Reputational Concerns in Repeated Negotiations

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Abstract

I examine a model of repeated negotiations between two negotiators where both are uncertain about their opponent's preferences and private information. Specifically, I study when and whether a negotiator can sway his opponent if they repeatedly negotiate. I show that a negotiator can influence his opponent's decision by means of communications, if the opponent is not too prejudiced by otherwise available information and sufficiently trusts the information provided by the negotiator.

I show that a negotiator can enhance his trustworthiness or reputation by providing truthful information, even if the information conflicts with the negotiator's objective. If by being truthful the negotiator actually foregoes any immediate payoffs which he otherwise could have gained, then his behavior enhances his reputation of trustworthiness.

If the opponent is heavily prejudiced, a negotiator's reputation will be insufficient to overcome the initial bias. In such a situation reputation plays no role in the negotiations and a negotiator has no incentive to invest in his reputation.

1 Introduction

Negotiations are often characterized by two kinds of uncertainty: By uncertainty about each side's objectives (or more generally, their preferences), as well as uncertainty about future conditions. Examples abound from political ones, such as the recurring negotiations between the US and North Korea over North Korea's nuclear weapons program[1], to the more economic ones, such as the negotiations in the transition period of the 1990's between governments in Eastern Europe and the IMF[2]. Negotiations in both examples were characterized by a high degree of mistrust about the other side's "true" objectives. How sincere

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[1] see Kim (2004)

[2] Stone (2002)

was each side in its interest to come to an agreement and how credible were any promises that were made ? According to Kim (2004) one significant challenge in the 1994 negotiations with North Korea for the US was the lack of an effective coordinator who could build trust between the two parties. Similarly Stone (2002) recounts the skepticism the Bulgarian government faced in the early 1990's when approaching the IMF with a request for a loan in exchange for promises of economics reform. Aside from the uncertainty whether reforms were feasible, the IMF also needed to assess questions about the Bulgarian government's objectives: How sincere was it about its willingness to reform? Was it maybe just trying to obtain loan for short-term political gain/survival ?
These examples illustrate how negotiators must take into account his reputation (or interchangeably his credibility) when engaging in negotiations. In this paper I focus in particular on the ability of the sender in a repeated cheap-talk game to use communication to his advantage. I ask whether a *biased* negotiator (who is biased in favor of an agreement under any circumstances) can ever persuade his opponent on the strength of his reputation. I show that when two parties negotiate with each other twice, a biased negotiator can influence an unbiased one in the 2nd period by sacrificing his 1st period payoff in order to enhance his reputation for truthtelling.

The repeated nature of negotations where the negotiators are acutely aware of reputation can be observed in many settings: For instance, Tomz (2009) describes the repeated interaction between sovereign governments and foreign investors over the centuries. Another example of repeated interactions are the long-running negotiations on the General Agreement on Trade and Tariffs (GATT): As Blustein (2009) chronicles the history of the GATT, nations would meet again and again throughout the decades and rounds of negotiations to work out agreements ranging from lowering tariffs to setting rules and institutions designed to strengthen international trade.

In particular, the salience of reputation within the context of repeated interaction is nicely illustrated in the following note about the Uruguay Round negotiations on the General Agreement on Trade and Tariffs (GATT): In this round the developing nations were uncertain about the US's motives for pressing for an agreement on intellectual property (TRIPS). In addition, the developing nations were undecided about the benefits of such an agreement. Nevertheless the US ultimately was able to persuade them, according to Winters (1990), in part because otherwise the US was believed to going to take unilateral actions which was a major concern for the other countries. As Hoekman (1993) documents the US had in fact relied on unilateral intellectual property policies in the past. Thus, this previous history increased its credibility and the credibility of its threats during the negotiations.
Similarly, during the disputes about barriers against US grain exports to the EU in 1986, the credibility of US retaliatory threats was an important factor in the negotiations outcome according to Odell (2000). The threats were taken seriously by the EU, especially so after US sanctions in the previous dispute

about citrus fruits and pasta, and subsequently led to accomodation of US demands by the EU.

In this paper, I present a stylized two-period model of repeated negotiation in which I show how reputational concerns affect the negotiators' behavior and rationale in situations as described in the examples above. I show that in this model negotiators decide whether to seek an agreement or not, by aggregating the different sources of information available to them, including any communication received from the opponent, which may or may not be credible. In most cases the receiver of information is already too biased in favor of one outcome for the communicated information to make a difference. Even if considered completely credible the sender's information cannot counter the bias from the otherwise available information.
However, what will also be demonstrated is that there is a limited set of situations where they can tip the scales through their communications. If the opponent is not too prejudiced by otherwise available information, this may influence the outcome. This is the case when the information the negotiator initially has is inconclusive. Then the sender's message can sway the receiver, provided that he deems the sender sufficiently trustworthy and privately available information is is more informative than the publicly known prior information.

Given such circumstances, the sender of information has a potential incentive to improve his reputation in the 1st period so that he will be believed in the 2nd period. In particular, a biased negotiator may maintain or enhance his reputation by completely or partially mimicking the messaging and voting behavior of an unbiased one (a negotiator who is selective about entering agreements) in the 1st period. The mimicking behavior's effect on the negotiator's reputation is directly related to its costliness. If by mimicking the unbiased negotiator actually foregoes any 1st period payoff which he otherwise could have gained, then his behavior enhances his reputation. On the other hand, if imitating the unbiased type does not reduce payoffs, then a negotiator is only able to maintain his (already strong) reputation. In other words, by forgoing an initial gain allows the negotiatior to obtain a (higher) second period payoff.
However, in the model I present the strategy of partially mimicking (and thus the ability to persuade) is limited to a narrow set of situations: In particular, the private information available to each negotiator must neither be too precise, nor too imprecise. Only then will we have a situation in which the information received from the opponent has the potential to influence one's decision. If one's own private information is sufficiently precise, a negotiator will not need to rely on any additional information and therefore dismiss the opponent's information. On the other if the private information (available to the opponent) is too imprecise then a negotiator will dismiss it as unreliable.
In addition, the payoffs associated with each of the period must be in a particular range: The 1st period payoff must not be too small or too large compared to the 2nd period, because otherwise there are incentives for a biased negotiatior to

either to simply "take the (first) period money and run" or for the first period sacrifice to be unconvincing.

The results provide a first step towards a richer and more general model. In this paper I assume that the relative importance of each of the negotiations in the two model periods is exogenously given. However, in many situations of one-on-one negotiations, part of the (pre-)negotiations involve the question of whether and how to split up the negotiation process into a series of issue-by-issue negotiations. That is, prior to the actual sequence of negotiations, the two sides need to agree on the relative importance of each negotiation period. It is therefore possible to re-interpret the findings presented in this paper as representing a subgame of the more general negotiations model, where players can choose how to split up negotiations.

The remainder of this paper is organized as follows: In section 2 I give an overview of the literature on negotiations and cheap-talk games. Subsequently, in section 3, a description of the model of the paper is given. Section 4 then presents the results for the 2nd period subgame. I specify conditions for the voting and messaging equilibrium behavior and describe three classes of subgame equilibria. The intuitions and results obtained from the subgame carry over to section 5 where I describe equilibria for the game where no trust-building occurs. Section 6 characterizes a "full mimicking" equilibrium in which one type successfully protects his reputation by imitating the other type. In a variation, section 7 looks at "partial mimicking" equilibria. I first describe equilibria for a simplified model and then extend it to the standard model. Finally in section 8 the findings of this paper are summarized.

2 Related Literature

Both Addison and Murshed (2001) as well as Lupia and McCubbins (1998) have looked at credibility and reputation in settings of (political) negotiations. However, they have used simpler models than the one presented in this paper. Addision and Murshed (2001) employ a two-period model where preferences are only uncertain for one of the negotiators and only one of the two sides gets to send any information. On the other hand, Lupia and McCubbins (1998) look at a one-sided cheap talk model with only a single period. I look at a two-period model with both sides sending and receiving information.

