Political actors playing games: Theory and experiments

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Chapter 5

Bargaining in the Presence of Condorcet Cycles: The Role of Asymmetries[1]

5.1 Introduction

The Condorcet Paradox arises when transitive individual preferences lead to intransitive collective preferences. It has been studied in the Social Choice literature for a very long time (see Arrow, 1963, and Black, 1958). Furthermore, it is more than simply a theoretical curiosity; it has been empirically observed in both small and large-scale settings (for a survey of the empirical detection of the paradox see van Deemen, 2014). The question then arises: How do groups manage to resolve the paradox to reach a decision? We consider this question in the strategic bargaining framework introduced by Baron and Ferejohn (1989) and investigate how asymmetries in payoffs and in the probability of being able to make a proposal affect behavior. To do so we implement the model by Herings and Houba (2010) in a controlled laboratory experiment and vary the symmetry of payoffs and recognition probabilities.

The reasons for employing a controlled laboratory experiment are two-fold. First, with observational data it is virtually impossible to test the model's performance since its underlying parameters are unknown and therefore we are not able to compute the theoretical benchmark necessary to test the theory. Furthermore, the institutional rules of the bargaining process are not exogenously assigned, which makes causal statements problematic. In the laboratory we do not have these problems since we control the underlying parameters and can vary institutions under ceteris paribus conditions. The second reason for employing an experiment is that the equilibrium outcomes result from subtle strategic effects of asymmetries and therefore players' bounded rationality or non-selfish preferences might cause systematic deviations from the theoretical predictions. An example of such systematic deviation is presented in a series of papers by Frechette et al. (2003, 2005a, and 2005b) who demonstrate that players under-exploit their proposer power in bargaining games since they anticipate that the unequal outcomes resulting from completely exploiting their bargaining power will not be accepted by the other players. If

[1] This chapter is baes on Kamm and Houba (2015).

this type of deviation from equilibrium occurs, we will be able to observe it directly in our experimental data.

From the experiment two main results arise: First, subjects are underexploiting their bargaining power and accept proposals too often.[2] This finding might be caused by subjects' risk aversion and is in line with results McKelvey (1991) reports for a related experiment. His experiment differs from ours in two main ways: For one thing, he only varies the payoffs and implements symmetric recognition probabilities while we vary both and for another thing, he is interested in testing the predictive power of the Baron & Ferejohn model and focuses therefore on the point predictions while we are mainly interested in the comparative statics effects of asymmetries in payoffs and recognition probabilities. The second main result that arises from the experiment is that for asymmetric recognition probabilities we observe systematic deviations from the model predictions. In comparison, subjects' change in behavior when going from symmetric to asymmetric payoffs is more in line with the theory when recognition probabilities are symmetric. The systematic deviations for asymmetric recognition probabilities do not only arise relative to the risk-neutral Nash equilibrium but also when a quantal response equilibrium –with risk-aversion and noise parameters estimated using experimental data– is used as theoretical benchmark. We therefore conclude that subjects have a harder time understanding the strategic implications of asymmetric recognition probabilities than asymmetric payoffs and rely on heuristics when dealing with asymmetric recognition probabilities. One such heuristic that is consistent with the data would be to equate recognition probabilities with bargaining power.

The remainder of this chapter will be structured as follows: In the next section we present the experimental design; then section 5.3 describes the experimental results. Section 5.4 concludes with a summary of the results and a discussion of potential avenues for future research.

5.2 Experimental design

5.2.1 The game[3]

The game consists of a group of three players that has to decide which of three available options to implement. Bargaining proceeds as follows: In each round one player is randomly chosen (as in Baron and Ferejohn, 1989) to make a proposal (where a proposal is an announcement of one of the three available alternatives). Subsequently, the other two members sequentially vote whether to accept or reject this proposal. The order is such that first the player that receives a higher payoff from the proposal must vote.[4] Given that we assume majority voting and since the proposer is assumed to be in favor of her own

[2] Interestingly, this leads to a proposer power that is larger than predicted, which is contrary to the common finding of lower proposer power, see for instance Palfrey (2013) and the references therein. The most likely explanation is our limited proposal space. Whereas previous studies were characterized by a (nearly) continuous proposal space, our subjects can choose from only three possible proposals.

[3] The game is obtained by adding a risk of breakdown to the game presented by Herings and Houba (2010).

[4] The reason for sequentially voting is to eliminate the equilibrium where both vote in favor of the proposal since they believe that the other will vote 'yes'.

proposal the third group member is only asked to vote if the first vote was a ‘no’. If a proposal is adopted the payoffs associated with the proposed alternative are implemented. If the proposal is rejected the game continues to the next period with probability δ while with probability $1-\delta$ bargaining breaks down and everyone receives a payoff of zero.

To generate a Condorcet paradox we assume the structure of payoffs (denoted in points) shown in Table 5.1.

Table 5.1: Payoffs

	Alternative I	Alternative II	Alternative III
Payoff player 1	9	4	0
Payoff player 2	0	β	4
Payoff player 3	4	0	9

Notes. β denotes player 2’s payoff associated with her favorite alternative

5.2.2 Treatments

The experiment consists of four between-subject treatments that are constructed in the 2x2 configuration shown in Table 5.2.

Table 5.2: Treatments

	Symmetric payoffs	Asymmetric payoffs
Symmetric recognition probabilities	SymPaySymRec N=10 78 subjects	AsymPaySymRec N=5 45 subjects
Asymmetric recognition probabilities	SymPayAsymRec N=7 51 subjects	AsymPayAsymRec N=7 51 subjects

Notes. Cell entries give the treatment acronym used throughout this chapter as well as the number of independent matching groups N and subjects for each treatment. The reason for having more sessions of treatment SymPaySymRec is that we accidentally implemented one session of this treatment when we planned on running treatment AsymPayAsymRec.

The first treatment dimension varies whether the alternatives are symmetric with respect to payoffs. In the symmetric case every player gets 9 (4, 0) points when her favorite (middle, worst) option is implemented, i.e. $\beta = 9$. When payoffs are asymmetric player 2 gets 15 points instead of 9 points when her favorite alternative is implemented, i.e. $\beta = 15$.

The second treatment dimension varies the probability that a player will be the proposer in any given period. In the symmetric treatments each player has a probability of 1/3 to be the proposer while in the asymmetric treatments player 1 is the proposer with a probability of only 10% while players 2 and 3 each have a probability of 45% of being the proposer.

Table 5.3 shows the resulting stationary subgame perfect Nash equilibria assuming risk-neutrality and a probability of continuation after each rejected proposal of $\delta = 0.9$ (the equilibria are derived in appendix 5.A). We only report the probabilities for accepting and proposing the middle alternative since the best alternative will always be accepted while the worst alternative will never be proposed or accepted and therefore an equilibrium is completely described by the behavior regarding the middle option.

Table 5.3: Equilibria

	SymPaySymRec	SymPayAsymRec	AsymPaySymRec	AsymPayAsymRec
Accept M	100 100 100	48 23 100	39 58 73	21 18 100
Propose M	0 0 0	0 0 13	0 0 0	0 0 10
Expected payoff	4.3 4.3 4.3	4.4 4.4 2.8	4.4 4.4 4.4	4.5 4.5 3.3

Notes. Cell entries give the Nash equilibrium probability of accepting (proposing) the middle option and the expected equilibrium payoffs by treatment and player role assuming risk-neutrality and a continuation probability $\delta = 0.9$

5.2.3 Hypothesis

From the equilibrium predictions we derive two sets of hypothesis.[5]

1. Effect of recognition probabilities
   a. For players 1 and 2 asymmetries reduce the likelihood of accepting the middle option
   b. For player 3 asymmetries increase the frequency of accepting the middle option when payoffs are asymmetric
   c. Asymmetric recognition probabilities increase player 3's frequency of proposing the middle option and do not affect the other players' proposing behavior.
   d. Asymmetric recognition probabilities reduce player 3's payoff and have no substantial effect on the other players' payoff
2. Effect of payoff structure
   a. For players 1 and 2 asymmetries reduce the likelihood of accepting the middle option
   b. For player 3 asymmetries decrease the frequency of accepting the middle option when probabilities are symmetric
   c. The payoff structure does not affect proposing behavior
   d. Introducing payoff asymmetries increases payoffs but this change is only substantial for player 3's payoff when the probabilities are asymmetric

[5] With the exception of 1(b) and 2(b) these hypotheses are also robust with respect to noisy decision-making as modeled by the quantal response equilibrium (McKelvey and Palfrey, 1995) and mild risk-aversion. For 1(b) mild risk-aversion is sufficient to make the treatment effect disappear while with noisy decision-making the acceptance rate is predicted to increase independently of the payoff structure. In case of 2(b) either mild risk-aversion or noisy decision-making lead to the treatment effect disappearing. In Appendix 5.B we present a model specification combining noisy decision-making with substantial risk-aversion.

