An Experimental Study of Bargaining with Low or no Costs of Delay and Constant or Alternating Roles

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Abstract

In this paper we study the robustness of the deadline effect in bargaining games using constant and slowly decreasing pies, different time horizons, and both constant and alternating role modes. With decreasing pies efficiency requires early agreements while constant pies allow for efficient late agreements. Our results indicate that decreasing pies and alternating roles increase initial generosity and lead to earlier agreements. In addition, conflicts decrease with experience.

Keywords: Ultimatum game, Deadline effect, Conflict resolution, Decreasing pie

JEL classification: C70; C90; D74

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1 Introduction

Roth, Murnighan & Schoumaker (1988) study the distribution of bargaining agreements over time and find strong evidence of a "deadline effect", i.e. a striking concentration of agreements just before the deadline. They claim that this phenomenon is quite robust (in the sense that the distribution of agreements does not respond to changes in the bargaining environment as much as other features of the bargaining outcome do), but conclude that understanding why the deadline effect occurs "is likely to have practical implications about the design and conduct of negotiations, and may also shed further light on the causes of bargaining inefficiencies" (Roth et al. 1988, p. 822).

This paper reports on an experiment designed to explore the robustness of the deadline effect, and identify which features (if any) of the bargaining environment may prevent it. Thus, our study may offer institutional advice on how conflicts can be avoided and early agreements be effectuated. In particular, we concentrate on three issues that can account for bargaining inefficiencies and the occurrence of conflicts: the length of the bargaining horizon, the shrinking of the pie, and the procedural unfairness of having the same party propose continuously.

While Roth et al. attempt to test the Nash (1950, 1953)-bargaining solution and allow for free exchange of proposals in real time, we impose rigid rules specifying who makes a proposal and when the proposal is made. In other words, time deadlines are here discretized by allowing for a certain number of rounds. Many bargaining experiments exist (see Güth & Tietz 1990, and Roth 1995 for surveys). Few though have allowed for multiple rounds of bargaining. Yet, in several natural bargaining situations, parties have the opportunity to exchange more than just one offer before reaching a final decision. Furthermore, negotiations can take place more or less often. For instance, in private business life, parties usually meet quite often, whereas the more formal rituals of collective wage bargaining and negotiations involving public authorities allow usually for only a few meetings. In our study, we capture the potential relevance of different bargaining horizons by comparing agreements over 3 and 11 periods.

In addition to the horizon of negotiations, the monetary amount at stake may affect agreements. If the pie, i.e. the amount p_t to be distributed in round t, does not decrease over time, multiple rounds of negotiation do not matter. Game theoretically the predicted outcome is determined by the anticipated behavior in the very last round. Thus, non-decreasing pies in multi-round bargaining games (while not precluding early agreements) render earlier negotiation rounds cheap talk. Decreasing pies, on the other hand, capture the cost of delaying an agreement. For example, in collective wage bargaining, workers could be already on strike, implying tremendous losses for both sides. Most multi-period experiments assume rather high costs of delaying an agreement. We are more interested in multi period-negotiations with no or nearly no costs of delay.

By distinguishing between constant and slowly decreasing (10%-decrease of the pie from the first to the last round) pies we are able to explore whether deadline effects are robust to small costs of delay. Do deadline effects apply to the case of small delay costs? Or do parties strive for early conflict settlements when delay is costly? Since pies altogether shrink by 10%, the delay costs per negotiation round are rather small in 11-round games and rather high in 3-round games. Thus, implicitly, the horizon length co-determines the delay costs per negotiation round. In our view, this confounding effect is not troublesome since both the long and the short horizons are also studied for the case of no delay costs.

In addition to the bargaining horizon and the pie amount, the procedural fairness of the proposer-mode may affect the occurrence of late agreements. We capture procedural fairness by distinguishing between constant-proposer games and alternating-proposer games. In the former, proposer (and responder) roles are maintained throughout bargaining; in the latter, roles change after an offer has been rejected. Institutional mechanisms favoring one party at the expense of others are often considered unacceptable and therefore may rarely be implemented. Constant roles and no or small costs of delay definitely favor the constantly proposing party and are not regarded as procedurally fair.[1] Procedural fairness refers to the individuals' perception that a particular activity in which they are involved is conducted fairly. Unfair procedures are assumed to trigger negative feelings leading, for instance, to impede or delay an agreement. Alternating roles like in Stahl (1972), Krelle (1991), and Rubinstein (1982) do not completely prevent the occurrence of procedural unfairness, but reduce it considerably.

Our data show that small (positive) costs of delay and alternating roles crowd out late concessions in bargaining, i.e. help avoiding the deadline effect. Hence, time pressure and role alternation can be deemed as means of avoiding or at least reducing the likelihood of conflicts. An easy way to implement institutionally small costs of delay would be, for instance, a small break off-probability, i.e. in earlier rounds the next round is not reached with certainty but only with a certain probability.

In Section 2 we explain the experimental design and specify our behavioral expectations. The experimental results are described and analyzed in Section 3. Section 4 concludes.

[1]See Lind & Tyler (1988) for the notion (and evidence) of procedural fairness.

2 The experiment

2.1 Subjects

The computerized experiment was conducted at the Humboldt-University of Berlin using the software Z-Tree (Fischbacher 1999). Participants, mainly students of business administration and economics, were all volunteers recruited by mail-shot invitations. Overall, we run 6 sessions: 3 employed the constant role treatment and 3 the alternating role treatment. Each session involved 12 participants who could be matched into 6 pairs. A session needed about two hours. The average earning per subject was €10.75, ranging from a minimum of €5 to a maximum of €14. The standard deviation of the individual earnings was €3.89.

2.2 Experimental design and procedures

Our experiment is based on a $2 \times 2 \times 2$-factorial design. The first factor refers to the pie dynamics (constant vs. decreasing pies), the second to the bargaining horizon (3 vs. 11 rounds), and the third to the role assignment (constant vs. alternating roles). The first two treatments are within-subjects factors, whereas the last treatment is a between-subjects factor. Thus, our subjects bargain for constant *and* decreasing pies as well as over 3 *and* 11 rounds with either constant or alternating roles.