This paper draws on the literature on sender-receiver games initiated by Crawford and Sobel (1982) and the ways by which the standard sender-receiver game has been extended:
Banerjee and Somanathan (2001) enrich the Crawford/Sobel model by introducing an additional parameter of private information. The sender is not only

uncertain about the receiver's preferences but also about the unknown state of the world, which determines payoffs. The receiver has imperfect private information about the state of the world. Any message sent, which is one-dimensional, then reflects a two-dimensional pair of signals. Because there are more possible pairs of signals (types) than messages, any equilibrium does involve some degree of pooling. This reduces or in extreme cases eliminates informative communication.
Morris (2001) also assumes that the private information has two dimensions, but adds a 2nd period to the model. He looks at a situation where the same players interact with each other twice, hence adding a reputational dimension to the game. He shows that there exist equilibria where the sender's concern about his credibility leads him to sacrifice 1st period gains in order to maintain his reputation in the 2nd period.
Doraszelski, Gerardi and Squintani (2003) also allow for two dimensional signals, but add the possibility for two-sided private information. Hence both players send and receive information and jointly determine the outcome, creating the conflicting motivations mentioned in the introduction for sending information.

I thus combine the three features mentioned – two-dimensional private information, repeated interaction and two-sided private information. To my knowledge this paper is the first to study the combination of those feature in negotiation settings. Li, Rosen and Suen (2001) examine the conflicting and coinciding interests of members of a group which has to make a joint decision, but they do not allow for pre-decision communication nor do they consider reputational concerns arising out of repeated interaction. Another variant of joint decision making is described by Gilligan and Krehbiel (1989). In their model, two privately-informed committee members try to influence an uninformed decision-maker. Their model deals with one-sided communication but (potentially) conflicting sources of information. In contrast my paper describes two-way communication and repeated interaction between players.

Finally, this paper shares a resemblance in themes with Watson (1999, 1997) who studies the phenomenon of gradualism in partnerships. He looks at how two parties deal with two-sided uncertainty about the incentives of the other side and how to ensure long-term partnership. He studies an equilibrium where both sides start with small stakes and increase them over time. His work differs from this paper in that there is no communication between players and the end of the game is endogenously determined.

The idea that people take into account how the way they communicate affects how their subsequent actions and statements are framed has been used as an explanation of herding behavior and conformity. Loury (1995) mentions that in public discourse (on issues such as affirmative action) there often occurs self-censorship as individuals recognize that "naive" communication (or truthful revelation of preferences) is almost never in the best interest of the individual as the individual runs the risk of being perceived to be "bad". Similarly, Frank

(1996) relates to the example of citizens of the former communist bloc countries, who knew that to criticize their government openly could derail their careers or land them in jail. Any criticism, regardless of how justified, carried the risk of being permanently stamped as a "subversive". In fact, Bernheim (1994) analyzes a model of social interaction where individuals care about reputation and therefore are induced to conform. Unlike in this model however reputational concerns are represented only in a reduced-form manner and he does not deal with issues of credibility in communication.

3 Model

Two players negotiate with one another repeatedly in two time periods $t = 1, 2$. Each player knows their type $\rho \in \{0, 1\}$ but is uncertain about his opponent's type $\rho^{'}$. Each player initially believes that the opponent's type is $\rho^{'} = 1$ with probability p - we may thus think of $\Pr ob(\rho = 1) = p$ as a player's initial reputation. The value of p is common knowledge and for simplicity we assume applies to both players.

In each time period t, nature draws the state of the world $\omega_t \in \{0, 1\}$, which remains unknown to the two players. We assume that it is common knowledge that $\Pr ob(\omega_t = 0)$=λ.

Each player privately observes an imperfect signal s_t for which $\Pr(s_t = \omega_t|\omega_t) = \gamma \in (0.5, 1)$.

Having observed s_t , each player updates his beliefs about his opponent: Let $\mu_t = \Pr(\rho^{'}, s_t^{'}|\mu, s_t)$ be the (updated) belief probability that the other player is of type $\rho^{'} = 1$ and received signal $s_t^{'}$, given the prior μ and the observed signal s_t. Then each player simultaneously decides on which message to communicate to his opponent. We will assume that each player follows a messaging strategy described by the function $m_t : \{0, 1\} \times \{0, 1\} \to \{0, 1\}$ to his opponent where the message sent $m_t(\rho, s_t)$ depends on his type and his signal s_t.

Once both players receive their opponent's message $m_t^{'}$, they update their beliefs to $\mu_t^m = \Pr(\rho^{'}, s_t^{'}|\mu_t, s_t, m_t')$. Then each player simultaneously decides on which voting decision to make. Each player follows a voting strategy v_t : $\{0, 1\} \times \{0, 1\} \times \{0, 1\} \to \{0, 1\}$ where his vote $v_t(\rho, s_t, m_t^{'})$ depends on his type, own signal and his opponent's message.

Having decided on their votes, both players learn whether or not an agreement has been reached. The two players reach an agreement if both players vote in favor or $v_t \cdot v_t^{'} = 1$, where the $v_t^{'}$ denotes the opponent's vote. Otherwise no agreement is reached. Finally ω_t is revealed, both players again update their beliefs on the new information of $v_t^{'}$ and ω_t to $\mu_t^v = \Pr(\rho^{'}, s_t^{'}|\mu_t^m, v_t, \omega_t)$, and the whole sequence of events repeats itself in another time period.

In terms of payoffs, a type $\rho = 0$ player obtains a payoff of V_t in period t if $v_t \cdot v_t^{'} = \omega_t$ - that is, he wants to reach an agreement in state $\omega_t = 1$ and reject an agreement in $\omega_t = 0$. In all other situations the player has a payoff of zero. V_1 and V_2 can have different values. He may thus be described as *unbiased* about an agreement. For simplicity, we assume the same V_t for all players and normalize V_1 to 1. A type $\rho = 1$ player always prefers to reach an agreement. His payoff is V_t if an agreement is reached and 0 otherwise. He may thus be characterized as *biased* towards an agreement.

4 Second period subgame

The key building block in understanding the model is the *period subgame.* Much of the model's results can be understood by looking at a single period and the link between the two periods.
Consider the $t = 2$ period subgame: Suppose in $t = 2$, each player's behavior is the same regardless of what happened in the period $t = 1$. Then a player's strategy in $t = 2$ does not need to condition on anything prior to the 2nd period. In this case the 1st and 2nd period subgames can be treated as two separate games.
The immediate question then is, under what conditions will the 1st period influence the 2nd period outcome ? For both periods players face the same environment in terms of exogenously given parameters λ and γ but differ in their belief about their opponent's reputation. This is because each player will use their observations from the 1st period to update their beliefs before making any decision in the 2nd period.
Hence if 2nd period behavior is conditioned on the opponent's reputation, players when making 1st period decision have to take into account how those decision affect reputation. Conversely, there is no link between the two periods if the 2nd period outcome is the same regardless of the reputation that the players have at the end of the 1st period. In that case reputation does not matter and the 1st period equilibrium behavior is identical to the 2nd period behavior.
I start off by looking at the 2nd period subgame and its subgame equilibria. In the 2nd period players are only concerned about maximizing that period's expected payoff, since there is no subsequent period. Hence the 2nd period results describe the players' communication and voting behavior if reputation does not matter.
I start with the conjecture that if reputation does not matter a biased player will always send a message $m_2() = 1$ and an unbiased player will always send $m_2 = s_2$, being truthful about their signal. They each do so to influence the opponent's belief about the unknown state of the world in a way favorable to them. I will show that this messaging behavior, which I will refer to as *sincere messaging* from hereon, is indeed optimal for both types in equilibrium. The messaging behavior is *sincere* in that it does not concern itself with its reputational effects.
Given sincere messaging , in equilibrium a biased player will ignore any message and always vote $v_2 = 1$. An unbiased player conditions his vote on his own signal and the message received. How he conditions his vote or which voting

strategy he chooses depends on the signal precision γ, the prior λ on the state of the world and the opponent's reputation μ_2^m. Under most settings an unbiased player's voting strategy does not depend on the opponent's reputation. I specify parameter conditions when additionally the opponent's message and the opponent's reputation do play a role.
I begin by formally defining the equilibria of the subgame and the player's strategies. I proceed by characterizing the voting behavior of each player type. Using the knowledge of voting strategies I describe the possible equilibria if we assume sincere messaging behavior. Finally, we verify that the conjectured messaging behavior is in fact optimal given the voting strategies and beliefs of the described subgame equilibria.

