Managing a Conflict: Optimal Alternative Dispute Resolution*

Benjamin Balzer† Johannes Schneider‡

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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. Optimal ADR is implementable through binding arbitration and mediation, but not through bilateral bargaining.

1 Introduction

Alternative Dispute Resolution (ADR) has been fully established within the legal system.[1] The Department of Justice (DOJ) reports that in 2017, ADR was a significant factor in 71% of the cases in which the DOJ was involved, regardless of whether the case was settled through ADR.[2] ADR, however, is an umbrella term: 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. Indeed, ADR can take many forms, with binding arbitration and non-binding mediation being the most prominent. Moreover, within a given form of ADR, the third party conducting it 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

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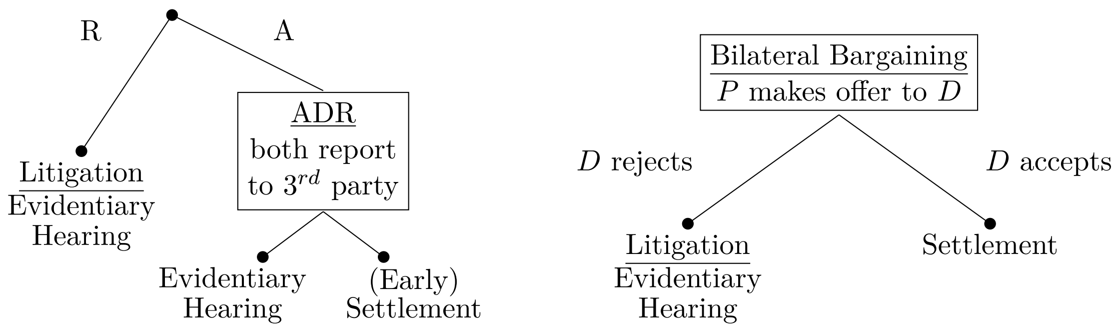
†University of Technology Sydney, benjamin.balzer@uts.edu.au

‡Carlos III de Madrid, Department of Economics, jschneid@eco.uc3m.es

[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] See `https://www.justice.gov/olp/alternative-dispute-resolution-department-justice`. Genn (1998) documents similar survey results among participants in London, UK.



(a) ADR

(b) Bilateral Settlement Bargaining

Figure 1: **Conceptual Difference between ADR and Bilateral Bargaining.** In ADR 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 via the third party. If at least one disputant rejects ADR (R), the case goes to court directly. In bilateral bargaining no third party is involved: disputants communicate directly.

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 ADR procedures possess these properties and therefore can implement optimal ADR.

Our first contribution is to obtain an upper bound on the settlement rate that ADR can achieve. We employ a systematic mechanism-design approach and characterize the settlement-maximizing ADR mechanism. A basic sketch of the model structure is in Panel (a) of Figure 1. Two disputants, a plaintiff and a defendant, hold private information about their cost of evidence provision. If both disputants agree on 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 settles the dispute by ruling on the share of damages the defendant is deemed liable for or 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 case 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 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, 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. They use their knowledge about their own report within ADR, as well as the resulting outcome of ADR, to conjecture about the opponent's report. Using equilibrium reasoning, they infer information about the opponent's cost. Anticipating such inference, 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 misguide the opponent's own reasoning. If, however, the information the plaintiff obtains within ADR 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.

Our second contribution addresses how to implement optimal ADR. We provide a protocol of both (court-annexed) arbitration (Holbrook and Gray, 1995) and mediation (Klerman and Klerman, 2015). Each implements optimal ADR. In contrast, we show that bilateral settlement bargaining cannot implement optimal ADR apart from trivial cases (Panel (b) of Figure 1 sketches the structure of bilateral bargaining). The main difference between third-party-run ADR and bilateral bargaining 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 acts as an informational gatekeeper, promising the disputants contingencies on which she passes on information. If disputants are wary about sharing information, the gatekeeper's role is of first-order importance. Other aspects, such as disputants' commitment to accept rulings, are less important. Thus, both binding arbitration and non-binding mediation can implement the optimal mechanism (see also Hörner, Morelli, and Squintani, 2015, for a similar result).

To effectively manage the information flow between disputants, ADR requires discretionary power within the process. Our model is consistent with real-world evidence. For example, by ruling on motions, the arbitrator can either "set the stage for settlement" or force the dispute into a costly process. The latter action need not imply mismanagement (e.g. Carver and Vondra, 1994; Stipanowich and Ulrich, 2014; Michaelson, 2016). Instead, it is part of the arbitrator's optimal strategy.

We also address a set of additional questions: How effective is ADR? Is it ex-ante fair? What changes if ADR aims at maximizing disputants' joint surplus? First, we find that ADR is effective. It achieves early settlement in more than 50% of the cases. Even if ADR fails to achieve settlement, it still reduces legal expenditure compared to a no-ADR case. 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. Our numerical results show that the asymmetry increases compared to settlement-maximizing ADR. Moreover, arbitration and mediation can also implement surplus-maximizing ADR, but bilateral settlement cannot.

Other Related Literature. The law and economics literature studying settlement under asymmetric information is extensive.[3] 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 also allow for a flexible ADR mechanism administered by a third party. In fact, the optimal mechanism always outperforms bilateral bargaining. Moreover, we show that pre-ADR bilateral bargaining *harms* the performance of ADR.

We contribute to a small literature in law and economics that studies dispute resolution from a mechanism-design perspective. Spier (1994) and Klement and Neeman (2005) are closest to us in 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 the optimal strategy in a hearing does not depend on information about the opponent. Thus, information released within the mechanism has no effect on behavior.

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 6 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 to our paper 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, but bilateral bargaining is not. We show that their result extends to settings where information does affect subsequent behavior. However, the properties of the optimal mechanism are fundamentally different once we

[3]For an overview of that literature see Daughety and Reinganum (2000, 2017). Recent examples include Prescott and Spier (2016) and Vasserman and Yildiz (2019).

allow for an effect on behavior. We discuss the relation to Hörner, Morelli, and Squintani (2015) in detail in Section 6 after presenting our results.[4]

Roadmap. We begin by setting up an abstract model in Section 2. We then analyze that model in Section 3. In Section 4 we show how our findings map to actual ADR mechanisms. Section 5 describes the main features of optimal ADR, Section 6 discusses and justifies our key assumptions, and Section 7 concludes the paper.

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, Defendant is liable for damages $S \geq 0$ and potentially liable for damages $X > 0$ with $W \equiv S + X$. That is, while it is commonly known that Defendant is liable for some damages (at least S), the parties dispute over the liability for the remainder X. 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.

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 $p \in (0, 1)$, the probability that $\theta_i = 1$.

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.

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.