Let p_t denote the monetary amount to be distributed in round t with $t = 1, ..., T$ where $T \in \{3, 11\}$ is the final round for reaching an agreement. If p_t is constant, we refer to the two games with $T = 3$ and $T = 11$ as C(3) and C(11), respectively. If p_t is decreasing, we refer to them as D(3) and D(11). This same notation was used in the general part of the instructions, common to both treatments (see Appendix A).

Constant pie means $p_t = 100$ for $t = 1, 2, 3$ in C(3), and for $t = 1, ..., 11$ in C(11). With decreasing pies, p_t varies over time as follows:

- In D(3), one has $p_1 = 110$, $p_2 = 105$ and $p_3 = 100$;
- In D(11), one has $p_1 = 110$ and $p_t - p_{t+1} = 1$ for $t = 1, ..., 10$, so that $p_{11} = 100$.

In the constant role treatment (see Appendix A.1 for specific instructions), the two parties X and Y bargain in each round t by player X making an offer θ_t (with $0 \leq \theta_t \leq p_t$), which then Y can either accept or reject. If Y accepts the offer, an agreement is reached with X earning $p_t - \theta_t$ and Y earning the offered amount θ_t. If Y rejects and $t < T$, bargaining continues with round $t + 1$. If Y rejects and $t = T$, conflict results with 0-payoffs for both.

In the alternating role treatment (see Appendix A.2 for specific instructions), player X makes a proposal in odd rounds and player Y in even rounds. The other party plays the role of the responder who either accepts or rejects the offer.

The instructions informed participants about the four games C(3), C(11), D(3), and D(11) of multiple-round bargaining. First, participants were arbitrarily assigned to X- or Y-role and kept their role over the entire experiment. After that, they played C(3) twice, each time with a different partner. Then, in the same way, they played C(11), D(3), and D(11) where between games partners were randomly matched.[2] This cycle of $8 = 2 \times 4$ successive bargaining games was once repeated (see Figure 1). Thus in total a participant experienced each of the four games four times.

Insert Figure 1 about here.

[2]A complete analysis of all $4! = 24$ possible orders of C(3), C(11), D(3), and D(11) would have been clearly impracticable. So we simply ordered games according to their complexity, by starting with the easiest one (namely the constant pie-short horizon game).

In the case of C(3) and C(11) as well as of D(3) and D(11) under the constant role mode the game theoretic solution prescribes:

$\theta_t^* = 0$ for the agreement round $t \in \{1, ..., T\}$ with X being the proposer.

When Y will accept such an offer is less obvious. If Y expects X to behave optimally, (s)he will accept all positive offers, whereas in case of 0-offers now and in the future Y is indifferent between accepting and rejecting them. By offering a small positive amount at least once, proposer X can avoid hoping for Y's acceptance in case of indifference. Thus, in spite of multiple rounds, the predicted outcome with no costs of delay and with constant roles is similar to that in the usual ultimatum game.[3]

When D(3) and D(11) are played with alternating roles, the continuous case (in the sense of $0 \leq \theta_t \leq p_t$) implies the solution play:

$\theta_1^* = 5$ and acceptance of X's initial offer by Y.

The claim can be proved by backward induction. Consider D(3) with alternating roles. Since $\theta_3^* = 0$, Y has to offer at least 100 to X in round 2, i.e. $\theta_2^* = 100$, what leaves 5 for Y. Hence, X has to offer $\theta_1^* = 5$ to induce an early agreement. In the same way one proves the claim in case of D(11).

Previous ultimatum experiments have, however, demonstrated that "buying" the responder's acceptance (and now even an early acceptance) is usually not inexpensive. Thus, behaviorally we expect more balanced payoffs than those predicted by game theory. Especially, X should try to induce an early and efficient agreement (by a more generous offer θ_1) in the case of decreasing pie-games. Furthermore, agreements should be reached earlier in D(3), when the pie shrinks quicker, than in D(11).

Although the asymmetry of roles sustains, alternating role-games appear pro-

[3]See, for instance, Güth, Schmittberger & Schwarze (1982).

cedurally fairer than constant role-games, since both parties (the X- and Y-participant) play both roles (the role of proposer and that of responder). In constant pie-games this is just a frame, since all what matters game theoretically is who is last in proposing. Nevertheless we expect that alternating roles provoke stronger fairness considerations and more early conceding than constant roles, especially in decreasing pie-games but also to some degree in constant pie-games.

3 Results

Let us start by describing the main effects. Tables 1 (Table 1a concentrates on 3-round games and Table 1b on 11-round games) list for all rounds and for each of the four repetitions of the games (columns I to IV):

(i) the frequency F of agreements (1st column),

(ii) the mean accepted offers M and their standard deviations SD (2nd and 3rd column),

(iii) the median MD of accepted offers (4th column),

(iv) the frequency, mean, standard deviation and median of final rejected offers (last row, i.e. the c-row).

In each table, this is done separately for constant and decreasing pies as well as for constant and alternating roles.

Insert Tables 1a and 1b about here.

The nearly universal tendency is described by:

Observation 1 *Later agreements rely on less generous offers than early accepted offers. Nevertheless later agreements are still far more generous than predicted by game theory.*

Aggregating over sessions and repetitions of the games with equal number of rounds, the average accepted offers in 3-round games are 41.81 in $T = 3$ versus 47.35 in $t = 1, 2$. Similarly, in 11-round games, the average accepted offers are 41.92 for $T = 11$ versus 47.95 in $t = 1, ..., 5$ and 47.05 in $t = 6, ..., 10$.[4] These averages indicate that later agreements rely on concessions by Y-participants.

In usual one-round ultimatum experiments, the average offered share is close to 40% although the mode is mostly to share equally. X-participants who are more generous early could be those who would share equally in ultimatum experiments, whereas those who concede lately could be those who would try to moderately exploit ultimatum power. Most early rejections in the current study refer to offers which are far less generous than traditionally observed. Thus, later concessions could be perceived as munificent by the responders in comparison to an early reference point and therefore be more likely to be accepted. In this sense, repeated interaction (in the sense of earlier rounds) can be seen as an anchoring cheap-talk allowing for (moderate) exploitation over time. We will come back to this issue later on when investigating in more details the deadline effect.

