X}{2}. \end{aligned}$$

Weighting these payoffs with their relative likelihoods using p and $\gamma(\theta_P, \theta_D)$ we obtain the hearing values depicted in panel (b) of Figure 3. The ex-ante expected payoff is the sum of the respective value in panel (a) and panel (b) of Figure 3. For strong types it is the same as that from rejecting ADR altogether. That is,

$$\Pi_i(1) = z_i(1) + y_i(1) = V^1 = (1-p)\frac{K-1}{K}X.$$

Weak types need an incentive to report their weakness to the designer. Thus, at the optimum, their payoff from truthfully reporting equals that of a misreport. Because a weak Plaintiff expects no payoff from a hearing, incentive compatibility implies that her settlement value, $z_P(K)$, is the same as that of a strong Plaintiff. A weak Defendant obtains positive payoffs from hearings. Thus, to be willing to truthfully report her type, she needs to obtain a settlement value that is *larger* than that of her strong counterpart. Yet, because of the positive hearing value, that settlement value is smaller than that of a weak Plaintiff. Total payoffs for weak types are the same, that is,

$$\Pi_D(K) = z_D(K) + y_D(K) = (1 - p(1+\alpha))\frac{K-1}{K}X = z_P(K) = \Pi_P(K). \tag{8}$$

Using the payoffs characterized above we can calculate the net gains in welfare from ADR. Strong types receive the same payoff as they would absent ADR. Thus, the welfare gain from offering ADR equals the expected payoff of the weak types multiplied by the likelihood with which they are present. The net gain in welfare, $\Delta(Welfare)$, is

$$\Delta(Welfare) = 2(1-p)\Pi_P(K) = 2(1-p)(1-p(1+\alpha))\frac{K-1}{K}X.$$

Comparative Statics. Figure 3 also illustrates the comparative statics of the optimal mechanism with respect to parameter p. There are two major obstacles to settlement: the strong type's incentive to veto ADR and the weak type's incentive to misreport within ADR. Making hearings more likely for the strong type serves as a remedy to both. First, hearings mitigate the incentive to veto by promising the strong type enough chances to leverage her strength. Second, increasing the risk of hearings makes it more costly for the weak type to misrepresent her type.

Within our model, both parameters p and K capture the power imbalance between strong and weak types. Whereas K directly measures the differences in costs, the implications of p are more subtle. The smaller p, the smaller the chances to meet a strong type. As a consequence, the quality of evidence needed to win a hearing is (in expectations) low. A strong type's expected payoff in a hearing becomes (all else equal) larger.

If p is small, optimal ADR thus fosters strong types' participation by offering them hearings with high probability. Everything else equal, the settlement rate declines. However, at the same time, if p is small strong types are unlikely to be present. Everything else equal, the settlement rate increases. Starting from the full settlement bound $\overline{p}$ and decreasing p the first effect dominates the second effect because at $\overline{p}$ all types always settle and split the surplus such that $z_i(\theta_i) = X/2$. However, once p becomes sufficiently small the second effect dominates the first effect. The reason is that the smaller p, the less costly it is to test a disputant's claim to be strong by sending her to a hearing. Thus, when p decreases, incentivizing weak types to report truthfully implies smaller costs on the settlement rate. Indeed, although we formally exclude the case in which $p < \underline{p}$, in the limit where $p \to 0$ those costs vanish and the settlement probability approaches one. The settlement rate is u-shaped in p.[17]

Overall the settlement rate is above 50% independent of parameter choices including cases in which $p < \underline{p}$.

Legal Expenditure. Total legal expenditure describes the welfare loss due to evidence provision in hearings. Our ADR mechanism does not explicitly target welfare. Instead it aims at maximizing the settlement rate. As expenditure reduces to 0 if ADR settles, a total welfare gain is not surprising.

However—perhaps more surprising—is the fact that also cases that fail to settle are solved more efficiently compared to the no ADR situation.

Proposition 2. *Expected expenditure conditional on failed settlement in ADR is smaller than expected expenditure absent ADR.*

There are two factors driving this result. The first is that the composition of type profiles after failed settlement differs. In particular, there are more low-cost types compared to the benchmark without ADR. Thus, even for the same average evidence level, average costs are lower. Second, the disputants adjust their strategies due to the changed composition of types. In particular, a high-cost D invests less into evidence provision as she expects to face a pessimistic high-cost P with larger probability.

4 Implementation

Proposition 1 provides an abstract benchmark for optimal ADR. In reality, the most prevalent form of ADR is mediation. Stipanowich (2004) reports that almost all corporations

[17] The comparative statics in K are straight-forward. As K increases, the participation constraint becomes tighter and the settlement rate decreases ceteris paribus to adjust for that.

(98%) in the Fortune 1000 Corporate Counsel Survey have experienced mediation as a version of ADR. In 2011, mediation was offered as ADR in more than 2/3 of the US District Courts—with more than 1/4 of the District Courts offering mediation as the only form of ADR (Stienstra, 2011). In what follows, we provide a mediation mechanism that implements optimal ADR.

4.1 Mediation

The main difference between our benchmark model and mediation is that mediation typically involves lower commitment on the part of the disputants. Even if the mediator provides a settlement offer, the parties can decide to (unilaterally) reject it and enforce a hearing. Mediation can take many forms in practice and among those districts that offer mediation as an ADR technique, the individual regulations differ substantially (see e.g. Stienstra, 2011).

Here, we show how a particular mediation mechanism, close to the one outlined in Klerman and Klerman (2015), implements optimal ADR.[18] For concreteness, most of our discussion centers around parameterized example with $(X, K, p) = (1, 3, 1/5)$. However, our result is general: the presented protocol implements optimal ADR. The main reason is that it allows both parties to retain privacy (which ensures compliance at the reporting stage). Indeed, although the underlying mechanism is precisely communicated, the communication from the mediator to a disputant is sufficiently imprecise for the disputant not to learn enough about her opponent (which ensures compliance when accepting a closing offer).

Definition 1 (Mediation—based on (Klerman and Klerman, 2015))**.**

1. P reports her reservation value, r_P, in private to the mediator.
2. D reports her reservation value, r_D, in private to the mediator.
3. The mediator prepares a separate *term sheet* which offers a *guaranteed share*, $\underline{x}_i$—a guaranteed minimum share in case the disputant accepts settlement—to each party. The mediator announces the guaranteed share to each party.

4a. If both parties agree, the final settlement agreement is implemented and parties receive their actual shares, which are at least as high as their *guaranteed shares.*

4b. If either party rejects an offer, the proposals become public and the parties return to the litigation track.

Example. Consider the following numerical example: $(X, K, p) = (1, 3, 1/5)$. Under that example the outside option to ADR for strong types is $V^1 = 8/15$, that of weak types is (as for all specifications) $V^K = 0$. An (expositionally) simple way to implement optimal ADR through mediation in this example is the following.

1. After the mediator collects the reservation value reports, she offers

[18] It also contains many elements typical of other mediation protocols used in practice. For an overview see Goldberg et al. (2017), in particular Chapter 4. For the connection to our model, see the discussion in Section 4.2.

(a) Plaintiff a guaranteed share of $\underline{x}_P = 7/15$ with probability 1 if her report was 7/15 or above. Otherwise, she offers Plaintiff a guaranteed share of $\underline{x}_P = 43/105$ with probability 1.

(b) Defendant a guaranteed share of $\underline{x}_D = 8/15$ with positive probability if her report was 8/15 or above. Otherwise, she offers Defendant a guaranteed share of $\underline{x}_D = 17/40$ with positive probability. For any report by Defendant, however, there is a positive probability, that the mediator offers her no guaranteed share, $\underline{x}_D = 0$.

2. The likelihood that she offers Defendant no guaranteed share depends on the report of *both* disputants and is (with abuse of notation)

$$\gamma(\geq 7/15, \geq 8/15) = 6/11, \qquad \gamma(\geq 7/15, < 8/15) = 9/44, \tag{9}$$
$$\gamma(< 7/15, \geq 8/15) = 1/11, \qquad \gamma(< 7/15, \geq 8/15) = 3/88.$$

3. If either party rejects her share, settlement has failed and the parties return to litigation. If *both* parties accept their guaranteed shares they receive their guaranteed shares. If these guaranteed shares do not add up to 1, the mediator uses the following rule to distribute the remainder:

(a) If Defendant accepted a 0 guaranteed share, Plaintiff obtains the entire remainder, $(1 - \underline{x}_P)$, in addition to $\underline{x}_P$.

(b) If Plaintiff (Defendant) accepted guaranteed share 7/15 (8/15), she obtains the entire remainder, $1 - \underline{x}_P - \underline{x}_D$, as a bonus share.

(c) If Plaintiff accepted a guaranteed share below 7/15 *and* Defendant a share below 8/15, then Plaintiff obtains an additional bonus of 59/680 and Defendant obtains an additional bonus of 73/714.

An equilibrium under the protocol outlined above exists where low-cost Plaintiff (Defendant) reports a reservation value of 7/15 (8/15) and a high-cost disputant reports a lower reservation value. Any positive guaranteed share is accepted and Defendant rejects 0 offers. All players prefer participating in mediation to enforcing litigation at the beginning. The values in (9) correspond to those of the optimal mechanism in (6) on page 15 under $(X, K, p) = (1, 3, 1/5)$. Thus, the above protocol implements optimal ADR.

Discussion. There are two important features of that protocol: (i) the mediator can ex-ante commit to her (mixed) strategy and (ii) disputants do not learn their opponent's type from their guaranteed share. In particular, at the acceptance stage Plaintiff still holds the prior belief about Defendant. Defendant, in turn, updates her belief using her knowledge of $\gamma(\cdot, \cdot)$. However, when deciding whether to accept the offer, she is still sufficiently unsure about Plaintiff's type. This ensures that she accepts the offer.

In the above protocol, there is no 'safe message' that guarantees settlement (*no guarantees*) and disputants are treated *asymmetrically.* The belief that, say, Plaintiff holds after observing a rejection by Defendant depends on the likelihood Plaintiff attaches to

Defendant receiving the 0 offer *and* having reported $r_D = 8/15$. That belief is, for a low-cost (high-cost) Plaintiff,

$$\frac{\frac{1}{5}\frac{6}{11}}{\frac{1}{5}\frac{6}{11}+\frac{4}{5}\frac{9}{44}}=\frac{2}{5}, \qquad \left(\frac{\frac{1}{5}\frac{1}{11}}{\frac{1}{5}\frac{1}{11}+\frac{4}{5}\frac{3}{88}}=\frac{2}{5}\right).$$

Thus, beliefs conditional on observing a rejection are *report-independent*.[19] Our next proposition states the general implementation result.

