Bargaining with Two-Person-Groups – On the Insignificance of the Patient Partner

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Abstract

Although many real bargaining situations involve more than two people, much of the theoretical and experimental research concentrates on the two player situation. We study the simplest possible extension: four people (two two-person groups) of different patience bargain with each other. Theoretically, only the more patient member of each group should be relevant for the outcome. The less patient members would agree to any outcome and are, hence, irrelevant. We find, however, that the impact of the patient member can be quite small.

JEL-Code: C780, D740.

Keywords: bargaining experiment, heterogeneous group members.

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1. Introduction

Bargaining is prevalent in many areas of social interaction. For example, employers bargain with employees, labor unions bargain with employers, political parties bargain with other political parties. Most situations have the potential of a mutually beneficial agreement. Nash (1950) defines a bargaining situation by the potential to reach a mutually beneficial agreement, the requirement of unanimity to implement such an agreement, and by a conflict of interest about which agreement to choose.

Such a bargaining situation can include two individuals negotiating with each other or it can include groups as negotiating parties. Bargaining individuals have already been investigated theoretically as well as experimentally (see Osborne and Rubinstein, 1990, for a theoretical and Roth, 1995, for an experimental overview). Inter-group bargaining, however, has received much less attention, although it is often groups that do the bargaining in real life: on a larger scale the labor unions and political parties from the examples above, on a smaller scale we have members of a team of researchers, members of a family, etc., who all negotiate situations which affect all members of the group and which require mutual consent.

Sequential bargaining experiments that are conducted inter-individually and anonymously are usually characterized by the following four properties (see Roth, 1995, p. 266). First, there is a consistent first-mover advantage. Second, average offers deviate from the perfect equilibrium prediction in the direction of an equal split. Third, second-movers reject a considerable proportion of first offers. And fourth, a substantial proportion of the participants that rejected the first offer make (in absolute terms) disadvantageous counterproposals to themselves.

Much of the bargaining literature models bargaining parties as individuals, although much of the real bargaining is done by groups. Families negotiate jointly with the seller of their new home, unions bargaing with employers, entire governments haggle with other governments about trade agreements, etc.. This is important since groups are known to behave differently from individuals in various strategic situations. More precisely, inter-group relations may be more competitive than inter-individual relations (see Wildschut et al., 2003, and Wildschut and Insko, 2007, for an overview of evidence on the so-called inter-individual – inter-group discontinuity effect). This behavioral difference might also play a role in inter-group bargaining. Nevertheless, there is relatively little experimental and theoretical literature on structured inter-group bargaining games.

There are only few bargaining experiments where at least one bargaining party consists of more than one person. Several of them only look at groups and make no comparison with the inter-individial situation. Messick et al. (1997) investigate ultimatum games where an individual interacts with a group of five people. The study asks how different decision rules of the five-person-group influence the individual's behavior, but it does not directly compare inter-individual to inter-group behavior. Hennig-Schmidt et al. (2002) and Hennig-Schmidt and Li (2005) compare alternating offers bargaining of 3-person-teams in Germany to 3-person-teams bargaining in China. Geng and Hennig-Schmidt (2007) analyze communication and quasi-communication in 3-person-groups playing ultimatum games. Hennig-Schmidt et al. (2008) analyze non-monotonic strategies of 3-person-groups in ultimatum games. All these video studies use groups rather than individuals as bargaining parties in order to generate data on spontaneous conversations which are then analyzed with respect to motives and cultural differences in bargaining. Again, they do not directly compare inter-individual to inter-group behavior.

Bornstein and Yaniv (1998) compare the behaviour of individuals with 3-person-groups in the ultimatum game. Within group discussions are allowed in their study. Since proposer groups make higher demands than individuals and acceptance rates are equal, Bornstein and Yaniv (1998) conclude that groups are more rational players in a game-theoric sense than individuals. Bornstein and Yaniv (1998) change several things between their treatments. In the inter-group case, they add face-to-face interaction and discussion within groups. Moreover, the number of people representing one bargaining party is changed for both parties at the same time.

In this paper, we will compare inter-individual with inter-group behavior. We will study the impact of three factors on bargaining behaviour: (1) the number of payoff-dependent, passive people, (2) the number of active people and (3) asymmetric power among players who belong to one small group. We will exclude face-to-face interaction as well as within and between group discussions. Our point of departure are Demidova and La Mura (2010) who extend Rubinstein's alternating offers bargaining game (see Rubinstein, 1982, 1985) to the simplest possible group case, namely to one individual bargaining with a two-person-group.[1]

2. Rubinstein's bargaining game and an extension by Demidova and La Mura (2010)

In a Rubinstein bargaining game with complete information (see Rubinstein, 1982), two players, player 1 and player 2, divide a pie of size one. Player 1 starts in round 1 and makes an offer how to divide the pie. If player 2 accepts, the offer is implemented and the game ends. If player 2 rejects, player 2 makes a counter-offer in round 2. If player 1 accepts this counter-offer, it is implemented and the game ends. If player 1 rejects, player 1 makes a counter-offer in round 3, and so forth. The game continues

[1]Demidova and La Mura (2010) analyze a situation where all group members are involved in each decision. Perry and Samuelson (1994), for instance, take another theoretical approach. They analyze a situation with two bargaining parties, one representing a (possibly large) constituency.

until an offer is accepted. To model the value of time, each player $i \in \{1,2\}$ has a discount factor $d_i \in (0,1)$. Whenever an offer is rejected and a new round begins, the value of the pie for each player shrinks according to the player's discount factor.[2] The higher a player's discount factor, the more patient and thus stronger is the player. The stronger she is, the higher her share will be. In the subgame perfect equilibrium of this game, player 1 offers in the first round $(1-d_2)/(1-d_1d_2)$ for herself and $1-(1-d_2)/(1-d_1d_2)$ for player 2. This offer will be immediately accepted by player 2. If players are equally patient, i.e. $d_1 = d_2$, then player 1 obtains the larger share of the pie.