Whereas in constant pie-games inefficiency is solely due to conflict, decreasing pie-games allow for another inefficiency, namely by late agreements. Our next result provides information on whether decreasing pies induce X-participants to make higher initial offers.

Observation 2 *Initial offers are significantly higher in decreasing pie-games than in constant pie-games.*

In D(.)-games the median relative first offer is 0.45 versus 0.4 in C(.)-games. A

[4]According to backward induction based on maximization of own monetary payoffs, in constant pie- and constant role-games, B should get a 0-share. In alternating role-games, the initial solution offer is $\theta_1^* = 5$. Neither the accepted nor the rejected average offers are in any way close to the theoretical solutions.

non-parametric Wilcoxon signed-rank test shows that this difference in initial offers is statistically significant ($z = 2.20$, $p < .05$). Thus, X-participants are inclined to offer more initially when delay is costly than when there are no costs of delay. A consequence of this early conceding is that:

Observation 3 *The percentage of late agreements (that is, agreements in the last bargaining round) is lower for decreasing pies than for constant pies.*

Support for this observation comes from Table 2, which reports the frequency and percentage of last period agreements (as well as the total numbers of conflicts and agreements reached) for all eight game types of the experiment. The table reveals that the percentage of late agreements is lower for decreasing pie-games as compared to constant pie-games ($\chi^2 = 36.00$, $p < .001$; mean-rank$_{\text{const-pie}}$ = 1.56, mean-rank$_{\text{decreas-pie}}$ = 1.44). Subjects seem to be worried about the welfare loss generated by the reduction of the pie and are thus reluctant to postpone agreements. This behavioral tendency is even more pronounced for the short bargaining horizon (3-round games). Here, late agreements are reached in 22.13% of the cases involving a decreasing pie, whereas in cases of constant pie the percentage of late agreements amounts to 44.09%. With respect to the long bargaining horizon (11-round games) late agreements are reached in 25.98% of the cases involving a decreasing pie as compared to 32.26% of the cases involving a constant pie. Our conjecture is that this discrepancy is due to the quicker shrinking of the pie in the short bargaining horizon.

<u>Insert Table 2 about here.</u>

Next, we compare the constant role-treatment with the alternating role-treatment. Remember that game theoretically alternating roles only matter (and then only just a tiny bit) in decreasing pie-games. In contrast to this prediction, we report the following observation:

Observation 4 *Alternating roles promotes in general more agreements than constant roles whatever game we consider.*

Overall, 264 agreements were reached out of a total of 288 negotiations in the alternating role-treatment, whereas 236 agreements out of 288 negotiations were reached in the constant role-treatment ($\chi^2 = 28.00$, $p < .001$; mean-rank$_{\text{const-role}}$ = 1.45, mean-rank$_{\text{alternat-role}}$ = 1.54). In addition, these agreements are reached earlier with alternating roles than with constant roles as testified by:

Observation 5 *The percentage of late agreements is lower for the alternating role-treatment than for the constant role-treatment.*

Evidence for Observations 4 and 5 is provided by Tables 2 and 3. According to Table 3, the average conflict ratio (i.e., relative number of plays with no agreement) is substantially lower for alternating than for constant roles ($\chi^2 = 28.00$, $p < .001$; mean-rank$_{\text{const-role}}$ = 1.45, mean-rank$_{\text{alternat-role}}$ = 1.54).[5] According to Table 2, participants who were assigned to the alternating role-treatment reveal a lower percentage of late agreements than participants in the constant role-treatment ($\chi^2 = 46.00$, $p < .001$; mean-rank$_{\text{const-role}}$ = 1.57, mean-rank$_{\text{alternat-role}}$ = 1.43).

Insert Table 3 about here.

These results are robust with respect to bargaining horizons (3 vs. 11 rounds) as well as to pie dynamics (constant vs. decreasing pie).

[5] For the sake of exposition, Table 3 aggregates all data from the same bargaining game without distinguishing whether it was played at the beginning or in later rounds. Nevertheless every statistical analysis of the pooled data was also conducted separately for each repetition of a specific game without ever revealing substantial differences.

Hence, although with constant pies the alternation in roles seems just a frame, subjects behave differently according to the treatment they are assigned to. This behavioral dissimilarity could be due to the fact that, when roles alternate, bargaining power is perceived as more balanced or the feelings of responders confronting an unfair offer are better understood. These arguments appeal to the intuition how boundedly rational participants compare alternating and constant role-games. They are supported by the following behavioral observation:

Observation 6 *In the alternating role-treatment rejected initial offers trigger higher successive offers than in the corresponding constant role-treatment.*

Figures 2 to 5 illustrate that, regardless of pie dynamics, in the alternating role-treatment Y-participants who rejected offers θ_t submit substantially higher offers θ_{t+1} (which are nevertheless frequently turned down) than those submitted by X-participants in the constant role-treatment (Mann-Whitney test, $z = 9.10$, $p < .001$). For the short bargaining horizon, the median offer of proposers in the alternating role-treatment after initial rejection is 50 compared to a median offer of 36.10 in the constant role-treatment. Similar results hold for the long bargaining horizon. Here, the median offer of the (X-) Y-participants over all even periods of the (constant) alternating role-treatment is (35) 49.77.[6] Y-participants seem to consider X-participants as more powerful when they are constantly proposing. Still when confronting a rather unfair offer responders tend to reject it.