4.1 Players' strategies and definition of subgame equilibria

Each player's strategy in the 2nd period subgame consists of a message function $m_2(\rho, s_2)$ and a vote function $v_2(\rho, s_2, m_2^{'})$. Further, each strategy profile $\sigma_2 = \{m_2, v_2, m_2^{'}, v_2^{'}\}$ is associated with a set of beliefs $\mu_2 = \{\mu_2, \mu_2^m, \mu_2^v, \mu_2^{'}, \mu_2^{'m}, \mu_2^{'v}\}$. The strategy profile and set of beliefs constitute an equilibrium if strategies σ_2 are sequentially rational in that they maximize each player's expected payoff and μ_2 represents consistent beliefs with σ_2.
Assuming sincere messaging induces consistent beliefs, for the voting strategy to be sequential rational it must maximize expected payoff. Additionally, since both players vote at the same time it has to be a best-response to the opponent's voting strategy. I will in turn consider the voting rationales for both types of players. For better readability I will in the subsequent section suppress the time-period subscript in the notation.
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4.2 Voting stage

Since a biased player always favors an agreement he does not attach any value to the information received. The updated beliefs μ^m are irrelevant to him when making a voting decision. Instead, he will choose a voting strategy that will maximize the chances of an agreement:

Proposition 1 *In the 2nd period subgame a biased player's best-response is* $v_2 = 1$.

Proof. Voting $v = 0$ ensures that there is no agreement and that the biased player obtains a payoff of zero. Because voting $v = 1$ cannot yield a lower payoff it is a sequential rational regardless of the opponent's vote. ■

In contrast, an unbiased player's voting strategy is driven by his desire to vote according to the likelier state of the world ω. To see this I show the connection between the expected payoff and the expected value for ω.The unbiased player's expected value is V times the probability that he obtains a non-zero payoff. When voting in favor, $v = 1$, the probability is $\Pr(v' = 1, \omega = 1|s, m') + \Pr(v' = 0, \omega = 0|s, m') \geq \Pr(\omega = 0|s, m')$. That is, he gets a non-zero payoff when there either is an agreement and $\omega = 1$ or there is no agreement and $\omega = 0$. When he votes against the agreement, $v = 0$, the probability is $\Pr(\omega = 0|s, m')$. Hence, it will be sequential rational for the unbiased player to vote $v = 1$, if

$$\Pr(v' = 1, \omega = 1|s, m') + \Pr(v' = 0, \omega = 0|s, m') \geq \Pr(\omega = 0|s, m') \quad (1)$$

Since a player votes simultaneously with his opponent, additionally his vote has to be a best-response to his opponent's vote. Suppose the opponent were to vote $v' = 1$: Then $\Pr(v' = 0, \omega = 0|s, m') = 0$ as $v' = 1$ with certainty and inequality (1) simplifies to

$$\Pr(\omega = 1|s, m') \geq \Pr(\omega = 0|s, m') \quad (2)$$

where

$$\Pr(\omega|s, m') = \sum_{\rho' \in \{0,1\}} \sum_{s' \in \{0,1\}} \frac{\Pr(\omega, s, s')}{\Pr(s, s')} \cdot \mu^m \quad (3)$$

The opponent essentially defers the decision to the unbiased player who votes according to the likelier outcome of ω.

Suppose now the opponent were to vote $v' = 0$ when unbiased and $v' = 1$ when biased. The probability that the players faces $v' = 1$ then is the same as the probability that he faces a biased opponent. Given the prior belief μ^m, his own signal s and the received message m' he knows by Bayesian updating that the opponent is a biased type with probability

$$P = \Pr(\rho' = 1|s, m') = \sum_{s' \in \{0,1\}} \mu^m(\rho' = 1, s') \cdot \frac{\Pr(s, s') \cdot m'(\rho', s')}{\sum_{\rho' \in \{0,1\}} \sum_{s' \in \{0,1\}} [\Pr(s, s') \cdot m'(\rho', s')]} \quad (4)$$

Inequality (1) therefore becomes

$$P \cdot \Pr(\omega = 1|s) + (1 - P) \Pr(\omega = 0|s, m') \geq \Pr(\omega = 0|s, m') \quad (5)$$

Note that the first term on the left-hand side of (5) now is a conditional probability on s only. This is because the player realizes that if he faces a biased opponent then the message he received is uninformative. If $P > 0$, inequality (5) can be further simplified to

$$\Pr(\omega = 1|s) \geq \Pr(\omega = 0|s, m') \tag{6}$$

which differs from inequality (2) in that the unbiased player now pays less attention to the message he receives from his opponent. Nevertheless, the best-response in voting for the unbiased player is equivalent to choosing the likelier outcome of ω.

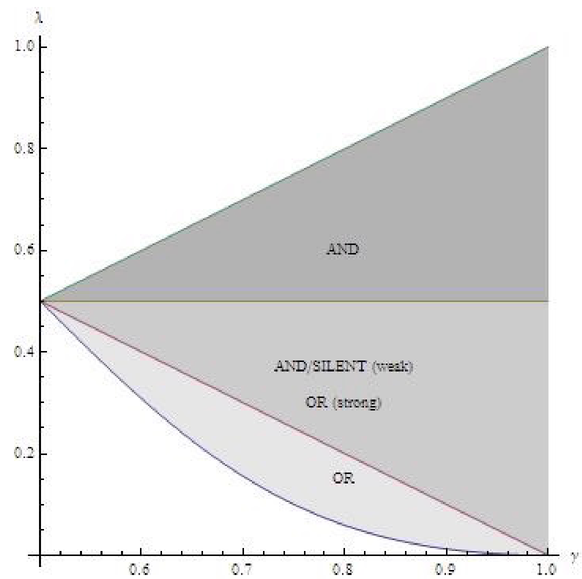
Thus, I summarize the unbiased player's best response voting behavior from inequalities (2) and (6) as follows:

Lemma 1 *If players use sincere messaging then in the 2nd period subgame an unbiased player's best-response in voting is to vote according to the likelier state of the world ω. The unbiased player evaluates the probabilities of ω conditional on s and m', unless he knows that m' is non-informative.*

Having understood the link between the voting decision and the likely outcome of ω, I now describe how the unbiased player uses the information available to him to determine the likely outcome of ω. He does so by aggregating the different pieces of information - $\Pr(\omega)$, s and m'. In specific, he aggregates them while attaching different weights to each piece of information. These weights are represented by the parameters for the prior probability λ for the state of the world, the signal precision γ and the opponent's reputation P. The unbiased player treats the message received like a signal with less precision (as measured by P) than his own. Depending on the values for λ, γ and P the following three voting strategies emerge which describe three meaningful ways of processing information within the given model framework:

Definition 1 *(i) SILENT or cautious voting strategy: An unbiased player always votes according to his own signal, always ignores opponent's message:* $v(\rho = 0, s, m') = s$
(ii) AND or pessimist voting strategy: An unbiased player votes against the agreement if any information (either own signal or opponent's message) indicates the likelihood of $\omega = 0$: $v(\rho = 0, s, m') = s \cdot m'$
(iii) OR or optimist voting strategy: An unbiased player votes in favor if any information indicates the likelihood of $\omega = 1$: $v(\rho = 0, s, m) = \max(s, m')$

Using inequalities (2) and (6), the different patterns of voting as described in the preceding definition occur for different sets of values of λ and γ. I find that



Proposition 2 *(a) When* $1-\frac{\gamma^2}{1-2\gamma+\gamma^2} < \lambda < 1-\gamma$*, the optimist voting strategy is a best-response for any* P*.*
(b) When $\gamma > \lambda > \frac{1}{2}$*, the pessimist voting strategy is always a best-response for any* P*.*
(c) When $1-\gamma < \lambda < \frac{1}{2}$*, the optimist strategy is a best-response if* P *is sufficiently low. The cautious strategy is a best-response if* P *is sufficiently high. The pessimist strategy is a best-response for any* P*.*[3]

In case (a) (see Figure 1 for a graphical representation of the three cases in the γ, λ parameter space) the prior λ carries so much weight relative to the signals that a single conflicting signal or message is not enough to overturn the updated probability. This holds true as long as the prior λ is larger than $1-\frac{\gamma^2}{1-2\gamma+\gamma^2}$, which is the probability that both signals turn out to be opposite to ω, and as long as λ is less then $1-\gamma$, which is the probability that one signal will be opposite to ω.
In case (b) the prior is now biased towards $\omega = 0$ and carries enough weight relative to the signals that a single conflicting signal or message is not enough to overturn it.
In case(c) the prior is biased towards $\omega = 1$ but carries little weight relative to the signals (in that $\lambda < 1-\gamma$). Unlike in case (b), if either their own signal or a credible enough received message confirm the prior the player will vote $v = 1$.