Proposition 3. *Optimal mediation implements the outcome of optimal ADR.*

4.2 Actual Mediation Practices

The above is a stylized implementation. As such, we abstract from actual mediation practices in several ways. Below, we address these differences and discuss whether and how they can be incorporated without changing the basic structure of the above protocol. We postpone discussing the protocol's asymmetry and related fairness issues to an extension in Section 5. There, we provide a potential remedy to guarantee larger procedural fairness.

A feature of the mediation protocol is that *the mediator mixes*—given reports—between announcing an unacceptable guaranteed share leading to a hearing and an acceptable guaranteed share leading to settlement. In addition, the mediator's randomization device is private, which may raise trust issues. Trust in the mediator is a first-order concern in the real-world. Goldberg and Shaw (2007) report that the key skill of successful mediators is to gain the trust and confidence of the parties in the procedure.

Whereas the properties from Corollary 1 imply some randomization in the optimal mechanism, the particular structure we used above is not unique. There also exists an alternative protocol to implement optimal ADR. Under that protocol high-cost types mix between announcements in equilibrium because they are indifferent between signaling low-cost and being truthful. The mediator guarantees settlement for a high-cost report and induces a hearing (with some probability) only for *mutual* low-cost reports. Here the mediator can use a public randomization device. In the online appendix we describe that protocol formally in the context of our numerical example.[20]

Our stylized implementation abstracts from modeling the mediation event sequentially. In contrast, actual mediation (Golann and Folberg, 2016; Goldberg et al., 2017) often starts with a *joint opening session* in which the situation is outlined. Then the parties *caucus*—separate meetings between the parties and the mediator take place. That routine translates to our setting. In the opening session, the parties present the case and work out

[19] Beliefs conditional on settlement are *not* report-independent. Both types start with the same prior, but a low-cost Plaintiff expects to enter litigation more often than a high-cost Plaintiff. By the martingale property, this implies that a low-cost Plaintiff's belief *conditional on settlement* is lower than that of a high-cost Plaintiff.

[20] Note that although the mediator guarantees settlement upon two high-cost reports, two high-cost types still move to hearings with some probability, as they sometimes try their luck through misreporting, hoping for a more favorable settlement outcome.

whether a simple solution is possible, i.e., whether $p > \overline{p}$. Otherwise the common grounds are set and the parties move to caucus and carry out the protocol of Definition 1.[21]

According to our model, parties report their reservation values as first offers (in caucus). In contrast, a common mediation practice (see Golann and Folberg (2016) and Goldberg et al. (2017)) is to ask parties to make a first offer that is "at the limit of what you can reasonably attain." In our model, however, the only purpose of the report is to inform the mediator about the cost of evidence provision. Stating maximum values thus works equally well. However, the mediator has to translate them to guarantees, which implies an extra step in the exposition.

Finally, notice that signing term sheets to confirm intermediate results is common in actual mediation (Moffitt, 2004; Goldberg et al., 2017). These sheets often involve contingent agreements and set the stage for negotiations about the remainder. In our protocol, term sheets are the guaranteed shares the parties agree to. However, just as participants know the mediation protocol, they also know the contingencies that top up the guaranteed share with bonuses. In practice, term sheets—although not always legally binding—provide enough commitment power for the parties to not withdraw from the settlement later. After the term sheets are signed (separately), the mediator prepares the final settlement agreement.

We conclude this part by relating our model to the *Model Standards of Conduct for Mediators* (2005). Although all elements of the conduct can be found in our model, we wish to highlight the connection to two particularly important ones: *Self-Determination* and *Impartiality.* Self-Determination is present in our model. The parties voluntarily select into mediation without any commitment and are free to report to the mediator. The second aspect of self-determination, that a "mediator shall not undermine party self-determination [...] for reasons such as higher settlement rates [...]"(*Model Standards of Conduct for Mediators* 2005), serves to justify the mediator's commitment to invoke hearings with some probability. Impartially is ensured despite the asymmetric protocol because expected (ex-ante) payoffs are symmetric.

4.3 Arbitration

On an abstract level, (textbook) arbitration differs from (textbook) mediation in that an arbitrator has enforcement power. That is, once the parties succumb to the arbitration protocol, the arbitrator can enforce both the arbitration result and hearings; however, 28 U.S.C 654(a) requires initial consent.

As mediation with *less* enforcement power can implement optimal ADR, it is clear that arbitration can do so as well. Thus, within our model arbitration and mediation can be used equivalently. In reality, mediation appears to be more preferred than arbitration. One reason (outside our model) could be that the parties have more control of the process

[21]Holding a caucus session is important to ensure confidentiality and thereby foster candor by the parties. Goldberg et al. (2017) advises mediators to make the following announcement: "if you tell me only what you tell the other party, you are not taking full advantage of what I can do to help you reach a settlement."

under mediation than under arbitration. If the parties have doubts about a third party's integrity, then mediation offers them the opportunity to leave the process upon discovery. Unilaterally terminating arbitration is considerably harder.[22]

Proposition 1 implies that in optimal arbitration, the arbitrator might award settlement shares without a formal hearing—an abstraction from reality. In practice, the arbitrator is not able to avoid hearings altogether (because of 9 U.S.C 10(a)), but she can influence their costs and length by employing specific techniques. By not granting discovery motions, for example, the arbitrator can reduce the costs of the hearing.[23]

Moreover, real arbitration cases often allow for settlement negotiations after the arbitration process has started. In such situations, a cost-efficient resolution is achieved if the arbitrator "sets the stage for settlement." The arbitrator can do so by ruling on motions early in the case (contingent on the disputants' (private) reports). This, in turn, decreases the disputants' level of asymmetric information about the outcomes should negotiations fail.[24]

Other techniques to influence the costs and length of hearings are granting disputants access to "Summary Jury Trials" (Prescott and Spier, 2016) or "med-arb," (Stipanowich and Ulrich, 2014). Each of these includes elements of arbitration and mediation. Often there is a third party deciding on the degree of eligibility, which matches the designer/mediator/arbitrator in our setting.

5 Discussion

Designer Commitment. It is crucial to our setting that the designer of ADR can commit to not reneging on her own mechanism after she has announced that no early settlement solution was found. Otherwise, disputants could expect the designer to renege once settlement negotiations fail, which in turn makes the initial mechanism not incentive compatible (Bester and Strausz, 2001).

In reality, third-parties can use techniques prohibiting their own reneging: for example, to move a case to a hearing stage an arbitrator can exercise "excessive, inappropriate, or mismanaged motion practice" (Stipanowich and Ulrich, 2014). As courts typically honor the arbitrator's rule on motions, the arbitrator is committed to her mechanism. In mediation building reputation is a strong rationale for designer commitment.

[22]To account for potential misconduct, 9 U.S.C 10(a)(3) leaves room to nullify the arbitrator's result if a hearing was requested but not conducted. The rule suggests that the actual power of an arbitrator under the law may not be greater than that of a mediator, if evidence provision in arbitration is as costly as that in litigation (or close to it). Carver and Vondra (1994) suggest that this is often the case.

[23]Prescott and Spier (2016) develop a comprehensive notion of partial settlement. A prominent form of settlement agreements involving *procedural modification* is limiting discovery—a partial settlement agreement which the arbitrator can implement without an overly costly hearing.

[24]Another prominent form of settlement negotiations—bilateral settlement negotiations—is incapable of implementing optimal ADR. Disputants themselves cannot control the information flow sufficiently. That point has been noted already in Ayres and Nalebuff (1996). Hörner, Morelli, and Squintani (2015) discuss it in the context of international peace negotiations.

ADR Objective. We selected settlement maximization as the designer's objective. A natural alternative objective for the designer is to maximize the joint expected surplus of the disputing parties.

Definition 2 (Surplus-Maximizing ADR)**.** A mechanism maximizes joint surplus if no other incentive-compatible mechanism provides higher ex-ante joint surplus,

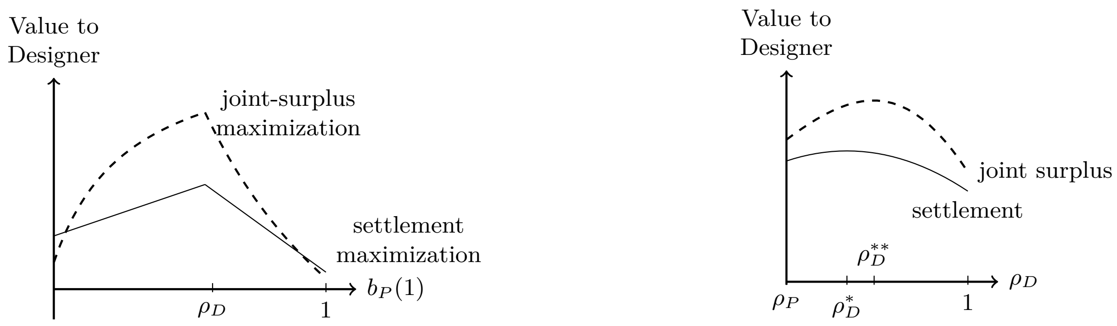
$$\mathbb{E}[\Pi_P(\theta_P) + \Pi_D(\theta_D)].$$

The mechanism we derived in Proposition 1 does not maximize the joint expected surplus in general. In addition to 'court-mandated' ADR, there are two other rationales for settlement maximization as objective. Both rationales build on the fact that ADR in reality is mainly provided by (retired) judges, law professors, or private mediation companies. The first rationale is reputation-building. The quality of its provider is integral to ADR and thus reputation is important for building up a successful ADR business. In mediator advertisement, for example, the proxy for quality is typically the settlement rate. Indeed, referring to the settlement rate provides a more credible signal than referring to clients' surplus, which cannot be inferred even if the settlement outcome is known.

The second, related, rationale is that market forces in the market for ADR mechanisms lead to that outcome. It is straightforward to show that even in surplus-maximizing ADR, a low-cost type's participation constraint binds. That is, she receives the same expected payoff from participating in a surplus-maximizing mechanism as in one that maximizes the settlement rate. Thus, a low-cost type is indifferent between the two mechanisms. If low-cost types opt for settlement-rate-maximizing ADR, high-cost types have no incentives to deviate by selecting surplus-maximizing ADR, which would reveal their type. If evidentiary hearings impose a small additional cost on the ADR designer, there is no market for surplus-maximizing ADR.