<u>Insert Figures 2 to 5 about here.</u>

One reason why we let players bargain for constant and decreasing pies as well as over different length horizons in different role assignments was that we

[6] All the summary statistics are normalized by the pie-size.

wanted to explore whether deadline effects are robust to (small) costs of delay and alternation in roles. In this regard we observe:

Observation 7 *Concessions in the last round are generally observable throughout the experimental conditions, however they are less frequent in cases of decreasing pies and alternating bargaining roles.*

To test for concession making in our experiment, we compare the offers by X-participants in round T with their earlier offers. Conceding means that later offers exceed the earlier ones. Denote by $\underline{\theta}_T$ the mean offers in the final period and by $\underline{\theta}^X_{t<T}$ the mean earlier rejected offers by the same X-participants.[7] Table 4 lists these two variables and reports their difference for each of the four repetitions of the 8 game types of the experiment.

Insert Table 4 about here.

The general tendency is that $\underline{\theta}_T$ exceeds $\underline{\theta}^X_{t<T}$. Nevertheless, while in the constant role-treatment (except for the first 2 repetitions of C(3)) the difference between $\underline{\theta}_T$ and $\underline{\theta}^X_{t<T}$ is larger than 5%, this does not generally apply to the alternating role-treatment, especially with decreasing pies. From Table 4 one can see that, when participants bargain over a decreasing pie and alternate their role, the mean offers in the last period are either smaller than the mean offers in the previous periods or about 1% higher. Non-parametric Wilcoxon signed ranks tests conducted for each repetition of all 8 games with individual data as observations reveal that the difference between $\underline{\theta}_T$ and $\underline{\theta}^X_{t<T}$ is significant ($p < .05$):

(i) for each of the 4 repetitions of C(11) and D(11) under the constant role-treatment,

[7] One may object that this does not control for last offers θ_T which are still too low to be acceptable. Even when one restricts attention to accepted last offers, late conceding can be validated, i.e. the average accepted offers exceed the mean earlier offers by the same X-participants.

(ii) for the last three repetitions of C(3) in the constant role-treatment, and of C(11) in the alternating role-treatment,

(iii) for the third repetition of C(3) in the alternate role-treatment, and

(iv) for the second repetition of D(3) in the constant role-treatment.

Thus, in case of decreasing pies and alternating roles, offers in the last period are not significantly different from offers in the t ($< T$) previous periods. In addition, the probability that offers are accepted increases from the earlier periods to the final period: According to Table 4, the probability $p(\underline{\theta}_T)$ that an offer is accepted in the final period exceeds the acceptance probability $p(\underline{\theta}^X_{t<T})$ of the previously submitted offers. This finding indicates that participants increased their offers in the final period strategically, and thereby engaged in late concessions, confirming our previous discussion related to Observation 1.

Last, we look at the dynamics over time in order to observe whether experience, in the sense of playing successively multi-period bargaining games, affects behavior. The data support the following result.

Observation 8 *The number of conflicts decreases with experience only over the four 11-round games.*

As indicated in Tables 1 and more clearly in Table 2 (c-rows), the number of conflicts decreases over the four repetitions of the long bargaining horizon. If one pools the number of conflicts over the four games (i.e., constant and decreasing pie-games, constant and alternating role-games) separately for the 3-round games and the 11-round games, one finds completely different patterns ($\chi^2 = 8.00$, $p < .01$; mean-rank$_{\text{long-horizon}} = 1.39$, mean-rank$_{\text{short-horizon}} = 1.43$): With respect to the long bargaining horizon, overall 14 conflicts occurred in the first repetition, 9 in the second and in the third, and only 5 in the fourth repetition. With respect to the short bargaining horizon, 11 conflicts were registered in the first repetition, 10 in the second, 8 in the third, and 10 in the last repetition. These findings suggest that the likelihood of conflicts decreases only over the long bargaining horizon but not over the short one.

Over the short horizon parties seem to make their point quickly and thus either they reach an agreement or they do not. The long horizon, on the contrary, seems to provoke more strategic considerations (like early obstinacy and late concessions) whose relative success can only be learned when such games are played repeatedly. Learning could therefore be more important for long than for short horizon games.

4 Conclusions

In this paper we report the findings of an experimental study on the by Roth et al. (1988) alleged robustness of the deadline effect in bargaining games. We investigate the occurrence of late concessions by varying the length of the bargaining horizon (3 vs. 11 rounds), the pie dynamics (constant vs. decreasing pies), and the procedural fairness of the allocation mechanism (constant vs. alternating roles).

Institutional advice aimed at reducing bargaining inefficiencies (in the form of conflicts or late agreements) may be based on comparisons of the game-theoretic solution outcome of the various games under consideration. For the case at hand, these comparisons are not very informative as all solution outcomes are quite similar. Thus, from a theoretic point of view, no institutional advice can be provided.

However, our experimental data show drastic discrepancies in the (observed) outcomes of the different bargaining games. Hence, our findings allow for institutional advice and cast doubt on the reliability of (mere) theoretical studies of mechanism design. Specifically, we derive the following three institutional recommendations. First, decreasing pies and alternating roles provoke more initial generosity and earlier agreements than constant pies and constant roles. Second, conflicts decrease with experience. Third, late serious concessions, while still observable, occur less often when pies decrease and roles alternate. Therefore, our results indicate that a short bargaining horizon with decreasing pies and alternating roles constitutes the most promising bargaining mechanism.

Decreasing pies could simply reflect the impatience of both proposers and responders. If this does not suffice, small break off-probabilities after each round could serve the same purpose. Thus, decreasing pies are both quite realistic and easily implemented.

Alternating roles have been previously viewed as highly realistic. But the game-theoretic solution of models with role alternation predicts an immediate agreement.[8] Hence, why should parties alternate and how could they implement this switching of roles? If both sides possess commitment power, why should they rely on it in an alternating fashion? A rigorous implementation of alternation as a strict rule seems to require a third party, e.g. an arbitrator, to whom both parties assign the authority to enforce role alternation. Institutions that could assume the part of the third party are ombudsmen in various forms, notaries, superiors or public authorities. Actually, such institutions might also rely on the intuitive idea that role alternation is procedurally more fair.

[8] A pioneering game theoretic study allowing for conflict and/or late agreements is Harsanyi & Selten (1972) who study bargaining under incomplete information and signaling in a negotiation context.