Demidova and La Mura (2010) extend this situation to the simplest possible group case. There are three players: player 1, player 2 and player 3. The latter two are the members of the couple.[3] Players have to split a pie of size one between player 1 and the couple. The members of the couple enjoy their share of the pie as a public good. Player 1 starts in round 1 and makes an offer how to divide the pie. If both members of the couple accept, the offer is implemented and the game ends. If at least one member of the couple rejects, round 2 starts and independently both members of the couple make a counter-offer. Player 1 learns both counter-offers, but can only accept or reject the minimum (for him) of the two counter-offers. If he accepts, the offer is implemented and the game ends. If player 1 rejects, player 1 makes a counter-offer in round 3. The game continues like this until one offer is accepted. Each player $i \in \{1,2,3\}$ has his own discount factor d_i. The equilibrium of this game is equivalent to the equilibrium of a game in which player 1 bargains with the more patient member of the couple. E.g., if (without loss of generality) player 2 is more patient than player 3, i.e., $d_2 > d_3$, then in the subgame-perfect equilibrium player 1 will receive a share of $(1-d_2)/(1-d_1d_2)$ and the couple will receive a share of $1-(1-d_2)/(1-d_1d_2)$.

Demidova and La Mura (2010) extend these two situations to scenarios under one-sided incomplete information about time preferences. They also investigate how different negotiation formats influence individual welfare and overall efficiency. In our experiment we focus on the simple case of complete information. We compare the inter-individual bargaining situation with the individual-couple situation to answer the question: Do participants behave differently when bargaining with a couple than when bargaining with an individual?

While it is straightforward to calculate equilibria of the infinite bargaining game if players have selfish preferences, with social preferences together with asymmetries within one couple there may be no subgame perfect equilibria. To see this, let us have a look at the situation where player 2 and player 3 have different discount rates, e.g. $d_2 > d_3$. To simplify matters we disregard player 1 and, furthermore, assume that

[2]The pie is multiplied with the discount factor.

[3]Since using the word "group" for this aggregation of only two people might be problematic (see Harris et al., 2009), we will use the terms "two-person-group" or "couple" in the following.

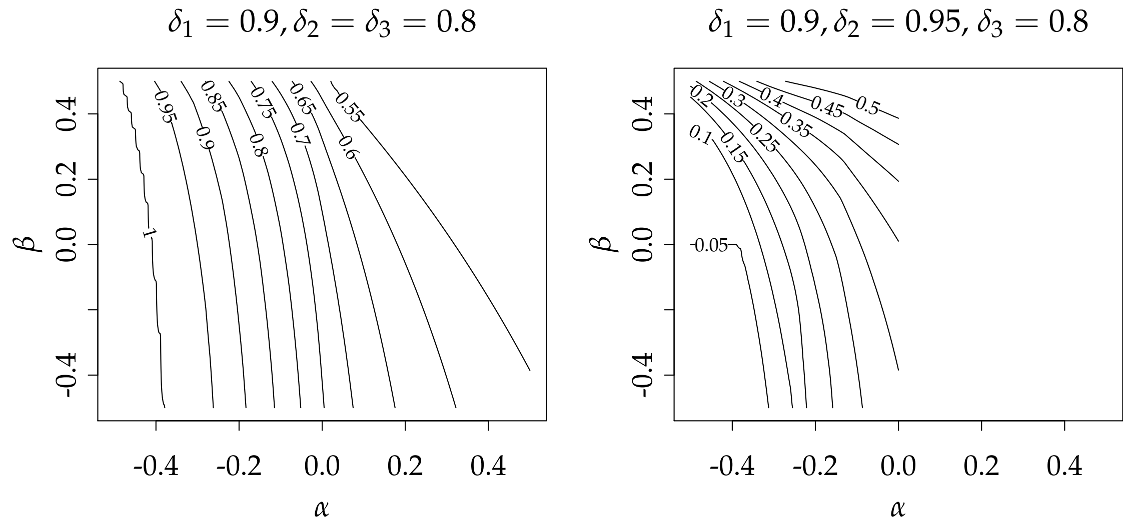


FIGURE 1: Equilibrium shares and social preferences
α and β correspond to the standard Fehr and Schmidt (2010) model. Contour lines show first round offers for player 1. We use a numerical approximation that starts the backward induction in round 100. We should note that for the case of asymmetric couples ($\delta_2 = 0.95, \delta_3 = 0.8$) there is no subgame perfect equilibrium for $\alpha > 0$.

players can be characterised by Fehr and Schmidt (2010) social preferences with inequality aversion $\alpha > 0$ (we will ignore β here). Then, if players 2 and 3, who belong to one couple, obtain a share x, player 3's utility in round n is $u_3 = \delta_3^n x - \alpha(\delta_2^n x - \delta_3^n x)$. Can we do backward induction and find an allocation that gives in period $n-1$ at least the same utility to player 3 as in period n? Even for a small positive α and a sufficiently large n we can not. The trouble is that when players look too far ahead into the future, they will realise that with asymmetries within a couple the payoff difference becomes quite large in relative terms but becomes smaller and smaller in absolute terms. Eventually, for any distribution x the more impatient player will prefer to wait.[4] Figure 1 shows how first round offers in the subgame perfect equilibrium depend on social preferences.