However, even for joint-surplus-maximizing ADR, our results do not change qualitatively. The properties from Corollary 1 remain valid, but we cannot derive a closed-form analogue to Proposition 1. The reason is that the objective becomes a mathematically complicated object. Given the intuition behind the asymmetry given in Section 3.2, it is unsurprising that surplus-maximizing ADR implies a larger degree of asymmetry. In Figure 4 we (numerically) compare the value of information structures to the designer as a function of the correlation between types (left panel) and the degree of asymmetry (right panel). Inducing report-independent beliefs is optimal in both cases, yet the degree of asymmetry is larger under surplus maximization. Importantly, also the implementation result from Section 4 holds under surplus maximizing ADR. In Appendix A.2 we provide further details.

(Ex-ante) Fairness and Additional Signals. From an ex-ante point of view, liability of the contested part X is symmetrically distributed among disputants. Still, the optimal mechanism induces asymmetries. That is, conditional on a hearing, it is common knowledge



(a) Optimal Correlation

(b) Optimal Asymmetry

Figure 4: **Settlement vs Surplus Maximization.** The designer's value of different levels of correlation between reports (left panel) and levels of asymmetry (right panel). The solid line is the value under the objective of settlement-rate maximization; the dashed line is the value of the objective under joint-surplus maximization. In this example $X = 1$, $K = 3$, $p = 1/5$, $\rho_P = (1-p)/2 = 2/5$. In the left panel $\rho_D = 5/8$; in the right panel $b_P(1) \equiv \rho_D$. The optimal level of asymmetry under settlement rate maximization is $\rho_D^* = (1+p)/2 = 3/5$; that under joint-surplus maximization is (given $\rho_P = 2/5$) is $\rho_D^{**} \approx 0.69 > 3/5$.

that Defendant has a 'better case' than Plaintiff.

Such an asymmetric treatment may raise fairness concerns and leads to the presumption that the designer is *biased*. However, asymmetric treatment is essential to implement the optimal mechanism because asymmetric hearings are less costly, which increases incentives to participate in ADR.

The asymmetric treatment does not jeopardize fairness for two reasons. First, as we have seen in equation (8) the optimal mechanism is not asymmetric in terms of payoffs. That is, if Defendant expects to have a "better case" after settlement fails, she expects a less favorable settlement arrangement. Overall, $\Pi_P(\theta) = \Pi_D(\theta)$. Second, the designer can augment her protocol by a simple coin flip that determines whether she carries out the optimal protocol resulting in $b_P(1) = \rho_D > b_D(1) = \rho_P$ or that resulting in $b_D(1) = \rho_P > b_P(1) = \rho_D$.

Such a coin flip can be implemented as follows. The disputants report to the mechanism without knowing which of the two protocols is carried out. After the reports, the designer performs an unbiased coin flip publicly and implements ADR accordingly. The mechanism is stochastic, but both disputants are treated (ex-ante) symmetrically. We refer to the public coin flip as the *symmetrizing signal.*

It turns out that the symmetrizing signal is the designer's optimal signal. If we allow the designer to send additional (report-contingent) public messages, she wishes at most to send the symmetrizing signal. Sending that signal never hurts the designer but strictly benefits her if $p > 1/3$.

Proposition 4. *Additional information revelation beyond the symmetrizing signal does not improve over the outcome without information revelation. If $p \leq 1/3$, no additional information revelation improves. Any ADR protocol that is optimal is also optimal when augmented by the symmetrizing signal.*

Evidentiary Hearings. According to our baseline model, evidentiary hearings within ADR are identical to litigation. Whereas trivially correct in the mediation case, the results are less obvious for other forms of ADR such as arbitration. Being less formal, ADR potentially provides a more efficient hearing process than litigation. Anecdotal evidence, however, suggests that in reality hearings inside the arbitration process are often no different than formal litigation (Carver and Vondra, 1994).

Still, litigation may involve an additional fixed cost due to, e.g., court fees as in the classic literature on settlement. It is conceptually straightforward to integrate this assumption into our model. The only (quantitative) difference is that the disputants' payoffs from rejecting ADR would decrease by the respective fee c, which relaxes their participation constraints. More generally speaking, the construction of the optimal mechanism does not depend on the alternative game per se. This game only micro-founds a disputant's outside option V^{θ_i}, which has only quantitative effects on our results. Specifically, it determines α. Recall from equation (6) that α is a scalar that linearly effects the probability that settlement fails, but has no effect on the induced information structure. It ensures that strong types are willing to participate in ADR. If the outside option becomes less attractive for strong types, the designer can reduce α—and thereby all failure probabilities—until strong types are indifferent between participating in ADR and directly going to court.

An extreme version of a model where hearings involve fixed costs is one where the level of evidence provision is exogenous. That is, litigation costs do not vary with the level of evidence. Parties present all available evidence at no additional cost. A party's type represents the amount of exogenous evidence that the party possesses.The model of Hörner, Morelli, and Squintani (2015) captures such a situation. In their model, failure to settle reduces the size of the surplus by a fixed amount c. The remainder $1 - c$ is given to disputant i with probability $F(\theta_i, \theta_{-i})$ and to $-i$ with the remaining probability $1 - F(\theta_i, \theta_{-i})$. The optimal mechanism differs drastically.

Proposition 5. *Optimal ADR in the model of Hörner, Morelli, and Squintani (2015) has the following features if high-cost types cannot be guaranteed settlement.*

(Symmetry) *The distribution of types is symmetric, $\rho_P = \rho_D$.*

(Report-Dependent Beliefs). *The information a disputant obtains within ADR is depends on her type report, $b_i(m_i) \neq \rho_{-i}$.*

(Weak types settle). *Whenever two high-cost types meet, they settle; i.e. $b_i(K) = 1$.*

Proposition 5 is the arbitration result in Hörner, Morelli, and Squintani (2015), adapted to our solution approach. The results in Proposition 5 oppose those from Proposition 1. In addition, joint-surplus maximization is identical to maximizing the settlement rate in their model. In terms of implementation, the two models coincide: optimal arbitration and optimal mediation implement the same outcome which mirrors our result from Section 4.

Different from us, Hörner, Morelli, and Squintani (2015) obtain a *sorting mechanism.* High-cost dyads enjoy guaranteed settlement. Intermediate dyads settle sometimes. Low-cost dyads are guaranteed to move to a hearing. Proposition 1 demonstrates that an effect of information on behavior in hearings overturns that results. The change in behavior becomes the primary concern of the arbitrator. It leads to the results from Proposition 1.

6 Conclusion

In this article we characterize optimal Alternative Dispute Resolution (ADR). We show that optimal ADR induces asymmetries by implementing an information structure that favors one disputant over the other if settlement fails. The other disputant obtains an advantage under settlement. The information a disputant obtains during the ADR process is independent of her report within the ADR mechanism. That independence prevents disputants from misreporting to achieve an informational advantage.

We provide a protocol for mediation that implements optimal ADR. We show that ADR is effective. Even if early settlement fails, ADR reduces the parties' expected expenditure in subsequent hearings. Despite the induced asymmetry, optimal ADR is ex-ante fair. The necessary asymmetry within the process, however, implies that imposing stricter notions of equal treatment, such as symmetric treatment throughout, comes at a cost. The same holds for mandatory disclosure policies: it is crucial that the third party conducting ADR acts as an informational gatekeeper who can credibly promise to not disclose part of the information to the other side.

In our model, parties can influence the hearing's outcome through strategic choices and the (ex-post) optimal choice depends on the choices made by the opponent. In this environment, managing the information flow is of first-order importance to ADR's success. This result demonstrates that the standard assumption of "lotteries over outcomes" as the alternative to settlement is not innocuous.

A natural question is how our findings interact with the rules on how to allocate the legal costs between disputants ('fee shifting'), or how the interim design of ADR interacts with ex-ante defined arbitration clauses. In either case, there are additional strategic choices available to the disputants. As an example, consider the Federal Rule of Civil Procedure 68. Under Rule 68, if a plaintiff rejects the defendant's offer and the final judgment is less favorable for the plaintiff than the offer, the plaintiff bears the additional legal costs after the defendant's offer was rejected. Thus, Rule 68 makes legal fees contingent on earlier settlement offers, adding an additional strategic dimension to such offers. Although the channels we point out here persist and we expect results to be overall similar, a careful description and analysis of the environment is essential. Making precise statements is thus beyond the scope of this article.[25]

In a broader context, conflicts evolve around a variety of battlefields on different subjects or points in time. If types are correlated over time, there is an additional signaling

[25]Spier (1994) finds that under Rule 68 settlement may increase. A rationale for her finding is that the encouragement of bilateral negotiations keeps disputants out of court. Opposing that rationale, in our setting bilateral settlement negotiations prior to ADR jeopardizes ADR's performance. Further research is needed to combine these observations.

dimension to be analyzed further. Although a richer model is needed to address these issues properly, we are confident that the channel and results we present in this article provide a helpful first step.

Appendix

The appendix is organized as follows. In Appendix A we provide the main steps to prove Proposition 1. Appendix B proves the remaining propositions. In the Supplementary Appendix C we provide omitted details.

A Constructing Optimal ADR (w/ Proof of Proposition 1)

We first provide details behind the construction of the settlement-rate-maximizing ADR. Thereafter, we show similarities and differences to joint-surplus-maximizing ADR.

A.1 Settlement-Rate-Maximizing ADR (w/ Proof of Proposition 1)

Here we present the main steps and provide the (economic) intuition behind it. We do so by summarizing the technical steps in a series of lemmas. The mechanical and technical details behind some lemmas are then relegated to Appendix C.

The structure is as follows:

1. We define what we refer to as a *consistent information structure.* A consistent information structure is any information structure that can arise in the evidentiary hearing process in a perfect Bayesian equilibrium both on and off the equilibrium path under *any* ADR mechanism.
2. We solve the potential continuation games and derive the expected continuation payoff, U_i, conditional on entering a hearing.
3. We describe the designer's trade-off and show that we can fully characterize the designer's problem in terms of the implied information structure.
4. We show the result in Proposition 1.

Information Structure

Let $\mathcal{B} := (\rho_P, \rho_D, b_P(1))$ be an information structure (see Section 3.2) and assume without loss that $\rho_D \geq \rho_P$. Figure 5 illustrates the relationship between distributions and information. In the left panel we plot a distribution of *type pairs.* In total there are four different type pairs, $(1,1), (1,K), (K,1)$, and (K,K). The likelihood of each pair is contained in $\mathcal{B}$. The right panel shows how these distributions add up to marginal type distributions of P and D.

The domain of $\mathcal{B}$ is determined by *internal consistency.* This means that given ρ_P and ρ_D, $b_P(1)$ can be rationalized by some correlation.

Definition 3 (Internal Consistency)**.** An information structure $\mathcal{B}$ with $\rho_P > 0$ is internally consistent if $b_P(1) \in [\max\left(0, 1 - \frac{1-\rho_D}{\rho_P}\right), 1]$.