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Appendix A: General instructions

In this experiment, two participants at a time will interact with each other over a sequence of rounds. Thereby, each participant will be confronted with different situations in which (s)he is negotiating with changing partners. The negotiations will extend over 3 or 11 negotiating rounds, and the amount to be distributed between participants is constant in case of situation C(t) and diminishing in case of situation D(t).

In case of situation D(t), the amounts that can be distributed are:

- 110 in the first round, 105 in the second round and 100 in the third round if $t = 3$;
- 110 in the first round, the amount of the previous round minus 1 in each of the subsequent rounds if $t = 11$.

The four different situations are thus:

C(3): In negotiations of at most three rounds, partners can distribute a constant amount of 100.

C(11): In negotiations of at most eleven rounds, partners can distribute a constant amount of 100.

D(3): In negotiations of at most three rounds, partners can distribute 110 in the first round, 105 in the second round, and 100 in the third round.

D(11): In negotiations of at most eleven rounds, partners can distribute 110, 109, 108, 107, 106, 105, 104, 103, 102, 101, 100 in the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th 9th, 10th, 11th round, respectively.

It remains to explain how the two partners can negotiate about the distribution of the amount in each round.

Appendix A.1: Specific instructions for constant roles

How can the two partners negotiate about the distribution of the amount B_t in round t?

In each round, participant P (P stands for proposer) proposes to the other participant R (because R responds) a part A of B_t with $0 \leq A \leq B_t$. This means that P claims the residual amount $B_t - A$ for him/herself.

- If R accepts the proposal, they have agreed: R obtains A and P obtains $B_t - A$.
- If R rejects the proposal, the next round starts in which the amount B_{t+1} must be distributed.
- If R rejects the proposal and it is the last round, both R and P obtain 0.

In the experiment, the roles P and R are assigned randomly. Your role will be told you at the beginning of the experiment and you will keep it throughout.

You will start with situation C(3) which you will experience twice, each time with a different partner. In the same way, you will then confront situations C(11), D(3) and D(11) in that order, where your partner will randomly change after each round.

This cycle of $8 = 2 \times 4$ rounds will be once repeated, i.e. you will once again interact in C(3), C(11), D(3) and D(11) with a different partner in each different round.

Appendix A.2: Specific instructions for alternating roles

How can the two partners negotiate about the distribution of the amount B_t in round t?

In odd rounds (i.e. $t = 1, 3$ in case of C(3) and D(3), and $t = 1, 3, 5, 7, 9, 11$ in case of C(11) and D(11)), participant O (O stands for odd) proposes to the other participant E (E for even) a part A of B_t with $0 \leq A \leq B_t$. This means that O claims the residual amount $B_t - A$ for him/herself.

In even rounds (i.e. $t = 2$ in case of C(3) and D(3), and $t = 2, 4, 6, 8, 10$ in case of C(11) and D(11)), the roles are reversed: Participant E proposes to O a part A of B_t with $0 \leq A \leq B_t$ and claims the residual amount $B_t - A$ for him/herself.

- If E accepts the proposal A of O in case of odd rounds, or O accepts the proposal A of E in case of even rounds, they have agreed: the accepting responder obtains A and the proposer obtains $B_t - A$.
- If the proposal A is rejected, the next round starts in which the amount B_{t+1} must be distributed between the two partners with reversed roles.
- If the proposal A is rejected and it is the last round, both O and E obtain 0.

In the experiment, the roles O and E are assigned randomly. Your role will be told you at the beginning of the experiment and you will keep it throughout.

You will start with situation C(3) which you will experience twice, each time with a different partner. In the same way, you will then confront situations C(11), D(3) and D(11) in that order, where your partner will randomly change after each round.

This cycle of $8 = 2 \times 4$ rounds will be once repeated, i.e. you will once again interact in C(3), C(11), D(3) and D(11) with a different partner in each different round.

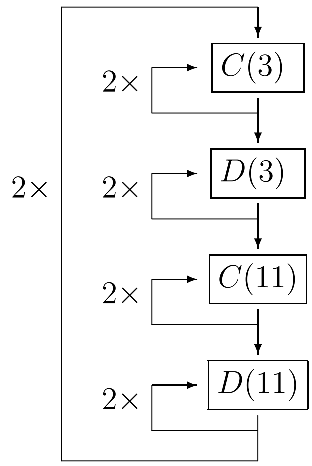

Figure 1: Sequence of events in the experiment.

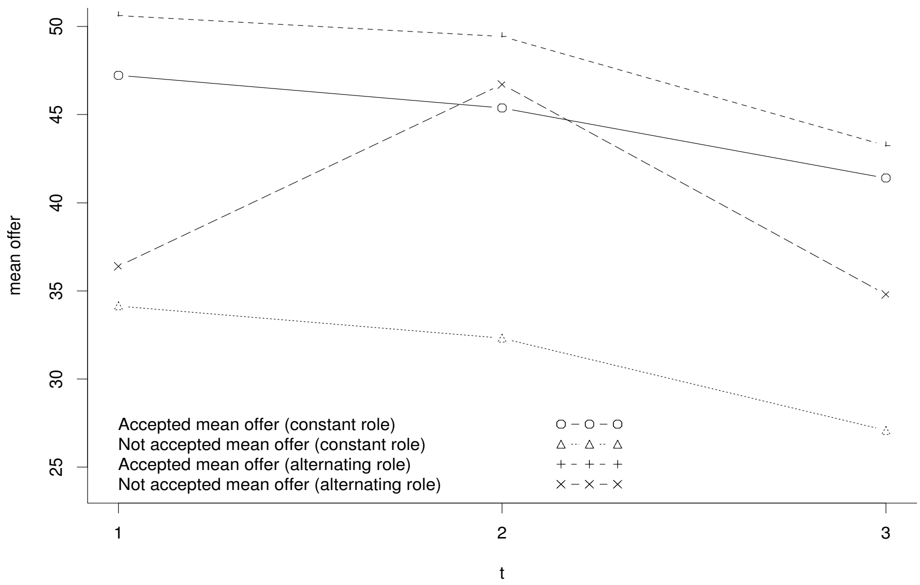

Figure 2: Average accepted and not accepted offers across the 3 periods of C(3) with respect to constant and alternating roles.

