Adversarial Bargaining with Exogenous Shocks.

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Abstract

This paper examines equilibrium strategies in adversarial bargaining—a conflict-based negotiation for resource allocation or payments under the threat of a welfare-destroying conflict—considering the credibility of threats and the influence of patience levels on negotiated deals. Using a multiperiod bilateral adversarial bargaining model, we find that an impatient proposer can secure the full responder's surplus through credible threats, while highly patient scenarios rely on probabilistic threats. Intermediate levels of patience result in mixed strategies. Equilibrium types are distinguished based on whether the proposer benefits or incurs a loss from conflict.

Keywords: Bargaining, conflict, resource allocation.

JEL Codes: C72, C78, D74.

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1 Introduction

Negotiations involving resource allocation and payments often manifest as adversarial bargaining, where a proposer employs the threat of conflict to obtain a desired outcome from a responder. This involves the proposer warning the responder that failure to comply with their demands will result in a welfare-destroying conflict, through which the proposer will obtain the desired resource or payment. To illustrate this concept, consider a scenario where a country possesses a territory with a strategically important resource coveted by a more powerful nation. The demanding country offers the transfer of the territory, or else they will initiate an invasion to seize it. While the invasion would result in the loss of the territory for the threatened country, the demanding country would still incur costs (such as reputation damage or casualties), making the total benefit lower than the value of the territory.

This setting raises several questions. Firstly, the credibility of the threat comes into question, as the demanding country might prefer to continue negotiations and persuade the other country to accept a deal. Secondly, the patience levels of the involved countries affect the outcome of the negotiation. A highly impatient demanding country might favor an immediate invasion, whereas a more patient country would be willing to wait longer before resorting to conflict.

In this paper, we contribute to the understanding of equilibrium strategies in adversarial bargaining. We show that the proposer can obtain the responder's entire surplus by employing a credible threat of initiating conflict, but this strategy only works if the proposer is impatient. In cases where the proposer is not impatient, he cannot establish a credible threat, resulting in the acquisition of only a portion of the responder's surplus. We also show that the optimal deal reaches its lowest value for the responder at an intermediate level of patience.

To analyze this phenomenon, we propose a multiperiod bilateral adversarial bargaining model. The proposer has the option to obtain the surplus through conflict, albeit at a cost. The conflict generates a welfare loss, where the proposer incurs a loss, and the responder experiences a benefit, but lower than the absolute value of the responder's loss. To avoid conflict, both parties negotiate a deal involving a welfare transfer from the responder to the proposer. The game unfolds as follows: the proposer presents a deal to the responder, and if accepted, the game concludes. However, if the deal is rejected, the proposer decides whether to initiate conflict, which we model as a reduced form function resulting in the responder's surplus loss and the proposer obtaining less than the responder's lost surplus. The conflict ends the game.

An essential aspect of our model is the consideration of risk in the negotiation process.

Even if the proposer decides against initiating conflict following a rejection, there is still a probability of an exogenous shock that could trigger conflict at the end of each period. This exogenous shock represents an element beyond the proposer's control, such as an unauthorized attack by an enraged general in a conflict between nations or an unexpected event like the "War of the Stray Dog" between Greece and Bulgaria in 1925, where a soldier's pursuit of his runaway dog led to a border incident and subsequent invasion by Greece.[1]

In equilibrium, the proposer and responder reach an agreement in the first period, thus avoiding conflict. We categorize equilibrium types based on whether the proposer benefits from conflict (albeit to a lesser extent than the responder's loss) or incurs a loss. In the case where the proposer benefits from the conflict, the equilibrium deal depends on the patience level (discount factor) of the involved parties. If both parties exhibit high impatience, the equilibrium features a deterministic threat, with the proposer initiating conflict upon deal rejection because the benefits outweigh the expected payments from continuing negotiations. By doing so, the proposer can coerce the responder into accepting a deal where the entire surplus is transferred.

Conversely, if both parties display high patience, the equilibrium involves a probabilistic threat. Here, the proposer refrains from initiating conflict following a deal rejection, instead relying on the exogenous shock as a threat to the responder. Given the parties' high patience levels, the expected payment the proposer can obtain from continuing negotiations surpasses the benefit derived from conflict. Consequently, the responder accepts an offer equivalent to the expected loss incurred through further negotiation.