For the case of $\rho_P = 0$, the value of $b_P(1)$ can be chosen arbitrarily because the left panel of Figure 5 is independent of $b_P(1)$.

We now show that the beliefs b_i we used in Lemma 1 arise from an internally consistent information structure.

Lemma 3. *Fix an information structure $\mathcal{B}$ with $\rho_D \geq \rho_P$. If that information structure arises on-path after some ADR protocol it is internally consistent. The associated on-path*

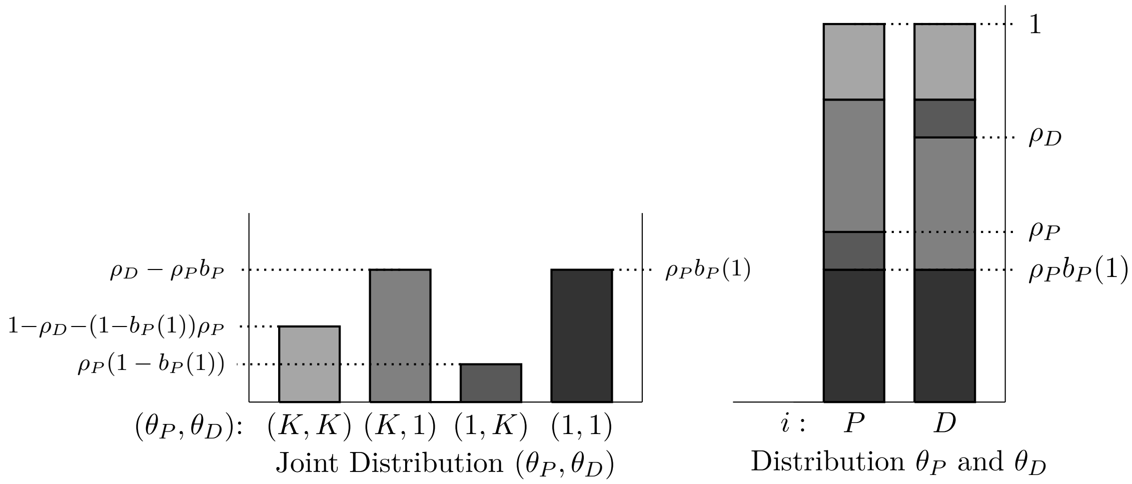


Figure 5: **Distributions and Information Structure.** The left panel shows a distribution of type pairs (θ_P, θ_D). Each element is a function of the information structure $\mathcal{B}$. The right panel shows the distribution of types by disputants. It stacks the elements of the left panel in different order. The likelihood that $\theta_P = 1$ is the joint likelihood of $(1, 1)$ and $(1, K)$. The correlation $b_P(1)$ determines the fraction of ρ_P attributed to $(1, 1)$. The likelihood that $\theta_D = 1$ is the sum of the likelihoods of $(1, 1)$ and $(K, 1)$.

beliefs imply $b_P(\theta_i) \geq b_D(\theta_i)$ *and are given by*

$$b_P(K) = \frac{\rho_D - \rho_P b_P(1)}{1-\rho_P}, \quad b_D(K) = \frac{\rho_P}{1-\rho_D}(1 - b_P(1)), \quad \textit{and } b_D(1) = \frac{\rho_P}{\rho_D} b_P(1).$$

Proof. Take any rule $\gamma(\cdot,\cdot)$ and suppose settlement fails. Recall that $\rho_i = Pr(\theta_i = 1|L) = \frac{p\gamma_i(1)}{Pr(L)}$ which is determined by $\gamma(\cdot,\cdot)$. Bayes' rule implies that

$$b_P(1) = Pr(\theta_D = 1|\theta_P = 1, L) = \frac{p\gamma(1,1)}{p\gamma(1,1) + (1-p)\gamma(1,K)} = \frac{\rho_D}{\rho_P} b_D(1).$$

An equivalent relation for any $b_i(\theta_i)$ exists. By the law of probability, one of these equations is redundant and we are left with three independent equations and six unknowns. Solving for $b_D(\theta_D)$ and $b_P(K)$ provides the relations in the lemma. Because $b_i(\theta_i) \in [0, 1]$, $b_P(1)$ is internally consistent. $\square$

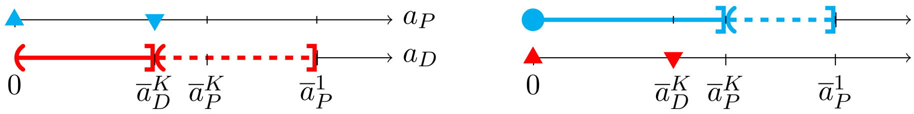
Next, we describe the mapping from the information structure $\mathcal{B}$ to $\gamma(\cdot,\cdot)$. Lemma 4 is helpful because it provides a relationship between $\gamma(\cdot,\cdot)$ and $\mathcal{B}$. Once we have determined $\mathcal{B}$, we have determined $\gamma(\cdot,\cdot)$ up to constant α.

Lemma 4. *Suppose* $\gamma(1, 1) = \alpha \in [0, 1]$. *Then any* $\gamma(\theta_P, \theta_D)$ *is completely determined by an internal consistent* $\mathcal{B}$ *and* α.

Proof. Take $\mathcal{B} = (\rho_P, \rho_D, b_P(1))$ and α. By Lemma 3 we can express all beliefs as a function of $\mathcal{B}$. By Bayes' rule each belief is given by

$$b_i(\theta_i) = \frac{p\gamma(\theta_i, 1)}{p\gamma(\theta_i, 1) + (1-p)\gamma(\theta_i, K)}.$$

Replacing left-hand sides by the expressions from Lemma 3 and $\gamma(1, 1) = \alpha$ and rearranging yields three linear equations uniquely determining $\gamma(1, K)$,$\gamma(K, 1)$, and $\gamma(K, K)$. $\square$



(a) Quality of evidence in the continuation game after Plaintiff type K deviates. *The deviator chooses action* ▲ *if* $b_P(1) > b_P(K)$ *and* ▼ *if* $b_P(1) < b_P(K)$. *The non-deviator follows her equilibrium strategy.*

(b) Quality of evidence in the continuation game after Defendant type K deviates. *The deviator chooses action* ▲ *if* $b_D(1) > b_D(K)$ *and* ▼ *if* $b_D(1) < b_D(K)$. *The non-deviator follows her equilibrium strategy.*

Figure 6: **Continuation strategies for different histories if** $b_P(1) \geq b_D(1) \neq b_D(K)$.

Hearings

On-path hearings in second-best ADR are characterized in Section 3.1. In contrast, off-path hearings after a misreport can be different. After misreporting her own type, disputant i either receives the settlement share of her reported type or a hearing is announced. In neither case does the opponent (nor the designer) suspect that a deviation had occurred in the reporting stage. In particular, the opponent believes that the hearing follows as an on-path event and follows her equilibrium strategy. The deviator, on the other hand, is aware of her own deviation. As a result, she optimizes taking into account that (i) she deviated previously and (ii) the opponent is unaware of that deviation.

Let $F_i^\theta(a_i)$ be the likelihood that disputant i type θ chooses a quality level of at most a_i. Then the continuation utility from (3) of type θ_i reporting type m_i is

$$U_i(m_i;\theta) = \sup_{a_i} \quad X \underbrace{\Big(b_i(m_i)F^1_{-i}(a_i) + (1-b_i(m_i))F^K_{-i}(a_i)\Big)}_{=F_{-i}(a_i|b_i(m_i))} - \theta_i a_i.$$

In the contest, low-cost types invest in higher levels than high-cost types (see Lemma 10 in Appendix B.1 below); thus, $F^1_{-i} \neq F^K_{-i}$. Moreover, if $b_i(1) \neq b_i(K)$, then the optimal action a_i^* is different off the equilibrium path than on the equilibrium path. For any quality level a_i the marginal cost θ_i of increasing quality is the same as on the equilibrium path. The marginal benefit, that is, the change in the likelihood of winning, however, is different because the belief differs. In addition, the deviation does not trigger any response of the opponent: the deviator's opponent does not detect the deviation and therefore does not change her behavior. If $b_i(K) > b_i(1)$, this is to the benefit of deviator $\theta_i{=}K$: If $\theta_{-i}{=}K$ knew that $\theta_i{=}K$ holds belief $b_i(1)$ rather than $b_i(K)$, $\theta_{-i}{=}K$ would increase her quality level. In turn, the gains from the change in beliefs decreased.

The on-path equilibrium is in mixed-strategies. Disputants are indifferent between any quality level in their equilibrium strategy support, $(\underline{a}_i^{\theta_i}, \overline{a}_i^{\theta_i}]$. In the interior of θ_i's equilibrium support U_i is differentiable and $b_i(\theta_i)f^1_{-i}(a_i) + (1-b_i(\theta_i))f^K_{-i}(a_i) = \theta_i/X$ on the equilibrium path. If $b_i(1) \neq b_i(K)$ that indifference does not hold off the equilibrium path. Instead, the deviator puts full mass on a single quality level. Figure 6 displays the optimal deviation strategies for type K deviators.

Suppose that $b_i(1) < b_i(K)$. High-cost types achieve a higher expected payoff from hearings after a deviation than from on-path hearings. Off path they face high-cost types more often than on path. As depicted in Figure 6 their optimal post-deviation quality level is positive. Thus, they obtain a higher utility than on path by the argument from above. The next lemma provides the statement behind that observation.

Lemma 5. *Suppose that* $b_i(1) \neq b_i(K)$. *A deviator's optimal action in the continuation* *game is a singleton. Moreover, if $b_i(1) < b_i(K)$, then $U_i(1;K) > U_i(K;K)$.*

Proof. Let $\overline{a}_i^{\theta_i}$ be the upper bound on θ_i's equilibrium action support. Each θ_i is indifferent over her strategy support on the equilibrium path. By monotonicity, (M), off the equilibrium path she faces strict incentives when holding different beliefs.

If $b_i(1) < b_i(K)$ for some i, then $b_{-i}(1) < b_{-i}(K)$ by the relation in Lemma 3. If the deviating high-cost type chooses any action in $(0, \overline{a}_D^K)$, she has the same cost as on the equilibrium path, however she wins with larger probability, as $1 - b_i(1) > 1 - b_i(K)$. Thus, her payoff increases compared to on-path litigation. □

Binding Constraints

We begin by stating a set of binding constraints.