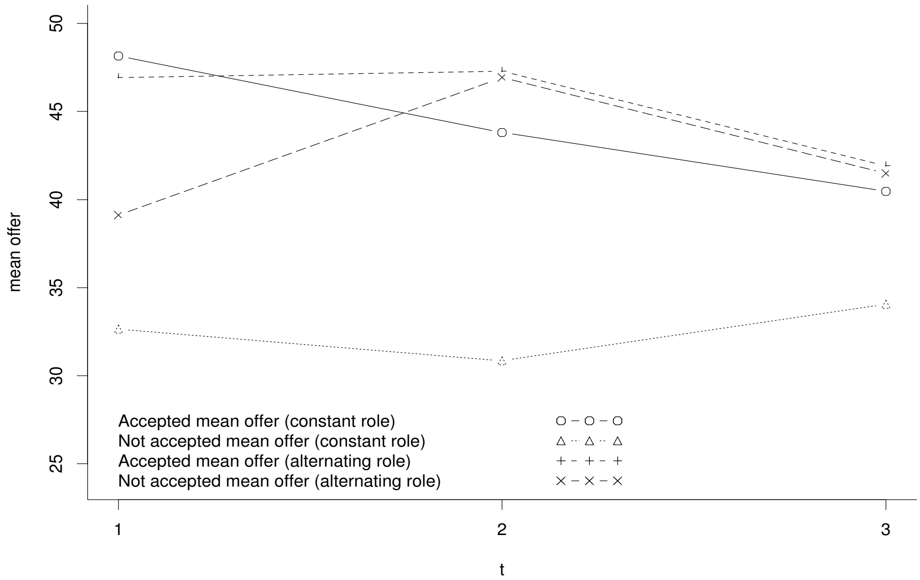

Figure 3: Average accepted and not accepted offers across the 3 periods of D(3) with respect to constant and alternating roles.

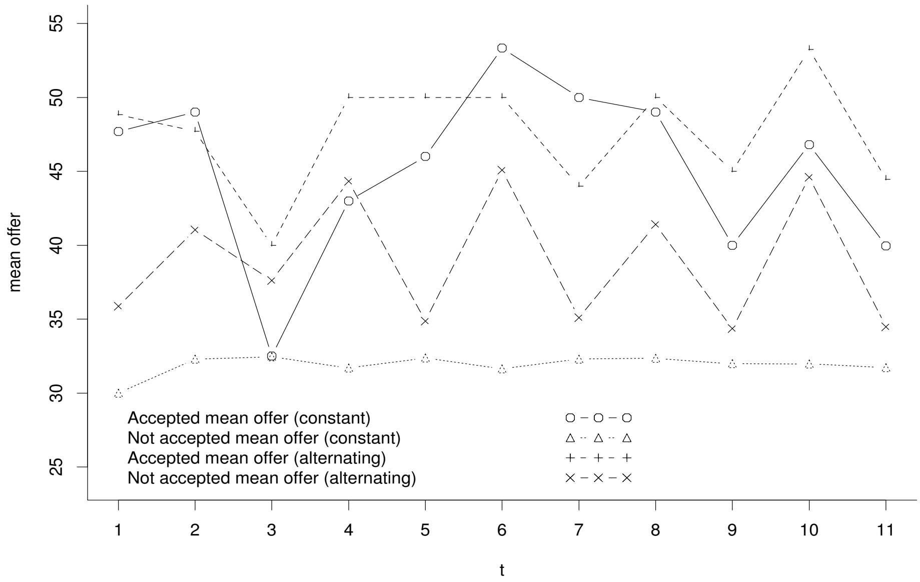

Figure 4: Average accepted and not accepted offers across the 11 periods of C(11) with respect to constant and alternating roles.

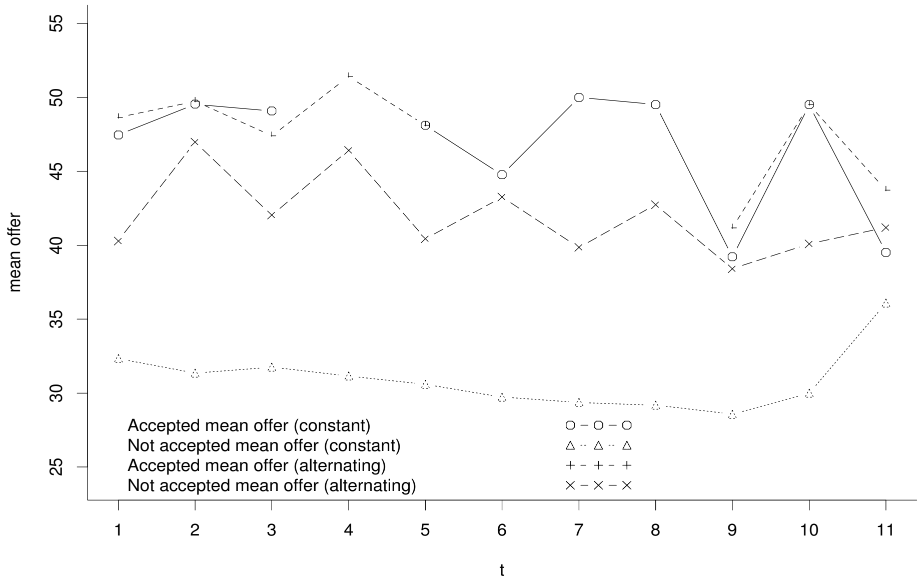

Figure 5: Average accepted and not accepted offers across the 11 periods of D(11) with respect to constant and alternating roles.

Table 1a: Frequency of agreements and percentage of mean relative accepted offers with respect to constant and decreasing pies as well as to constant and alternating roles for the short time horizon.