The intuition for these hypotheses is not always obvious and relies on complex reasoning regarding best-response patterns. For instance the hypothesis that player 2 does not have a higher expected payoff when she gets more points for her best alternative or that player 1 does not suffer a reduction in expected earnings when she is less likely to be the proposer are both unintuitive, but follow from the equilibrium analyses.[6]

5.2.4 Experimental Protocol

The experiment was conducted at the CREED laboratory at the University of Amsterdam in December 2013 and February 2014 and implemented using php/mysql.[7] Participants were recruited using CREED's subject database. In each of nine sessions, 18, 24 or 27 subjects participated. Most of the 225 subjects in the experiment were undergraduate students of various disciplines.[8] Earnings in the experiment are in 'points', which are converted to euros at the end of the experiment at an exchange rate of 10 points = 1€. The experiment lasted on average 80 minutes and the average earnings were 19€ (including a 7€ show-up fee).

After all subjects have arrived at the laboratory, they are randomly assigned to one of the computers. Once everyone is seated they are shown the instructions for the first part of the experiment on their screen.[9] After everyone has read these and the experimenter has privately answered all questions, a summary of the instructions is distributed. Then, all subjects have to answer quiz questions that test their understanding of the instructions. After everyone has successfully finished this quiz, the experiment starts. When everyone has finished part I the instructions for part II are shown on the screen and again a summary is distributed and a quiz has to be passed before part II begins. Finally, after everyone has finished part II the instructions for part III are shown on the screen and subjects make their decision for part III. At the end of the session, all subjects answer a short questionnaire and are privately paid their cumulative earnings from the three parts.

To make sure that subjects have an incentive to think carefully about their choices, for part I of the experiment the game was as described above but with 10-times the payoffs.[10] Subjects were informed that in this part they would participate in a bargaining game, that they stay the same player throughout the first part and that they will never meet the two other group members in part II and part III of the experiment. The game started in period 1 with subjects learning their role (player 1, 2, or 3) and applied the strategy method, i.e., everyone decided on their proposal before one proposal was randomly chosen to be voted on. If the first voter (the non-proposing group member that likes the proposal better) votes 'yes' part I of the experiment ends and the payoffs according to the implemented

[6] In general all the results rely on the effect a parameter change has on the 'cost' of making a player accept a proposal. For instance, the lower recognition probability of player 1 makes her 'cheaper' to satisfy which implies that she gets her middle option more often and less often receives her lowest payoff.

[7] For screenshots of the interface as well as the text of the instructions and the summary handout, see Appendix 5.C.

[8] 148 of the 225 participants were students in business or economics.

[9] They are informed that there will be three parts in the experiment but not what these parts will entail.

[10] This does not have any effect on the equilibrium predictions, provided the risk-neutrality also holds at this payoff level.

alternative are realized. If the first voter votes ‘no’ the second voter has to decide. If she accepts the first part ends and payoffs are realized. If she rejects, then with probability 0.9 the game moves to the next period, which proceeds exactly the same as period 1. With the remaining probability bargaining breaks down, part I ends and all group members earn zero points.

Part II works in a way similar to part I, but the payoffs are not multiplied by ten and this part consists of 10 bargaining games which allows for learning to take place. Each game works as described for part I but after each round groups are randomly re-matched and every subject is randomly assigned one of the three roles within the group. For econometric reasons this re-matching is not done using the complete group of subjects in the laboratory but is based on independent matching groups (i.e. subgroups) of size 6 or 9.[11]

In part III we measure risk-aversion using the task proposed by Eckel and Grossmann (1998). Subjects have to choose one of seven lotteries with varying payoff for winning and losing but all with a winning probability of 50%.

5.3 Results

Given that it is always optimal to accept the best option if offered and accepting or proposing the worst option are dominated strategies,[12] we focus in the analysis of the results on the acceptance and proposing behavior with respect to the middle option. After briefly discussing the results from part I of the experiment, the remainder of this section will focus on an in-depth analysis of behavior observed in part II of the experiment. In a first step we present a within-treatment analysis that investigates whether observed behavior corresponds to the equilibrium predictions. Next, we investigate what might cause the deviations from the theory and present results for the quantal response equilibrium with risk-aversion and noise parameter fitted to the observed data. Finally, we analyze differences across treatments and investigate the effect of asymmetries on subjects’ behavior.

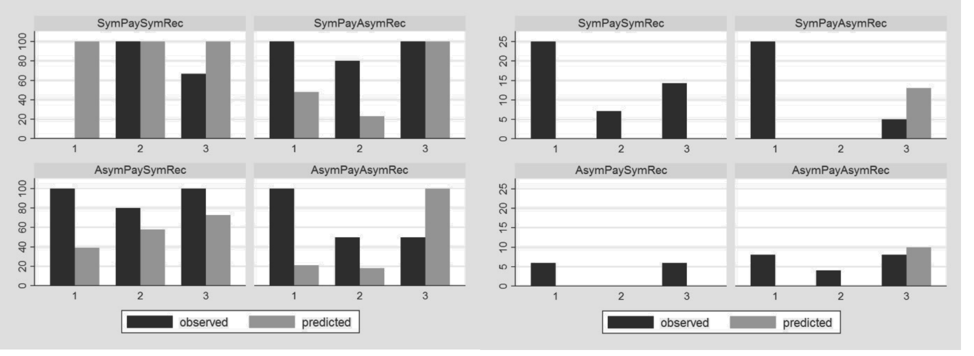
5.3.1 Analysis of part I

Overall, subjects accept and propose the middle option more often than predicted, which leads to faster agreement than predicted (see Figure 5.1). As a result we have only few observations of proposing behavior and even fewer acceptance decisions (for instance in treatment SymPaySymRec not a single player 1 was proposed her middle option[13]). We therefore do not investigate the differences in behavior using a detailed statistical analysis but instead focus on three stylized facts that we will compare to what we find in part II of the experiment.

[11] Subjects were simply told that they would be rematched with other participants.

[12] Indeed, in line with theory the worst option is almost never proposed (14 out of 2697 decisions) and rarely accepted (6 out of 173 decisions) and the frequencies do not vary much by treatment. Furthermore, the best option is almost never rejected (1 out of 57 decisions).

[13] Recall that alternative II is the middle option for player 1. It is the best option for player 2, who hardly ever proposes it.



(a) frequency of accepting middle option (b) frequency of proposing middle option

Figure 5.1: Accepting and Proposing the Middle Option in Part I

Notes. The figure shows the average frequency of accepting and proposing the middle option observed in part I of the experiment, split by role and treatment and compares them to the Nash equilibrium predictions.

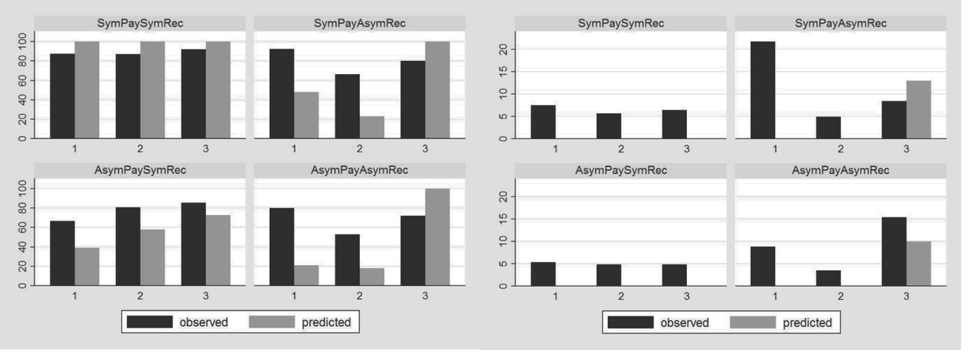
First, the already mentioned higher overall acceptance rates are especially pronounced for player 1. For instance when she is the 'weak' player who has a low recognition probability, she always accepts her middle option while in the predicted equilibrium she should frequently reject her middle option. As discussed below, a similar pattern is also observed in part II of the experiment. Second, when the game is completely symmetric (SymPaySymRec) players frequently propose their middle option while they are predicted to always propose their best option. This may be because with the high payoffs in part I, breakdown would be socially very costly and the payoff of one's second favorite option is still substantial. This, in addition to learning, would also explain why in part II of the experiment we observe behavior that is closer to equilibrium (there, the best option is almost always proposed). Third, in treatment SymPayAsymRec it is not (the predicted) player 3 that is mostly likely to propose her middle option. Instead, and similar to part II of the experiment, player 1 very frequently proposes her middle option.

5.3.2 Analysis part II

Within-treatment analysis

For treatment SymPaySymRec, where all players are completely symmetric, Figure 5.2 shows behavior that is quite close to the prediction of immediate agreement (i.e., players propose their best option and the other player for whom this is the middle option almost always accepts). Though all players sometimes reject the middle option, this only happens rarely and does not significantly vary by player (p-value: 0.29).[14] Furthermore, sometimes a player proposes the middle option but this happens only occasionally and the frequency does not significantly vary across players (p-value: 0.61).