Lemma 6. *At the optimum the high-cost types' incentive constraints and the low-cost types' participation constraints hold with equality.*

Proof. We prove the Lemma ignoring constraint $z_i(\theta_i) > 0$. Using the terms provided in the main text we calculate the settlement shares to be

$$\begin{aligned} z_P(1) = z_P(K) = V^1 - \gamma_P(1)U_P(1) &= (1 - p(1+\alpha))\frac{K-1}{K}X, \\ z_D(1) = V^1 - \gamma_D(1)U_D(1) &= \left(1 - p\left(1 + \alpha\frac{1+p}{1-p}\right)\right)\frac{K-1}{K}X, \\ z_D(K) &= z_D(1) + (\gamma_D(1) - \gamma_D(K))U_D(K) \\ &= z_D(1) + 2\alpha\frac{p^2}{(1-p^2)}\frac{(K-1)}{K}X. \end{aligned} \tag{10}$$

Equation (10) implies that this constraint is satisfied at the optimum. Suppose that disputant i's participation constraint holds with strict inequality. Then, the designer can decrease both $z_i(1)$ and $z_i(K)$ by the same amount until the participation constraint binds without violating any other constraint.

Second, the high-cost types' incentive constraints hold with equality at the optimum. Otherwise, the designer could reduce $z_i(K)$ without violating any other constraint. □

The binding constraints imply

$$z_i(1) = V^1 - \gamma_i(1)U_i(1;1) \tag{IR}$$

and

$$z_i(K) = \gamma_i(1)U_i(1;K) - \gamma_i(K)U_i(K;K) + z_i(1). \tag{IC^K}$$

Finally, the designer's resource constraint implies

$$X \underbrace{(1 - Pr(L))}_{\textit{Prob. of settlement}} \geq \underbrace{\sum_i (pz_i(1) + (1-p)z_i(K))}_{\textit{expected settlement shares },\ \mathbb{E}z}. \tag{B}$$

Condition (B) is necessary for the designer's resource constraint, $\sum_i x_i(\theta_i, \theta_{-i}) \leq X$, to hold. Indeed, only if the *expected rate of settlement* is at least as high as the *expected shares* $\mathbb{E}z$, the designer has sufficient funds to distribute them. In contrast, by leaving slack on (B) the designer leaves money on the table which could be used to compensate the disputants to settle more cases. Hence, (B) holds with equality at the optimum.

Lemma 7. (B) *holds with equality at the optimum.*

Proof. Suppose condition (B) holds with strict inequality. Then, the designer could increase the share of each disputant and type. In turn, the low-cost type's expected payoff would increase. This allows her to decrease all $\gamma(\cdot,\cdot)$'s proportionally without changing (i) beliefs in the hearing and (ii) incentives within ADR. □

Note that (B) is a necessary condition and need not be sufficient. The reason is that we look only at a reduced-form problem. ADR cannot provide transfers other than liability shares and there may be no ex-post distribution that implements a given $z_i(\theta_i)$ satisfying (B) such that $\sum_i x_i(\theta_i, \theta_{-i}) \leq X$. If ADR had access to additional utility transfers that problem would disappear. For the case without transfers, previous work by Border (2007) shows that, provided a general implementation constraint holds, implementation through some feasible $x_i(\theta_i, \theta_{-i})$ is possible.[26]

We proceed under the conjecture that the optimal $z_i(\theta_i)$ is implementable through some $x_P(\theta_P, \theta_D) + x_D(\theta_D, \theta_P) \leq X$ and solve the relaxed problem. By plugging the solution into our analogue of the constraints of Border (2007), we then verify that solving the relaxed problem entails no loss.

Similarly, we guess that the participation constraints for high-cost types and the incentive constraints for low-cost types are redundant and drop them for now in the analysis. We revisit all omitted constraints once we have calculated the relaxed optimum.

The (Reduced-Form) Problem

Using Bayes' rule we can represent the probability that settlement fails using

$$\gamma_i(1) = \frac{Pr(L)\rho_i}{p} \quad \textit{and} \quad \gamma_i(K) = \frac{Pr(L)(1-\rho_i)}{(1-p)}.$$

Substituting (IR), (IC^K), and $\gamma_i(m_i)$ into (B) under equality and rearranging yields

$$Pr(L) = \frac{p(2V^1 - X)}{\sum_i \rho_i U_i(1;1) + \sum_i p(1-\rho_i)U_i(K;K) - \sum_i (1-p)\rho_i U_i(1;K) - p} \tag{11}$$

with $2V^1 > X$ if $p < \overline{p}$.

Maximizing the denominator of the right-hand side (RHS) of (11) minimizes $Pr(L)$.

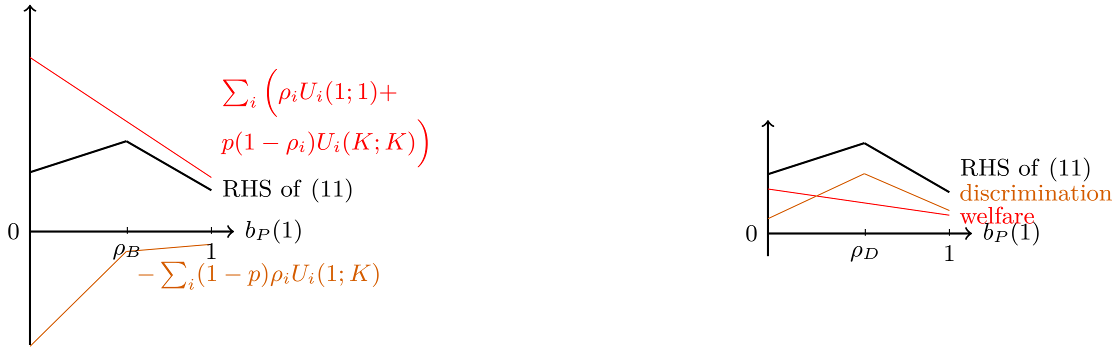
Optimal Information Structure

Using Lemma 1, 2 and 3 to 7 we solve the problem

$$\max_{\mathcal{B}} \sum_i \rho_i U_i(1;1) + \sum_i p(1-\rho_i)U_i(K;K) - \sum_i (1-p)\rho_i U_i(1;K).$$

We do so in five steps. First, we show that maximizing over $\mathcal{B}$ is sufficient. Second, we show that all utilities are piecewise linear in $b_P(1)$. Third, we solve for the optimal $b_P(1)$. Fourth, we solve for the optimum in ρ_i. Fifth, we show that the solution is feasible according to Step 1, and all omitted constraints have either slack or (in case of (IC^1)) can be omitted through additional information provision.

[26] The literature refers to these type of constraints as the Matthews-Border constraints (Matthews, 1984; Border, 1991, 2007).



(a) Decomposition as in equation (11)

(b) Decomposition in economic channels

Figure 7: **Designer's objective as function of $b_P(1)$ (with $K = 4$, $X = 1$ and $p = 1/4$).** The left panel decomposes the RHS of equation (11). The right panel decomposes the RHS alongside two economic channels, discrimination, $(1-p)\sum_i \rho_i(U_i(1;1) - U_i(1;K))$, *and* welfare, $p\sum_i \rho_i U_i(1;1) + (1-\rho_i)U_i(K,K)$. Discrimination measures how much better a low-cost type performs compared to a high-cost deviator. The deviator suffers from her higher cost, but benefits from the information advantage. If $b_P(1) = \rho_D$ the information advantage is 0 and discrimination is the highest. Welfare decreases in $b_P(1)$ as increased correlation in types implies more intense litigation.

Step 1: Feasible $\mathcal{B}$. The RHS of equation (11) depends entirely on $\mathcal{B}$. Yet, not all $\mathcal{B}$ can be implemented by some $\gamma(\cdot,\cdot) \in [0,1]$ given p. We assume $\gamma(1,1) = \alpha$ and solve for $\mathcal{B}$ that maximizes the RHS of equation (11). At the end we verify that $\alpha \leq 1$ which together with Lemma 4 implies that an ADR mechanism exists that implements $\mathcal{B}$.

Step 2: (Piecewise-)Linearity in $b_P(1)$. Fix some (ρ_P, ρ_D). A disputant's winning probability, $F_i(\overline{a}_D^K|m_i)$, is linear in $b_P(1)$ because $1 - b_i(m_i)$ is linear in $b_P(1)$. $\overline{a}_D^K$ is linear in $b_P(1)$ too and so are the payoffs. Finally, $\gamma_i(\theta_i)$ is linear in b_i and thus in $b_P(1)$. Thus, the RHS of (11) is linear in $b_P(1)$. Observe that due to the change of action the deviator's utility $U_i(1;K)$ has a kink at $b_P(1) = b_P(K)$. According to Lemma 3, $b_P(1) = b_P(K)$ implies $b_P(1) = \rho_D$.

Step 3: No interior optimum. Linearity implies that it is sufficient to consider the boundary points of each interval for $b_P(1)$. That is, the optimal $b_P(1)$ is on one of these points:

$$\underline{b} = \frac{\rho_P}{K(1-\rho_D)+\rho_D}, \qquad \overline{b} = \frac{(K-1)(1-\rho_P)+\rho_D}{K(1-\rho_P)+\rho_P}, \qquad b^* = \rho_D.$$

We choose the candidate $b^* = \rho_D$ and proceed.

Step 4: Solving for ρ_i. Replacing $b_P(1)$ by ρ_D in (11) reveals a concave quadratic function for the RHS with independent first-order conditions. The unique solution is $(\rho_P, \rho_D) = ((1-p)/2, (1+p)/2)$. The derivative with respect to $b_P(1)$ is

$$\frac{\partial \text{RHS of (11)}}{\partial b_P(1)}|_{\rho^*} = \begin{cases} \frac{K(1-(p)^2)-(1-(p)^2)}{K(1+p)} & \text{if } b_P(1) < \rho_D \\ -\frac{K(1-(p)^2)-(1-(p)^2)}{K(1+p)} & \text{if } b_P(1) > \rho_D \\ \text{undefined} & \text{if } b_P(1) = \rho_D, \end{cases}$$

and $(\rho_P, \rho_D, b_P(1)) = ((1-p)/2, (1+p)/2, (1+p)/2)$ is a local optimum of the RHS of (11). Assuming $b_P(1) = \underline{b}$ and $b_P(1) = \overline{b}$, solving for the optimal ρ_i, and comparing results implies that the solution is also a global maximizer for the RHS of (11).