In the intermediate case, where neither party is highly impatient nor highly patient, the equilibrium involves a mixed strategy concerning the proposer's decision to initiate conflict following a deal rejection. The proposer lacks sufficient impatience to opt for conflict, yet lacks high patience to continue negotiations. As a result, in equilibrium, the proposer remains indifferent between initiating conflict and pursuing further negotiation. The responder accepts an offer that incorporates the probability of continuing negotiation if the deal is rejected.

Under the deterministic threat equilibrium (low discount factor), the accepted deal matches the responder's surplus. This equilibrium allows the proposer to achieve the highest possible payoff due to the credible threat of initiating conflict.

When it comes to higher discount factors, the accepted deal exhibits a U-shaped relationship. For the mixed strategies threat equilibrium, the accepted deal decreases on the patience levels. The proposer makes the offer to make himself indifferent between initiating conflict or presenting the same offer in the subsequent period if the responder rejects the

[1]See Gregory (2009)

deal. Therefore, a higher discount factor elevates the continuation value, necessitating a lower offer to reduce it.

Conversely, for probabilistic threats, the accepted deal increases with higher patience levels. The responder is more inclined to accept a higher offer as the discount factor rises, as a higher expected loss is incurred with a higher discount factor.

In the second set of results, where the proposer incurs a loss from conflict, the only equilibrium observed is the probabilistic threat. Here, the proposer relies on the exogenous shock and offers a deal equivalent to the responder's expected loss in the conflict, assuming the proposer never initiates conflict. This equilibrium is the only possible option since the proposer would never prefer to initiate conflict and incur a negative payoff rather than rely on the exogenous shock to reach an agreement with the responder in the subsequent period.

In this case, we refer to the equilibrium as brinkmanship, as the proposer places themselves in a risky position where rejection of the deal exposes them to the risk of getting a loss from the conflict.

In summary, our research sheds light on equilibrium strategies in adversarial bargaining. We establish the conditions under which the proposer can secure the responder's surplus through credible threats of conflict, highlighting the role of impatience. We develop a multiperiod bilateral adversarial bargaining model that accounts for risk in negotiations. Our results show the different equilibrium outcomes based on the patience levels of the involved parties, ranging from deterministic and probabilistic threats to brinkmanship. Understanding these equilibrium strategies enhances our comprehension of adversarial bargaining dynamics.

Related Literature. This paper relates to the bargaining literature on conflict prevention through transfers.[2]Leng (1993), Huth (1988), Hensel and Diehl (1994), Wittman (2007) focus on whether transfers are efficient. Fearon (1995) provides explanations why a mutually beneficial agreement might not be reached, Powell (2006) argues that failure in bargaining is due to commitment problems, and Rajan and Zingales (2000), Acemoglu and Robinson (2006), and Acemoglu (2003) shows that the lack of commitment power in the enforcement of the transfer make that conflict arises.

Regarding the results of the paper, Shavell (1992) focuses on the case in which both parties get a negative payment for conflict and shows that in the absence of an exogenous shock, there are no transfers. Fearon (1996), Shavell and Spier (2002), Powell (2006), Acemoglu and Robinson (2006), and Schwarz and Sonin (2008) show that spreading transfer over time prevent conflcit. Our model can be seen as a generalization of Schwarz and Sonin (2008),

[2]Blainey (1988), and Holsti et al. (1991) provide a survey of the reasons for starting a war.

as they analyze the case in which both players get a negative payment for the conflict, but there is an exogenous shock that might start it. We also analyze that case but also provide the equilibrium for the case in which one party might benefit from the conflict.

Outline. The paper is organized as follows. Section 2 introduces the model, Section 3 analyzes the equilibrium, and Section 4 discusses more applications. Appendix A contains all the proofs.

2 Model

Two players, the proposer and the responder, play a discrete-time infinite horizon adversarial bargaining game. At each period $t \in \{0, 1, 2, ...\}$, the proposer offers a deal involving a transfer $x \in \mathbb{R}$ from the responder to the proposer. The responder can either accept or reject the deal. If accepted, the game concludes with payments $U_P = x$ for the proposer and $U_R = -x$ for the responder.

If the deal is rejected, the proposer decides whether to initiate conflict, which is a reduced-form function that assigns payoffs to the proposer and the responder. In the event of the conflict, the payoffs are u_P for the proposer and u_R for the responder, with $u_P + u_R < 0$ and $u_R < 0$.