[3] Please see the appendix for the other possible cases and voting strategies.

Because in the last case the beliefs about the opponent's type influence the voting strategy, it is of particular interest. For the subsequent discussions therefore let a setting in which γ and λ satisfy case (c) of Proposition (2) be called *ambivalent*.

In equilibrium both biased and unbiased players use the strategies described in Propositions (1) and (2) and have beliefs about the opponent's type consistent with equation (4). There are unique equilibrium outcomes for all cases other than the ambivalent case.
When the setting is ambivalent and the opponent's reputation is strong enough, an unbiased player is more optimistic in his voting behavior and thus it is more likely that there is an agreement. Checking for each possible combination of s and m' I find that,

Lemma 2 *In the subgame equilibrium, when an unbiased player faces a biased type , the biased player will always vote $v = 1$ and the unbiased type votes according to Proposition 2. If the unbiased player is optimistic there will always is an agreement, while if he is pessimistic or cautious only when his signal is $s = 1$.*[4]

For a biased player this link between outcome and reputation can be used to induce an unbiased opponent to switch from an AND or SILENT to an OR strategy in the 2nd period and thereby increase the chances of an agreement. If the gain from the 2nd period switch is large enough he has an incentive to invest in his reputation during the 1st period. From the discussion of Proposition (2) it is apparent that reputation only has an influence on a negotiator if he is not too prejudiced and the signal precision is relatively high. Interestingly enough, reducing signal precision in such a case can actually increase the chances of an agreement. This is, because as player becomes more uncertain about his own information he will have to depend more on the other information sources.

4.3 Messaging behavior

I complete the discussion of the 2nd period subgame equilibrium by showing that sincere messaging is sequentially rational given the voting strategy described above. I first do so for the biased type: A biased player only obtains a positive profit if there is an agreement. There can only be an agreement if the opponent votes $v' = 1$. From the discussion of voting behavior in the preceding section, it

[4] A complete characterization of equilibrium outcomes when (1) two opportunistic players face each other, (2) an opportunistic player faces a committed player and (3) two committed players face each other is in the appendix.

is clear that the opponent is always more likely to vote $v' = 1$ when he receives a message $m = 1$ than $m = 0$. Therefore,

Lemma 3 *A biased player will always send $m = 1$ in the 2nd period subgame when unbiased players use the SILENT, AND or OR voting strategies.*

For an unbiased player the choice of message will depend on the expected payoff. Analogous to the voting stage reasoning, a player will only send a message $m = 1$ in favor if the expected payoff from doing so exceeds the one obtained under sending $m = 0$. His message will potentially influence his opponent's voting behavior, which is described by the equilibrium voting strategy $v(\rho, s, m')$. Suppose that both player's use $v(\rho, s, m')$ equilibrium. Then let $\pi_2(\rho, s, m')$ be the expected payoff to a type ρ player with private signal s who received message m' in equilibrium. Let $\widetilde{\pi}_2(\rho, s, m')$ be the expected payoff when he deviates from the equilibrium messaging strategy.
Then a player will follow the equilibrium messaging strategy $m(\rho, s)$ if the expected payoff from doing so is higher than deviating. Since the opponent's message m' is unknown at the messaging stage the player averages over the possible messages. Mathematically this is:

$$\begin{aligned} &\sum_{m' \in \{0,1\}} \Pr(m'|s) \cdot \pi_2(\rho, s, m') \\ \geq &\sum_{m' \in \{0,1\}} \Pr(m'|s) \cdot \widetilde{\pi}_2(\rho, s, m') \end{aligned} \quad (7)$$

Notice that the effect of the player's message on the expected payoff is by way of influencing the opponent's vote, which may or may not influence expected payoff. If either the player's message fails to influence the opponent's vote or if the opponent's vote fails to change expected payoff then inequality (7) is trivially satisfied. In terms of the equilibrium voting strategies this means:

Proposition 3 *an unbiased player will always follow sincere messaging behavior. If $s = 0$, conditions are always trivially satisfied for sincere messaging. If $s = 1$, conditions for sincere messaging is always satisfied when subsequently followed by SILENT voting behavior. Given an AND voting strategy, it is satisfied if $\lambda < \frac{\gamma^2}{1-2\gamma+2\gamma^2}$, which holds in equilibrium. If he uses an OR strategy, it is satisfied for $\lambda < \frac{1}{2}$, which holds in equilibrium.*

The intuition for the result is as follows: When players follow a SILENT voting strategy then messages are meaningless and hence an unbiased type has no incentive to deviate. If a player follows an AND strategy given $s = 0$ he will vote $v = 0$ and thus does not care about influencing his opponent by deviating in his message. In the OR case with $s = 0$, both a player's vote and his opponent's vote will be identical as they solely rest on the opponent's message. Hence the player's own message becomes irrelevant and he has no incentive to deviate.

5 Two-period game without reputational concerns

Having characterized the 2nd period subgame, I now expand the analysis to the entire game. I begin with the simplest class of games where reputation does not play a role. In such settings reputation does not matter and there is no investment in reputation. I describe the equilibrium characteristic and specify the necessary 2nd period off-equilibrium behavior to sustain such a two-period game equilibrium. However, before doing so I formally define what constitutes an equilibrium of the game.

5.1 Equilibrium concept

Analoguous to the 2nd period subgame, players make decisions on their message and vote in the 1st period. Hence a player's strategy for the two-period game consists of message and voting function m_1, v_1 as well as m_2, v_2 for periods 1 and 2 respectively. Similarly he holds beliefs μ_1, μ_1^m, μ_1^v and μ_2, μ_2^m, μ_2^v at each stage of period 1 and 2. Let $\pi_t(\rho, s_t, m_t'|\mu)$ be the expected profit in period t if the opponent follows equilibrium messaging and voting strategies.
Let $\sigma_t = \{m_t, v_t, m_t', v_t'\}$ be the strategy profile of each period and $\mu_t = \{\mu_t, \mu_t^m, \mu_t^v, \mu_t^{'}, \mu_t^{'m}, \mu_t^{'v}\}$ be the belief profile for each period.
Then,

Definition 2 *The strategies and beliefs $\{\sigma_1, \sigma_2, \mu_1, \mu_2\}$ represent an equilibrium for the two-period game if for every type ρ, signal s_t , (1) $\{\sigma_1, \sigma_2\}$, given beliefs $\{\mu_1, \mu_2\}$, at each stage maximize the expected payoff*

$$E_{\rho', s_1', s_2'}\ [\pi_1(\rho, s_1, m_1'|\mu) + \pi_2(\rho, s_2, m_2'|\mu)]$$

and (2) beliefs $\{\mu_1, \mu_2\}$ are updated consistently with $\{\sigma_1, \sigma_2\}$ such that $\mu \in \{\mu_1, \mu_2\}$ at each stage of each period in the game

Note that a player's first-period decisions m_1, v_1 not only impact 1st period payoff π_1 but also influence μ_2. The 2nd period beliefs μ_2 in turn may influence his opponent's second-period decisions m'_2, v'_2 and thus π_2. I now describe under what circumstances the equilibrium will be such that the first-period and second-period strategies, σ_1, σ_2, are identical in equilibrium.