3. Design, predictions and procedures

We cannot simply go in one big step from standard two-person bargaining to bargaining of asymmetric two-person groups. This would not allow us to disentangle the effect of asymmetries within groups from the effect that just the number of decision

[4]More technically, for any $\alpha > 0$ and for any share $x \in (0,1)$ in round n, there exists an n such that for any division of payoffs in round $n-1$ either player 2 or player 3 or both players will prefer to wait.

TABLE 1: The four treatments

Treatment	Discount factors of players...				Equilibrium shares [%]	
	1A	1B	**2A**	2B	odd rounds	even rounds
2playerSingle	**0.9**	-	**0.8**	-	(71.4,28.6)	(64.3,35.7)
2player	**0.9**	0.9	**0.8**	0.8	(71.4,28.6)	(64.3,35.7)
3playerSym	**0.9**	0.9	**0.8**	**0.8**	(71.4,28.6)	(64.3,35.7)
3playerAsym	**0.9**	0.9	**0.8**	**0.95**	(34.5,65.5)	(31.0,69.0)

Note: In all treatments players would under the subgame-perfect equilibrium agree in round 1. In the experiment, we call the player 1s "red" and the player 2s "blue" to avoid that participants perceive an order of players according to the numbers 1 and 2. Bold type is used for active, normal type for passive players.

makers has increased or that the number of involved (payoff-dependent, but passive) people has increased. We will, therefore, go step by step and compare four treatments (see table 1). To control concerns for efficiency we keep the number of players on both sides always the same: Either one player is bargaining with one other player, or two players are bargaining with two other players. In treatments where only one player makes decisions, we call this player *active* and the other one *passive*. In order not to bore the passive players too much in the experiment, they are asked what they expect their partner to do each round. These expectations are not communicated to the other players.

Treatments are called "2playerSingle", "2player", "3playerSym" and "3playerAsym". The numbers in the names refer to the number of *active* players in each treatment. "Sym" and "Asym" refer to the (a)symmetry of bargaining power within the couple consisting of player 2A and player 2B.

2playerSingle In the baseline treatment, two individuals bargain with each other. Player 1 has a discount factor of $d_1 = 0.9$, player 2 of $d_2 = 0.8$.

2player In the second treatment, we add one passive player on each side: player 1B and player 2B. Player 1A and player 2A bargain with each other. Only the A-players are able to make offers and to accept or reject, the B-players are not, but receive the same payment as their partners. Both player 1s have a discount factor of $d_1 = 0.9$, both player 2s of $d_2 = 0.8$.

3playerSym In the third treatment, player 2B is an active player. When player 1A makes an offer, both player 2A and player 2B have to accept it for the game to end. If at least one of them rejects the offer, both make independent counter-offers. Player 1A learns both offers, but can only accept or reject the lower offer (for herself). In this treatment, player 2A and player 2B have the same discount factor $d_2 = 0.8$.

3playerAsym In the fourth treatment, the only thing we change is player 2B's discount factor which is now $d_{2B} = 0.95$.

During all treatments, we employ the binary lottery technique to control for risk preferences (see Roth and Malouf, 1979). Thus, participants actually bargain over lottery tickets, starting with a total number of 90 in round 1. The more lottery tickets a participant owns in the end, the higher her probability of winning a prize.

The discount factors are chosen to be multiples of 0.05 to keep the numbers as simple as possible for participants while ensuring a sufficiently large difference between player 2A and player 2B in "3playerAsym" and while getting a large difference in the subgame-perfect equilibrium prediction in terms of shares between "3playerSym" and "3playerAsym". In the subgame-perfect equilibrium of all four treatments, the first offer will be immediately accepted and the game ends in the first round. Equilibrium shares for player 1 and player 2 are the same for the first three treatments. The player 1s, who move first and who have higher discount factors, are stronger and get 71.4% of the pie in equilibrium. The player 2s are weaker and get only 28.6%. The fourth treatment ("3playerAsym") is different since there player 2B has a very high discount factor. Player 1s get only 34.5% in equilibrium while player 2s get 65.5%. As mentioned in section 2, the subgame-perfect equilibrium predictions in terms of shares are already known not to serve as precise point predictors but can still be useful to predict directions of behavior (see Roth, 1995). This is sufficient for our purposes since we are interested in differences between the number of involved bargainers and in how participants react to asymmetric power within the couple.

In November and December 2009, we conducted 13 experimental sessions at the economics laboratory at the University of Jena, Germany. 16 people participated per session, adding up to a total of 208 subjects.[5] Participants were invited using ORSEE (Greiner, 2004). 95% of our participants were students from Jena, 60% were female and 40% male participants. The average age was 23 years. As part of the lab policy to ensure that participants understood the instructions, only subjects that had passed a short German language test took part in the experiment. To ensure that participants had approximately the same level of experimental bargaining practice, only persons without prior experience in bargaining experiments in Jena were invited. Subjects participated in only one session of the experiment.

An experimental session proceeded as follows. Upon arrival, participants were randomly assigned to cubicles were they read the instructions.[6] Participants were not allowed to talk to each other. Questions of participants were answered privately in their cubicle. The experiment was programmed and conducted with z-Tree 3.3.6 (Fischbacher, 2007).[7] At the beginning of the experiment, participants had to answer five control questions. After the control questions, the bargaining started.

[5]See table 11 in appendix A for details.

[6]The instructions can be found in appendix B.

[7]An example screenshot can be found in appendix C.