If the proposer opts against conflict, an exogenous shock may activate it with probability $p \in [0, 1]$ at the end of each period. That is, with probability $(1-p)$, a new period starts, and with probability p the game ends, and the payoffs are the conflict payments. Both players discount future payoffs using the same discount factor $\delta \in (0, 1)$.

Strategies: A strategy for the proposer at period t is (x^t, θ^t), an offer $x^t \in \mathbb{R}$ and the probability of starting the conflcit $\theta^t \in [0, 1]$ following a rejection. A strategy for the responder at period t is a probability of acceptance $\beta^t \in [0, 1]$ of the offer x^t.

Equilibrium: The equilibrium concept is Subgame Perfect Nash Equilibrium (SPNE).

3 Analysis

3.1 Proposer positive payoff of conflict: $u_p > 0$

We first analyze the case where $u_P > 0$. Despite this positive benefit, the proposer may still prefer reaching an agreement rather than initiating conflict because the losses of the responder are higher than the proposer's benefit from the conflict. The equilibrium outcome is contingent on the level of patience exhibited by the players. We introduce two cutoffs:

$$\underline{\delta} = \frac{u_P}{u_R} \quad \text{and} \quad \bar{\delta} = \frac{u_P}{pu_R + (1-p)u_P},$$

where $\underline{\delta}$ and $\bar{\delta}$ represent the lower and upper thresholds, respectively.

Additionally, we define the *discounted shock probability* as:

$$\tilde{p} = \frac{p}{1-(1-p)\delta}.$$

The discounted shock probability reflects the likelihood of a shock occurring in an alternative one-period game where the conflict either initiates with assigned payoffs or does not start, resulting in both players receiving a payment equal to zero.

Furthermore, we denote V_P as the proposer's continuation value of abstaining from conflict initiation, and V_R as the responder's continuation loss from rejecting an offer.

Proposition 1 *The equlibrium depends on δ on the following way:*

- *For $\delta < \underline{\delta}$, the only equilibrium is the proposer chooses $x^t = u_R$ and $\theta^t = 1$ for all t, and the responder chooses $\beta^t = 1$ for all t.*
- *For $\delta \in [\underline{\delta}, \bar{\delta}]$, the proposer chooses $x^t = \frac{u_P}{\delta}$ and $\theta^t = \theta^*$ for all t, with*

$$\theta^* = \frac{p(\delta x - u_R) - x(1-\delta)}{(1-p)(u_R - \delta x)},$$

  and the responder chooses $\beta^t = 1$ for all t.
- *For $\delta > \bar{\delta}$, the only equilibrium is the proposer chooses $x^t = \tilde{p}u_R$ and $\theta^t = 0$ for all t, and the responder chooses $\beta^t = 1$.*

Proposition 1 shows the dependence of the equilibrium on the players' patience levels, leading to different types of equilibria based on the credibility of threats.

1. Impatient Players: When players exhibit impatience ($\delta < \underline{\delta}$), the proposer can persuade the responder to accept a deal equivalent to her potential conflict loss. After rejection, the proposer prefers initiating the conflict and receiving a payoff of u_P instead of potentially waiting for an additional period, even if the responder would accept u_R in the subsequent period. This condition can be expressed as:

$$pu_P + (1-p)\delta u_R < u_P \quad \iff \quad \delta < \frac{u_P}{u_R}$$

The responder anticipates a loss of u_R for rejecting the deal and, therefore, is willing to accept a deal where $x \le u_R$. In this scenario, the proposer can extract the maximum surplus from the responder.

2. More Patient Players: In an equilibrium where $\delta > \underline{\delta}$, it cannot be the case that the proposer strictly prefers initiating conflict following a rejection. If such an equilibrium were to exist, the stationary offer x would need to satisfy $u_P > \delta x^{\iff x < \frac{u_P}{\delta}}$. However, if this condition holds, the responder is willing to accept offers up to u_R. Consequently, the proposer has an incentive to deviate to $x^{*'} = u_R$, as $u_R > \frac{u_P}{\delta}$ for $\delta > \underline{\delta}$. Therefore, for $\delta > \underline{\delta}$, the equilibrium must satisfy $u_P \le V_P$.