5.2 Second period off-equilibrium behavior

In the section 4.2 it was found that for all non-ambivalent values for γ, λ the players' equilibrium strategies and hence the subgame equilibrium outcome for the 2nd period are independent of of reputation.
However, if the 2nd period subgame equilibrium outcome is independent of reputation then the 1st period messaging and voting behavior will never be motivated by considerations of enhancing one's reputation. Hence players will follow the same messaging and voting strategies in the 1st period which have been laid out in section 4. Additionally, in such a setting the 2nd period off-equilibrium behavior is not relevant. To summarize:

Lemma 4 *If γ, λ are not ambivalent, there exists an equilibrium with no reputational concerns where each player follows sincere messaging and the same voting strategy in each period. There cannot be any profitable deviations in the 1st period regardless of the off-equilibrium beliefs and actions that are assumed.*

It is possible to obtain the same equilibrium outcome even if γ, λ are ambivalent. Now, deviating in the 1st period could lead to an improved reputation and thus a changed 2nd period subgame equilibrium.
In order to sustain two-period game equilibria with no reputational concerns there must not be such incentives to deviate. Thus deviations must not have any (improving) effect on beliefs. One way to achieve this is that the 2nd period off-equilibrium actions and beliefs have to be to identical to the corresponding equilibrium actions and beliefs:

Lemma 5 *If γ, λ are ambivalent, there exists an equilibrium with no reputational concerns where each player follows sincere messaging and the same voting strategy in both periods, if off-equilibrium beliefs and actions are identical to beliefs and actions on the equilibrium path.*

Thus if the 2nd period off-equilibrium actions and beliefs follow lemma 5 then in equilibrium the 2nd period outcome is independent of reputation and the two-period game equilibrium does not involve trust-building.

6 Two-period game with complete mimicking

I now turn my attention to situations where γ and λ are ambivalent and the unbiased player's voting behavior can be influenced by his opponent's reputation. In such a case a biased player may have an incentive to actively manage his reputation in the 1st period in order to induce an unbiased opponent to behave in a more favorable way in the 2nd period. In fact, I show that,

Proposition 4 *For ambivalent γ, λ and a sufficiently strong a priori reputation p there exists an equilibrium in the two-period game as follows: Players use sincere messaging in both periods. An unbiased player votes pessimistically in the 1st and optimistically in the 2nd period. A biased player also votes pessimistically in the 1st period. If any player deviates his type is believed to be* 1 *with probability* 1.

To verify that the strategies and beliefs in the above proposition constitute an equilibrium, I will show that neither a radical nor an unbiased player ever have an incentive to deviate in the 1st period. Before I turn to the biased type's incentives to deviate, recall that a biased player always prefers an agreement and thus would rather have his opponent use an OR voting strategy in the 2nd period:

Lemma 6 *A biased player will weakly prefer his (potentially unbiased) opponent to follow an OR voting strategy in the 2nd period.*

Proof. Under an 2nd period OR voting strategy the chances of reaching an agreement are higher than when the opponent follows an AND strategy because under an OR strategy the opponent is more likely to vote $v_2' = 1$. ■

If a biased player mimics the unbiased player in the 1st period then (i) he will vote $v_1 = 0$ if he receives a message $m_1' = 0$ and (ii) $v_1 = 1$ if he receives $m_1' = 1$ (as he himself will always send $m_1 = 1$) .
If he receives $m_1' = 0$, he knows that his opponent is unbiased with certainty and hence also knows that under the AND voting strategy his opponent will vote $v_1' = 0$ with certainty. Hence there will never be an agreement and the biased type's payoff (from the 1st period only) will be zero with certainty - his own vote does not affect the 1st period outcome.
However, the vote does have repercussions on his reputation. If he mimics an unbiased type by voting $v_1 = 0$ he maintains his previous reputation $\mu_1'^m$ and will be able to induce his opponent to follow an OR voting strategy in the 2nd period. On the other hand, if he were to deviate in the 1st period by voting $v_1 = 1$, he will destroy his reputation - the opponent will now assume that he is a biased type with certainty. Hence his opponent will then follow an AND voting

strategy in the 2nd period. Given that the 1st period payoff is zero regardless of the vote, a biased player will strictly prefer to vote $v_1 = 0$ (mimic an unbiased type) in order to maintain his reputation and induce a more favorable 2nd period outcome.
If, on the other hand, the biased player receives $m_1' = 1$ (in the 1st period), a vote $v_1 = 0$ will yield a zero payoff while $v_1 = 1$ yields a payoff of 1. Voting $v_1 = 1$ thus leads to the higher 1st period payoff and does not affect his reputation. Hence it is the preferred choice.
In short, a biased type is willing to mimic an unbiased one because there is no cost (in the sense of lowering his expected 1st period payoff) in doing so.

I now turn to the unbiased player's 1st period voting choices and show he will never deviate from the AND voting strategy:

If an unbiased player received $m_1' = 0$, he knows that his opponent is unbiased as well and that his opponent also uses an AND voting strategy. From the results in the equilibrium without reputational concerns it is known that neither player would then want to deviate.
Now suppose the unbiased player received $m_1' = 1$ and his own signal was $s_1 = 1$. In this situation, the voting strategies described in proposition (4) are identical to the ones in the equilibrium without reputational concerns. Hence the same conditions need to hold for an unbiased player not to deviate. Since he would not deviate from the AND voting strategy in the equilibrium without reputational concerns he will not do so under complete mimicking either.
Imagine the unbiased player received $m_1' = 1$ and his own signal was $s_1 = 0$ instead. This will affect the vote by the opponent. Whereas in the equilibrium without reputational concerns, there was a chance that the opponent would vote $v_1 = 1$ because he was a biased type, now with complete mimicking the opponent is guaranteed to vote $v_1 = 0$. This implies that the outcome will always be "no agreement" regardless of one's own votes. Therefore there is no incentive for any unbiased player to deviate from the equilibrium voting behavior. Hence, I have established that the equilibrium described in the proposition above holds. Furthermore, from the arguments and results above I additionally find:

Corollary 1 *There exists no equilibrium with complete mimicking in which a biased player in the 1st period only partially mimics the unbiased player, that is a equilibrium which involves mixing in voting by the biased type.*

Proof. If a biased player did not fully mimic an unbiased player when receiving $m_1' = 0$ in the 1st period (say by voting $v_1 = 0$ only with a probability $\alpha < 1$), then he would be able to induce his opponent to play an OR voting strategy in the 2nd period only with probability $\alpha < 1$. Hence his 2nd period expected payoff would be smaller by a fraction of $1 - \alpha$ as compared to the equilibrium described in the proposition above. Since his choice of α does not impact his

1st period payoff (remember: zero payoff regardless of own vote), a biased type would always have an incentive to increase α to 1 - that is, the equilibrium described in the proposition above. ■

The results of this section demonstrate that when the setting is ambivalent, a player's message can influence an unbiased player's voting behavior. In such a case reputation does play a role and the purpose of communication in the 1st period becomes partly to influence the opponent's beliefs about one's type. Here, the influencing is to maintain rather than to improve one's reputation.
In the equilibrium described the biased player uses the 1st period vote to maintain his reputation and influence his opponent's 2nd period vote - he disguises himself to be an unbiased player. The 1st period message on the other hand is used to influence the opponent's 1st period vote. Using the message to influence the opponent comes at the cost of decreasing his reputation - when using sincere messaging a player's reputation will decrease after the 1st period messaging stage. Nonetheless, the as long as the diminished reputation will still be sufficient to influence his opponent in the 2nd period of the game a biased type can employ complete mimicking.
In this equilibrium with complete mimicking the biased player cannot use his 1st period vote to improve his reputation, because such an action is not credible. "Trust-building" through his vote is not credible, because the biased player would not incur any costs in doing so.
This result indicates that "trust-building" has to be costly in order to be effective. The following section deals with equilibria in which "trust-building" occurs through partial mimicking. Finally notice that the equilibrium with complete mimicking does not put any restrictions on the potential payoffs V_1 and V_2 for each period.