[14] Unless mentioned otherwise all p-values are taken from a logit regression with proposing (accepting) the middle option as dependent variable and standard errors clustered at the matching group level. All regression results are reported in Appendix 5.D. We also ran nonparametric tests, and all p-values were in the same order of magnitude as reported here. Hence, the conclusions reported here are robust to testing non-parametrically.



(a) frequency of accepting middle option (b) frequency of proposing middle option

Figure 5.2: Accepting and Proposing the Middle Option in Part II

Notes. The figure shows the average frequency of accepting and proposing the middle option observed in part II of the experiment split by role and treatment and compares them to the Nash equilibrium predictions.

In treatment SymPayAsymRec, where player 1 has a lower recognition probability, we find systematic deviations from the theory. As we can see, player 1 is proposing her middle option regularly while in the predicted equilibrium she should only propose her favorite option. For player 3 we observe the opposite, the middle option is proposed less often than predicted. This results in player 1 being significantly more likely to propose the middle option than player 3 (p-value <0.01) who in turn is significantly more likely to propose the middle option than player 2 (p-value: 0.04). With respect to the acceptance behavior in this treatment, we observe that behavior does not differ as much as predicted across players since players 1 and 2 accept the middle option more often than predicted. Furthermore, it is not the case player 3 is most likely to accept her middle option. Instead player 1 has the highest acceptance rate[15] while player 3's behavior is statistically indistinguishable from player 2's behavior (p-value: 0.30).

For the treatment with asymmetric payoffs and symmetric recognition probabilities (AsymPaySymRec) we find that the proposing behavior is in line with the predictions since everyone is almost always proposing the best alternative and there is no difference across players (p-value: 0.88). For the accepting behavior we again find that the difference between players is smaller than predicted and that all players accept their middle options more often than predicted. We find that there is no significant difference between player 1 and 2 (p-value: 0.09) or between player 2 and 3 (p-value: 0.36) but player 3 accepts her middle option significantly more often than player 1 does (p-value: 0.03). Overall, we find some support for the equilibrium predictions since proposing behavior and the ranking of acceptance rates is as predicted even though the differences in acceptance behavior are not as pronounced as predicted.

In the treatment were both payoffs and recognition probabilities are asymmetric (AsymPayAsymRec) we find that players 1 and 3 are proposing the middle option more

[15] The difference between players 1 and 2 is significant at the 1%-level while the difference 1-3 gives a p-value of 0.08.

frequently than predicted. This results in player 2 being significantly less likely to propose the middle option than player 1 (p-value: 0.04) who in turn has an insignificantly lower probability of proposing the middle option than player 3 (p-value: 0.09). For the acceptance behavior we find similar results to treatment SymPayAsymRec: players 1 and 2 accept their middle option substantially more often than predicted. Given that this effect is stronger for player 1 we observe a significantly higher acceptance rate by player 1 compared to player 2 (p-value: 0.02), which is not in line with the small predicted difference in acceptance rates. Furthermore, we do not find that player 3's acceptance rate is the highest but it is statistically indistinguishable from the other players' behavior (p-values are 0.49 and 0.15 for player 1 and 2, respectively). Overall, we find only limited support for the equilibrium predictions since the middle option is proposed not only by player 3 and the pattern of acceptance rates is not in line with theory.

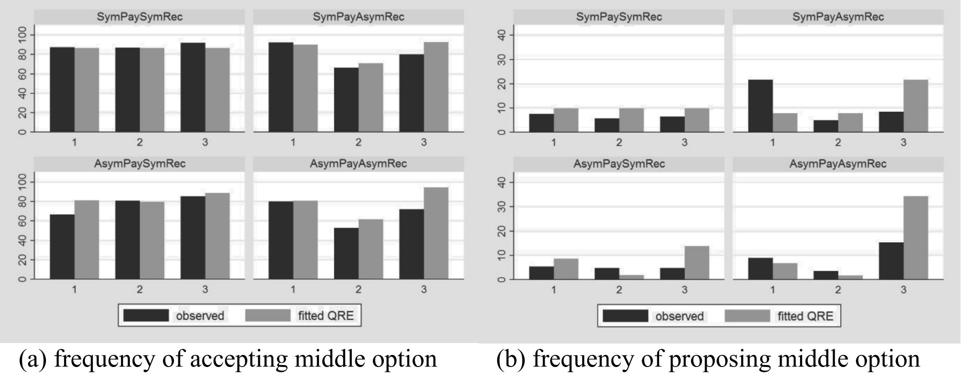
Combining all these results, two main observations arise. First, subjects do not fully exploit their bargaining power when making their acceptance decision since they often accept their middle option. This is in line with findings reported by McKelvey (1991) who investigated the predictive power of the Baron & Ferejohn model with symmetric recognition probabilities and asymmetric payoffs in a laboratory experiment. Second, we find mixed support for the equilibrium predictions. The perfectly symmetric treatment corresponds nicely to the predictions and while asymmetric payoffs by themselves have less of an effect on behavior than expected, the general pattern is still in line with predictions. For the treatments with asymmetric recognition probabilities we find almost no support for the equilibrium predictions since the patterns of both acceptance and proposing behavior are far from what is predicted.

This begs the question as to the causes of these deviations from equilibrium. In the following analysis we will consider two possible channels that might be at work: risk-aversion and noisy decision-making. The finding that players overall are more accommodating in their acceptance behavior would be in line with players being risk-averse since risk-averse players are less willing to take the gamble of rejecting their middle option in the hope of getting their favorite option in a future period.[16] Furthermore, we know that humans are not always able to solve for the best-response as necessary for playing the Nash equilibrium but are often observed to find a 'better-response', i.e. they tend to choose better options more often than worse options. This idea is captured by the quantal response equilibrium concept, which assumes that the probability of choosing an action increases in the associated payoff. Previous experimental work (for instance, Goeree and Holt 2005) has shown that this equilibrium concept outperforms Nash equilibrium predictions in explaining experimental data. It has been successfully applied to experiments on strategic bargaining (Battaglini and Palfrey 2014; Nunnari and Zapal 2014).

[16] An analysis of decision-making at the individual level shows no systematic or substantial influence of risk-aversion and gender on behavior. Detailed results of this analysis are presented in Appendix 5.D.

We operationalize these two channels by using the experimental data to estimate, first, the parameter α of the CRRA utility function x^{α} and, second, the noise parameter λ of the quantal response equilibrium. This results in estimates of $\alpha = 0.44$ and $\lambda = 3.6$. The former is in line with previous work that estimated α's in the range of 0.3 to 0.6 (see Battaglini and Palfrey 2014 and references therein). For these estimated parameters, Figure 5.3 shows the choice probabilities predicted by the quantal response equilibrium.

Considering the acceptance decisions, we see that observed behavior is quite close to the quantal response predictions.[17] Instead of being more accommodating than predicted (as in the Nash equilibrium) subjects are actually less likely to accept than predicted. Turning to the proposing decision, we see that even with the fitted model we are not able to accurately capture proposals when the recognition probabilities are asymmetric. As when using Nash equilibrium as a solution concept, the 'weak' player 1 is proposing the middle option more often than predicted and player 3 doing so less often than predicted.



(a) frequency of accepting middle option (b) frequency of proposing middle option

Figure 5.3: QRE for accepting and Proposing middle option in part II

Notes. The figure shows the average frequency of accepting and proposing the middle option observed in part II of the experiment split by role and treatment and compares them to the quantal response equilibrium for the estimated noise-parameter λ=3.6 and risk-aversion parameter α=.44.

Overall, we can conclude that while noisy decision-making and risk-averse subjects can explain most of the deviations from the Nash equilibrium when probabilities are symmetric, the adjusted model still falls short in explaining all of the effects of asymmetric recognition probabilities. This suggests that it is easier for subjects to understand the strategic effects of asymmetric payoffs than of asymmetric recognition probabilities and that players therefore rely on heuristics to deal with asymmetric recognition probabilities.