Given the facts of the case, the variable component of a disputant's payoff is $\Xi_i(\theta_i) \in \{\Pi(\theta_i), V^{\theta_i}\}$. That variable component either results from participating in ADR—payoff $\Pi_i(\theta_i)$—or from litigation without ADR—payoff V^{θ_i}. Plaintiff's total expected payoff is thus $\Xi_P(\theta_i) + S - W$; Defendant's total payoff is $\Xi_D(\theta_i) - W$. In the following analysis,

[4]Other papers studying peace negotiations Bester and Wärneryd (2006), Fey and Ramsay (2011), Meirowitz et al. (2017), and Zheng (2018) make similar assumptions. Zheng and Kamranzadeh (2018) discuss joint-surplus-maximizing bilateral bargaining in an environment identical to ours.

we drop the constants W and S for notational clarity and focus on the intensive margin $\Xi_i(\theta_i)$. We define $\Pi_i(\theta_i)$ and V^{θ_i} in more detail below.

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, 1988, for early related models). Whichever party provides the highest quality of evidence wins.[5]

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 but can destroy parts of it, i.e. $x_P(m_P, m_D) + x_D(m_D, m_P) \leq X$.[6]

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.[7] ADR is incentive compatible if disputants truthfully report their type in equilibrium.

Timing. The timing of the game is as follows.

[5] We choose this all-or-nothing structure for simplicity. It emerges as the limiting case of a Tullock contest, where awards smoothly depend on both disputants' evidence levels. However, only for special cases these contests have closed form solutions.
Moreover, introducing differences between litigation and within-ADR hearings has no qualitative effects on the outcomes. See Section 6 for further details.

[6] Almost all our results hold if ADR is *required* to distribute the entire X, i.e. $x_P(m_P, m_D) + x_D(m_D, m_P) = X$. Optimal ADR fully distributes X on the equilibrium path. The ability to "burn money" is only relevant in our mediation example in Section 4.2. There, the designer triggers a hearing by proposing shares that do not sum up to X. In particular, D can receive an unfavorable offer, leaving her no choice but to reject it.

[7] 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.

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 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.*

Let V^{θ_i} be the ex-ante expected payoff for a hearing in stage 3(a), and $U_i(\theta_i)$ be the ex-ante expected payoff for a hearing in stage 4(b). Then, the expected (on-path) payoff from participating in incentive-compatible ADR, $\Pi_i(\theta_i)$, is

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

Solution Concept and Objective. Our solution concept is perfect Bayesian equilibrium. For now, 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 discuss other rationales for settlement maximization in Section 6 and provide a discussion of joint-surplus-maximizing ADR at the end of Section 3.

Modeling Choices. We discuss our key assumptions in Section 6. While we do not allow for bilateral bargaining explicitly in our baseline model, we show in Section 4.1 that bilateral bargaining within ADR can be part of a process that implements the abstract optimal ADR mechanism.

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 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. Since parties are ex-ante symmetric, this case is redundant.

Using backward induction we solve the evidentiary hearing game for arbitrary beliefs

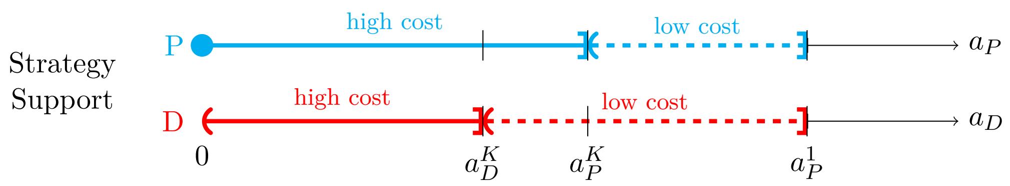


Figure 2: **Equilibrium evidence provision in on-path hearings.** All types (piece-wise uniformly) mix. Solid lines denote the the strategy support of θ_i=K; dashed lines denote that of θ_i=1. The equilibrium distribution is non-atomistic, apart from the mass point at 0 for Plaintiff, type K.

$b_i(m_i)$. 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

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

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.

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*

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

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,

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

3.2 Optimal ADR

We characterize optimal ADR in three steps. First, we rule out trivial cases in which optimal ADR achieves full settlement (the first best). Second, we state the designer's problem if the first best is not implementable. Third, we provide a characterization and interpretation of optimal ADR.

Preliminaries: Ruling Out Cases

From the formulation of V^{θ_i} it is evident that full settlement is achieved whenever $V^1 < X/2$: 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. We rule these cases out by making the assumption that $V^1 > X/2$. In terms of model primitives, this condition is equivalent to

$$p < \overline{p} := \frac{K-2}{2(K-1)}.$$

Observe that $\overline{p} < 1/2$ as it is increasing in K and converges to $1/2$ as $K \to \infty$. In addition $\overline{p} > 0$ only if $K > 2$. If $p < \overline{p}$ no full-settlement mechanism (no matter how sophisticated) exists. Optimal ADR is characterized by the second-best solution, to which we turn next. To facilitate the analysis, we define in addition a lower bound:

$$\underline{p} := \frac{2(K-1) - \sqrt{8 - 4K + K^2}}{2 + 3K}.$$

The lower bound mainly serves a technical purpose: it allows us to derive closed-form solutions. Qualitatively our results do not depend on it, but the exact solution can only be derived numerically.[8] If $\overline{p} > 0$ then $\overline{p} > \underline{p}$.

Assumption 1. $K > 2$ and $p \in (\underline{p}, \overline{p})$.

Assumption 1 implies that the parties' private information is the main obstacle to settlement. We want to highlight that we rule out (i) cases in which the parties can contract to waive any form of hearings before they have any sort of private information about their cost of evidence production,[9] and (ii) cases in which the parties would agree on a particular settlement outcome irrespective of the private information they hold. If the parties instead contracted to waive litigation before learning their private information, their outside option would reduce to $pV^1 + (1-p)V^K < X/2$. The parties could achieve full settlement. If $p \geq \overline{p}$, the parties settle at $X/2$ each and no third-party-led ADR is needed.

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

[8] In particular, the results in Corollary 1 below remain valid. We provide a computer program to calculate the optimal solution for any p on our websites.

[9] That is, in our model ADR is designed at an interim stage when the Plaintiff's damages have already realized.

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.[10] 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 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

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

Incentive-compatible ADR can be implemented with *full participation* if and only if

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

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

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. Under Assumption 1 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 $(\rho_P, \rho_D, b_P(1))$. While $b_P(1)$ 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 these marginal probabilities, the belief $b_P(1)$ captures the entire correlation between i's and $-i$'s beliefs. Thus $(\rho_P, \rho_D, b_P(1))$ describes the information structure. Appendix A provides the technical details. Our first proposition characterizes optimal ADR.

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

Note that 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. A corollary to Proposition 1 describes the main properties of optimal ADR.

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.