Step 5: Verifying omitted constraints. We have to verify that none of the constraints we dropped from the problem are violated. Specifically, we need to verify that (i) high-cost types find it optimal to participate, (ii) the information structure we have obtained is indeed internal consistent under the prior, (iii) a low-cost type has no incentive to mimic a high-cost type, (iv) the (reduced-form) budget constraint from (B) is sufficient, and (v) no better outcome exists in which condition (M) is violated. We describe the first two here in detail. The verifications of (iii) follows the arguments used around Proposition 4. We provide the corresponding lemma here. Finally, (iv) and (v) require a sequence of purely technical arguments with little intuition. We defer them to Appendix C.

ad (i). Substituting into the terms in Lemma 1 to obtain U_i, and using equations (IC^K) and (IR) to obtain z_i (see also equation (10) on page 31 for the formulations) and finally calculating $\Pi_i(K;K)$ through equation (4) on page 16 (see also equation (8) on page 16), we verify that $\Pi_i(K;K) \geq 0 = V^K$.

ad (ii). Plugging in for V^1 in the LHS of equation (11) and translating all $\gamma_i(\theta_P, \theta_D)$ using Lemma 4 we verify that $\alpha \leq 1$ if $p \geq \underline{p}$ (see also equation (7) on page 15). Although omitted here for simplicity, results do not change qualitatively if $p < \underline{p}$.

ad (iii). This part also serves as (part of) the proof of Proposition 4. We state it as a lemma.

Lemma 8. *If $p \leq 1/3$, then low-cost types' incentive constraints hold for a mechanism that implements $b_P(1) = b_P(K) = \rho_D = (1+p)/2$ and $b_D(1) = b_D(K) = \rho_P = (1-p)/2$. If $p > 1/3$ they hold for a (stochastic) mechanism that implements $b_P(1) = b_P(K) = \rho_D = (1+p)/2$, $b_D(1) = b_D(K) = \rho_P = (1-p)/2$ and its flipside $b_D(1) = b_D(K) = \rho_P = (1+p)/2$, $b_P(1) = b_P(K) = \rho_D = (1-p)/2$ each with equal likelihood.*

Proof. Plugging into the low-cost types incentive constraints and rearranging implies

$$z_i(1) + \gamma_i(1)U_i(1;1) \geq z_i(K) + \gamma_i(K)U_1(K;1).$$

Rearrange and substitute the high-cost type's binding incentive constraint:

$$\gamma_i(1)\Big(U_i(1;1) - U_i(1;K)\Big) = z_i(K) - z_i(1) \geq \gamma_i(K)\Big(U_i(K;1) - U_i(K,K)\Big).$$

By report-independence this simplifies to

$$\gamma_i(1) \geq \gamma_i(K) \Leftrightarrow \frac{\rho_i}{p} \geq \frac{1-\rho_i}{1-p} \Leftrightarrow \rho_i \geq p. \qquad (IC^1)$$

Condition (IC^1) thus implies that low-cost types' incentive constraints hold at the optimum if $p \leq 1/3$. If, however, $p > 1/3$ it is violated for P, but never for D. Yet, nothing in our analysis relies on our working assumption $b_P(1) \geq b_D(1)$ because P and D are not fundamentally different. Fix any feasible information structure $\overline{B} = (\rho_1, \rho_2, b_1(1)\}$ with the implied $b_2(1) = b_1(1)\rho_1/\rho_2$. The following protocol is neutral to the value of the objective:

- With probability 1/2 implement information structure $\rho_D = \rho_1, \rho_P = \rho_2, b_P(1) = b_1(1)\}$ and with probability 1/2 implement $\rho_P = \rho_1, \rho_D = \rho_2, b_D(1) = b_1(1)\}$. Before parties enter the hearing announce which of the two cases realized.

Because (IC^1) is linear in ρ_i only the expected ρ_i at the time of decision making is important and $E[\rho_i] = 1/2$. (IC^1) holds under the augmented mechanism because $p < 1/2$. It satisfies Proposition 1. ☐

ad (iv) and (v).

Lemma 9. *The solution in Proposition 1 is implementable under $x_P(\theta_P, \theta_D) + x_D(\theta_D, \theta_P) \leq X$. Moreover, no information structure violating condition* (M) *improves upon it.*

Proof. See Appendix C. ☐

A.2 Joint-Surplus-Maximizing ADR

The arguments of Lemma 2 and 6 apply analogously. As a consequence, Lemma 7 holds too and $\mathcal{B}$ and α are once again a sufficient statistics for the optimal mechanism. Any optimal mechanism promises expected utility V^1 to low-cost types by Lemma 6. Maximizing joint surplus reduces to maximizing the sum of high types' expected payoffs,

$$\begin{aligned}\sum_i (1-p)(z_i(K) + \gamma_i(K)U_i(K;K)) &= (1-p)\left(z_i(1) + \sum_i \gamma_i(1)U_i(1;K)\right) = \\ &= (1-p)2V^1 - (1-p)\sum_i \gamma_i(1)(U_i(1;1) - U_i(1;K)) = \\ &= (1-p)V^1 - \frac{Pr(L)}{p}\underbrace{\sum_i (1-p)\rho_i(U_i(1;1) - U_i(1;K))}_{=:\mathbb{E}[\Psi]}.\end{aligned} \tag{12}$$

Using that by equation (11)

$$Pr(L) = \frac{p(2V^1 - X)}{p\sum_i \underbrace{(\rho_i U_i(1;1) + (1-\rho_i)U_i(K;K))}_{=:\mathbb{E}[U_i]} + \sum_i \mathbb{E}[\Psi] - p}$$

and replacing $Pr(L)$ in equation (12) yields

$$2V^1 - \frac{p(2V^1 - X)\mathbb{E}[\Psi]}{p\mathbb{E}[U_i] + \mathbb{E}[\Psi] - p}.$$

By dropping constants, maximizing the above equation is equivalent to minimizing

$$\frac{\mathbb{E}[\Psi]}{p(\mathbb{E}[U_i] - 1) + \mathbb{E}[\Psi]},$$

which in turn is equivalent (by rearranging and dropping constants once again) to maximizing

$$\frac{\mathbb{E}[\Psi]}{p(1 - \mathbb{E}[U_i])}. \tag{13}$$

Thus, maximizing the above maximizes joint surplus, whereas maximizing $\mathbb{E}[U_i] + \mathbb{E}[\Psi]$ maximizes settlement. The latter is simpler than the former as it is linear in $b_P(1)$. However, numerically maximizing equation (13) reveals that the properties of Corollary 1 remain.

B Proofs

B.1 Proof of Lemma 1

Proof. We provide the main arguments behind the equilibrium construction. Let $F_i^{\theta_i} : [0, \infty) \to [0, 1]$ describe type θ_i's distribution of actions a_i. Fix F_{-i}^1 and F_{-i}^K. Then disputant i, type θ_i, holding belief $b_i(\theta_i)$ solves

$$\max_{a_i} \quad XF_{-i}(a_i|b_i(\theta_i)) - \theta_i a_i, \tag{14}$$

where $F_{-i}(a_i|b_i(\theta_i))$ is the expected likelihood that $a_i > a_{-i}$ given belief $b_i(\theta_i)$. We can decompose $F_{-i}(a_i|b_i(\theta_i))$ to

$$F_{-i}(a_i|\theta_i) = b_i(\theta_i)F_{-i}^1(a_i) + (1 - b_i(\theta_i))F_{-i}^K(a_i).$$

Fix a set of beliefs $b_i(m_i)$. An equilibrium is a fixed point solving each type's and player's maximization problem simultaneously. We provide a full characterization of monotone equilibria following Siegel (2014). Graphically, Figure 2 summarizes the equilibrium characterization. The upper bound of the joint support is the same for both disputants. Consistently outperforming the opponent by some margin cannot be optimal as investment in quality is costly. For the same reason the equilibrium is in mixed strategies and disputants make their opponent indifferent. Marginal costs are constant and so are densities. If the distribution of costs is asymmetric, equilibrium strategies are asymmetric too. If $b_P(1) = b_D(1)$, then $a_D^K = a_P^K$ and the equilibrium is symmetric. Moreover, the mass point disputant P has at 0 vanishes in that case. Disputant $\theta_P = K$ is the weakest of all potential realizations. She has high cost and faces an opponent that is likely to have low cost. She expects zero payoff in equilibrium and is willing to abstain with positive probability. Analytically, the following lemma provides the characterization.

Lemma 10. *Assume* $1 > b_P(1) \geq b_D(1) > 0$, *and* (M). *Evidentiary hearing has a unique equilibrium and is characterized by quality levels* $\overline{a}_P^1 > \overline{a}_P^K \geq \overline{a}_D^K > 0$ *that partition the action space. The support of each disputant's equilibrium strategy is on the intervals*

- $(0, a_P^K]$ *for Plaintiff, type* K, *and* $(a_P^K, a_P^1]$ *for Plaintiff, type 1,*
- $(0, a_D^K]$ *for Defendant, type* K, *and* $(a_D^K, a_P^1]$ *for Defendant, type 1.*

In addition, Plaintiff, type K, *has a mass point at* 0 *if* $b_P(1) > b_D(1)$. *The density* $f_i^1(a) = \frac{\theta_{-i}}{Xb_i(\theta_{-i})}$ *for all quality levels* a *in the joint support of* $\theta_i = 1$ *and* θ_{-i}. *Similarly, type* $\theta_i = K$ *has density* $f_i^1(a) = \frac{\theta_{-i}}{X(1-b_i(\theta_{-i}))}$ *for quality levels in the joint support with* θ_{-i}. *The mass point is*

$$F_P^K(0) = 1 - \frac{1 - b_P(K)}{1 - b_D(K)} - \left(1 - \frac{b_D(1)}{b_P(1)}\right) \frac{b_P(K)}{1 - b_D(1)} \frac{1}{K}.$$

Further

$$\begin{aligned}
\overline{a}_D^K &= \frac{X(1 - b_P(K))}{K}, \\
\overline{a}_P^K &= \overline{a}_D^K + \left(1 - \frac{b_D(1)}{b_P(1)}\right) \frac{Xb_P(K)}{K}, \\
\overline{a}_P^1 &= \overline{a}_P^K + Xb_D(1).
\end{aligned}$$

Proof. The proof is an adaptation of the algorithm in Siegel (2014). We relegate it to

Appendix C. $\square$

Using Lemma 10, Lemma 1 follows. First, $U_P(K) = 0$ because the high-cost type of P puts positive mass on investment 0. Second, $U_D(K) = X(1 - b_D(K))F_P^K(0)$. Substituting for $F_P^K(0)$, yields the result. Finally, $U_i(1) = X - \bar{a}_P^1$. Again, substituting $\bar{a}_P^1$ from the proof of Lemma 10 yields the result. $\square$

B.2 Proof of Lemma 2

Proof. Disputant's i's veto payoff, $V^1 = (1 - \min(p, b_{-i}^V))\frac{K-1}{K}X$ and $V^K = \max(b_{-i}^V - p, 0)\frac{K-1}{K}X$ are convex in p. Applying Proposition 2 in Balzer and Schneider (2019) implies that it is without loss to assume full participation at the optimum. $\square$