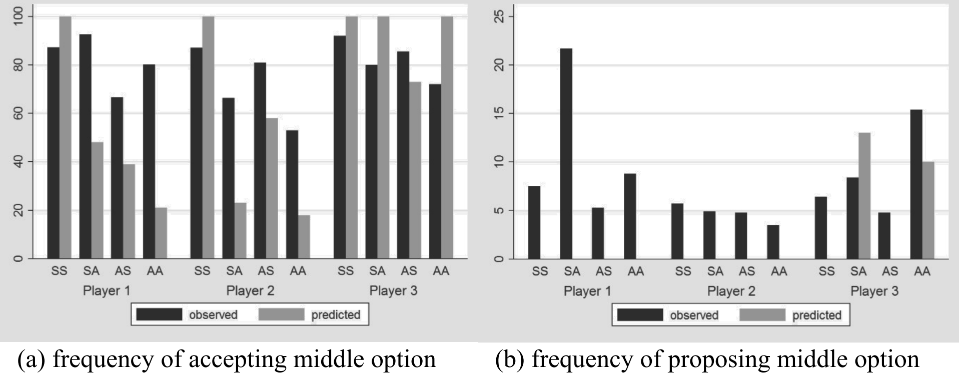
One possible heuristic that players might employ when confronted with asymmetric recognition probabilities is suggested by player 1's behavior of accepting and proposing the middle option more often than predicted. This heuristic would be to equate recognition probabilities with bargaining power. In this case player 1 would think that she is in a weak

[17] Given that the QRE predictions have two parameters that are based on observed behavior it is obvious that it will give a better fit than the Nash equilibrium predictions.

bargaining position, which would lead her to become more accommodating in her accepting and proposing behavior.

Comparison across treatments

First, we consider the effect of going from symmetric to asymmetric recognition probabilities. As Figure 5.4 shows, for both payoff configurations this asymmetry is predicted to lead to a decrease in the acceptance rates of players 1 and 2 (Hypothesis 1a) while player 3's acceptance behavior should only be affected when payoffs are asymmetric (Hypothesis 1b). We find only partial support for these hypotheses. As predicted player 2 reduces her probability of accepting the middle option (for symmetric payoffs, p-value <0.01; for asymmetric payoffs, p-value: 0.03) when recognition probabilities become asymmetric. Additionally, when payoffs are symmetric the recognition probability does not significantly affect player 3's acceptance rate (p-value: 0.10). On the other hand for asymmetric payoffs asymmetric recognition probabilities do not significantly increase the probability that player 3 accepts her middle option but decreases it (albeit insignificantly; p-value: 0.49). Furthermore, player 1 increases her acceptance rate instead of decreasing it, when recognition probabilities are asymmetric and with asymmetric payoffs this reduction is even significant (for symmetric payoffs p-value: 0.35 and for asymmetric payoffs 0.05).



(a) frequency of accepting middle option (b) frequency of proposing middle option

Figure 5.4: Accepting and Proposing middle option in part II

Notes. The figure contrasts for each role and treatment the average observed frequency of accepting and proposing the middle option with the Nash equilibrium predictions. SS (SA, AS, AA) denotes the treatment with symmetric (symmetric, asymmetric, asymmetric) payoffs and symmetric (asymmetric, symmetric, asymmetric) recognition probabilities.

The deviations from the theoretically predicted effect of asymmetric recognition probabilities are even more pronounced with respect to proposing behavior. The predicted increase in the frequency of proposing the middle option by player 3 is only significant when payoffs are asymmetric (p-values are 0.50 for symmetric and 0.04 for asymmetric payoffs) while for symmetric payoffs player 1 significantly increases the probability of proposing the middle option when payoffs are asymmetric (p-value <0.01). While the absence of a significant effect on player 2's behavior (p-values are 0.69 for symmetric and 0.46 for asymmetric payoffs) and the fact that the middle option is only regularly proposed when probabilities are asymmetric are in line with predictions overall our data do not provide much support for Hypothesis 1c.

Table 5.4: Predicted and observed payoffs in part II

	SymPaySymRec	SymPayAsymRec	AsymPaySymRec	AsymPayAsymRec
observed	4.6 4.0 4.4	3.1 6.3 3.6	4.7 5.3 4.6	3.8 8.4 3.7
predicted	4.3 4.3 4.3	4.4 4.4 2.8	4.4 4.4 4.4	4.5 4.5 3.3

Notes. Cell entries give the observed and predicted payoffs by treatment and player role assuming risk-neutrality and continuation probability $\delta = 0.9$

The observed deviations from theory in accepting and proposing the middle option also result in payoff consequences of asymmetric recognition probabilities that differ from the predicted effect. Hypothesis 1d states that asymmetric probabilities reduce player 3's average payoff while both player 1's and 2's payoff remain unchanged. This implies that having a lower recognition probability should not hurt player 1. The data presented in Table 5.4 show that player 3 indeed suffers a significant reduction in payoffs but we also see that player 2 increases her payoff at the expense of player 1 (all changes are significant at the 1%-level).

We now turn to the effects of payoff asymmetries. For accepting behavior we expect that asymmetric payoffs reduce player 1's and 2's propensity to accept their middle option (Hypothesis 2a) while only affecting player 3's behavior when recognition probabilities are symmetric (Hypothesis 2b). The observed behavior is broadly in line with these predictions but the decrease in the probability of accepting the middle option is only significant for player 1 when recognition probabilities are symmetric (p-value: 0.05) and for player 2 when they are asymmetric (p-value <0.01). Furthermore, player 3 shows a lower probability of accepting the middle option when payoffs are asymmetric but this effect is not significant (p-value: 0.23 when probabilities are symmetric and .49 for the asymmetric case).

With respect to proposing behavior we expect payoff asymmetry to play no role (Hypothesis 2c). While this is what we observe when recognition probabilities are symmetric (p-values are 0.39, 0.73 and 0.42 for players 1, 2 and 3) this prediction is not supported when recognition probabilities are asymmetric. Now payoff asymmetries significantly reduce player 1's probability of proposing her middle option (p-value <0.01) and significantly increases the frequency of player 3 proposing her middle option (p-value: 0.04). In sum, hypothesis 2c is only supported for symmetric recognition probabilities.

For the average payoffs shown in Table 5.4 we expect to find no effect of asymmetric payoffs for players 1 and 2 and an increase for player 3 when the recognition probabilities are asymmetric (Hypothesis 2d). The predictions that player 2 is unable to exploit the increased payoff associated with her favorite option is not observed in the laboratory since player 2 is able to significantly increase her payoff (p-value <0.01 for both recognition probabilities). For asymmetric recognition probabilities it is not player 3 that significantly increases her payoffs but player 1 (p-value: 0.02 for player 1 and 0.78 for player 3).

Overall, from the between-treatment comparison a similar picture to the one found in the within-treatment analysis arises: Subjects do not react to asymmetries as predicted by theory and the deviations are more pronounced with asymmetric recognition probabilities than with asymmetric payoffs, indicating that subjects have more difficulties understanding the strategic effects of asymmetric recognition probabilities.

5.4 Conclusions

In this chapter we implemented in a controlled laboratory experiment the model of strategic bargaining in the presence of Condorcet cycles formulated by Herings and Houba (2010). To investigate the effect of asymmetries on bargaining behavior we varied the payoff structure (comparing symmetric payoffs to a situation where one player is advantaged) and the recognition rule (comparing symmetric recognition probabilities to a situation where one player has a lower probability of being recognized).

While subjects' behavior corresponds nicely to the equilibrium predictions when the game is perfectly symmetric, deviations from theory begin to appear when asymmetries are introduced. The two main deviations we observe are: First, subjects are more accommodating than expected and regularly accept their middle option; this might be due to risk-aversion. Second, subjects do not react to asymmetries in the way predicted by theory. While introducing asymmetric payoffs when recognition probabilities are symmetric leads to a change in the predicted direction (albeit less than expected), with asymmetric recognition probabilities substantial and systematic deviations from the theory arise. The most pronounced aspect of these deviations is that the player with the low recognition probability is much more accommodating than predicted, since she accepts and proposes the middle option more often than theory prescribes. A very similar result also arises for the tenfold payoffs employed in part I of the experiment. It is partly supported by a theoretical benchmark consisting of a quantal response equilibrium with risk-aversion and noise parameters estimated using our experimental data. A possible explanation for this finding could be that subjects use a heuristic that equates recognition probabilities and bargaining power which would lead the 'weak' player with the low recognition probability to be more accommodating than predicted.

Our finding that the strategic effect of asymmetries in recognition probabilities is difficult for subjects to comprehend warrants further investigation. First of all, the robustness of this phenomenon could be explored by running other games with random recognition rules – including the general class of Markov recognition processes studied in, e.g., Herings and Houba 2015– and experimentally varying the probabilities. Another possibility would be to run our experimental design again and give subjects more opportunity for learning either by letting them play the game for more rounds or by giving them more extensive feedback on their own and other players' decisions. Should the finding that players have problems with asymmetric recognition prove to be robust one could in a second step look for the underlying causes for this.[18] In conclusion, this chapter offers a first step towards understanding the effect of asymmetric recognition probabilities in bargaining institutions on behavior. Given the importance and prevalence of strategic bargaining in determining political and economic outcomes we are looking forward to further work in this direction. Our results suggest that there is still much we do not understand.

[18] Possible mechanisms could be incorrect beliefs about other players' strategies or subjects having correct beliefs but not reacting optimally to them. This could be explored by eliciting beliefs or adapting the design employed by Esponda and Vespa (2014) for studying strategic voting and letting subjects play against a computer that follows a known strategy.