		C(3)															
Role		I				II				III				IV			
Const.	t	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD
	1	7	46.4	4.8	50	3	41.7	14.4	50	3	49	6.6	50	4	49.8	4.1	49.5
	2	3	46	9.5	50	4	45	4.1	45	0	–	–	–	1	45	–	45
	3	5	41.4	6.2	40	8	38.4	7.6	42	13	41.8	5.2	40	9	43.6	3.8	40
	c	3	18.7	17	20	3	23	23.6	20	2	35	7.1	35	4	32.5	11.9	37.5
Altern.	1	9	54	17.5	50	6	49.5	8.8	52	8	48.6	5.8	49.5	5	49	1.4	50
	2	7	48.6	4.8	50	5	48	4.5	50	1	50	–	–	5	52	2.1	52
	3	1	35	–	–	6	42.3	5.0	43	7	46.3	3.3	46	7	42.1	2.2	41
	c	1	33	–	–	1	20	–	–	2	40	2.8	40	1	41	–	–

		D(3) *															
Role		I				II				III				IV			
Const.	t	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD
	1	6	51	2.2	50	10	47.9	11.6	49	7	47.9	5.4	50	8	47.1	4.2	46
	2	3	41.3	8.6	43	0	–	–	–	3	47	3.5	49	2	43.5	2.1	43.5
	3	3	43.3	4.2	42	4	38.8	2.5	40	5	39.6	3.7	40	5	41	5.1	40
	c	6	34.3	5.8	32.5	4	32.5	7.1	31.5	3	40	–	–	3	34.3	5.1	33
Altern.	1	9	47.3	2.2	45.5	10	47.1	4.4	45.9	9	46.5	2.8	45.5	10	47.1	2.7	48.0
	2	5	48.6	3.2	49.5	3	49.8	5.6	49.5	6	43.6	16.7	49.8	2	51.4	1.4	51.4
	3	3	42.5	3.5	42.5	3	45.9	5.6	42	2	42.5	3.5	42.5	4	42	2.5	41.5
	c	1	35	–	–	2	39.5	1	39	1	45	–	–	2	45	–	45

* *Note*: Mean, standard deviation and median are based on relative accepted offers normalized by the pie-size.

Table 1b: Frequency of agreements and percentage of mean relative accepted offers with respect to constant and decreasing pies as well as to constant and alternating roles for the long time horizon.

		C(11)																D(11) *															
Role		I				II				III				IV				I				II				III				IV			
Const.	t	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD	F	M	SD	MD
	1	2	44	8.49	44	2	42.5	10.6	42.5	4	49.8	4.1	49.5	5	49.6	3.6	49	5	47.6	6.8	55	8	46.0	6.7	52.5	8	48.1	4.1	54	8	48.2	3.2	51
	2	0	–	–	–	0	–	–	–	0	–	–	–	1	49	–	–	1	50	–	–	1	50	–	–	0	–	–	–	0	–	–	–
	3	0	–	–	–	2	32.5	0.7	32.5	0	–	–	–	0	–	–	–	0	–	–	–	1	49	–	–	0	–	–	–	0	–	–	–
	4	4	43	0.71	48.5	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	5	0	–	–	–	0	–	–	–	1	46	–	–	0	–	–	–	1	48	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	6	0	–	–	–	2	57.5	17.7	57.5	0	–	–	–	1	45	–	–	0	–	–	–	0	–	–	–	1	45	–	–	0	–	–	–
	7	1	50	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	1	50	–	–
	8	0	–	–	–	2	49	1.4	49	0	–	–	–	0	–	–	–	1	49.5	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	9	1	40	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	1	39	–	–
	10	1	50	–	–	1	40	–	–	2	47	4.2	47	1	50	–	–	1	49.5	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	11	6	39	11.4	50	6	39.7	7.4	40	8	39.3	4.7	40	7	42	3.2	40	5	37.6	6	40	5	38	4.5	40	6	40.5	4.18	40	6	41.3	4.5	40
	c	3	26.5	17.8	31.5	3	31.7	7.6	30	3	36	6.9	40	3	33.8	6.9	34.5	4	34.8	6.9	37	3	36.7	4.7	35	3	36.3	10	40	2	37.5	3.5	37.5
Altern.	1	2	52.5	3.5	52.5	3	50	–	–	5	47.6	4.3	50	5	47.9	4.8	50	6	48	2.1	48.6	6	48.6	1.8	49.3	9	49.4	5.7	48.2	10	48.4	2.8	48.2
	2	5	51	2.2	50	5	48.2	4.6	50	3	37	23.4	50	4	51	2.7	50	5	49.9	0.5	49.5	4	48.9	2.0	49.5	3	48.6	2.4	49.5	4	51.3	1.9	50.4
	3	1	40	–	–	0	–	–	–	0	–	–	–	1	40	–	–	1	50	–	–	3	46	4.2	46.3	1	49.1	–	–	0	–	–	–
	4	0	–	–	–	1	50	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	1	51.4	–	–
	5	2	50	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	1	48.1	–	–	0	–	–	–
	6	1	50	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	7	0	–	–	–	2	46	5.7	46	1	40	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	8	0	–	–	–	0	–	–	–	0	–	–	–	1	50	–	–	0	–	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	9	2	48.5	2.1	48.5	1	33	–	–	1	49	–	–	1	46	–	–	1	41.2	–	–	0	–	–	–	0	–	–	–	0	–	–	–
	10	0	–	–	–	1	51	–	–	2	55	2.8	55	1	52	–	–	0	–	–	–	0	–	–	–	0	–	–	–	1	49.5	–	–
	11	1	45	–	–	3	42.7	6.8	45	4	45	3.6	46	5	45	3.5	45	2	45	–	–	4	44.8	0.5	45	3	47.1	2.9	40	2	43.5	5.0	43.5
	c	4	31.23	12.2	32	2	40	–	–	2	37.5	5.0	37.5	0	–	–	–	3	40	5	40	1	42	–	–	1	44	–	–	0	–	–	–

[*] *Note*: Mean, standard deviation and median are based on relative accepted offers normalized by the pie-size.

Table 2: Frequency and percentage of last period agreements, total number of agreements and conflicts for constant and decreasing pies, short and long bargaining horizons, and constant and alternating roles.