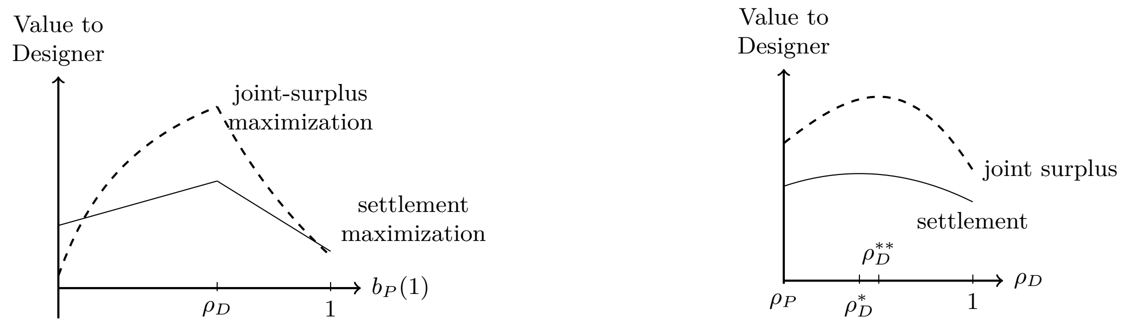
Asymmetry operates through a discouragement effect. If a low-cost type is sure to face a high-cost type and vice versa, both types are reasonably certain about the outcome. The high-cost type has little incentives to invest in evidence provision. She expects to lose with high probability. The low-cost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



(a) Optimal Correlation (b) Optimal Asymmetry

Figure 3: **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 $X = 1$, $K = 4$, $p = 1/4$, $\rho_P = (1-p)/2 = 3/8$. In the left panel $\rho_D = 5/8$, while in the right panel $b_P(1) \equiv \rho_D$. The optimal level of asymmetry under settlement rate maximization is $\rho_D^* = (1+p)/2 = 5/8$, while that under joint-surplus maximization is $\rho_D^{**} \approx 0.689$.

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.

Surplus-Maximizing ADR

Our baseline model aims at maximizing settlement rates. The mechanism derived in Proposition 1 does not maximize the joint expected surplus in general.

Definition 1 (Surplus-Maximizing ADR)**.** A mechanism maximizes joint surplus if no other incentive-compatible mechanism provides higher ex-ante joint surplus,

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

Yet, even if there are no costs to hold evidentiary hearings and we are looking 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 above, it is unsurprising that surplus-maximizing ADR implies a larger degree of asymmetry. In Figure 3 we (numerically) compare the value of information structures to the designer as a function of the correlation between types

Table 1: Different types of Settlement attempts

	Binding Arbitration	Mediation	Bilateral Settlement Bargaining
3^{rd}-party assistance	Yes	Yes	No
Settlement	Pre-Evidence Settlement	Mediator's Proposal	Bargaining Outcome
Evidentiary Hearing	Within Arbitration Adversarial Hearing	Litigation	Litigation
Outside Option for ADR	Litigation	Litigation	Litigation

(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, our implementation results below apply to both specifications.

4 Implementation

Proposition 1 provides a benchmark to optimal ADR. Table 1 summarizes how the three basic building blocks of our abstract model—(early) settlement, evidentiary hearing, and the outside option for ADR—translate into observed features of actual resolution approaches.[11] Below, we argue that (court-annexed) binding arbitration or mediation can implement optimal ADR, yet bilateral settlement bargaining cannot.

This result is intuitive in light of Corollary 1. An integral part of ADR is managing the information flow between disputants. A third-party arbitrator or mediator can manage that information flow and thereby calibrate the signals sent between the parties. In bilateral bargaining with asymmetric information, in contrast, parties cannot commit to providing unbiased information.

4.1 Court-annexed Arbitration

Shortly after a case has been filled, the court offers the disputants the option to refer it to an arbitration process. If both disputants agree to participate in the binding process, arbitration takes place. Otherwise, the dispute resolves via litigation (see Holbrook and Gray (1995)).

Cases where arbitration is considered a success are characterized by a fast and small discovery process.[12] However, not every arbitration case is a success story. Legal scholars have observed that it can be as cost-intensive and long as formal litigation (e.g. Carver

[11] See also Holbrook and Gray (1995) for a classification of the different modes of ADR.

[12] As, for example, Wilkinson (2014) points out: "*arbitrating parties typically were content with a swift dose of rough justice without any discovery at all.*"

and Vondra, 1994; Stipanowich and Ulrich, 2014; Michaelson, 2016). Recent evidence from both scholars and practitioners (in addition to the above Wilkinson, 2014) suggests that cost- and time-intensive arbitration results from the arbitrator's mismanagement. Indeed, the arbitrator has discretion when managing the case.

The arbitrator's practice when ruling on motions is a key determinant of how the process evolves.[13] She can bypass the costly hearing process by ruling on summary motions and awarding arbitration awards early. In contrast, denying summary motions but granting discovery motions lengthens the process.

In line with the above observations of actual arbitration practices, we now present a mapping from the abstract ADR mechanism of Section 2 and 3 into (court-annexed) binding arbitration.

Definition 2 (Arbitration)**.** Arbitration is defined by the following sequence of moves.

1. The disputants and the arbitrator meet at a preliminary conference; at this conference both disputants report their reservation value of a settlement to the arbitrator in private. The arbitrator recommends to each party whether she should file a dispositive motion, such as a summary judgment, or a discovery motion.
2. Both disputants have the ability to file dispositive and discovery motions.
3. The arbitrator rules on dispositive and discovery motions without any hearing. If the arbitrator recommended that a party file a dispositive motion, she grants an arbitration award. If the arbitrator recommended only discovery motions, she grants one of them.
4. The arbitrator dismisses all motions that she did not recommend.

To map court-annexed arbitration to optimal ADR, recall the key assumptions in our abstract model. First, at a very early stage in the process the arbitrator influences whether the case resolves without costly documentation or whether it escalates to a costly hearing. In line with the abstract model, if the arbitrator does not grant any party a dispositive motion (and/or grants discovery motions), the arbitration process results in costly documentation. Second, the arbitrator can also influence the terms of the resolution. In line with the abstract model, the arbitrator decides on the arbitration awards by granting dispositive motions.

Arbitration, as in Definition 2, is in line with real-world practice. The role of ruling on motions is crucial in the arbitration process. Motions can include summary judgments, dispositive motions, or motions to limit the scope of evidence. Courts typically respect the arbitrator's authority to rule on these motions.[14] Wilkinson (2014) reports:

> Shortly after appointment of the arbitrator in a commercial dispute, the ar-

[13]Stipanowich and Ulrich (2014) report: "*On the one hand, motion practice often adds to arbitration costs and cycle time without clear benefits, as in court. The filing of a motion can trigger the setting of a schedule for briefing and argument requiring major efforts by counsel, all of which may come to naught if the arbitrators conclude that the unresolved factual disputes require action on the motion to be postponed pending a full hearing on the merits*". See also Michaelson (2016).

[14]See, e.g., `https://www.arbitrationnation.com/dispositive-motions-arbitration-just/` and Ferris and Biddle (2007)

> bitrator typically convenes a conference with the parties for the purpose of planning the entire case. This conference is the single most important event in an arbitration; it is the engine that makes the process run and can be the foundation for a limited, cost-effective discovery program. Following the conference, the arbitrator typically drafts and circulates a procedural order that sets forth dates for everything that needs to be done between the conference and the hearing on the merits and establishes the dates for the actual hearing.