We conducted two treatments per session. To introduce the game, we always started with "2playerSingle". The second treatment was then either "2player", "3player-Sym" or "3playerAsym". Players did not change their roles (player 1A, player 1B, etc.) during the experiment.[8] Each treatment was played for five periods.[9] At the end of each bargaining period, participants were asked to copy the results of this period into a table so that they had a record of the experiment's history.

Participants were randomly rematched after each period. To approximate the infinite horizon of the game as closely as possible, we did not explicitly limit the number of bargaining periods. Similar to Rapoport et al. (1990), we told subjects that they could take their time. However, if they needed "unexpectedly long", the computer would interrupt the current period. In fact, the computer was programmed to interrupt a period if more than 200 seconds[10] had elapsed or if all other groups had already reached agreement and the last group was already in round 8 or 9.[11] In case of such an interruption, the payoff was then calculated as if these players had, after the interruption, behaved like the average group of players.[12]

After the five bargaining periods, one period was chosen randomly for payment and a winning number was drawn to determine the winners of a prize. The experiment ended with a questionnaire in which we asked for demographic data. Each participant was then paid in private and dismissed. A session lasted on average about one and a half hours. Every participant received a 6 EUR show-up fee plus a potential prize of 10 EUR. On average, a participant earned 10.29 EUR during a session.

4. Results

4.1. Descriptives

In this section, we will give an overview of several experimental results for each treatment: first round demands, second round offers and the number of rounds needed to reach an agreement or until participants were stopped.[13] Whenever we refer to

[8] A player 1 in the first treatment could only be a player 1A or player 1B in the second treatment. A player 2 in the first treatment could only be a player 2A or player 2B in the second treatment.

[9] A period consisted of one or more rounds. In the first two sessions we tried 6 periods which turned out to be too much.

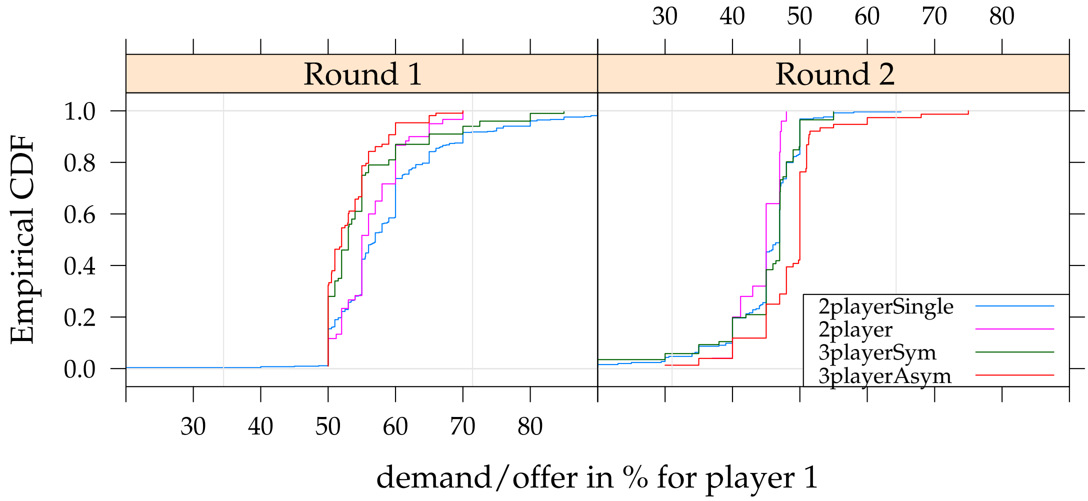
[10] 400 seconds in period 1, 300 seconds in period 2.

[11] The round was drawn as a random number.

[12] E.g., if bargaining was interrupted in round 8 and the average group of players in that session had reached an agreement of 50:50 in round 4, then the "interrupted" players would get 50:50, too, now discounted by 12 rounds.

[13] We had a small technical problem which, in our opinion, does not compromise the validity of our results: Participants were assisted by a visual tool when they made their choices. This tool would al-

FIGURE 2: Distribution of demands and offers for player 1 in the first two rounds



Vertical lines indicate the equilibrium offers (in the first round 34.5% for 3PlayerAsym, and 71.4% for all other treatments, in the second round 31% for 3PlayerAsym and 64.3% for all other treatments).

demand, offer or share, we mean the percentage for player 1 if not stated otherwise. We write first round *demands* as they are made by player 1s and second round *offers* as they are made by player 2s.

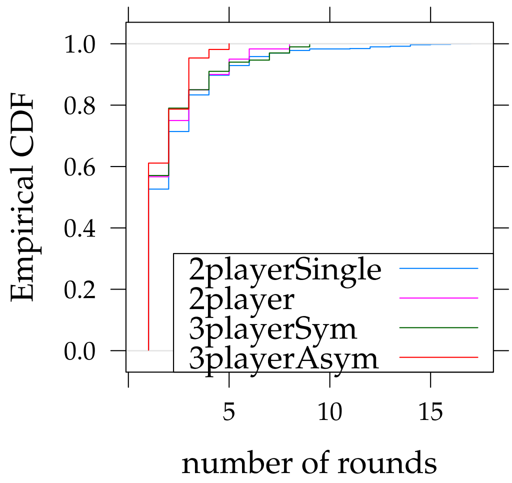
TABLE 2: Summary statistics by treatment

	2playerSingle	2player	3playerSym	3playerAsym
Mean first demand (%)	58.94	56.53	55.40	53.37
Mean second offer (%)	44.79	44.27	44.82	48.66
Mean number of rounds	2.27	2.02	2.03	1.67
Stopped participants (%)	7.46	3.33	6.99	7.41

The left panel in Figure 2 shows the empirical cumulative distribution function of the first round demand for the four treatments. In equilibrium we should expect a share

low them study the bargaining situation in an arbitrary period in the future. In some situations the number of lottery tickets shown by this tool was slightly too small for both players. Furthermore, in some situations the irrelevant of the player 2's offers was not transmitted correctly. Excluding the potentially affected data (9.89%) does not change qualitative results for the shares. Such an exclusion would, however, complicate the analysis for the number of rounds tremendously, since these technical problem could only occur after specific choices. We decided, hence, to report the following results using all data.