7 Two-period game with partial mimicking

If γ, λ are ambivalent but the initial reputation p of a biased player is not sufficiently strong, he will not be able to use complete mimicking as described in the preceding section. Instead, he will employ mixed strategies in the 1st period, referred to as *partial mimicking*, in the first period in order to improve his reputation and consequently achieves a better 2nd period outcome. He does so by trading off 1st and 2nd period expected payoffs. By acting like an unbiased type in the 1st period some of the time the biased player is foregoing part of his 1st period expected payoff.
I start off by initially looking at a simplified model where the 1st period is reduced into a voting stage only. The motivation for this model modification is to simplify the analysis. In equilibrium, a biased player mimics the unbiased types's voting behavior some of the time to improve his reputation and incurs a 1st period loss. However, 2nd period gains allow him to recoup his investment

in reputation. I show that for this type of equilibrium to hold the potential payoff of the 2nd period V_2 has to be higher than the 1st period payoff V_1. These results can be extended to the standard two-period game with messaging and voting in both periods. For there to be an equilibrium with partial mimicking the biased player has to imitate his opponent in both the 1st period messaging and voting stage some of the time. The voting stage then essentially serves to make the mimicking at the messaging stage costly and therefore credible.

7.1 Simplified two-period model

In contrast to the model described in section 2 I now assume that in the 1st period, the two negotiators directly vote on the agreement without being able to send and receive messages beforehand. However, in the 2nd period, as in the previous model, negotiators first send and receive messages and only then simultaneously vote on the agreement.

In such a model there exists an *equilibrium with partial mimicking* which we define as follows:

Definition 3 *In an equilibrium with partial mimicking any biased type with signal* s_1 *votes* $v_1 = 0$ *with probability* $1 - \alpha(s_1)$*, while an unbiased one votes according to his signal. In the 2nd period players follow sincere messaging behavior. The biased type always votes* $v_2 = 1$*. The unbiased type uses (i) an OR voting strategy if in the 1st period he observed* $v_1' = 0$*, (ii) SILENT if in the 1st period* $v_1' = 1$ *and* $v_1 = 0$ *or, (iii) AND if* $v_1' = v_1 = 1$*.*

For an equilibrium with partial mimicking to hold γ, λ need to be ambivalent. In addition, the probability $\alpha(s_1)$ with which a biased type imitates an unbiased player, the initial reputation p and the 2nd period payoff V_2 have to meet a number of conditions. Intuitively these are: (i) The biased player has to be indifferent about voting in the 1st period in order to mix strategies, (ii) a vote $v_1 = 0$ by the biased type must improve his reputation enough such that his opponent would pursue an OR voting strategy in the 2nd period, (iii) for a biased type to improve in reputation from $v_1 = 0$ he has to be more likely to vote $v_1 = 1$ than an unbiased one, and (iv) an unbiased player prefers to follow own signal. I will discuss each of these four conditions in turn in more detail:

7.1.1 Biased type is indifferent about 1st period vote

In order for the biased type to remain indifferent between either vote, the expected payoff for the entire 2 period game has to be same whether he votes $v_1 = 0$ or $v_1 = 1$ in the 1st period. This is equivalent to saying that the 2nd period gain from voting $v_1 = 0$ (and thereby mimicking an unbiased type) has to match the resulting loss in 1st period payoffs.

First consider the 1st period loss from voting $v_1 = 0$. If the biased type votes $v_1 = 0$ his 1st period payoff is zero, while if he votes $v_1 = 1$ his 1st period expected payoff is strictly positive, as there is at least some chance of an agreement. His opponent votes $v_1' = 1$ either because he is mixing as a biased type or because he is an unbiased player with signal $s_1' = 1$. The chances that the opponent has $s_1' = 1$ are $\beta(s_1) = \frac{\Pr(s_1'=1|s_1)}{\Pr(s_1)}$. The probability that a biased opponent chooses $v_1' = 1$ is α'. However, α depends on the opponent signal s' which is not known to the player. Thus I calculate the expected value of $\alpha(s_1')$ which is

$$\overline{\alpha}(s_1) = \alpha(0)\ (1 - \beta(s_1)) + \alpha(1)\ \beta(s_1). \tag{8}$$

The 1st period expected loss then equals the overall probability that the opponent votes $v_1' = 1$:

$$\Delta\pi_1(s_1) = [\overline{\alpha}(s_1)\ p + \beta(s_1)\ (1 - p)] \tag{9}$$

This expected loss is offset by gains from voting $v_1 = 0$ in the 2nd period, which is

$$\Delta\pi_2(s_1) = V(1 - p)\Pr(s_2' = 0) \tag{10}$$

The player gains in the 2nd period if his opponent receives a signal $s_2' = 0$ and is an unbiased type. This is because an improved reputation after voting $v_1 = 0$ will lead the opponent to use the OR strategy instead of AND/SILENT in the 2nd period. The OR strategy leads to a different 2nd period outcome than AND/SILENT whenever an unbiased opponent receives $s_2' = 0$.

Combining (9) and (10) I find:

Condition 1 *In order for a biased player to be indifferent with regard to his vote in the 1st period,* $\Delta\pi_1(s_1) = \Delta\pi_2(s_1)$ *for any* s_1

Note that the expected losses and gains in the two periods differ according to s_1. The condition thus consists of two simultaneous equations, which can be used to solve for $\alpha(0)$, $\alpha(1)$. Since $\alpha(1) = \alpha(0) - \frac{(1-p)}{p}$, we find that when γ, λ are ambivalent $\alpha(1) < \alpha(0)$ for any p, V. The intuition here is as follows: A biased type will only mix between the two vote choices if his 1st period expected loss is the same regardless of his own signal s_1. If this was not true, then the biased type would have an incentive to deviate by tailoring his vote according to his signal. However, when γ, λ are ambivalent then $\beta(1) > \beta(0)$, which implies that the opponent's signal are positively correlated to the biased player's signal. This in turn means that the probability of an unbiased opponent is more likely to vote $v_1' = 1$ if $s_1 = 1$ than otherwise. In order to keep 1st period expected losses the same for $s_1 = 1$ and $s_1 = 0$ a biased opponent then has to be less likely to vote $v_1' = 1$ if $s_1 = 1$ than if $s_1 = 0$.

7.1.2 In equilibrium first-period vote sufficiently improves reputation for biased type

In order for the biased type to use partial mimicking it has to improve his reputation in such a way that it affects his opponent's 2nd period voting decision. More formally, let μ^* be the belief about the opponent's type such that the expected 2nd period payoff from using an OR voting strategy in the 2nd period is equal to the expected payoff when using SILENT. For any belief $\mu_2' < \mu^*$ which an unbiased opponent holds at the beginning of the 2nd period, the opponent will use the OR voting strategy in the 2nd period and AND/SILENT otherwise. Let $\mu_1' = \Pr(\rho, s_1 | p, m_1, s_1')$ be the biased type's reputation *before* having voted in the 1st period, if his initial reputation was p. Let $\mu_1'^v = \Pr(\rho, s_1 | \mu_1', v_1)$ be the biased type's reputation *after* having voted v_1.
Then, for an equilibrium with partial mimicking to hold, the biased type's reputation should be such that

Condition 2 *When a biased type votes $v_1 = 0$, his reputations improves enough to change his opponent's 2nd period voting decision, while it does not otherwise:*

$$\forall s_1' : \mu_1'^v < \mu^* \text{ if } v_1 = 0 \text{ and } \mu_1'^v \geq \mu^* \text{ if } v_1 = 1.$$

In this case the 1st period vote of the biased player does determine his opponent's voting strategy in the subsequent period. The restriction on a player's reputation which these inequalities impose are more strict (in the sense of requiring a stronger initial reputation) when $s_1' = 1$. The intuition here is that given $s_1' = 1$, the opponent knows that the distinctions in voting behavior between an unbiased player and a biased player are going to be less sharp than when $s_1' = 0$, because $\frac{1}{2} < \alpha(1) < \alpha(0)$.

Therefore if the biased player votes $v_1 = 0$ given $s_1' = 1$, it will improve his reputation less dramatically than given $s_1' = 0$. Consequentially, with $s_1' = 1$ the biased player will have to have a stronger initial reputation p for a vote $v_1 = 0$ to make a difference.