Corollary 2. *Optimal arbitration implements the outcome of optimal ADR.*

Recall that, according to Proposition 1, optimal arbitration means that the arbitrator has to manage the information flow between disputants. Key for that result is that the arbitrator has enough discretion to manage the information flow by making her ruling on motions contingent on the disputants' (private) reports. Indeed, Corollary 2 does not depend on the specific techniques the arbitrator uses to achieve settlement. Real arbitration cases often allow for settlement negotiations after the arbitration process has started. In such situations, cost-efficient resolution is achieved if the arbitrator "sets the stage for settlement." She influences the likelihood and terms of the settlement solution by granting motions.[15] In a similar vein, Stipanowich and Ulrich, 2014 argue for the common practice of "med-arb," that is, a hybrid version between mediation and arbitration, where the arbitrator facilitates the process of settlement negotiations between disputing parties soon after a first hearing. By using (or not using) any of these techniques the arbitrator decides if she opts for a cost-efficient resolution and under what terms.

4.2 Mediation

Mediation is another common form of ADR. Stipanowich (2004) notes that almost all corporations (98%) in the Fortune 1000 Corporate Counsel Survey have experienced mediation as a version of ADR. Mediation is led by a neutral third party that assists disputants in reaching a mutually satisfactory resolution. There are two main differences from binding arbitration. First, mediation is non-binding. That is, a party which is not satisfied with the (proposed) settlement solution can opt out of the mediation process. Second, mediation is non-adversarial, that is, mediation does not call for an adversarial hearing. Instead, if the mediator finds that evidence is necessary, it sends the parties directly or indirectly back to the litigation track (Holbrook and Gray, 1995).

Klerman and Klerman (2015) analyze more than 400 real mediation cases and provide insights into the mediation practice. A mediator privately interacts with each party to elicit their reservation value, defining a party's minimal acceptable share. Parties strategize about what reservation value to report. Appearing inflexible makes high settlement values

[15] For example, Stipanowich and Ulrich (2014) reports that *"The granting of a motion may also motivate a party to initiate settlement discussions rather than incur the expense and risk of pursuing a claim that is diminished in value and less amenable to pressing through adjudication. Conversely, arbitrators' reflexive refusal to come to grips with such issues represents a lost opportunity to save the parties time and money."* See also Michaelson (2016).

likely, at the risk that no solution is found. The process ends with the mediator proposing to each party *in private* a settlement share ("the mediator's proposal"). The parties then respond confidentially to the mediator. Only if both parties accept their share, a settlement solution is found.

We propose a mediation game to capture mediation, as reported by Klerman and Klerman (2015).

Definition 3 (Mediation)**.** Mediation is defined by the following sequence of moves.

1. P proposes her reservation value (potentially contingent on D's proposal) in private to the mediator.
2. D proposes her reservation value (potentially contingent on P's proposal) in private to the mediator.
3. If the proposals are non-compatible with each other, the mediator does not propose a closing offer and the disputants go to court. If the proposals are compatible, the mediator proposes a closing offer, in private, to each party.

4a. If both agree, the proposal is implemented.

4b. If either party rejects a proposal that was within her reported reservation value, the mediator publicly announces that the party refused to sign the mediator's proposal and litigation follows.

Our next proposition shows that the mediation game can implement optimal ADR.

Proposition 2. *Optimal mediation implements the outcome of optimal ADR.*

The above mechanism allows the mediator to ensure the privacy of the parties' proposals until the deal is mutually signed. Indeed, such contracts are common in mediation practice. According to Klerman and Klerman (2015) mediators often use so-called "bracketed offers," that is, offers where the proposal to one party is made contingent on the other party making a concession.[16] Moreover, Klerman and Klerman (2015) report that trust in the mediator's ability to maintain privacy is key to the success of mediation. Proposition 2 also reproduces the findings that Hörner, Morelli, and Squintani (2015) obtain in an otherwise different model of conflict management. We discuss the differences at the end of Section 6.

The mediator induces litigation by proposing to one party a share that is below her reservation value; e.g. she proposes a share of 0 to D. P, in turn, is aware that D sometimes receives an offer below her reservation value but she cannot infer D's offer from the one presented to her. By (partially) concealing whether D received an offer *below* her reservation value, the mediator makes sure that neither D nor P have an incentive to reject an offer *within* their reservation values. Under this protocol, the mediator has to burn money if D unexpectedly accepts the 0-offer. However, such burning of money only happens off the equilibrium path.

[16] Spier and Prescott (2019) provide further evidence on the value of contingent offers in legal disputes.

4.3 Bilateral Settlements

In light of the Coase theorem, the most natural way for disputants to settle is through bilateral settlement bargaining. Yet asymmetric information is an obstacle to the Coase theorem—and bilateral bargaining between disputants cannot fully resolve the dispute. Indeed, fixing the designer's objective, bilateral settlement bargaining cannot outperform optimal ADR by the revelation principle. Below, we show that bilateral settlement bargaining also cannot implement the optimum. Even more significant, allowing bilateral settlement *prior* to ADR harms its performance.

To keep the model simple, we use the bilateral bargaining structure from Schweizer (1989). One of the disputants (say P) makes a take-it-or-leave-it offer to the other (D). If D accepts, the parties settle. Otherwise they proceed to litigation. We find that this bilateral bargaining is dominated by a third-party-led ADR approach.

Proposition 3. *Any equilibrium in bilateral bargaining leads to a strictly* lower *settlement rate than optimal ADR from Proposition 1 and to strictly* lower *expected joint surplus than those achieved under surplus-maximizing ADR.*

As we have seen, private information decreases the scope of bilateral bargaining. Moreover, bilateral bargaining also jeopardizes the effectiveness of ADR in the presence of private information. Suppose the disputants engage in settlement bargaining before joining an ADR mechanism. More specifically, we refer to the bilateral-bargaining-in-the-shadow-of-ADR game as the following. First, P makes an offer to D. If accepted, the game ends and the disputants settle. If D rejects the offer, the disputants play the ADR game introduced in Section 2.

Proposition 4. *Take an arbitrary ADR mechanism as the second stage. Any equilibrium in the bilateral-bargaining-in-the-shadow-of-ADR game leads to a strictly* lower *settlement rate than optimal ADR from Proposition 1 and to strictly* lower *expected joint surplus than those achieved under surplus-maximizing ADR.*

Proposition 4 shows that bargaining *before* ADR is harmful to the outcome of ADR. This result provides a rationale for ADR clauses already at the contracting stage, stating that disputes are solved with the help of a third party. Although it is hard to prevent parties from engaging in private bargaining, we expect such clauses to disincentivize parties to do so by framing them into ADR.

5 Properties of Optimal ADR

In this section we address the implications of the optimal ADR protocol. We focus on the intuition and trade-offs behind the economic implications. Formally, all the results follow from the construction of optimal ADR in Appendix A.