2.A. Very Patient Players: In the case of players exhibiting very high levels of patience ($\delta > \bar{\delta}$), the proposer prefers to continue the negotiation instead of initiating conflict, given that $u_P < V_P$. In this scenario, the expected loss incurred by the responder from rejecting any offer is given by:

$$V_R = pu_R + (1-p)\delta V_R \quad \iff \quad V_R = \tilde{p}u_R.$$

In equilibrium, the proposer offers $x = \tilde{p}u_R$, which the responder accepts. This equilibrium holds only when $\delta > \bar{\delta}$, as $u_P < \delta\tilde{p}u_R$ is satisfied only when $\delta > \bar{\delta}$.

2.B. Intermediate Patient Players: In the case where players exhibit intermediate levels of patience ($\delta \in [\underline{\delta}, \bar{\delta}]$), the equilibrium is characterized by $u_P = V_P$. Before delving into the intuition, we establish two key observations regarding the responder's behavior in any equilibrium.

Firstly, the responder must be indifferent between accepting and rejecting the offer. If the proposer strictly prefers the rejection of an offer, they can decrease the offer to incentivize acceptance. Conversely, if the proposer strictly prefers acceptance, they can increase the offer while still ensuring acceptance.

Secondly, in any equilibrium, $\beta = 1$. In other words, the responder always accepts the offer. If $\beta < 1$, the proposer can slightly reduce the offer, resulting in a higher payment that is guaranteed due to acceptance.

Hence, in an equilibrium where $u_P = V_P$, the equilibrium offer x must satisfy $u_P = \delta x^{\iff x^* = \frac{u_P}{\delta}}$. To render the responder indifferent, the offer must satisfy the following condition:

$$\frac{u_P}{\delta} = \theta u_R + (1-\theta)\left[pu_R + (1-p)\delta\frac{u_P}{\delta}\right],$$

where θ^* represents the equilibrium value of θ as described in Proposition 1.

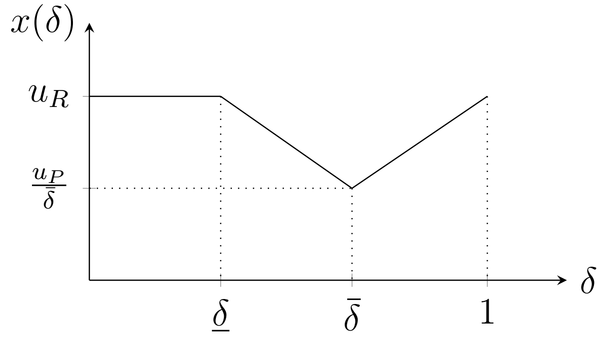

Figure 1: Accepted offer made bythe proposer.

U-shaped Accepted Offer: As depicted in Figure 1, when δ is very small ($\delta < \underline{\delta}$), the proposer achieves the highest possible payoff as the game reduces to a one-period scenario. For $\delta \geq \underline{\delta}$, the proposer's payoff exhibits a U-shaped pattern: it decreases in δ for $\delta < \bar{\delta}$ and increases for $\delta > \bar{\delta}$.

When $\delta \in [\underline{\delta}, \bar{\delta}]$, the proposer lacks both extreme impatience and extreme patience to exploit the situation fully. The proposer strategically selects an offer such that, in the event of rejection, they become indifferent between initiating conflict or waiting for one additional period. Simultaneously, the responder remains indifferent between accepting or rejecting the offer.

The accepted offer decreases as δ increases. Intuitively, the proposer needs to establish credibility regarding their willingness to initiate conflict with a certain probability. Achieving this requires equalizing the payoff from reaching an agreement in the next period with the payoff obtained from engaging in conflict in the present. As the discount factor increases, the payoff in the next period also increases. Consequently, the proposer must reduce the offer to align the future payoff with u_P.

For $\delta > \bar{\delta}$, the proposer relies on the exogenous shock to incentivize the responder to accept an offer. The proposer can make an offer equivalent to the responder's expected loss, which increases as the responder's patience grows.

Remark 1: The influence of the exogenous shock probability is relevant only when $\delta > \underline{\delta}$. In the case of very impatient players, the game effectively becomes a one-period game as the proposer immediately initiates conflict following a rejection.