Appendix 5.A: Nash equilibrium analysis

In this appendix, we apply the concept of stationary subgame perfect Nash equilibrium, abbreviated as Nash equilibrium, to a player's decision whether to propose her best or middle option and whether or not to accept her middle option. It can be shown that each player's expected equilibrium payoff lies strictly between the utility of receiving her worst and best option. Therefore, if a player is proposed her best option, her best response is to accept it and if she is offered her worst option, she should reject it. Furthermore, proposing one's worst option is dominated by proposing the middle option, because the latter will be accepted.

Player i's strategy is then fully described by two probabilities; P_i^{acc}, the probability of accepting her middle option whenever it is proposed to her and P_i^{prop}, the probability of proposing her middle option and with complementary probability proposing the best option. We will use the following notation: u_i^j denotes player i's utility from player j's best option; θ_i is the probability that player i is the proposer and δ denotes the probability that the game continues to the next period when a proposal has been rejected.

With monetary payoff distributions in the experiment given by

$$(9; 0; 4)\ ;\ (4; \beta; 0)\ ;\ (0; 4; 9)$$

with β equal to either 9 or 15, j's best option is $j-1$ ($j+1$)'s middle (worst) option with the convention that $j+1=4$ means 1 and $j-1=0$ means 3.

The ex-ante expected utility π_i of player i is then given by :

$$\begin{aligned} \pi_i = \theta_1\left\{P_1^{prop} * u_i^2 + \left(1-P_1^{prop}\right) * [P_3^{acc} * u_i^1 + (1-P_3^{acc}) * \delta * \pi_i]\right\} \\ +\theta_2\left\{P_2^{prop} * u_i^3 + \left(1-P_2^{prop}\right) * [P_1^{acc} * u_i^2 + (1-P_1^{acc}) * \delta * \pi_i]\right\} \\ +\theta_3\left\{P_3^{prop} * u_i^1 + \left(1-P_3^{prop}\right) * [P_2^{acc} * u_i^3 + (1-P_2^{acc}) * \delta * \pi_i]\right\} \end{aligned} \quad (1)$$

The ex-ante expected utility consists of the expected utility of possible and stochastically-reached agreement in the current bargaining round plus the present value of the ex-ante expected equilibrium utility of continuing after the current bargaining round, i.e. π_i. The current-period expected utility depends on who is recognized as the proposing player and whether this player proposes her middle option that is accepted immediately, or her best option that is randomly accepted.

The equilibrium conditions for player i's probability of accepting the middle option are given by:

$$\begin{aligned} P_i^{acc} > 0 \Rightarrow u_i^{i-1} \geq \delta * \pi_i \\ P_i^{acc} < 1 \Rightarrow u_i^{i-1} \leq \delta * \pi_i \end{aligned} \quad (2)$$

The intuition is that if player i accepts (rejects) the middle option with positive probability, then the utility of the middle option cannot be smaller (larger) than the expected continuation utility of rejecting the offer. In particular, if player i randomly accepts her middle option, $0 < P_i^{acc} < 1$, then both implications of (2) have to hold, and consequently, player i's ex-ante expected equilibrium utility is given by $\pi_i = \delta^{-1} * u_i^{i-1}$.

The equilibrium conditions for player i's probability of proposing the middle option are given by:

$$\begin{aligned} P_i^{prop} > 0 &\Rightarrow u_i^{i-1} \geq P_{i-1}^{acc} * u_i^i + (1 - P_{i-1}^{acc}) * \delta * \pi_i \\ P_i^{prop} < 1 &\Rightarrow u_i^{i-1} \leq P_{i-1}^{acc} * u_i^i + (1 - P_{i-1}^{acc}) * \delta * \pi_i \end{aligned} \tag{3}$$

The intuition is that if player i proposes the middle (best) option with positive probability, then the utility of the middle option cannot be lower (higher) than the expected utility arising from player i's best option being accepted with probability P_{i-1}^{acc} by player $i-1$, whose middle option it is, and the complementary probability that player i's best option is rejected and bargaining continues to the next round with probability $(1 - P_{i-1}^{acc}) * \delta$. In particular, if player $i-1$ always accepts her middle option for sure, $P_{i-1}^{acc} = 1$, then the implication of (3) cannot hold, and consequently, player i always proposes her best alternative for sure, $P_i^{prop} = 0$. Therefore, player i randomly proposing the middle option requires sufficiently large probabilities of acceptance of the middle option by player $i-1$.

Table 5A.1: Nash equilibrium

	SymPaySymRec	SymPayAsymRec	AsymPaySymRec	AsymPayAsymRec
Accept M	100	48	39	21
	100	23	58	18
	100	100	73	100
Propose M	0	0	0	0
	0	0	0	0
	0	13	0	10

Notes. Cell entries give the probability of accepting (proposing) the middle option and the expected equilibrium payoffs by treatment and player role for the Nash equilibrium.

Deriving Nash equilibria is a routine exercise that is tedious because it involves going through four cases, each related to the number of players with $P_i^{prop} > 0$, and each of these cases has several subcases, each related to $P_i^{acc} > 0$ or $P_i^{acc} < 0$. We refer to Herings and Houba (2010) for an illustration of how to derive equilibria under $\delta = 1$ and omit a detailed derivation in this appendix. For our numerical predictions, we will assume that the players have identical CRRA utility functions of the form $u(x) = x^\alpha$ and risk neutrality ($\alpha = 1$). Table 5A.1 shows the Nash equilibrium for this case and $\delta = 0.9$ as in the experiment. We briefly discuss each case.

SymPaySymRec

In the Nash equilibrium, each player always accepts the middle option, $P_i^{acc} = 1$, and for each player it is then trivially optimal to always propose the best option, $P_i^{prop} = 0$.

Consequently, there is immediate agreement and we have $\pi_i = \frac{u_i^{i-1}+u_i^i}{3}$. Under CRRA and $\delta = 0.9$, the equilibrium condition for acceptance becomes $4^\alpha \geq \delta * \pi_i$, which can be rewritten as $\alpha * \ln(\frac{9}{4}) \leq \ln(3 * \delta^{-1} - 1)$ and holds for $\alpha \leq 1.04$. This range of α's includes the entire range of risk averse parameter values.

AsymPaySymRec

In the Nash equilibrium, all players randomly accept the middle option with a probability strictly between zero and one, and each player always proposes the best option, $P_i^{prop} = 0$.

By (2) random acceptance implies that $\pi_i = \delta^{-1} * u_i^{i-1}$ and always proposing the best option requires $u_i^{i-1} \leq P_{i-1}^{acc} * u_i^i + (1 - P_{i-1}^{acc}) * \delta * \pi_i$. For risk neutrality, this sets up the following set of equilibrium conditions

$$\pi_1 = \frac{1}{3}[P_3^{acc} * 9 + (1 - P_3^{acc}) * 4 + 4 + (1 - P_2^{acc}) * 4] = 4 * \delta^{-1}$$

$$\pi_2 = \frac{1}{3}[P_1^{acc} * 15 + (1 - P_1^{acc}) * 4 + 4 + (1 - P_3^{acc}) * 4] = 4 * \delta^{-1}$$

$$\pi_3 = \frac{1}{3}[P_2^{acc} * 9 + (1 - P_2^{acc}) * 4 + 4 + (1 - P_1^{acc}) * 4] = 4 * \delta^{-1}$$

$$4 \leq P_3^{acc} * 9 + (1 - P_3^{acc}) * \delta * \pi_1$$

$$4 \leq P_1^{acc} * 15 + (1 - P_1^{acc}) * \delta * \pi_2$$

$$4 \leq P_2^{acc} * 9 + (1 - P_2^{acc}) * \delta * \pi_3$$

which solves for $\delta = 0.9$ as $P_1^{acc} = 0.38$, $P_2^{acc} = 0.57$ and $P_3^{acc} = 0.72$.