Expenditure. If optimal ADR is designed to maximize the settlement rate, its objective ignores any effect on expenditures *conditional* on failed settlement. Yet, it turns out that while the settlement rate is always above 50%, the conditional expected expenditure also decreases compared to the scenario in which no ADR is offered.

Related to expenditures is the question of whether disputants feel regret after they have been through ADR and have observed its outcome. A disputant *regrets participation* after failed settlement if her continuation utility is smaller than it would have been had she rejected ADR in the first place. It turns out that low-cost types can regret initial participation in ADR once settlement fails.

Proposition 5. *Consider ADR as in Proposition 1. The settlement rate is above* 50%*. Expected expenditure conditional on failed settlement in ADR is smaller than expected expenditure absent ADR. Conditional on an evidentiary hearing as the outcome of ADR, low-cost types regret initial participation if* $p < 1/3$*, while high-cost types do not regret participation.*

While ADR is able to settle more than 50% of the cases and thereby reduces expenditure to 0 in those cases, the remaining cases are also solved more efficiently. 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. Thus, even for the same average evidence level, average costs are lower. Second, the disputants adjust their strategies. In particular, a high-cost D does not invest too much in evidence when expecting to face a high-cost P with larger probability.

Although ADR leads to welfare gains, parties might regret having agreed to ADR once settlement fails. High-cost types never regret it. For low-cost types, two effects interact. On one hand, the asymmetry in the hearing decreases legal expenditure. On the other hand, the increase in the likelihood of low-cost types intensifies competition. The second effect dominates if p is small. For large p, the first dominates.

(Ex-ante) Fairness and Additional Signals. From an ex-ante point of view, who is liable for the contested part X is symmetrically distributed. Still, the optimal mechanism induces asymmetries. That is, conditional on a hearing, it is common knowledge that Defendant has a 'better case' than Plaintiff.

Asymmetric treatments can raise fairness concerns and lead to the presumption that the designer is *biased.*[17] 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, below we show that the optimal mechanism is not asymmetric in terms of payoffs. That is, a disputant who has the "better case" after settlement fails can expect a less favorable settlement arrangement, and $\Pi_P(\theta) = \Pi_D(\theta)$. Second, the designer can augment her

[17] Despite the common belief that symmetrical procedural treatment is a fundamental part of fairness, most ADR guidelines state other aspects as their fairness and impartiality principles. Shapira (2012) provides a summary. The fairness principles mentioned there are satisfied for the optimal ADR protocol.

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 protocol is carried out. After the reports, the designer performs the 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 6. *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.*

Payoffs. Our characterization is based entirely on the induced information structure. In Appendix A we show that we can back out all other variables of the model by plugging these beliefs into the constraints. Here we report the outcomes. The expected payoff in ADR can be decomposed into three parts.

One part is the continuation payoffs in case of a hearing. The report-independent information implies that $U_i(1, \theta_i) = U_i(K, \theta_i)$ and expected continuation payoffs are

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

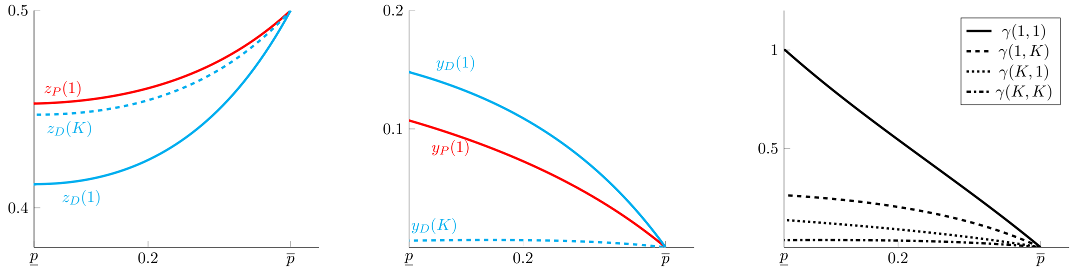
Another part is the likelihood that settlement fails, $\gamma(\theta_P, \theta_D)$. It is

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

where α is a scalar in $[0, 1]$. We discuss the derivation of α later. First we derive the expected probability that settlement fails as a function of a disputant's report, $\gamma_i(m_i)$,

$$\gamma_P(1) = \frac{2p}{1+p}\alpha, \quad \gamma_D(1) = \frac{2p}{1-p}\alpha, \quad \gamma_P(K) = 2\left(\frac{p}{1-p}\right)^2\alpha, \quad \gamma_D(K) = \frac{2p^2}{1-p^2}\alpha,$$

and settlements fail with probability



(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 4: **Properties of the optimal mechanism as a function of p (with $K = 3$).** To the right of $\overline{p}$, full settlement is possible. In any case, $z_P(K) = z_P(1)$ and $U_P(K) = 0 \Rightarrow y_P(K) = 0$.

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

The third part, the expected settlement value $z_i(m_i)$, is determined through the low-cost type's (IR) constraint and the high-cost type's (IC^K) constraint. They are

$$\begin{aligned} z_P(1) = z_P(K) &= V^1 - \gamma_P(1)U_P(1) = (1-p(1+\alpha))\frac{K-1}{K}X, \\ z_D(1) &= V^1 - \gamma_D(1)U_D(1) = \left(1 - p\left(1 + \alpha\frac{1+p}{1-p}\right)\right)\frac{K-1}{K}X, \\ z_D(K) &= z_D(1) + (\gamma_D(1) - \gamma_D(K))U_D(K) \\ &= z_D(1) + 2\alpha\frac{p^2}{(1-p^2)}\frac{(K-1)}{K}X. \end{aligned} \tag{6}$$

The (ex-post) settlement shares $x_i(\theta_i, \theta_{-i})$ are not uniquely defined. There is a range of payoff equivalent shares. However, the expected share conditional on a disputant's own report is

$$x_i(m_i) = z_i(m_i)/(1 - \gamma_i(m_i)).$$

Finally, α is the solution to

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

and we obtain expected payoffs from participation of

$$\begin{aligned} \Pi_i(1) = V^1 &= (1-p)\frac{K-1}{K}X, \\ \Pi_P(K) = z_P(K) &= (1-p(1+\alpha))\frac{K-1}{K}X \\ &= z_D(K) + \gamma_D(1)U_D(K) = \Pi_D(K). \end{aligned} \tag{8}$$

6 Discussion of The Modeling Choices

We now address our key modeling choices.

Liability. We focus entirely on the distribution of the contested part X and assume that an all-pay contest resolves that dispute. Our model relies on three implicit assumptions. First, Plaintiff can prove the commonly known part of the liability S at no further cost, which is therefore uncontested. Second, both parties have *enough potential evidence* to influence the ruling on the size of the damages, i.e. to win X. Third, any ex-ante asymmetries between the parties are captured in S.