Remark 2: $\bar{\delta}$ decreases as p increases, and it lies within the interval $[\underline{\delta}, 1]$. A higher probability of the exogenous shock, denoted by p, leads the proposer to increasingly rely on that shock for lower values of the discount factor, δ.

3.2 Proposer negative payoff of conflict: $u_p \leq 0$

If the proposer's payoff from the conflict is zero or negative, it is not optimal for the proposer to initiate the conflict after a rejection. Instead, the equilibrium behavior takes on a *Brinkmanship* form. The proposer makes an offer, choosing not to start the conflict, but relies on the exogenous probability of conflict to persuade the responder to accept the offer. A crucial distinction from the case where $u_P > 0$ is that the proposer exposes themselves to risk by offering a nonzero amount. In the event of rejection, the proposer may face a loss.

Proposition 2 *In the only equilibrium, the proposer chooses $x^t = \tilde{p}u_R$ and $\theta^t = 0$ for all t, and the responder chooses $\beta^t = 1$ for all t.*

As shown in Proposition 2, the only equilibrium in this case is where the proposer relies on a probabilistic threat and offers the responder's continuation loss for rejecting the offer, which the responder accepts. The distinction between this result and Proposition 1 (when $\delta > \bar{\delta}$) is that, in this case, the equilibrium takes the form of *Brinkmanship*. The proposer deliberately assumes a risky position to gain bargaining power. If the responder rejects the offer, the proposer may incur a loss.

In contrast to the U-shaped accepted offer in Proposition 1, in this case, for a fixed p, the proposer benefits from being more patient, as illustrated in Figure 2.

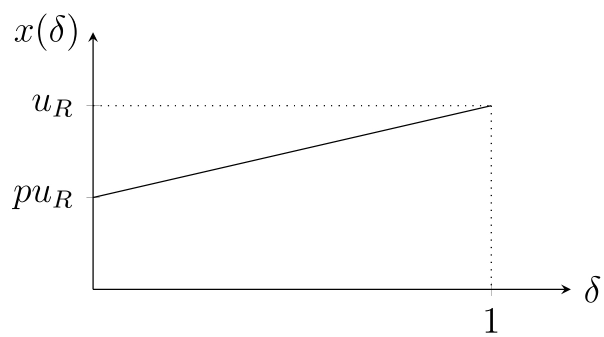

Figure 2: Accepted offer made by the proposer.

Remark 3: The proposer's payoff is not influenced by u_P for any δ. The crucial factor is the responder's loss if the proposer receives a negative payoff from the conflict.

Remark 4: If $p = 0$, the only equilibrium is where the proposer offers $x = 0$ and the responder accepts it. In the absence of the exogenous shock, the proposer cannot extract any welfare from the responder.

Remark 5: Schwarz and Sonin (2008) presented an alternative interpretation of the exogenous shock probability p. They argue that it represents the proposer dividing the one-time conflict into a sequence of smaller conflicts.

4 Discussion

This paper shows that when the proposer derives some benefit from initiating the conflict, albeit lower than the responder's loss, the optimal accepted offer exhibits a U-shaped pattern in relation to the discount factor.

In the introduction, we explore the application of adversarial bargaining to a scenario where a country possesses a territory with a valuable resource desired by another country. However, adversarial bargaining finds relevance in various contexts. In this section, we discuss two different applications.

1. Plea bargaining: In this context, a prosecutor seeks to maximize the assigned sentence to the defendant, while the defendant aims to minimize it. If the defendant is acquitted, she receives a payoff of zero, but the prosecutor incurs a negative reputational cost. Consequently, the defendant's expected loss exceeds the prosecutor's benefit from going to trial. The prosecutor and defendant engage in negotiations for a plea deal to avoid trial. At the end of each period, the prosecutor can choose to proceed with the trial or request a trial delay, with the judge granting the extension with probability $1-p$ and commencing the trial immediately with probability p.

2. Debt renegotiation: In this scenario, an entity faces the risk of default and aims to renegotiate its debts with a bank. At the end of each period, the entity may default with probability p, leading to bankruptcy and the sale of assets to pay only a portion of the debt, resulting in a loss for the bank. The entity presents a renegotiation offer at each period, and if the offer is not accepted, the entity decides whether to continue negotiations (with the risk of default) or proceed with filing for bankruptcy.