7.1.3 Biased type is more likely to vote in favor in 1st period

For the biased type to use partial mimicking voting $v_1 = 0$ must improve his reputation. This only occurs if a biased type is more likely to vote $v_1 = 1$ than an unbiased player. Recall a biased type's likelihood of voting $v_1 = 1$ is $\overline{\alpha}(s_1)$, while for an unbiased player it is $\beta(s_1)$. Hence in equilibrium $\overline{\alpha}(s_1) \geq \beta(s_1)$ must be true for all s_1. Since we know $\overline{\alpha}(0) > \overline{\alpha}(1)$ and $\beta(1) > \beta(0)$ this reduces to the following:

Condition 3 *In an equilibrium with partial mimicking the biased player is more likely to vote $v_1 = 1$ than an unbiased player, such that*

$$\overline{\alpha}(1) \geq \beta(1)$$

7.1.4 Unbiased type votes according to signal in 1st period

Finally, I need to consider the unbiased player's voting strategy. For the equilibrium to hold the unbiased player must vote according to his signal. First, I look at the situation when the unbiased player has a signal $s_1 = 0$. Let $\Pi_1(s_1, v_1)$ be the expected 1st period payoff to the unbiased player from voting v_1 given signal s_1. We find for an equilibrium with partial mimicking:

Condition 4 *An unbiased player with signal $s_1 = 0$ votes according to his signal in the 1st period if*

$$\Pi_1(0,0) \geq \Pi_1(0,1)$$

where $\Pi_1(0,0) = \Pr(\omega = 0|s_1 = 0)$ and $\Pi_1(0,1) = \Pr(\omega = 1, v_1^{'} = 1|s_1 = 0) + \Pr(\omega = 0, v_1^{'} = 0|s_1 = 0)$.

I can ignore 2nd period payoffs because including 2nd period payoffs only further increases the expected payoff from voting $v_1 = 0$ as compared to voting $v_1 = 1$. This is because $v_1 = 0$ improves the player's reputation thereby leading to higher 2nd period expected payoffs.
Suppose now the unbiased player had a signal $s_1 = 1$ instead. If he votes according to his signal it causes the unbiased player to worsen his reputation

and induces the opponent to use a AND/SILENT voting strategy in the 2nd period. Hence in order to prefer voting $v_1 = 1$ the 1st period payoff $\Pi_1(1,1)$ must not only yield a higher expected 1st period payoff than when voting $v_1 = 0$, but also must compensate for the subsequent 2nd period loss $\Delta\Pi_2$. If the player votes $v_1 = 1$, the changed 2nd period voting strategy used by the opponent will result in a changed 2nd period subgame outcome only in one case. This is, when the player were to receive a signal $s_2 = 1$, a message $m_2' = 0$ from his opponent. The expected 2nd period payoff when using the AND voting strategy is λ while it is $1 - \lambda$ when OR is used. Thus the overall change in payoff is $1 - 2\lambda$ and $\Delta\Pi_2 = V_2 \Pr(s_2 = 1, m_2' = 0)\,(1 - 2\lambda) = \gamma(1-\gamma)(1-2\lambda)(1-p)$. Then, the unbiased player will vote according to his signal if $\Pi_1(1,0) + \Delta\Pi_2 \leq \Pi_1(1,1)$. It is straight-forward to show that $\Pi_1(1,0) + \Delta\Pi_2 \leq \Pi_1(1,1)$ is always satisfied if γ, λ are ambivalent.

To summarize:

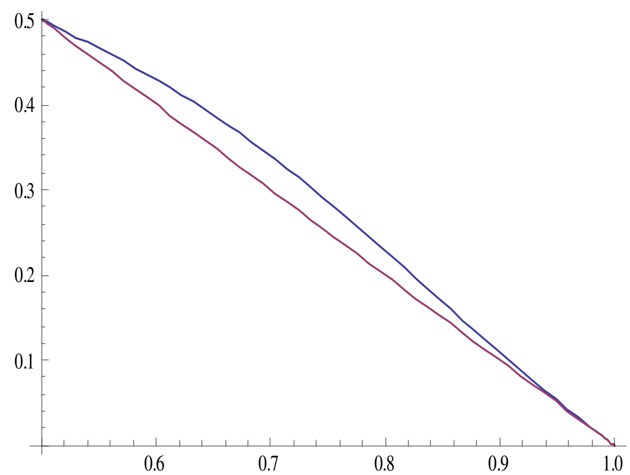
Proposition 5 *If γ, λ are ambivalent and p, V satisfy conditions 1 to 4 then we have an equilibrium with partial mimicking.*

I now show that there in fact exist equilibria with partial mimicking by demonstrating that the set of values for p, V satisfying condition 1 to 4 is non-empty. Let $h(\gamma)$ denote the highest possible value for λ that still satisfies condition 2. More formally, $h(\gamma)$ is the implicit solution for $\mu_1'^v = \mu^*$, given $\alpha(0) = 1$ and $p = 0.5$. Similarly let $\overline{V}$ be the highest value for V that still allows us to satisfy condition 1 or more formally, $\overline{V}$ is the implicit solution for $\alpha(0) = 1$ in terms of V. Finally, let $\underline{V}$ be the lowest value of V that satifies confition 3 or 4, whichever is more restrictive. That is, $\underline{V}$ is the implicit solution for $\overline{\alpha}(1) = \beta(1)$ or $\Pi_1(0,0) = \Pi_1(0,1)$ in terms of V, whichever solution is larger.

Then by combining and simplifying the conditions from above, I find the following characterization for γ, λ and V which hold in an equilibrium with partial mimicking:

$$\frac{1}{2} < \gamma < 1,$$
$$1 - \gamma < \lambda < h(\gamma),$$
$$\text{and } \underline{V} < V < \overline{V}$$

Depicting the set of partial equlibria in the γ, λ space (ignoring V for now), I obtain the following graph with value for γ on the horizontal axis and λ on the vertical axis:



Additionally, the table below provide information on range for V for selected values of γ and λ:[5]

λ	γ	lowest V	highest V
0.1	0.905	2.50705	80.9346
0.2	0.805	6.128316	60.9848
0.2	0.81	3.053364	30.9686
0.2	0.815	2.026414	20.9511
0.2	0.82	1.511428	15.9325
0.3	0.705	7.162704	40.9941
0.3	0.71	3.632071	20.9879
0.3	0.715	2.453453	14.3145
0.3	0.72	1.862785	10.9741
0.3	0.725	1.507277	8.96654
0.3	0.73	1.269321	7.62522
0.3	0.735	1.238164	7.519744111
0.4	0.605	4.817739	20.9977

From the graph one can see that an equilibrium with partial mimicking only holds for combinations of γ, λ in a narrow range of value just above to the $\gamma + \lambda = 1$ diagonal, which signifies situations where the private signal is just barely more informative than the prior probability of the state of the world. Outside of this range, it is always better for the biased player to always lie or to never lie and hence no partial mimicking would take place.

[5] For simplicility of exposition I have omitted information on the range of values of p, the a-priori reputation of players, that would sustain an equilibrium with partial mimicking. The "lowest V" and "highest V" shown here are based on the choosing values for p that in combination with the value of V would lead to $\alpha(0) = 1$ and $\alpha(1) = 0$ respectively.

From the table one can see that in addition any equilibrium imposes limits on V or how much more important the 2nd period must or can be relative to the 1st period. The intuition for this restriction can be best understood if one is to rearrange conditions 1 to 4 as conditions on V (given γ, λ and p). In fact, Conditions 1 and 2 impose upper bounds on V for an equilibrium whereas conditions 3 and 4 limit how low a value V can have.

Recalling condition 1 one notices that $\overline{\alpha}(s_1)$ and V are linearly proportional. Thus the relative importance of the 2nd round has a direct influence on the mixing probabilities in the 1st round of the biased negotiator. Furthermore, since $\overline{\alpha}(s_1)$ represents a probability which by definition cannot exceed 1 (or be lower than 0), condition 1 also imposes limits on the value of V that sustain the equilibrium with partial mimicking. This is because when V increases, 2nd period gains from investing in reputation increase as well. However, these gains must be offset be larger 1st period losses in order to keep the biased negotiator indifferent between the two periods.This can only achieved by increasing $\overline{\alpha}(s_1)$. However if condition 1 implies $\overline{\alpha}(s_1) > 1$ then the 2nd period gains always outweigh any 1st period losses. Hence the biased negotiator will always vote $v_1 = 0$ and the mixing equibrium breaks down. If V is too large, the 2nd period becomes too attractive relative to the 1st period and if V is too small then the 1st period is too attractive relative to the subsequent period.