FIGURE 3: Distribution of the number of rounds



of 71.4% for player 1 except for "3PlayerAsym" where the share is 34.5%. In the experiment the majority of first round demands is between 50% and 60%. Table 2 shows summary statistics for each treatment. First round demands are, on average, highest for "2playerSingle", lowest for "3playerAsym" and intermediate for "2player" and "3playerSym".

The right panel in Figure 2 shows the empirical cumulative distribution function of the second round offer for each treatment. In equilibrium we should expect a share of 64.3% for player 1 except for "3PlayerAsym" where the share is 31%. In the experiment, the majority of second round offers is between 40% and 50%. Largest are offers for "3playerAsym". Offers for the other three treatments are smaller and rather similar. Table 2 shows the mean second round offers for each treatment. Again, second round offers are, on average, very similar for "2playerSingle", "2player" and "3playerSym", and higher for "3playerAsym".

Figure 3 shows the empirical cumulative distribution function of the number of rounds needed to reach an agreement or until partcipants were stopped[14] for each treatment. In all treatments, at least 50% of the participants reached an agreement immediately in round 1. The line for "3playerAsym" is always above the other three lines, indicating that participants needed fewer rounds in "3playerAsym" than in the other treatments. Table 2 shows the mean number of rounds for each treatment. It confirms the observation that participants needed, on average, approximately the same num-

[14]In all cases in which participants were stopped, we add one round to the round in which they were stopped as these participants could have agreed one round after they were stopped at the earliest.

ber of rounds in “2playerSingle”, “2player” and “3playerSym”, and needed fewest rounds in “3playerAsym”.

Figure 2 and 3 as well as table 2 also include participants who were stopped in the bargaining process because they took more than the allowed time or number of rounds to reach an agreement. The corresponding frequencies are shown in table 2 and range from 3.33% to 7.46%.

4.2. Does the number of payoff-dependent, passive people make a difference?

In a first step we compare “2playerSingle” and “2player”. The “2player” treatment is identical to the “2playerSingle” treatment, except that each player also decides for a passive partner who has no voice in the bargaining process at all. According to table 1 we should expect no difference. Since we start each session of the experiment with a “2playerSingle” treatment and then move on to one of the other three treatments, we can not disentangle differences between “2playerSingle” and “2player” from pure learning.

Figure 2 and table 2 already indicate that the second round offers are, indeed, very similar. We therefore refrain from estimating a regression. Nevertheless, Figures 2 and 3 show small differences in first round demands and in the number of rounds. We will present the results of three regression models in this section to test whether these effects are significant.

For the first round demands, we estimate a simple linear mixed effects model which regresses the first round demand on the treatments.

$$firstRoundDemand = \beta_0 + \beta_{2Player} \cdot d_{2Player} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (1)$$

Here, and in all following estimations, we include random effects for sessions ϵ_k and subjects ϵ_i. The residual is ϵ_{it}. The reference treatment is “2PlayerSingle”. The dummy $d_{2Player}$ is one in the 2Player-treatment and zero otherwise. Unless mentioned otherwise standard deviations, confidence intervals and p-values are based on bootstraps with 5000 replications.[15] Estimation results are reported in table 3.[16] The coefficient of $d_{2Player}$ is negative and significant at the 5% level indicating that first round demands are significantly lower in “2player” than in “2playerSingle”.

Let us continue with the number of rounds. Here, a generalized linear mixed effects model where the number of rounds follows a Poisson distribution could be adequate.

[15] p-values are obtained via the function “pvals.fnc()” from the statistical software R (see R Development Core Team, 2011), using 5000 bootstrap replications for this and for all following estimations.

[16] Q-Q normal plots of these and of all following estimated residuals can be found in appendix D.

TABLE 3: Linear mixed effects estimation of equation 1, treatments: "2playerSingle", "2player"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	58.947	57.488	60.4369	0.0002
2player	-3.006	-5.388	-0.4356	0.0216

Note: HPD95lower is the lower endpoint of the 95% highest posterior density interval of the respective coefficient. HPD95upper is the upper endpoint of this interval. pMCMC is the p-value based on Markov chain Monte Carlo samples.

TABLE 4: Generalized linear mixed effects estimation of equation 2, treatments: "2playerSingle", "2player"

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.6434	0.0615	10.4555	0.0000
2player	-0.0104	0.0863	-0.1207	0.9039

Since bootstrapping p-values for such a model is computationally expensive, we rely on the standard p-values provided by `glmer` in R. In addition we estimate a logarithmic model where we can (within reasonable time) bootstrap p-values and confidence intervals.

$$P(numberOfRounds = n) \sim \text{Poisson}(n|\lambda = \beta_0 + \beta_{2Player} \cdot d_{2Player} + \epsilon_k + \epsilon_i) \quad (2)$$
$$\log(numberOfRounds) = \beta_0 + \beta_{2Player} \cdot d_{2Player} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (3)$$

The estimation of equation (2) with standard p-values is shown in table 4, the estimation of equation (3) with bootstrapped p-values is shown in table 5. Both estimates find no significant difference in the number of rounds between the two treatments.