The first assumption can be easily relaxed by, e.g., assuming there is a small fixed cost of providing convincing evidence (the 'facts') on S. In this case, Plaintiff provides that evidence in any hearing. Thus, the expected utility in any hearing process would reduce by a constant in an otherwise identical model. Our results continue to hold. The second assumption requires that the facts about the contested (exact) size of the damage are sufficiently unclear and supporting evidence can be provided both ways. The information in our model is about the time, cost, and effort it takes to improve the legal argument on the intensive margin. That is, the parties hold private information about how costly it is for them (or their lawyers) to produce further (expert) witness testimonies or circumstantial evidence in their favor. Relaxing this assumption by, e.g., introducing a maximum evidence level complicates the model substantially, but the basic intuition remains. The third assumption is entirely driven by the ease of exposition. Including asymmetries in the cost distributions does not affect the qualitative results.[18]

ADR Objective. In addition to 'court-mandated' ADR, there are two other rationales for why we focus on settlement-rate-maximizing ADR. Both build on the fact that actual ADR is often 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 a surplus-maximizing ADR, which would reveal their type. If

[18] In fact, the asymmetry is reversed: suppose P is ex-ante stronger, then D becomes stronger in any on-path hearing.

evidentiary hearings impose a small additional cost on the ADR designer, there is no market for surplus-maximizing ADR.

Evidentiary Hearings. According to our baseline model, evidentiary hearings within ADR are identical to litigation. While trivially correct in the mediation case, the results are less obvious for 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.

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 actual arbitration (see Section 4) the arbitrator can use techniques prohibiting her own reneging: to move the case to a hearing stage she can exercise "excessive, inappropriate, or mismanaged motion practice" (Stipanowich and Ulrich, 2014). Since courts typically honor the arbitrator's rule on motions, the arbitrator is committed to her mechanism. Reputational concerns provide an additional rationale for designer commitment.

Other Continuation Games. In contrast to the classic models of pre-trial settlement, we assume that actions (and thus costs) in evidentiary hearings depend on the information parties obtain in ADR. A natural question is whether our results change when *outcomes depend* on the type profile (θ_P, θ_D), but the *choice* which evidence to present *does not*.

Below we revisit the model of Hörner, Morelli, and Squintani (2015) and translate it into our context. Their model is close to ours, but they assume a type-dependent lottery if settlement fails. Failure reduces the size of the pie by a fixed amount c and gives the remainder $1 - c$ to disputant i with probability $F(\theta_i, \theta_{-i})$ and to $-i$ with the remaining probability $1 - F(\theta_i, \theta_{-i})$. The following proposition shows that the optimal mechanism differs drastically.

Proposition 7. *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 7 is the arbitration result in Hörner, Morelli, and Squintani (2015), adapted to our solution approach. The results in Proposition 7 oppose those from Proposition 1. In addition, joint-surplus maximization is identical to maximizing the settlement rate in their model.

In terms of implementation, however, the two models coincide. Hörner, Morelli, and Squintani (2015) show that, in their model, optimal arbitration and optimal mediation implement the same outcome. Bilateral bargaining cannot achieve this result. An outcome that mirrors ours in Section 4.

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.

When to apply which model? The effect on continuation strategies is important if disputants have sufficient time to react to the information they obtain within arbitration. Adjusting strategies may be difficult in international conflicts. Failure to negotiate a settlement may immediately lead to war, leaving disputants no time to re-optimize military strategies. Legal disputes are different. Disputants face a sufficient time lag between failed early settlements and the beginning of hearings.[19] That time lag allows parties to incorporate the information and to adjust strategies. Disputants' behavior in hearings becomes a first-order concern.

7 Conclusion

In this paper 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 binding arbitration and one for mediation. Each implements optimal ADR. We also 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

[19] Litigation for example follows a strict procedure overseen by the court. Courts typically do not have excess capacities, which leads to long waiting times between failed mediation and litigation.

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.[20] 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 paper.

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 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 paper provide a helpful first step.

[20]Under Rule 68, if a plaintiff rejects the defendant's offer and the final judgment is less favourable for the plaintiff than the offer, the plaintiff bears the additional legal costs after the defendant's offer was rejected. Spier, 1994 finds that this rule typically increases settlement when disputants contest the size of the damages (as in our model). A rationale for this policy is to encourage bilateral negotiations to keep disputants out of court. Opposing that rationale, we find that bilateral settlement negotiations jeopardize ADR's performance if the disputants negotiate before the ADR process starts. Incentivizing bilateral negotiations may harm the performance of ADR. Further research is needed to combine these two observations.

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 4 (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*

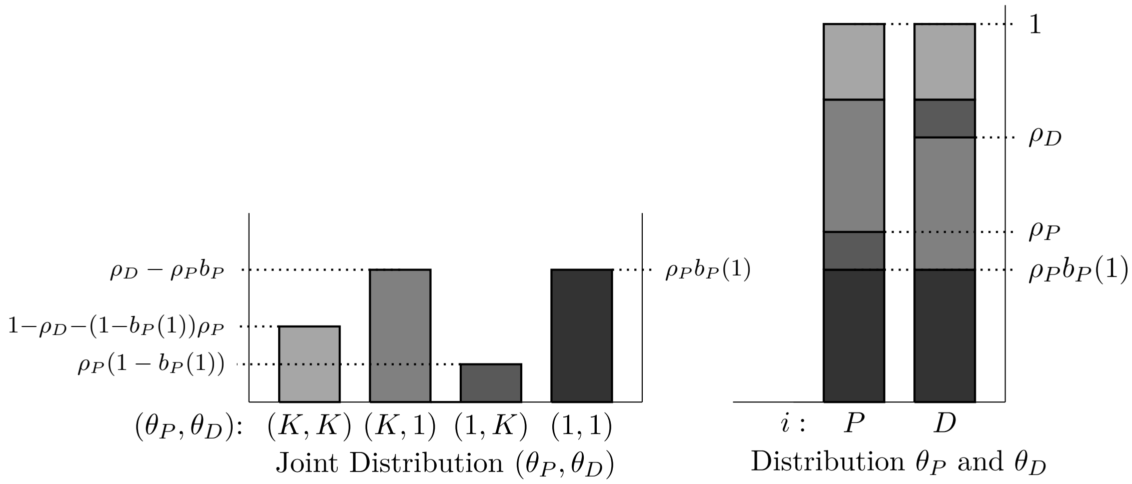


Figure 5: **Distributions and Information Structure.** The left panel shows a distribution of type pairs (θ_P, θ_D). Each element is a function of the information structure $\mathcal{B}$. The right panel shows the distribution of types by disputants. It stacks the elements of the left panel in different 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. $\square$

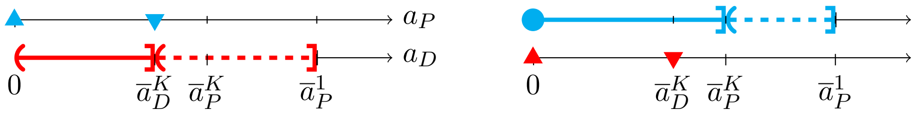
Next, we describe the mapping from the information structure $\mathcal{B}$ to $\gamma(\cdot,\cdot)$. Lemma 4 is helpful because it provides a relationship between $\gamma(\cdot,\cdot)$ and $\mathcal{B}$. Once we have determined $\mathcal{B}$, we have determined $\gamma(\cdot,\cdot)$ up to constant α.