B.3 Proof of Proposition 2

Proof. Legal expenditure conditional on no-settlement is

$$1 - \underbrace{(\rho_P + \rho_D)}_{=1} U_i(1) + (1 - \rho_D)U_D(K; K) = (1 + 2p - p^2)\frac{K-1}{K}\frac{X}{2}$$

which is less than the ex-ante expected expenditure (because $p < 1/2$)

$$2pV^1 = 2p(1-p)\frac{K-1}{K}.$$

$\square$

B.4 Proof of Proposition 3

Proof. Take $z_i(\theta_i)$ as defined by (10). By Lemma 9 we know that there are $x_i(\theta_i, \theta_{-i})$ such that

$$x_i(\theta_i) = \frac{z_i(\theta_i)}{1 - \gamma_i(\theta_i)} = \frac{p(1 - \gamma_i(\theta_i, 1))x_i(\theta_i, 1) + (1-p)(1 - \gamma_i(\theta_i, K))x_i(\theta_i, K)}{1 - \gamma_i(\theta_i)}.$$

For each i and θ_i, define $r_i(\theta_i) := \min\{x_i(\theta_i, 1), x_i(\theta_i, K)\}$. Fix $r_i(K)$ and partition the real line as follows

$$[0, r_i(K)] \cup (r_i(K), 1].$$

By a slight abuse of notation, we say that a disputant who reported reservation value $r_i \in [0, r_i(K))$ submitted report $m_i = K$ and a disputant who reported reservation value $r_i \in (r_i(K), 1]$ submitted report $m_i = 1$. The mediator's protocol is then as follows.

$$\underline{x}_P = \begin{cases} r_P(K) & \textit{if } m_P = K \\ r_P(1) & \textit{if } m_P = 1, \end{cases} \qquad \underline{x}_D = \begin{cases} 0 \textit{ with prob. } \gamma(m_P, K) \textit{ and } r_D(K) \textit{ else} & \textit{if } m_D = K \\ 0 \textit{ with prob. } \gamma(m_P, 1) \textit{ and } r_D(1) \textit{ else} & \textit{if } m_D = 1. \end{cases}$$

If both parties accepted their guaranteed shares $\underline{x}_i \neq 0$, the mediator clears the settlement share such that each party receives expected share $x_i(m_i)$ conditional on settlement. If D accepted $\underline{x}_D = 0$, the mediator assigns share 1 to Plaintiff.

We want to show that the equilibrium of this game is to report $\theta_i = m_i$ and to accept any guaranteed share but $\underline{x}_D = 0$.

Disputant P learns nothing from the designer's proposal, $\underline{x}_P$, and attaches the prior probability p to D's type distribution if she rejected her proposal. Thus, she has no incentive to reject the proposal.

Define $q_D(m_D) := Pr(\theta_P = 1|m_D$ and settlement). According to the protocol, P learns about the deviation by D and thus holds an off-path belief, say q_P^r. We are looking for an off-path belief q_P^r such that D accepts her share and no double deviation (misreport and reject) occurs.

The law of iterated expectations implies that after the report $m_D = 1$ the following holds.

$$(1-p) = (1-\gamma_D(1))(1-q_D(1)) + \gamma_D(1)(1-\rho_P).$$

Multiplying both sides with $\frac{K-1}{K}X$,

$$\underbrace{(1-p)\frac{K-1}{K}X}_{=V^1} = (1-\gamma_D(1))(1-q_D(1))\frac{K-1}{K}X + \gamma_D(1)\underbrace{(1-\rho_P)\frac{K-1}{K}X}_{=U_i(1;1)}.$$

The low-cost type's participation constraint binds, and therefore $x_D(1) = (1 - q_D(1))\frac{K-1}{K}X$. If $q_P^r \geq q_D(1)$ the share a low-cost type receives from accepting is equal to her expected payoff from deviating and rejecting the share, $(1 - \min(q_P^r, q_D(1))\frac{K-1}{K}X$. Disputant $\theta_D = 1$ has no incentive to reject the proposal. Similar, type $\theta_D = K$ has no incentive to reject the proposal after pretending to be type 1. The high-cost types incentive constraint at the reporting stage are not affected.

After a report of $m_D = K$ the following holds by the law of iterated expectations.

$$(1-p) = (1-\gamma_D(K))(1-q_D(K)) + \gamma_D(K)(1-\rho_P).$$

We first show that the low-cost type does not gain by imitating the high-cost type at the reporting stage and then rejecting the proposed share. Multiplying both sides of the above equation with $\frac{K-1}{K}X$ implies

$$V^1 - \gamma_D(K)U(1;1) = (1-\gamma_D(K))(1-q_D(K))\frac{K-1}{K}X \geq x_D(K).$$

Where the last inequality follows from the low-cost type's incentive constraint at the reporting stage. If $\theta_D = 1$ reports K and rejects, her continuation payoff is $(1 - \min(q_P^r, q_D(K)))\frac{K-1}{K}X$. Setting $q_P^r \geq q_D(K)$ implies an expected payoff at the reporting stage,

$$(1-\gamma_D(K))(1-q_D(K))\frac{K-1}{K}X + \gamma_D(K)U(1;1) = V^1 = \Pi_D(1;1),$$

and provides her no incentives to deviate.

Moreover, if type $\theta_D = K$ deviates by rejecting the proposal after truthfully reporting, it is observed and the mediator announces that deviation. Because $q_P^r \geq q_D(K)$, $\theta_D = K$ obtains utility $(q_P^r - q_D(K))\frac{K-1}{K}X$ if she rejects the proposal. She prefers to accept the proposal if $(q_P^r - q_D(K))\frac{K-1}{K}X \leq x_D(K)$. For an off-path belief $q_P^r = q_D(K)$ she is willing to accept any share.

The symmetrizing signal does not affect the outcome as players learn their assigned role upon observing x_i. $\square$

B.5 Proof of Proposition 4

Proof. The proof follows from Lemma 8 and the following lemma.

Lemma 11. *If the low-cost types' incentive constraint is satisfied at the maximum of the RHS of equation* (11)*, then the designer does not benefit from disclosing additional information.* □

Proof. See Appendix C. □

B.6 Proof of Proposition 5

Proof. We describe the result in Hörner, Morelli, and Squintani (2015) and how they map in the variables we are interested in. First, the result in Hörner, Morelli, and Squintani (2015, in particular their Lemma 1.) is symmetric throughout. Thus, $b_P(\theta) = b_D(\theta)$. Moreover, depending on the parameter values, Hörner, Morelli, and Squintani (2015) distinguish between two cases. In the first case, high-cost dyads settle for sure and the hearing occurs only between low-cost types. In the second case, settlement fails for high-cost types with positive probability. Then, they face a low-cost type opponent with probability 1. Thus, $b_i(K) = 1$ if settlement fails for high-cost types. But as low-cost dyads never settle and sometimes face a high-cost type in the hearing, it follows $b_i(1) < 1$. Thus, $b_i(1) \neq b_i(K)$. □

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C Omitted Proofs

C.1 Proof of Lemma 9

Proof. For implementability of $z_i(\cdot)$ through some $x_P(\theta_P, \theta_D) + x_D(\theta_D, \theta_P) \leq X$ we invoke Theorem 3 in Border (2007). The conditions are as follows.

For every message $m \in \{1, K\}$, let $m^c := \{k \in \{1, K\} | k \neq m\}$ be its complement. Further, let $p(1) \equiv p$ and $p(K) \equiv (1-p)$. Fix some γ and non-negative z_i for every i. Then there exists an ex-post feasible x_i (i.e. $x_i(\theta_i, \theta_{-i}) \in [0, X]$ and $x_P(\theta_P, \theta_D) + x_D(\theta_D, \theta_P) \leq X$) that implements z_i if and only if the following constraints are satisfied:

- $\forall m, n \in \{1, K\}$:

$$p(m)z_i(m) + p(n)z_{-i}(n) \leq \qquad (EPI)$$

$$X(1 - Pr(L)) - X(1 - \gamma(m^c, n^c))p(m^c)p(n^c)$$

- $\forall m, i$:

$$z_i(m) \leq X(1 - \gamma_i(m)). \qquad (IF)$$

Plugging in the values at the optimum defined from page 24 onwards verifies the inequalities.

If condition (M) is violated, the equilibrium is no-longer monotonic. Instead, overlapping strategies may be possible: If, e.g., $b_P(1)K < b_P(K)$ the likelihood of meeting a low-cost type for $\theta_D = K$ is too high compared to that of $\theta_D = 1$. $\theta_D = K$ has strong incentives to *provide more evidence* than $\theta_D = 1$. Further, because belief systems are consistent, whenever $\theta_D = K$ faces a $\theta_P = 1$, that low-cost type (rationally) expects to face $\theta_D = K$ with large probability. This provides an incentive for $\theta_D = K$ to compete more aggressively and for $\theta_P = 1$ to compete softer than under condition (M). The equilibrium strategy support in the non-monotonic equilibrium is depicted in Figure 8. $\theta_D = 1$ and $\theta_D = K$ overlap on the middle interval but are otherwise "close to monotonic". $\theta_P = K$'s support covers the whole interval, $\theta_P = 1$ only competes on the middle interval. In addition, a high-cost Defendant also has a mass point at 0.

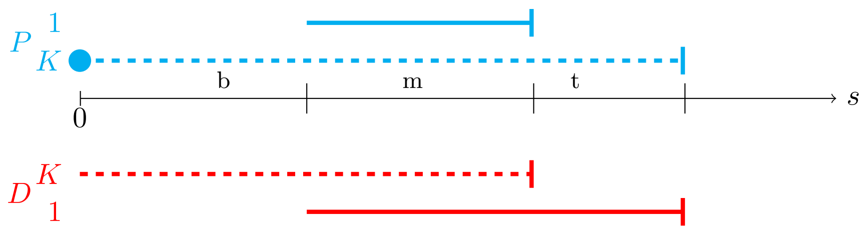

Figure 8: **Strategy support of P and D if monotonicity fails.**

Inside the space of non-monotonic equilibria there is no interior solutions for the same reasons as in Appendix A.1. The designer picks $b_P(1)$ equal to any discontinuity point or at the respective borders. That is, either $b_P(1) = 0$ or $b_P(1) = \max\{b_D(1), b_P(K)/K\}$. If $b_P(1) = b_D(1) = \rho_i$ under non-monotonicity, the first-order condition of the designer's problem is monotone in ρ_i, requiring $\rho_i = 0$ which is never optimal. If $b_P(1) = b_P(K)/K$ utilities converge to their monotone counterparts and thus, the solution is no different than that for monotonicity. Finally, $b_P(1) = 0$ is never optimal as the objective is always decreasing at this point. $\square$

C.2 Proof of Lemma 10

Proof. The proof follows Siegel (2014). We omit proving uniqueness and the following properties: (i) the equilibrium is in mixed strategies, (ii) the equilibrium support of both disputants shares a common upper bound, and (iii) the equilibrium support is convex and at most one disputant has a mass point which is at 0. All arguments apply exactly as in Siegel (2014).