For α's in the range from 0.64 to 0.93, the equilibrium slightly changes. All players still always propose their best option, player 1 and 2 randomize in accepting, and consequently $\pi_1 = \pi_2 = 4^\alpha * \delta^{-1}$ as before, and $P_3^{acc} = 1$, which by (2) imposes the equilibrium condition $\pi_3 \leq 4^\alpha * \delta^{-1}$. This gives the following set of equilibrium conditions

$$\pi_1 = \frac{1}{3}[9 + 4 + (1 - P_2^{acc}) * 4] = 4 * \delta^{-1}$$

$$\pi_2 = \frac{1}{3}[P_1^{acc} * 15 + (1 - P_1^{acc}) * 4 + 4] = 4 * \delta^{-1}$$

$$\pi_3 = \frac{1}{3}[P_2^{acc} * 9 + (1 - P_2^{acc}) * 4 + 4 + (1 - P_1^{acc}) * 4] \leq 4 * \delta^{-1}$$

$$4 \leq P_3^{acc} * 9 + (1 - P_3^{acc}) * \delta * \pi_1$$

$$4 \leq P_1^{acc} * 15 + (1 - P_1^{acc}) * \delta * \pi_2$$

$$4 \leq P_2^{acc} * 9 + (1 - P_2^{acc}) * \delta * \pi_3$$

from which we obtain

$$P_1^{acc} = \frac{3*\delta^{-1}-2}{\left(\frac{15}{4}\right)^{\alpha}-1} \text{ and } P_2^{acc} = \left(\frac{9}{4}\right)^{\alpha} + 2 - 3*\delta^{-1}$$

SymPayAsymRec and AsymPayAsymRec

In these two treatments, player 3 proposes the middle option with positive probability. In the equilibrium, player 1 and 2 always propose the best option and randomly accept the middle option, $P_1^{prop} = P_2^{prop} = 0$ and $0 < P_1^{acc}$; $P_2^{acc} < 1$, player 3 randomly proposes her middle option and always accepts the middle option for sure, $0 < P_3^{prop} < 1$ and $P_3^{acc} = 1$.

Like before, random acceptance imposes $\pi_1 = \pi_2 = 4^{\alpha} * \delta^{-1}$ and player 3's acceptance of the middle option for sure requires $\pi_3 \leq 4^{\alpha} * \delta^{-1}$. Through (3), randomly proposing by player 3 imposes $P_2^{acc} * 9^{\alpha} + (1 - P_2^{acc}) * \delta * \pi_3 = 4^{\alpha}$ and always proposing the best option by players 1 and 2 requires $u_i^{i-1} \leq P_{i-1}^{acc} * u_i^i + (1 - P_{i-1}^{acc}) * \delta * \pi_i$ $(i = 1; 2)$. This leads to the following set of equilibrium conditions

$$\pi_1 = 0.1 * 9^{\alpha} + .45 * \left[4^{\alpha} + (1 - P_3^{prop}) * (1 - P_2^{acc}) * 4^{\alpha} + P_3^{prop} * 9^{\alpha}\right] = 4 * \delta^{-1}$$

$$\pi_2 = .45 * \left[P_1^{acc} * u_2^2 + (1 - P_2^{acc}) * 4^{\alpha} + (1 - P_3^{prop}) * 4^{\alpha}\right] = 4 * \delta^{-1}$$

$$\pi_3 = .55 * 4^{\alpha} + .45 * (1 - P_1^{acc}) * \delta * \pi_3 \leq 4^{\alpha} * \delta^{-1}$$

$$4 \leq P_3^{acc} * 9 + (1 - P_3^{acc}) * \delta * \pi_1$$

$$4 \leq P_1^{acc} * u_2^2 + (1 - P_1^{acc}) * \delta * \pi_2$$

$$P_2^{acc} * 9^{\alpha} + (1 - P_2^{acc}) * \delta * \pi_3 = 4^{\alpha}$$

Although it is possible to derive a closed-form solution, where after several substitutions π_3 solves a quadratic equation, this solution is rather cumbersome. For that reason, we resorted to numerical methods to investigate equilibrium conditions and robustness with respect to α. For $\alpha = 1$, the probabilities for SymPayAsymRec are given by

$$P_1^{acc} = 0.49; P_2^{acc} = 0.24; P_3^{prop} = 0.14$$

with all equilibrium conditions satisfied, and similar for AsymPaySymRec, we find

$$P_1^{acc} = 0.21; P_2^{acc} = 0.18; P_3^{prop} = 0.11$$

with all equilibrium conditions satisfied. With respect to robustness, our numerical simulations show that this equilibrium structure holds for α above 0.71 and in case of SymPayAsymRec, and for α above 0.52 in case of AsymPayAsymRec.

To summarize, our closed-form solutions and numerical results indicate that the equilibrium probabilities do change quantitatively to changes in the CRRA risk coefficient parameter α. However, the investigation of robustness also shows that the hypotheses formulated in the main text do not change qualitatively and that these are quite robust with respect to the risk coefficient parameter α.

Appendix 5.B: Quantal response analysis

In this analysis we apply the concept of noisy best-response as captured by the quantal response equilibrium to a player's decision whether to propose her best or middle option and whether to accept her middle option. For the case where a player is proposed her best (worst) option we assume that the player does not make any mistakes and follows the intuitively optimal strategy of accepting (rejecting) her best (worst) option. Furthermore, the player will never propose her worst option.

Player i's strategy is therefore described by two probabilities; P_i^{acc}, the probability of accepting her middle option and P_i^{prop}, the probability of proposing her middle option. We will assume that the players have identical CRRA utility functions of the form $u(x) = x^\alpha$. We will furthermore use the following notation: u_i^j denotes player i's utility from option j; θ_i is the probability that player i is the proposer; δ denotes the probability that the game continues to the next period after a proposal has been rejected and λ is the noise parameter of the quantal response equilibrium (where the larger is λ, the closer behavior is to the behavior predicted by the Nash equilibrium).

The expected utility π_i of player i is then given by :

$$\begin{aligned}\pi_i = \theta_1 &\{P_1^{prop} * u_i^2 + \left(1 - P_1^{prop}\right) * [P_3^{acc} * u_i^1 + (1 - P_3^{acc}) * \delta * \pi_i]\} \\ +\theta_2 &\{P_2^{prop} * u_i^3 + \left(1 - P_2^{prop}\right) * [P_1^{acc} * u_i^2 + (1 - P_1^{acc}) * \delta * \pi_i]\} \\ +\theta_3 &\{P_3^{prop} * u_i^1 + \left(1 - P_3^{prop}\right) * [P_2^{acc} * u_i^3 + (1 - P_2^{acc}) * \delta * \pi_i]\}\end{aligned}$$

Player i's probability of accepting the middle option is given by:[19]

$$P_i^{acc} = \frac{\exp(\lambda * u_i^{i+1})}{\exp\left(\lambda * u_i^{i+1}\right) + \exp(\lambda * \delta * \pi_i)}$$

where the numerator captures the utility when accepting the middle option and the additional term in the denominator captures the expected utility when rejecting the offer.

Player i's probability of proposing the middle option is given by:[20]

$$P_i^{prop} = \frac{\exp(\lambda * u_i^{i+1})}{\exp\left(\lambda * u_i^{i+1}\right) + \exp(\lambda * \left[P_{i-1}^{acc} * u_i^i + (1 - P_{i-1}^{acc}) * \delta * \pi_i\right])}$$

where the numerator captures the utility associated with proposing her (with certainty accepted) middle option and the additional term in the denominator captures the expected utility when proposing the best option.

The three payoff functions and the six equations for the probabilities form a set of equations and the quantal response equilibrium is given by the solution to this fixed point

[19] For ease of notation we define $u_i^{i+1=4} = u_i^1$.

[20] For ease of notation we define $P_{i-1=0}^{acc} = P_3^{acc}$

problem. Table 5.B1 shows the quantal response equilibrium for the risk-aversion parameter ($\alpha = 0.44$) and the noise parameter ($\lambda = 3.6$) that are derived using a maximum likelihood estimation using the data from our experiment.

Table 5B.1: Quantal response equilibrium

	SymPaySymRec	SymPayAsymRec	AsymPaySymRec	AsymPayAsymRec
Accept M	87 87 87	90 71 93	81 80 89	81 62 95
Propose M	10 10 10	8 8 22	9 2 14	7 2 34
Expected payoff	4.7 4.7 4.7	3.7 5.3 3.8	5.1 6.8 4.3	4.5 7.6 3.3

Notes. Cell entries give the probability of accepting (proposing) the middle option and the expected equilibrium payoffs by treatment and player role for the quantal response equilibrium with α=.44 and λ=3.6

Appendix 5.C: Instructions and screenshots of the experiment

In this appendix, we provide the instructions that the subjects read on their monitors. We also give the summary of the instructions that was handed out to subjects after they had read these on-screen instructions. Finally, we provide screenshots of the user interface of the experiment.

5.C.1 Instructions[21]

Welcome to this experiment on decision-making. Please carefully read the following instructions. If you have any questions, please raise your hand, and we will come to your table to answer your question in private.

In this experiment you will earn points. At the end of the experiment, your earnings in points will be exchanged for money at rate 10 eurocent for each point. This means that for each 10 points you earn, you will receive 1 euro. Additionally, you will receive a show-up fee of 7 euros. Your earnings will be privately paid to you in cash at the end of the experiment.

This experiment consists of 3 parts. You will first receive the instructions for the first part. The instructions for the second part you will only receive once the first part is done. The instructions for the third part you will receive after the second part is done.

Instructions for part I

In the first part of the experiment you will be randomly matched with two other persons in the lab with whom you will never interact in parts II and III of this experiment. Your group of three consists of a player 1, a player 2 and a player 3. These roles are randomly determined in the beginning of the first part of the experiment and the roles stay the same throughout the first part of the experiment.