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 expresions 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

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

In the contest, low-cost types invest in higher levels than high-cost types (see Lemma 10 in Appendix B.1 below); thus, $F_{-i}^1 \neq F_{-i}^K$. 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 $b_i(\theta_i)f_{-i}^1(a_i) + (1-b_i(\theta_i))f_{-i}^K(a_i) = \theta_i/X$ 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 $z_i(\theta_i) > 0$. Equation (6) in the main text (page 22) 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

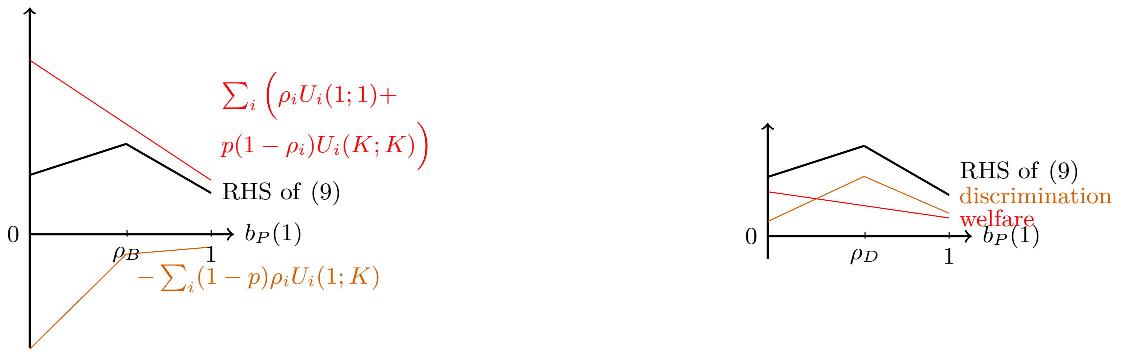
$$X \underbrace{(1 - Pr(L))}_{Prob.\ of\ settlement} \geq \underbrace{\sum_i (pz_i(1) + (1-p)z_i(K))}_{expected\ settlement\ shares\ ,\ \mathbb{E}z}. \tag{B}$$

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



(a) Decomposition as in equation (9)

(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 (9). 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.

(B) such that $\sum_i x_i(\theta_i, \theta_{-i}) \le X$. 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.[21]

We proceed under the conjecture that the optimal $z_i(\theta_i)$ is implementable through some $x_P(\theta_P, \theta_D) + x_D(\theta_D, \theta_P) \le X$ 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

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

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

$$Pr(L) = \frac{p(2V^1 - X)}{\sum_i \rho_i U_i(1;1) + \sum_i p(1-\rho_i)U_i(K;K) - \sum_i (1-p)\rho_i U_i(1;K) - pX} \tag{9}$$

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

Maximizing the denominator of the right-hand side (RHS) of (9) minimizes $Pr(L)$.

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

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.

Step 1: Feasible $\mathcal{B}$. The RHS of equation (9) 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 (9). 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 $b_P(1)$ since $1 - b_i(m_i)$ 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 (9) 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 (9) 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

$$\frac{\partial \text{RHS of (9)}}{\partial b_P(1)}\Big|_{\rho^*} = \begin{cases} \frac{K(1-(p)^2)-(1-(p)^2)}{K(1+p)} & \text{if } b_P(1) < \rho_D \\ -\frac{K(1-(p)^2)-(1-(p)^2)}{K(1+p)} & \text{if } b_P(1) > \rho_D \\ \text{undefined} & \text{if } b_P(1) = \rho_D, \end{cases}$$

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 (9). 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 (9).

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 6. 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 (6) on page 22 for the formulations) and finally calculating $\Pi_i(K;K)$ through equation (4) on page 22 (see also equation (8) on page 22), we verify that $\Pi_i(K;K) \geq 0 = V^K$.
ad (ii). Plugging in for V^1 in the LHS of equation (9) 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 22). 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 6. 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 $E[\rho_i] = 1/2$. By Assumption 1 we get that $p < 1/2$ and thus (IC^1) holds under the augmented mechanism which still 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,

$$\begin{aligned}\sum_i (1-p)(z_i(K)+\gamma_i(K)U_i(K;K)) &= (1-p)\left(z_i(1)+\sum_i \gamma_i(1)U_i(1;K)\right) = \\ &= (1-p)2V^1-(1-p)\sum_i \gamma_i(1)(U_i(1;1)-U_i(1;K)) = \\ &= (1-p)V^1-\frac{Pr(L)}{p}\underbrace{\sum_i (1-p)\rho_i(U_i(1;1)-U_i(1;K))}_{=:\mathbb{E}[\Psi]}.\end{aligned} \tag{10}$$

Using that by equation (9)

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

and replacing $Pr(L)$ in equation (10) yields

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

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

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

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

$$\frac{\mathbb{E}[\Psi]}{p(X-\mathbb{E}[U_i])}. \tag{11}$$

Thus, maximizing the above maximizes joint surplus, while 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 (11) 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

$$\max_{a_i} \quad XF_{-i}(a_i|b_i(\theta_i))-\theta_i a_i, \tag{12}$$

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

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

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. Since marginal costs are constant, so are densities. If the distribution of costs is asymmetric, equilibrium strategies are asymmetric too. If $b_P(1) = b_D(1)$, then $a^K_D = a^K_P$ 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* $\overline{a}^1_P > \overline{a}^K_P \geq \overline{a}^K_D > 0$ *that partition the action space. The support of each disputant's equilibrium strategy is on the intervals*

- $(0, a^K_P]$ *for Plaintiff, type* K, *and* $(a^K_P, a^1_P]$ *for Plaintiff, type 1,*
- $(0, a^K_D]$ *for Defendant, type* K, *and* $(a^K_D, a^1_P]$ *for Defendant, type 1.*

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

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

Further

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

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

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

B.2 Proof of Lemma 2

Proof. Disputant's i's veto payoff, $V^1 = (1 - \min(p, b^V_{-i}))\frac{K-1}{K}X$ and $V^K = \max(b^V_{-i} - p, 0)\frac{K-1}{K}X$ 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. □

B.3 Proof of Proposition 2

Proof. We first provide additional notation.

We allow for contingent proposals that take the following form. Let $\hat{x}^i_k$ be i's proposal for contingency $k \in \{1, 2\}$. For given real numbers y_1 and y_2, the contingent proposal $\tilde{x}_i(\hat{x}^i_1, \hat{x}^i_2, y_1, y_2)$ is then given by

$$\tilde{x}_i(\hat{x}^i_1, \hat{x}^i_2, y_1, y_2) = \begin{cases} \hat{x}_1 & \text{if } (\hat{x}^{-i}_1, \hat{x}^{-i}_2) = (y_1, y_2) \\ \hat{x}_2 & \text{else .} \end{cases}$$

We construct the following equilibrium. Disputant P, type θ_P, proposes

$$\tilde{x}_P(x_P(\theta_P, 1), x_P(\theta_P, K), x_D(K, K), x_D(K, 1)) =: \tilde{x}_P(\theta_P)$$

to the mediator. Moreover, D, type θ_D, proposes

$$\tilde{x}_D(x_D(\theta_D, 1), x_D(\theta_D, K), x_P(K, K), x_P(K, 1)) =: \tilde{x}_D(\theta_D)$$

to the mediator. If the proposals are incompatible, i.e. $\hat{x}^D_k + \hat{x}^P_{k'} > X$ for some $k, k' \in \{1, 2\}$, the mediator sends the parties to litigation. If the proposals are compatibility, i.e. $\hat{x}^D_k + \hat{x}^P_{k'} \leq X$ for any $k, k' \in \{1, 2\}$, the mediator does the following.