		Constant roles					Alternating roles				
Game		I	II	III	IV	Sum	I	II	III	IV	Sum
C(3)	F	5	8	13	9	35	1	6	7	7	21
	%	33.33	53.33	81.25	64.29	58.33	5.89	35.29	43.75	41.18	31.34
	a	15	15	16	14	60	17	17	16	17	67
	c	3	3	2	4	12	1	1	2	1	5
D(3)	F	3	4	5	5	17	3	3	2	4	10
	%	25	28.57	33.33	33.33	30.36	17.65	18.75	11.76	25	15.15
	a	12	14	15	15	56	17	16	17	16	66
	c	6	4	3	3	16	1	2	1	2	6
C(11)	F	6	6	8	7	27	1	3	4	5	13
	%	40	40	53.33	46.67	45	7.14	18.75	25	27.78	20.31
	a	15	15	15	15	60	14	16	16	18	64
	c	3	3	3	3	12	4	2	2	0	8
D(11)	F	5	5	6	6	22	2	4	3	2	11
	%	35.71	33.33	40	37.5	36.67	13.33	23.53	17.65	11.11	16.42
	a	14	15	15	16	60	15	17	17	18	67
	c	4	3	3	2	12	3	1	1	0	5

Note: a denotes the total number of agreements reached, and c the total number of conflicts.

Table 3: Average conflict ratio, relative average sum of X's earnings, Y's average offered pie-share in case of agreement, and Y's average offered pie-share in case of rejection.

	C(3)			C(11)			Both			D(3)			D(11)			Both		
	Const. roles	Altern. roles	Both	Const. roles	Altern. roles	Both	Const. roles	Altern. roles	Both	Const. roles	Altern. roles	Both	Const. roles	Altern. roles	Both	Const. roles	Altern. roles	Both
c_r	0.15	0.07	0.11	0.19	0.11	0.15	0.17	0.11	0.14	0.19	0.07	0.13	0.17	0.07	0.12	0.18	0.07	0.13
e	0.56	0.52	0.54	0.56	0.53	0.54	0.56	0.52	0.54	0.55	0.54	0.54	0.55	0.52	0.54	0.55	0.53	0.54
s_+	43.57	47.98	45.90	43.61	47.37	45.52	43.59	47.69	45.71	45.15	45.99	45.59	44.57	47.94	46.33	44.85	46.99	45.97
s_-	32.49	39.82	35.45	32.03	39.47	34.78	32.11	39.54	34.89	32.24	41.64	35.88	30.58	42.06	34.64	30.89	41.97	34.88

Note: c_r denotes the average conflict ratio (relative number of plays with no agreement), e denotes the average sum of X's earnings divided by p_1, s_+ denotes Y's average offered share in case of agreement, and s_- denotes Y's average offered share in case of rejection.

Table 4: Mean offers in the last period, T, and in all $T-1$ previous periods for constant and decreasing pies, short and long bargaining horizons, and constant and alternating roles.

		Constant roles				Alternating roles			
Game		I	II	III	IV	I	II	III	IV
C(3)	$\underline{\theta}_T$	32.88	34.18	40.87	40.15	34.00	39.13	44.89	42.00
	$p(\underline{\theta}_T)$	0.00	1.00	0.75	0.75	1.00	1.00	0.87	1.00
	$\underline{\theta}^X_{t<T}$	29.50	29.77	34.33	34.62	20.00	36.57	41.67	39.13
	$p(\underline{\theta}^X_{t<T})$	0.00	0.00	0.00	0.00	0.00	0.02	0.25	0.02
	$\underline{\theta}_T - \underline{\theta}^X_{t<T}$	3.38	4.41	6.53	5.54	14.00	2.56	3.22	2.88
C(11)	$\underline{\theta}_T$	33.44	37.00	38.36	38.70	33.18	41.60	42.50	45.00
	$p(\underline{\theta}_T)$	0.38	0.00	0.67	0.67	0.38	0.71	0.50	0.87
	$\underline{\theta}^X_{t<T}$	25.50	29.10	32.64	33.49	30.48	35.96	38.12	32.52
	$p(\underline{\theta}^X_{t<T})$	0.03	0.00	0.12	0.11	0.07	0.02	0.07	0.12
	$\underline{\theta}_T - \underline{\theta}^X_{t<T}$	7.94	7.90	5.73	5.21	2.70	5.64	4.38	12.48
D(3)	$\underline{\theta}_T$	36.20	35.63	39.71	38.50	40.50	40.75	43.33	43.00
	$p(\underline{\theta}_T)$	1.00	0.60	1.00	0.67	0.74	0.74	0.67	0.67
	$\underline{\theta}^X_{t<T}$	31.58	28.68	34.19	29.02	38.64	41.45	44.24	43.86
	$p(\underline{\theta}^X_{t<T})$	0.32	0.00	0.00	0.00	0.07	0.25	0.21	0.11
	$\underline{\theta}_T - \underline{\theta}^X_{t<T}$	4.62	6.95	5.52	9.48	1.86	-0.70	-0.91	-0.86
D(11)	$\underline{\theta}_T$	36.33	37.50	39.11	40.38	42.00	44.20	42.25	43.50
	$p(\underline{\theta}_T)$	1.00	0.00	1.00	0.74	0.50	0.87	1.00	0.67
	$\underline{\theta}^X_{t<T}$	30.51	31.69	28.34	26.01	37.98	41.43	41.38	43.19
	$p(\underline{\theta}^X_{t<T})$	0.07	0.00	0.00	0.00	0.07	0.25	0.25	0.11
	$\underline{\theta}_T - \underline{\theta}^X_{t<T}$	5.82	5.81	10.77	14.36	4.02	2.77	0.87	0.31

Note: $p(\underline{\theta}_T)$ denotes the probability that an offer θ_T is accepted based on the probability distribution of all final offers, whereas $p(\underline{\theta}^X_{t<T})$ denotes the probability of acceptance based on the probability distribution of all previous offers.