Recall that condition 2 ensures that the gain in reputation from the 1st period vote is enough to sway one's opponent to change his behavior. V influences how strongly reputation can improve. If V increases one sees a weaker gain in reputation from voting $v_1 = 0$ in the first period, because the increased attractiveness of the 2nd period creates more incentive to improve, which in turn leads to more suspicion about (and discounting of) any observed $v_1 = 0$. Therefore, if we set V too high (which will lead to a high α) then there is not enough improvement in reputation from voting $v = 0$ and the equilibrium cannot be sustained.

From condition 3 we know that the biased type has to vote $v_1 = 0$ so with less probability than the unbiased types, so that voting $v_1 = 0$ in fact improves a negotiator's reputation. If V (and thus $\overline{\alpha}(s_1)$) is set too low, then voting $v_1 = 0$ will lower a player's reputation.

Similarly, condition 4 can only be satisfied if V is sufficiently large. The intuition here is that in equilibrium a low value for V increases the payoff for an unbiased player with signal $s_1 = 0$ to vote $v_1 = 1$, that is to vote against his signal becomes more attractive. This is because as V increases a biased player is more and more likey to vote $v_1^{'} = 0$. This increases the expected payoff to the unbiased player if he votes $v_1 = 1$, but does not affect expected payoff if he votes $v_1 = 0$. If the probability for $v_1^{'} = 0$ is high enough, condition 4 no longer holds and the unbiased player will no longer follow his own signal.

7.2 Standard two-period model

Suppose now, that prior to the voting stage in the 1st period there was a messaging stage. That is, both the 1st and 2nd period would be identical in their timeline and consist of a messaging and voting stage. I show that in such a set-up there exist "partial mimicking" equilibria where the mimicking takes place in the messaging stage of the 1st period and the equilibrium conditions from the section above apply almost identically to the new model. In specific, I demonstrate that:

Proposition 6 *In the standard two-period game there exists a partial mimicking equilibrium, in which the biased player with signal* s_1 *sends* $m_1 = 0$ *with probabilities* $1 - \alpha(s_1)$ *in the 1st period, while an unbiased player sends message* $m_1 = s_1$*. Both types use AND voting in the 1st period. If any player deviates, he is assumed to be a biased type with certainty. In the 2nd period players follow sincere messaging. The biased type always votes* $v_2 = 1$*. The unbiased type uses OR voting if* $m_1' = 0$ *, SILENT if* $m_1' = 1$ *and* $m_1 = 0$ *and AND if* $m_1' = m_1 = 1$*.*

Because both types of players follow the same 1st period voting strategy, the 1st period votes do not provide any useful information about the opponent's type. Analogous to the model in the previous section, in the 1st period players update their beliefs about the opponent's type based on their own signal $s_1$and the opponent's message m_1'. Otherwise, the same rationale and trade-offs as in the simplified model hold. In order for the biased player to be willing to mix, his total expected payoff from sending $m_1 = 0$ has to equal the one from communicating $m_1 = 1$. This is achieved by ensuring that after sending $m_1 = 0$ a player's reputation improves enough as to induce the opponent to use an OR voting strategy in the 2nd period and thereby obtain a higher 2nd period expected payoff. This gain in 2nd period payoff offsets the lower 1st period payoff that a biased player get when sending $m_1 = 0$ and following the AND voting strategy in period 1. As in the previous, the probability of a biased type sending $m_1 = 1$ has to be larger than by an unbiased one and the initial reputation p has to be strong enough as to allow 2nd period OR voting behavior. What does differ in this model is that one needs to verify that neither type of player is tempted to deviate at the 1st period voting stage.

Thus, I show that a biased type in fact never has an incentive to deviate given the strategy described above. As a biased type, he can only gain if his opponent votes $v_1' = 1$. This is only the case when $m_1 = 1$ and $m_1' = 1$. However in this setting he could only deviate to $v_1 = 0$, which would make him worse off. Hence, he will never deviate in the 1st period voting stage.
An unbiased player will also never deviate. If he were to deviate, his reputation will be at its worst and hence he can never expect any 2nd period gains in

expected payoff from deviating. Hence I only need to consider first period expected payoffs. The results regarding the period subgame indicated that when γ, λ are ambivalent the AND voting behavior is a best-response irrespective of his beliefs. Thus the changes in the messaging strategies with partial mimicking will have no effect on the player's voting behavior as the AND voting behavior is independent of his beliefs.

Because 2nd period expected payoffs never need to be taken into account, the conditions for the moderate to send $m_1 = s_1$ are even simpler than the corresponding conditions on moderate player's voting behavior from the previous section. Any set of parameters that satisfied the equilibrium with partial mimicking in the simplified model will also ensure that the unbiased type will send $m_1 = s_1$ in this model.

8 Summary and Conclusion

In this paper I have shown that in a limited set of circumstances biased players are able to build up their credibility in the eyes of the opponent by sacrificing 1st period gains and that the larger the sacrifices, the larger the reputational gains. Investing in trust or credibility is only possible if the initial degree of reputation is sufficiently high and the precision of private information is large enough to override conflicting a-priori information about the state of the world. If the a-priori information on the state of the world is heavily tilted towards a specific outcome or if the signal precision is low, then reputation does not play a role in communications and voting behavior. In such cases even under the best circumstances, it is impossible to sway the opponent's voting behavior through communications and therefore there is no incentive to invest in credibility. In such cases the prior information as well as the player's own private information always trump any (conflicting) message they might receive from their opponent.

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Appendix

Corollary 2 *(to Proposition 2)*
(a) When $\lambda < 1 - \frac{\gamma^2}{1-2\gamma+\gamma^2}$ or $\lambda > \frac{\gamma^2}{1-2\gamma+\gamma^2}$, the player ignores all signals and messages. He votes according to the likelier outcome of ω. The prior carries so much weight relative to the signals that even if both private signal and message conflict with the prior they are ignored.
(b) When $\frac{\gamma^2}{1-2\gamma+\gamma^2} > \lambda > \gamma$, the moderate player follows an AND strategy if the opponent's reputation is sufficiently strong and always votes $v = 0$ otherwise. The prior is biased towards $\omega = 0$ but this bias is reversed if both his own signal and a credible enough received message conflict with the prior.

Each player votes without knowing the type of his opponent. The results below therefore represent an ex-post view. I restrict my results to situations where both players follow the same voting strategy:

Corollary 3 *(to Lemma 2) When two unbiased player face each other,*
(i) they will both play OR voting strategies for $1 - \frac{\gamma^2}{1-2\gamma+\gamma^2} < \lambda < 1 - \gamma$. There will be an agreement for all situations where at least one of the players has a signal $s = 1$.
(ii) They will both play any of the voting strategies for $1 - \gamma < \lambda < \frac{1}{2}$ depending on the reputation of the opponent. If the opponent's reputation is weak (high p) players will play SILENT, if it is strong they will use OR. Additionally an AND voting equilibrium is always possible. When using SILENT or AND there will be an agreement only if both players have a signal $s = 1$.
(iii) They will both play SILENT or AND voting strategies for $\frac{1}{2} < \lambda < \frac{\gamma^2}{1-2\gamma+\gamma^2}$. There will be an agreement only if both players have a signal $s = 1$.
(iv) The players' voting strategy will be $v = 1$ if $\lambda < 1 - \frac{\gamma^2}{1-2\gamma+\gamma^2}$ and there is always an agreement.
(v) The players' voting strategy will be $v = 0$ if $\lambda > \frac{\gamma^2}{1-2\gamma+\gamma^2}$ and there is never an agreement.
Furthermore, when an unbiased player faces a biased one, the biased one will always vote $v = 1$ and the unbiased type follows the same voting strategies as stated above. If the unbiased type uses OR there will always be an agreement, if he uses SILENT or AND then only when his signal is $s = 1$. When two biased players face each other, both votes $v = 1$ and the outcome is an agreement.