Each disputant θ_i holds belief $b_i(\theta_i)$, and maximizes

$$(1-b_i(\theta_i))\, XF_{-i}^{K}(a)+b_i(\theta_i)XF_{-i}^{1}(a)-a\theta_i,$$

over a. Define the partitions $I_1=(0,\overline{a}_D^K]$, $I_2=(\overline{a}_D^K,\overline{a}_P^K]$ and $I_3=(\overline{a}_P^K,\overline{a}_P^1]$. We define indicator functions $\mathbb{1}_{\in I_l}$ with value 1 if $a\in I_l$ and 0 otherwise. Similar the indicator function $\mathbb{1}_{>I_l}$ takes value 1 if $a>\max I_l$ and 0 otherwise. Disputant θ_i mixes such that the opponent's first-order condition holds on the joint support. The densities are

$$f_D^1(a)=\mathbb{1}_{\in I_2}\frac{K}{Xb_P(K)}+\mathbb{1}_{\in I_3}\frac{1}{Xb_P(1)},\quad f_D^K(a)=\mathbb{1}_{\in I_1}\frac{K}{X(1-b_P(K))},$$
$$f_P^1(a)=\mathbb{1}_{\in I_3}\frac{1}{Xb_D(1)},\qquad f_P^K(a)=\mathbb{1}_{\in I_1}\frac{K}{X(1-b_D(K))}+\mathbb{1}_{\in I_2}\frac{1}{X(1-b_D(1))}.$$

This leads to the following cumulative distribution functions:

$$\begin{aligned}
F_D^1(a)&=\mathbb{1}_{\in I_2}a\frac{K}{Xb_P(K)}+\mathbb{1}_{\in I_3}\left(\frac{a}{Xb_P(1)}+F_D^1(\overline{a}_D^K)\right)+\mathbb{1}_{>I_3},\\
F_D^K(a)&=\mathbb{1}_{\in I_1}a\frac{K}{X(1-b_P(K))}+\mathbb{1}_{>I_1},\\
F_P^1(a)&=\mathbb{1}_{\in I_3}\frac{a}{Xb_D(1)}+\mathbb{1}_{>I_3},\\
F_P^K(a)&=\mathbb{1}_{\in I_1}\left(a\frac{K}{X(1-b_D(K))}+F_P^K(0)\right)+\mathbb{1}_{\in I_2}\left(\frac{a}{X(1-b_D(1))}+F_D^K(\overline{a}_D^K)\right)+\mathbb{1}_{>I_2}.
\end{aligned}$$

Disputants' Strategies: Interval Boundaries. The densities define the strategies up to the intervals' boundaries. These boundaries are determined as follows

1. $\overline{a}_D^K$ is determined using $F_D^K(\overline{a}_D^K)=1$, i.e. $\overline{a}_D^K f_D^K(a)=1$ for $a\in I_1$. Substituting yields
$$\overline{a}_D^K=\frac{X(1-b_P(K))}{K}.$$
2. For any $\overline{a}_P^K$, $\overline{a}_P^1$ is determined using $F_P^1(\overline{a}_P^1)=1$, i.e. $\left(\overline{a}_P^1-\overline{a}_P^K\right)f_P^1(a)=1$ with $a\in I_3$. Substituting yields
$$\overline{a}_P^1=\overline{a}_P^K+Xb_D(1).$$
3. $\overline{a}_P^K$ is determined by $F_D^1(\overline{a}_P^K)=1$. That is, $\left(\overline{a}_P^K-\overline{a}_D^K\right)f_D^1(a)+\left(\overline{a}_P^1-\overline{a}_P^K\right)f_D^1(a')=1$ with $a\in I_2, a'\in I_3$. Substituting yields
$$\overline{a}_P^K=\overline{a}_D^K+\left(1-\frac{b_D(1)}{b_P(1)}\right)\frac{Xb_P(K)}{K}.$$
4. $F_P^K(0)$ is determined by the condition $F_P^K(\overline{a}_P^K)=1$, i.e. $F_P^K(0)=1-\overline{a}_D^K f_P^K(a)-\left(\overline{a}_P^K-\overline{a}_D^K\right)f_P^K(a')$ with $a\in I_1, a'\in I_2$. Substituting yields

$$F_P^K(0) = 1 - \frac{1-b_P(K)}{1-b_D(K)} - \left(1 - \frac{b_D(1)}{b_P(1)}\right) \frac{b_P(K)}{1-b_D(1)} \frac{1}{K}. \quad \square$$

C.3 Proof of Lemma 11

Proof. A public signal implies a lottery over several (internally consistent) information structures.

Take the set $\{\rho_A, \rho_B, b_A(1)\}$ that maximizes (11). Assume that it violates neither (IC^1) and is feasible. By the definition of an optimum this implies that no other information structure provides a higher value of (11). Thus, no lottery over information structures can improve upon that optimum either. Hence signals have no use. $\square$

D Alternative Implementation for Mediation

In this section we show that the abstract optimal ADR mechanism can be implemented by a mediation mechanism in which a disputant can secure herself a settlement solution by claiming a moderate reservation value. More precisely, the game is as follows.

1. Both disputants claim a reservation value, $r_i \in \{w_i, s_i\}$, with $s_i > w_i$
2. The case settles with probability 1 if at least one disputant claimed reservation value w_i
3. If both disputants claimed reservation value s_i, the case goes to litigation with probability $\alpha = \gamma(1, 1)$.

Let $\tilde{m}_i \in \{w_i, s_i\}$. Suppose there is a settlement solution. Then, the mediator clears the shares as follows: Party i, who reported $\tilde{m}_i$, receives ex-post share $\tilde{x}_i(\tilde{m}_i, \tilde{m}_{-i})$.

Take the numerical example with $(X, K, p) = (1, 3, 1/5)$. This game has an equilibrium in which (i) the high type mixes between reporting w_i and s_i and (ii) the probability of settlement is the same as that under the optimal mechanism.

Suppose that K_i reports s_i with probability σ_i. Moreover, let $\sigma_P = \frac{p(1+p)}{(1-p)^2} = \frac{6}{16}$ and $\sigma_D = \frac{p}{1+p} = \frac{1}{6}$. Given this strategy, we have $Pr(L|\theta_i, \theta_{-i}) = \gamma(\theta_i, \theta_{-i})$ for all type combinations (θ_i, θ_{-i}).

Next, we construct the expected shares, $\tilde{z}_i(\tilde{m}_i)$ with $\tilde{m}_i \in \{w_i, s_i\}$, such that (i) reporting w_i yields to expected share $\tilde{z}_i(1)$ and K_i is indeed indifferent between reporting w_i and s_i. Then, it directly follows that 1_i strictly prefers to report s_i.

- 1_P receives expected share $\tilde{z}_P(s_i) = z_P(1) = \frac{76}{165}$
- K_P receives $U_P(K) = 0$ whenever there is litigation. Thus, she needs expected share $\tilde{z}_P(w_i) = \tilde{z}_P(s_i) = z_P(1)$
- 1_D receives expected share $\tilde{z}_i(s_i) = z_D(1) = \frac{14}{33}$
- K_D receives $U_D(K) = \frac{2}{15}$ whenever there is litigation. Thus, $\tilde{z}_D(K)$ must satisfy $z_D(1) + \gamma_D(K)U_D(K) = \tilde{z}_D(w_i)$ or $\tilde{z}_D(w_i) = z_D(1) + \gamma_D(1)U_D(K) = \frac{14}{33} + \frac{3}{11}\frac{2}{15} = \frac{76}{165}$.

The ex-post shares $\tilde{x}_i(\tilde{m}_i, \tilde{m}_{-i})$ that give rise to these expected shares solve the following system of equation.

$$\tilde{z}_P(s) = \tilde{x}_P(s, s)(1-\alpha)(p + (1-p)\sigma_D) + \tilde{x}_P(s, w)(1-p)(1-\sigma_D) \tag{15}$$

$$\tilde{z}_P(w) = \tilde{x}_P(w, s)(p + (1-p)\sigma_D) + \tilde{x}_P(w, s)(1-p)(1-\sigma_D) \tag{16}$$

$$\tilde{z}_D(s) = (1 - \tilde{x}_P(s, s))(1-\alpha)(p + (1-p)\sigma_P) + (1 - \tilde{x}_P(w, s))(1-p)(1-\sigma_P) \tag{17}$$

$$\tilde{z}_D(w) = (1 - \tilde{x}_P(s, w))(p + (1-p)\sigma_P) + (1 - \tilde{x}_P(w, w))(1-p)(1-\sigma_P) \tag{18}$$

Substituting $\alpha = \frac{6}{11}$, σ_D, σ_P, and $\tilde{z}_i(\tilde{m}_i)$ the system becomes

$$\frac{76}{165} = \tilde{x}_P(s,s)\frac{5}{33} + \tilde{x}_P(s,w)\frac{2}{3} \tag{19}$$
$$\frac{76}{165} = \tilde{x}_P(w,s)\frac{1}{3} + \tilde{x}_P(w,w)\frac{2}{3} \tag{20}$$
$$\frac{10}{33} = \tilde{x}_P(s,s)\frac{5}{22} + \tilde{x}_P(w,s)\frac{1}{2} \tag{21}$$
$$\frac{89}{165} = \tilde{x}_P(s,w)\frac{1}{2} + \tilde{x}_P(w,w)\frac{1}{2} \tag{22}$$

The following ex-post shares

$$\begin{pmatrix} \tilde{x}_P(s,s) \\ \tilde{x}_P(s,w) \\ \tilde{x}_P(w,s) \\ \tilde{x}_P(w,w) \end{pmatrix} = \begin{pmatrix} \frac{8}{15} \\ \frac{94}{165} \\ \frac{4}{11} \\ \frac{84}{165} \end{pmatrix}$$

with $\tilde{x}_D(\tilde{m}_D, \tilde{m}_P) = 1 - \tilde{x}_P(\tilde{m}_P, \tilde{m}_D)$ implement an equilibrium. Thus, the allocation (including the probability of settlement) is the same as that of the optimal abstract ADR mechanism.