The task that the group has to perform is to select one out of three alternatives that then determines the payoffs in this round. In the table below you see the payoffs assigned to each type of player by the different alternatives. Remember that each point is worth 10 cents.

Alternative 1	Alternative 2	Alternative 3
Player1: 90 points	Player1: 40 points	Player1: 0 points
Player 2: 0 points	Player 2: 150 points	Player 2: 40 points
Player 3: 40 points	Player 3: 0 points	Player 3: 90 points

The process of choosing an alternative is organized by periods. In each period all group members submit a proposal (being one of the three alternatives) they want the other group members to vote on. After every group member has submitted a proposal one of the

[21] We provide here the instructions used for the treatment AsymPayAsymRec. The instructions for other treatments are analogous and available upon request.

proposals is randomly chosen to be voted on. The probabilities for the different players are presented in the table below.

Player 1	Player 2	Player 3
33.3%	33.3%	33.3%

As you can see the proposal by player 1 has a lower chance of being put up for a vote than the a proposal by players 2 or 3.

The proposal of the selected player (the "proposer") is then communicated to the other two group members which then can vote to accept or reject the proposal. The voting procedure works as follows: First the player who earns a higher payoff from the proposal gets to cast his vote. Given that the proposer supports his own proposal the proposal is accepted if the first voter accepts the proposal. In this case the first part of the experiments ends and the payoffs for this part are computed according to the chosen alternative. After this the experiment moves to the second part of the experiment.

If the first voter rejects the offer the remaining group member (who is not the proposer) gets to cast his vote. If he votes yes the proposal is accepted, the payoffs for this part are computed according to the chosen alternative and the experiments moves to the second part.

Should also the second group member reject the proposal two things can happen: With probability 90% the game continues to the next period and again proposals have to be submitted. With a 10% chance the game ends after a proposal was rejected and payoffs for the first part are zero for all group members. Furthermore the experiment moves to part II.

Instructions for part II

The second part of the experiment consists of 10 rounds. In each round you will play a similar game to the one in part I.

In each round you will be randomly matched with two other persons in the lab (that can not be the same persons you interacted with in part I). Again, a group of three always consists of a player 1, a player 2 and a player 3. These roles are randomly determined in every round. This means, for instance, that you can be player 1 in one round and player 2 in another round.

As in part I the task that the group has to perform is to select one out of three alternatives that then determines the payoffs in this round. In the table below you see the payoffs assigned to each type of player by the different alternatives. Please note that the payoffs are different from part I.

Alternative 1	Alternative 2	Alternative 3
Player1: 9 points	Player1: 4 points	Player1: 0 points
Player 2: 0 points	Player 2: 15 points	Player 2: 4 points
Player 3: 4 points	Player 3: 0 points	Player 3: 9 points

The process of choosing an alternative is organized as in part I. As a reminder: This means that in each period all group members submit a proposal (being one of the three alternatives) they want the other group members to vote on. After every group member has submitted a proposal one of the proposals is randomly chosen to be voted on. The probabilities for the different players are presented in the table below and are the same as in part I.

Player 1	Player 2	Player 3
33.3%	33.3%	33.3%

The game proceeds than in the same fashion as in part I: The proposal of the selected player is communicated to the other two group members which then can vote to accept or reject the proposal. First the player who earns a higher payoff from the proposal gets to cast his vote. If this first voter accepts the proposal the proposal is accepted. In this case the round ends and the payoffs for this round are computed according to the chosen alternative. After this the experiment moves to the next round.

If the first voter rejects the offer the remaining group member (who is not the proposer) gets to cast his vote. If he votes yes the proposal is accepted and the experiments moves to the next round.

Should also the second group member reject the proposal two things can happen: As in part I with probability 90% the round continues to the next period and again proposals have to be submitted. With a 10% chance the rounds ends after a proposal was rejected and payoffs for this round are zero for all group members. Furthermore the experiment moves to the next round.

After all 10 rounds have passed the payoffs from all rounds are added it up and exchanged at a rate of 10 cent per point.

Instructions for part III

The third part of the experiment only consists of the choice described below. Again each point is worth ten cent.

In the table below, we present six different options. Please select one of the options.

Your earnings will depend on the outcome of a fair coin toss. Every option shows the amount in points you earn in case a head shows up or a tail shows up.

When determining your total earnings for this experiment, the computer will "toss a coin" and add an amount according to the outcome of the toss and the choice you made to your earnings of parts 1 and 2. The outcome of the coin toss will be determined after you submitted your choice and will be shown to you on the next page.

	Your earnings when coin indicates heads	Your earnings when coin indicates tails
Option 1	25 points	25 points
Option 2	33 points	21 points
Option 3	41 points	17 points
Option 4	49 points	13 points
Option 5	57 points	9 points
Option 6	62 points	5 points
Option 7	65 points	0 points

5.C.2 Printed summary of instructions

Summary instructions: Part I

- The experiment consists of three parts; these are the instructions for the first part
- You will be in a group of three players. A group always consists of a player 1, a player 2 and a player 3.
- For the whole first part you will be player 1 or player 2 or player 3.
- Your task is to decide which of three alternatives (see below) to implement

	Alternative 1	Alternative 2	Alternative 3
Payoff player 1	90	40	0
Payoff player 2	0	90	40
Payoff player 3	40	0	90

- The process of choosing an alternative is organized by periods. In each period every player will propose an alternative to the other two players. The proposal of only one player will be randomly chosen to be voted upon and then be shown to the other two players.
- The probability that a given player's proposal is chosen is given below

	Player 1	Player 2	Player 3
probability	33.3%	33.3%	33.3%

- The voting procedure works as follows:
    1. Out of the two players who are not the proposer, the player who has a higher payoff from the proposal gets to cast his vote first. If he accepts this proposal is implemented.
    2. If the proposal gets rejected by the first voter the other player who is not the proposer gets to cast his ballot. If he votes "Yes" the proposal is accepted. If he also votes "No" the proposal is rejected.
- If the proposal is accepted, this proposal is implemented and everyone gets the payoffs associated with this alternative. The first part of the experiment ends then.
- If the proposal is rejected, two things can happen:
    1. In 1 out of 10 cases: the first part of the experiment ends and everyone receives a payoff of zero for this part.
    2. In 9 out of 10 cases: the game continues to the next period where again proposals are made and voted upon.

At the end of the experiment each point is worth ten cents and together with a show-up fee of 7€ you will receive these earnings in private at the end of the experiment together with your earnings of parts two and three of the experiment.

Summary instructions: part II

- The experiment consists of three parts; these are the instructions for the second part
- This part consists of 10 rounds
- In each round you will be in a group of three players. A group always consists of a player 1, a player 2 and a player 3.
- In each round you will be player 1 or player 2 or player 3.
- After each round you get randomly rematched with two other persons in the lab and be randomly assigned player 1 or player 2 or player 3.
- Your task in each round is to decide which of three alternatives (see below) to implement

	Alternative 1	Alternative 2	Alternative 3
Payoff player 1	9	4	0
Payoff player 2	0	9	4
Payoff player 3	4	0	9

- The process of choosing an alternative is organized by periods. In each period every player will propose an alternative to the other two players. The proposal of only one player will be randomly chosen to be voted upon and then be shown to the other two players.
- The probability that a given player's proposal is chosen is given below

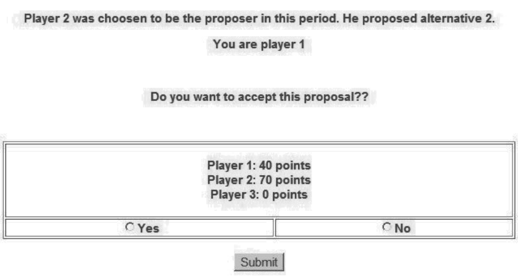
	Player 1	Player 2	Player 3
probability	33.3%	33.3%	33.3%

- The voting procedure works as follows:
  3. Out of the two players who are not the proposer, the player who has a higher payoff from the proposal gets to cast his vote first. If he accepts this proposal is implemented.
  4. If the proposal gets rejected by the first voter the other player who is not the proposer gets to cast his ballot. If he votes "Yes" the proposal is accepted. If he also votes "No" the proposal is rejected.
- If the proposal is accepted, this proposal is implemented and everyone gets the payoffs associated with this alternative.
- If the proposal is rejected, two things can happen:
  3. In 1 out of 10 cases: the round ends and everyone receives a payoff of zero for this round.
  4. In 9 out of 10 cases: the round continues to the next period where again proposals are made and voted upon.
- At the end of the experiment each point is worth ten cents and together with a show-up fee of 7€ you will receive these earnings in private at the end of the experiment together with your earnings of parts one and three of the experiment.