Appendices

A Proofs

A.1 Proposition 1

For $\delta < \underline{\delta}$. Consider $\beta(u_R, t+1) = 1$, then $V_p(t) = pu_P + (1-p)\delta u_R$. Then, after a rejection of the offer x^t at t the proposer's payoff of choosing $conflcit$ is $u_p > pu_P + (1-p)\delta u_R$, for $\delta < \frac{u_P}{u_R} \equiv \underline{\delta}$. That is, the highest continuation payoff the proposer can get is lower than starting the conflict. Therefore $\theta = 1$. At $t = 1$, for responder $V_R(t) = u_R$, therefore $\beta(u_R, t) = 1$. The proposer optimally chooses $x = u_R$.

For $\delta > \bar{\delta}$. Suppose stationary offers $x^t = x$ for all t. The proposer does not start the conflict after a rejection because $u_P < \delta \tilde{p} u_R$ for $\delta > \bar{\delta}$. The responder accepts the offer because $\tilde{p} u_R = V_R$, and the proposer offers $x = \tilde{p} u_R$ because it is equal to V_R. A lower offer is accepted by the responder but implies a lower proposer's payoff and a higher offer is rejected.

It cannot be an equilibrium in which the proposer starts the conflict. Suppose $\theta = 1$, then the optimal offer is $x = u_R$. If the responder rejects the offer, the proposer gets u_P by starting the conflict, but he gets $pu_P + (1-p)\delta u_R$ which is higher than u_P for $\delta \geq \underline{\delta}$.

It also cannot be an equilibrium in which the proposer is indifferent between starting the conflict and continuing the negotiation. In that case, the optimal offer is such that the responder is indifferent between accepting it or rejecting it; otherwise, the proposer can always increase the offer. In that case, $u_P = pu_P + (1-p)\delta V_P$, and $V_P = \beta x + (1-\beta) u_P$. The responder is indifferent between accepting and rejecting the offer, then $x = \theta u_R + (1-\theta)(pu_R + (1-p)\delta V_R)$, with $v_R = x$. Therefore:

$$\beta = \frac{(1-\delta)u_P}{\delta(x - u_P)} \quad \text{and} \quad \theta = \frac{x(1-\delta) - p(u_R - \delta x)}{(1-p)(u_R - \delta x)}.$$

Suppose the equilibrium offer is x^*. If $\beta < 1$, the proposer can always offer $x^* - \epsilon$, such that the responder accepts. That is always better for the proposer than the responder accepting with probability β. Therefore, the equilibrium is $\beta = 1$, which implies $x^* = \frac{u_p}{\delta}$. This implies $\theta^* = \frac{\frac{u_p}{\delta}(1-\delta) - p(u_R - u_P)}{(1-p)(u_R - u_P)}$, which is larger or equal than zero if

$$\frac{u_p}{\delta}(1-\delta) - p(u_R - u_P) \geq 0 \quad \Longleftrightarrow \quad \delta \leq \frac{u_P}{pu_R + (1-p)u_P} \equiv \bar{\delta},$$

which is not possible because $\delta > \bar{\delta}$.

Following the above arguments, the equilibrium is $\beta^* = 1$, $\theta^* = \frac{\frac{u_p}{\delta}(1-\delta) - p(u_R - u_P)}{(1-p)(u_R - u_P)}$, and

$x = \frac{u_P}{\delta}$. This is an equilibrium because following a rejection, the proposer has no incentives to deviate from $\theta = \theta^*$ as $u_P = V_P$. The responder does not deviate from accepting the offer x^* as $\frac{u_P}{\delta} = V_P$. Finally, the proposer does not offer $x < x^*$ because it is accepted and provides a lower payoff, and does not offer $x > x^*$ because it is rejected for sure and $\frac{u_P}{\delta} > \theta^* u_P + (1-\theta)(p u_P + (1-p) u_P) = u_P$.

It is not possible $u_P > V_P$ because $\delta > \underline{\delta}$ as shown above. It is also not possible $u_P < V_P$ because $u_P \geq \delta \tilde{p} u_R$ for $\delta \geq \bar{\delta}$.

A.2 Proposition 2

The proposer does not start the conflict because $u_P \leq 0 < V_P$. Therefore, following proposition 1, the only equilibrium is the proposer offers $\tilde{p} u_p$ and the responder accepts in every period.

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