To summarize, we find no evidence that adding two passive people to the bargaining process influences second round offers or the number of rounds. However, we find evidence that adding two passive people to the bargaining process leads to lower first round demands although there should not be any differences according to the predictions in table 1.

4.3. Does the number of active bargainers make a difference?

Next, we make the formerly passive players active and compare treatments "2player" and "3playerSym". According to table 1, there should not be any difference.

Figure 2 and table 2 already reveal that the second round offers and number of rounds are similar. We, therefore, refrain from estimating regressions. Nevertheless, Figure 2

TABLE 5: Linear mixed effects estimation of equation 3, treatments: "2playerSingle", "2player"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	0.4792	0.3715	0.5733	0.0002
2player	-0.0243	-0.1608	0.1051	0.7312

TABLE 6: Linear mixed effects estimation of equation 4, treatments: "2player", "3playerSym"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	56.528	52.956	59.995	0.0002
3playerSym	-1.127	-5.914	3.076	0.5792

shows a small difference in first round demands. We, thus, estimate the following mixed effects model:

$$firstRoundDemand = \beta_0 + \beta_{3playerSym} \cdot d_{3playerSym} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (4)$$

The reference treatment is "2player". The dummy $d_{3playerSym}$ is one in the "3playerSym" treatment and zero otherwise. Results are reported in table 6. The effect of *3playerSym* is negative but not significant at any conventional level.

To summarize, there is no evidence that turning one passive player 2 into an active player 2 influences first round demands, second round offers or the number of rounds. This is in line with the predictions in table 1.

4.4. How do participants react to asymmetric power within the two-person-group?

Let us now turn to the question how participants react to asymmetric power. To do this we will compare treatments "3playerSym" and "3playerAsym". According to table 1, first round demands should be lower by 36.9 percentage points in "3playerAsym" than in "3playerSym". No other differences are predicted.

Figure 2 and table 2 already indicate that there are small differences regarding first round demands, second round offers and the number of rounds. We will present the results of four regression models in this section to show if any of these effects is significant.

For first round demands, we estimate the following model:

$$firstRoundDemand = \beta_0 + \beta_{3playerAsym} \cdot d_{3playerAsym} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (5)$$

TABLE 7: Linear mixed effects estimation of equation 5, treatments: "3playerSym", "3playerAsym"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	55.40	53.228	57.63	0.0002
3playerAsym	-2.13	-5.317	1.04	0.1668

TABLE 8: Linear mixed effects estimation of equation 6, treatments: "3playerSym", "3playerAsym"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	44.754	43.055	46.495	0.0002
3playerAsym	3.974	1.449	6.299	0.0040

The baseline treatment is "3playerSym". The dummy $d_{3playerAsym}$ is one on the treatment "3playerAsym" and zero otherwise. Results are reported in table 7.

The estimate for *3playerAsym* is negative as we would expect from table 2 but not significantly different from zero at any conventional level. It is, however, significantly larger than the theoretical prediction of -36.9 percentage points

($p \leq 0.0000$).

For second round offers, we estimate the following model:

$$secondRoundOffer = \beta_0 + \beta_{3playerAsym} \cdot d_{3playerAsym} + \epsilon_k + \epsilon_i + \epsilon_{it} \tag{6}$$

The results are reported in table 8. The estimate for *3playerAsym* is positive as we would expect from table 2 and is significant at the 1% level. This indicates that second round offers are significantly higher when we increase player 2B's discount factor.

Similar to the comparison of "2playerSingle" with "2Player" (equations 2 and 3) we compare now the number of rounds in the treatments "3playerSym" and "3playerAsym". We estimate equations 7 and 8.

$$P(numberOfRounds = n) \sim \text{Poisson}(n|\lambda = \beta_0 + \beta_{3playerAsym} \cdot d_{3playerAsym} + \epsilon_k + \epsilon_i) \tag{7}$$

$$\log(numberOfRounds) = \beta_0 + \beta_{3playerAsym} \cdot d_{3playerAsym} + \epsilon_k + \epsilon_i + \epsilon_{it} \tag{8}$$

Results are reported in tables 9 and 10. The effect of 3playerAsym is not significant in either model.

To summarize, there is no evidence that asymmetric power within the couple influences first round demands although lower first round demands are predicted according to table 1. Moreover, there is no evidence that asymmetric power within the

TABLE 9: Generalized linear mixed effects estimation of equation 7, treatments: "3playerSym", "3playerAsym"

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.6603	0.0948	6.9657	0.0000
3playerAsym	-0.1855	0.1352	-1.3724	0.1700

TABLE 10: Linear mixed effects estimation of equation 8, treatments: "3playerSym", "3playerAsym"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	0.4691	0.3021	0.6459	0.0002
3playerAsym	-0.1003	-0.3457	0.1347	0.3672

couple influences the number of rounds. Quite unexpectedly, we find evidence that asymmetric power within the couple leads to higher second round offers although these should be smaller in equilibrium.[17]

5. Discussion and conclusion

In this paper, we compared inter-individual bargaining with the simplest possible inter-group case, namely one individual bargaining with a two-person-group. We studied the impact of three factors on bargaining behaviour: (1) the number of payoff-dependent, passive people, (2) the number of active people and (3) asymmetric power among players who belong to one small group. Unlike Bornstein and Yaniv (1998), we excluded face-to-face interaction and group discussions.