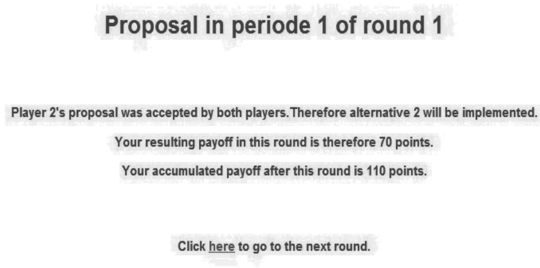
5.C.3 Screenshots of the interface

Notes. The screen subjects saw when making a decision for which option to propose.

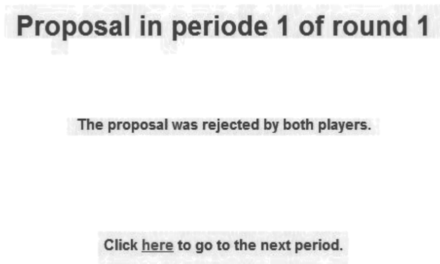
Notes. The screen subjects saw when making a decision for which option to propose; the table at the bottom of the screen shows an example of the history box.



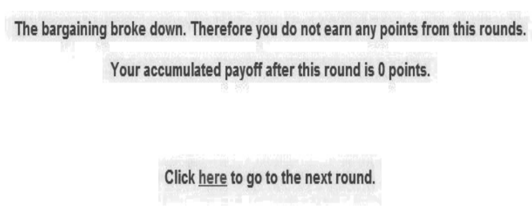
Notes. The screen subjects saw when deciding whether to accept a proposal.



Notes. The screen subjects saw after a proposal was accepted.



Notes. The screen subjects saw after a proposal was rejected.



Notes. The screen subjects saw when bargaining broke down.

Appendix 5.D: Regression analysis for part II

For the analysis of part II of the experiment we employ logit regressions with the decision to accept or propose the middle option as the dependent variable and standard errors clustered at the matching group level. To investigate within treatment variations across roles we run regressions with the subject's role in a given round as independent variable. Table 5D.1 shows the results of this regression by treatment.

Table 5D.1: Logit regressions by treatment

	SymPay SymRec	SymPay AsymRec	AsymPay SymRec	AsymPay AsymRec
Accepting the middle option				
Player 2	-.00	-.28***	.11*	-.28**
Player 3	.05	-.21*	.16**	-.10
Proposing the middle option				
Player 2	-.02	-.13***	-.01	-.06**
Player 3	-.01	-.09***	-.01	.05*

Notes. The table shows the marginal effects of a logit regression with the decision to accept (propose) the middle option as the dependent variable. 'Player 2' ('Player 3') is equal to one if the player's role is player 2 (player 3). Standard errors are clustered at the matching group level. * (**; ***) denotes that the coefficient is significantly different from zero at the 10% (5%; 1%)-level.

Table 5D.2: Behavior over time by role and treatment

	SymPay SymRec	SymPay AsymRec	AsymPay SymRec	AsymPay AsymRec
Accepting the middle option				
Player 1	-.000	-.002	-.030	-.002
Player 2	.010	-.018	-.038***	-.040
Player 3	.010	.014**	-.019	.011
Proposing the middle option				
Player 1	-.008	-.014	-.011	-.005
Player 2	-.010***	-.005	-.005	-.005
Player 3	-.004*	-0.05	-.000	.015***

Notes. The table shows the marginal effects of a logit regression with the decision to accept (propose) the middle option as the dependent variable and the round of the decision as independent variable run separately for each role and treatment. Standard errors are clustered at the matching group level. * (**; ***) denotes that the coefficient is significantly different from zero at the 10% (5%; 1%)-level.

To investigate behavior over time we also ran regressions with the decision round as independent variable for each role and treatment separately. Table 5D.2 shows the results. As we can see for most roles and treatments there are no significant changes in behavior over time but overall the direction of the change is in line with behavior getting slightly closer to equilibrium over time. The sole exception is the proposal behavior of player 3 in the treatments with asymmetric probabilities where the direction of the change is away from the equilibrium choice probabilities.

To investigate the treatments effect on the acceptance and proposing decision table 5D.3 presents the results from logit regressions with treatment dummies as independent variables run separately by players' role.

Table 5D.3: Logit regression by role

	Player 1	Player 2	Player 3
Accepting the middle option			
SymPayAsymRec	.07	-.27***	-.16*
AsymPaySymRec	-.21*	-.09	-.08
AsymPayAsymRec	-.07	-.39***	-.24***
Proposing the middle option			
SymPayAsymRec	.14***	-.01	.02
AsymPaySymRec	-.03	-.01	-.02
AsymPayAsymRec	.02	-.02	.09**

Notes. The table shows the marginal effects of a logit regression with the decision to accept (propose) the middle option as the dependent variable. 'SymPayAsymRec' ('AsymPaySymRec', 'AsymPayAsymRec') is equal to one if the treatment has asymmetric (symmetric, asymmetric) recognition probabilities and the payoffs are symmetric (asymmetric, asymmetric). Standard errors are clustered at the matching group level. * (**; ***) denotes that the coefficient is significantly different from zero at the 10% (5%; 1%)-level.

To test the treatment effects regarding the payoffs we ran linear regressions for each role with a player's payoffs as the dependent variable and treatment dummies as independent variables. The results are shown in table 5D.4.

Table 5D.4: Effect of treatments on payoffs

	Player 1	Player 2	Player 3
SymPayAsymRec	-1.5***	2.3***	-0.8***
AsymPaySymRec	0.1	1.3**	0.2
AsymPayAsymRec	-0.8***	4.4***	-0.7**

Notes. The table shows the coefficients of a linear regression with a player's payoff as the dependent variable. 'SymPayAsymRec' ('AsymPaySymRec', 'AsymPayAsymRec') is equal to one if the treatment has asymmetric (symmetric, asymmetric) recognition probabilities and the payoffs are symmetric (asymmetric, asymmetric). Standard errors are clustered at the matching group level. * (**; ***) denotes that the coefficient is significantly different from zero at the 10% (5%; 1%)-level.

Finally, we investigate whether there are gender effects in data and what effect subjects' elicited risk-aversion has on their decision to propose and accept the middle option. The results shown in Table 5D.5 indicate that a subject's gender is not an important determinate of behavior since most coefficients are small and insignificant. Furthermore, for the acceptance decision most of the 'risk' coefficients are negative (as we would expect since more risk-averse players have a lower value of the variable 'risk' and are ceteris paribus more likely to accept their middle option) if we aggregate choices over all treatments and roles the coefficient is not significant (p-value: 0.41).[22] The same holds true for the proposing behavior where again the majority of the coefficients are negative but overall there is no significant effect of the risk-variable (p-value: 0.54) .[23]

Table 5D.5: Effect of risk-aversion and gender

		SymPay SymRec	SymPay AsymRec	AsymPay SymRec	AsymPay AsymRec
Accepting the middle option					
Player 1	male	.032	-.017	.236	.015
	risk	-.000	-.022*	-.027	.021
Player 2	male	-.022	-.091	-.170*	-.219*
	risk	-.006	-.002	-.024	.027
Player 3	male	-.043	-.169	.157*	*omitted*
	risk	-.021**	.047	-.074	-.010
Proposing the middle option					
Player 1	male	-.067**	-.036	.036	-.012
	risk	.002	.003	-.016	.006
Player 2	male	-.056	.018	-.049	-.020
	risk	-.007	-.015	.003	-.008
Player 3	male	-.017	.056	.000	-.024
	risk	-.003	-.017	-.014	.004

Notes. The table shows the marginal effects of a logistic regression with the decision to accept (propose) the middle option as the dependent variable. 'Male' is equal to one if the subject is male and 'risk' is equal to the choice made in the risk-elicitation task in part III of the experiment (possible values are 1-7 where higher number indicate less risk-averse preferences). Standard errors are clustered at the matching group level. * (**; ***) denotes that the coefficient is significantly different from zero at the 10% (5%; 1%)-level.

[22] If we aggregate choices only over treatments but run regression for separate roles we find that the effect of 'risk' is only significantly negative for player 3 with p-values of 0.96 (0.77; 0.05) for player 1 (2;3). When aggregating over players and running separate regressions by treatments the only significant effect is a positive coefficient in treatment AsymPayAsymRec (p-value <0.01) while in the other three treatments the coefficients are negative and insignificant (SymPaySymRec: 0.25; SymPayAsymRec: 0.87; AsymPaySymRec: 0.43).

[23] If we aggregate choices only over treatment and have separate regressions for different roles all coefficients are insignificant (player 1: 0.63; player 2: 0.11; player 3: 0.30). The same holds true for aggregating by treatment (SymPaySymRec: 0.72; SymPayAsymRec: 0.50; AsymPaySymRec: 0.27; AsymPayAsymRec: 0.96)