By a small abuse of notation, let $m_i = \tilde{x}^{-1}_D(\tilde{x}_D(\theta_D))$.

1. The mediator announces $\tilde{x}_P(\theta_P)$ to disputant P.
2. The mediator announces 0 to disputant D with probability $\gamma_D(m_D)$.
3. The mediator announces $\tilde{x}_D(m_D)$ to disputant D with probability $1 - \gamma_D(m_D)$.
4. The mediator publicly announces if D rejects a non-zero proposal.

First note that, on the equilibrium path, if party i proposes the share $\tilde{x}_i(\theta_i)$, then under optimal ADR it is the case that $x_P(\cdot, \cdot) + x_D(\cdot, \cdot) = X$. Note next that no disputant has an incentive to propose $\tilde{x} \notin \{\tilde{x}_i(\theta_i)\}_{\theta_i \in \{1, K\}}$. Indeed, proposing a share that is (in at least one dimension) larger, triggers litigation. The party then receives the (off-equilibrium path) payoff V^{θ_i}. Moreover, proposing a share that is (in at least one dimension) lower is not a profitable deviation either. Conditional on settlement that party is worse off. Conditional on escalation to litigation, this deviation is not observed by the opponent and therefore does not trigger any other litigation play.

Disputant P learns nothing from the designer's proposal, $\tilde{x}_P(m_P)$, 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^r_P. We are looking for an off-path belief q^r_P 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. Since $q_P^r \geq q_D(K)$, $\theta_D = K$ 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. □

B.4 Proof of Proposition 3 and 4

We prove Proposition 3 and 4 jointly.

Proof. By the revelation principle, no (sequential) game form outperforms a direct revelation mechanism. Observe that for both the settlement-rate-maximizing mechanism (see Proposition 1) and the joint-surplus-maximizing mechanism, Lemma 6 and 7 apply. Thus, any optimal mechanism implements the same on-path payoffs. Moreover, by report-independence any type profile moves to a hearing with positive probability.

We now show that every equilibrium implements a payoff strictly larger than the outside option V^1 for Defendant $\theta_D = 1$ (1_D henceforth). By contradiction, assume that 1_D receives a payoff equal to her outside option. Consider the following (feasible) deviation:

reject any offer that is lower than V^1. From D's point of view, the equilibrium play induces a distribution over offers. Each offer, say $\check{x}_D$, induces an updated belief $\beta^P(\check{x}_D)$ with the property that $\sum_{\check{x}_D} Prob(\beta^P(\check{x}_D))\beta^P(\check{x}_D) = p$. Moreover, note that a lower bound on 1_D's continuation payoff from rejecting offer $\check{x}_D$ is

$$(1 - \beta^P(\check{x}_D))\left(\frac{K-1}{K}\right) X =: \underline{\Pi}(\beta^P(\check{x}_D)),$$

which is her payoff from entering litigation.

The expected payoff of 1_D from the above deviation strategy is given by

$$\sum_{\check{x}_D} Prob(\beta^P(\check{x}_D)) \max(\underline{\Pi}(\beta^P(\check{x}_D)), \check{x}_D) \geq V^1,$$

where the last inequality follows from the fact that $\underline{\Pi}(\beta^P)$ is linear in β^P and holds with equality iff $\underline{\Pi}(\beta^P(\check{x}_D)) = \check{x}_D$. Thus, only if 1_D is indifferent between accepting and rejecting any (on-path) share the deviation does not guarantee her an (expected) payoff larger than V^1.

If, however, 1_D is indifferent between accepting and rejecting a share, K_D strictly prefers to accept any share as $1 < K$. Thus, evidentiary hearing does not occur for the type profiles $(1_P, K_D)$ and (K_P, K_D) and the game does not implement the optimal allocation. $\square$

B.5 Proof of Proposition 5

Proof. If $p > \underline{p}$, then $U_i(1;1) = (1-\rho_P)\frac{K-1}{K}X$ and $U_D(K;K) = (\rho_D - \rho_P)\frac{K-1}{K}X$. The expected welfare conditional on the hearing is

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

which is larger than the ex-ante welfare

$$2p(1-p)\frac{K-1}{K}X,$$

because $p < 1/2$.

Moreover, observe that if disputants' expected payoffs conditional on the hearing are larger after failed settlement, then hearing expenditures are smaller.

Finally, a low-cost type's conditional payoff is larger if $1/2 + p/2 \geq 1 - p$ which holds if $p \geq 1/3$. Otherwise low-cost types regret participation conditional on the hearing outcome. $\square$

B.6 Proof of Proposition 6

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* (9)*, then the designer does not benefit from disclosing additional information.* $\square$

Proof. See Appendix C. $\square$

B.7 Proof of Proposition 7

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 since low-cost dyads never settle and sometimes face a high-cost type in the hearing, it follows $b_i(1) < 1$. Thus, $b_i(1) \neq b_i(K)$. $\square$

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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:

- $\forall m, n \in \{1, K\}$:
$$p(m)z_i(m) + p(n)z_{-i}(n) \leq X(1 - Pr(L)) - X(1 - \gamma(m^c, n^c))p(m^c)p(n^c) \tag{EPI}$$

- $\forall m, i$:
$$z_i(m) \leq X(1 - \gamma_i(m)). \tag{IF}$$

Plugging in the values at the optimum defined from page 21 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, high-cost Defendant also has a mass point at 0.

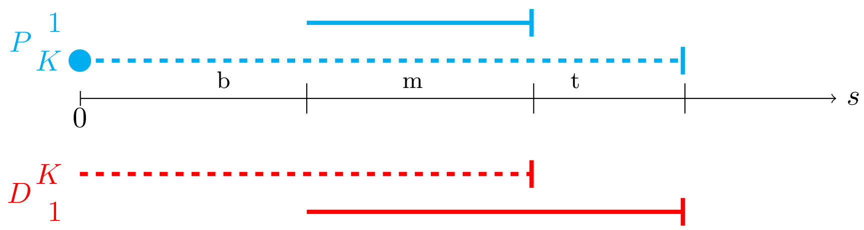

Figure 8: **Strategy support of P and D if monotonicity fails.**

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:

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

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 (9). 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 (9). Thus, no lottery over information structures can improve upon that optimum either. Hence signals have no use. $\square$