Although we use a sequence of treatments where the predicted effect of asymmetry within one party in the bargaining process is rather large, we found that in the experiment whatever effect we observe is rather small. To some degree this is a common finding in bargaining experiments. Also in experiments with single decision makers players do not react too much to changes in discount factors (see, e.g., Ochs and Roth, 1989). Still, we have the impression that we have given the effect of asymmetries within a party a good chance.

We learned that although the equilibrium does not predict any differences, (1) the number of payoff-dependent, passive people has an effect on first round demands. Adding one passive player on each side leads to lower first round demands. We did not find effects on second round offers and the number of rounds. (2) As we

[17]In addition, the second round would not be reached in equilibrium in any of the treatments.

would expect according to the game-theoretic predictions, we did not find any effects of the number of active bargainers. (3) First round demands (and second round offers, should they ever be reached) are predicted to be lower with asymmetric power within the couple. The number of rounds is not predicted to change. We did not find any significant effects on first round demands. Instead, we learned that asymmetric power within the couple leads to significantly higher second round offers. We did not find an effect on the number of rounds.

There are at least two possible explanations for our results. One explanation could be that participants react to more complex situations by offers which are closer to the equal split. "3playerAsym" is more complex than "3playerSym" which is more complex than "2player" which is more complex than "2playerSingle". Table 2 shows that first round offers decrease as we move from one treatment to the other. Nevertheless, only the difference between "2playerSingle" and "2player" is significant, but this might be due to the higher number of observations in "2playerSingle".[18] This could also explain why second round offers are closer the equal split in "3playerAsym". As it is the most complex treatment, participants react by moving closer to the norm or focal point of an equal split. It does, however, not explain why we do not find any differences between second round offers for the other three treatments.

Another explanation could be the influence of intra-group dependence. Maybe participants feel responsible for their dependent group member and therefore make lower first round demands to increase the probability that the demands are immediately accepted. This could explain why the first round offers are significantly lower in "2player" compared with "2playerSingle", and why we do not find significant differences between the other treatments. If the crucial point is the dependent group member, we should expect a difference only between "2playerSingle" and "2player" as the dependent group members are absent in "2playerSingle", but present in "2player". This could also explain why second round offers are higher in "3playerAsym". The strong member of the couple may feel responsible for the weaker member and therefore offer more to the player 1s in round 2. But this does not explain why we do not find any differences regarding second round offers between "2playerSingle" and "2player".

In any case, since this experiment was not designed to distinguish between different explanations, these questions remain for future research. We conclude that, even though the number of bargainers does not change the strategic aspects of the game, they may significantly influence the bargaining process. Furthermore, asymmetric power within a two-person-group, which does change the strategic aspects of the

[18]First, as mentioned in section 3, we always started a session with "2playerSingle" to introduce the game. The second treatment was then either "2player", "3playerSym" or "3playerAsym". Second, there were more units of observation in "2playerSingle" as a bargaining party consisted of 1 person only. In "2player", "3playerSym" and "3playerAsym", a bargaining party consisted of two persons.

game and should, therefore, influence the bargaining process, influences it differently than predicted.

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A. Number of sessions and participants

Table 11 shows the number of sessions and participants for the different treatments. In each session, 2playerSingle was followed by one of the other treatments. Hence, the total numbers are not the sum of all entries in a row.

TABLE 11: Number of sessions and participants

	2playerSingle	2player	3playerSym	3playerAsym	Total
Sessions	13	3	5	5	13
Participants	208	48	80	80	208

B. Instructions

The following is a translated version of the German instructions for "2PlayerSingle". The instructions for "2Player", "3PlayerSym" and "3PlayerAsym" appeared on the screen after "2PlayerSingle" was finished. Apart from the number of players and discount factors, respectively, they are very similar to those for "2PlayerSingle" and are available from the corresponding author upon request.

Welcome to this experiment!

By participating, you support our research and you can earn money in return. The amount you will earn depends on your and on the other participants' decisions. The experiment is financed by the Friedrich Schiller University Jena. It is important to read the following instructions very carefully in order to understand how the experiment will proceed. None of the other participants will receive any information on your decisions or on your payoffs. All data will be treated confidentially and will be used exclusively for research.

Questions Should you have questions at any point in time, please raise your hand. We will answer your question privately. Please do not ask your question in a loud voice. If a question is relevant for all participants, we will repeat it in a loud voice and answer it.

General rules All participants of this experiment have received the same instructions. However, the information that participants will see on their screens during the experiment is only intended for the respective participant. Therefore, please do not look at other screens and do not talk to other participants. Please turn off your mobile phones now. You will be excluded from the experiment if you break any of these rules. In this case, you will not be paid.

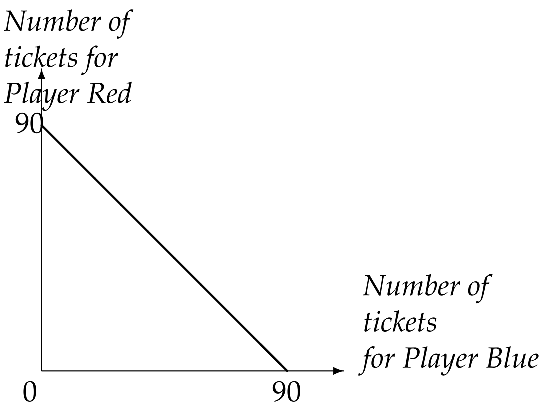
Procedure and payment The experiment consists of two parts and a concluding questionnaire. Every *part* consists of several *periods*, which in turn can consist of several *rounds*. You will learn the respective number during the experiment. In the end, all participants will receive a show-up fee of 6.00 €, irrespective of the decisions they will have made during the experiment. In addition, we will raffle several prizes of 10.00 € at the end of the experiment. Your chances to win one of these prizes depend on your and the other participants' decisions during the experiment and will be explained in the following paragraphs.

Part 1 The first part consists of five periods. There are two roles: Player Red and Player Blue. First, the computer will determine randomly, who of you will become Player Red and who will become Player Blue. (You will keep these roles during the whole part 1. This means, if you are Player Red in the first period, you will stay Player Red in the following periods and if you are Player Blue in the first period, you will stay Player Blue in the following periods.) In each period, every two participants play together: one Player Red and one Player Blue. At the beginning of each period, the computer matches you anonymously and randomly with another participant. Your task is to divide (initially) 90 lottery tickets between you and the other participant. The more lottery tickets you own in the end, the higher your probability to win a prize of 10.00 €.

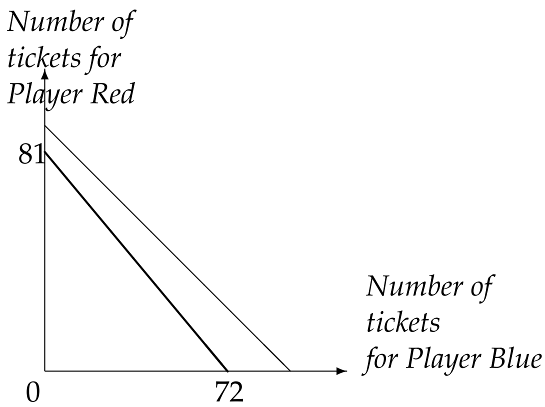
The first period starts with round 1 and Player Red proposes a proportion how to divide the lottery tickets between himself and Player Blue, i.e., x % for himself and (100 - x) % lottery tickets for Player Blue. (x does not have be integer, also fractions can be divided.) Player Blue can now accept or reject the proposal. If he accepts, the 90 lottery tickets will be divided accordingly and the first period will end in round 1.

However, if Player Blue rejects the proposal, round 2 starts. At the beginning of round 2, the maximum number of available lottery tickets is reduced: by 10 % for Player Red, by 20 % for Player Blue. Player Blue now makes a counter-proposal according to which proportion the remaining lottery tickets should be divided between himself and Player Red. Subsequently, Player Red can accept or reject this proposal. If he accepts, the lottery tickets are divided accordingly and the first period ends in round 2.

Possible divisions of tickets (rd. 1)



Possible divisions of tickets (round 2)



The diagrams illustrate the possible divisions in round 1 and in round 2. The points *on* the bold lines represent all possible divisions. Example: In round 2, Player Red could receive 100% of his maximum number of available lottery tickets (81 tickets), consequently, Player Blue would receive 0 % of his maximum number of available lottery tickets (72 tickets). Or Player Red could receive 0% of his maximum number of available lottery tickets (81 tickets), consequently, Player Blue would receive 100% of his maximum number of available lottery tickets (72 tickets). All divisions in between that add up to 100 % are also possible.

If Player Red rejects Player Blue's proposal, round 3 starts and the number of lottery tickets is reduced like in the previous round: by further 10 % for Player Red, by further 20 % for Player Blue. Player Red then makes a counterproposal according to which proportion to divide the remaining lottery tickets between himself and Player Blue. Subsequently, Player Blue can accept or reject this proposal like in round 1 and so on. The maximum number of available lottery tickets is reduced by 10 % for Player Red and by 20 % for Player Blue at the beginning of each new round, i.e., every time a proposal is rejected. A period will end only if a proposal is accepted.

When the first period will have ended, the second period will start. The task will be the same, namely to divide (initially) 90 lottery tickets between you and the other participant.

We have planned enough time for each period and you can take your time to reach an agreement with the other participant. However, if you take unexpectedly long to reach an agreement, the computer will break off the current period. In this case, you will receive from your remaining lottery tickets in that round the proportion that the other participants received on average. In case all other participants should also not yet have reached an agreement, the computer will determine a division.

Part 2 You will receive the instructions for part 2 including your player role after part 1 has ended.

Drawing When all parts of the experiment will have ended, two things will be drawn: the period relevant for payment and the participants winning a prize of 10.00 €.

1. First, out of all periods one period relevant for payment will be drawn. For this purpose, a volunteer will draw a table tennis ball out of a container with as many table tennis balls as there are periods. The number of the drawn ball determines the payoff relevant period for all participants. The other periods will not be considered when paying the participants.

2. Subsequently, the participants winning a prize will be drawn. Assume that Player Red has received x lottery tickets and Player Blue has received y lottery tickets in the payoff relevant period with x+y $\leq$ 90. First, each player's lottery ticket interval is determined. Player Red receives the interval from 0 (inclusive) to x (inclusive), Player Blue receives the interval from x (exclusive) to x+y (inclusive). (Player Blue's interval ranges up to 90 maximum since only 90 can be divided.) If two participants agreed on 3 lottery tickets for Player Red and 4 lottery tickets for Player Blue, Player Red would receive the interval from 0 (inclusive) to 3 (inclusive). Player Blue's interval would range from 3 (exclusive) to 7 (inclusive). Afterwards, the winning number (the same for all participants) is drawn. For this purpose, a volunteer draws a table tennis ball six times with replacement out of a second container. Ten table tennis balls numbered from 0 to 9 are in this second container.

   The number of the first ball determines the tens digit of the winning number.

   The number of the second ball determines the units digit.

   The number of the third ball determines the first digit after the decimal point.

   The number of the fourth ball determines the second digit after the decimal point.

   The number of the fifth ball determines the third digit after the decimal point.

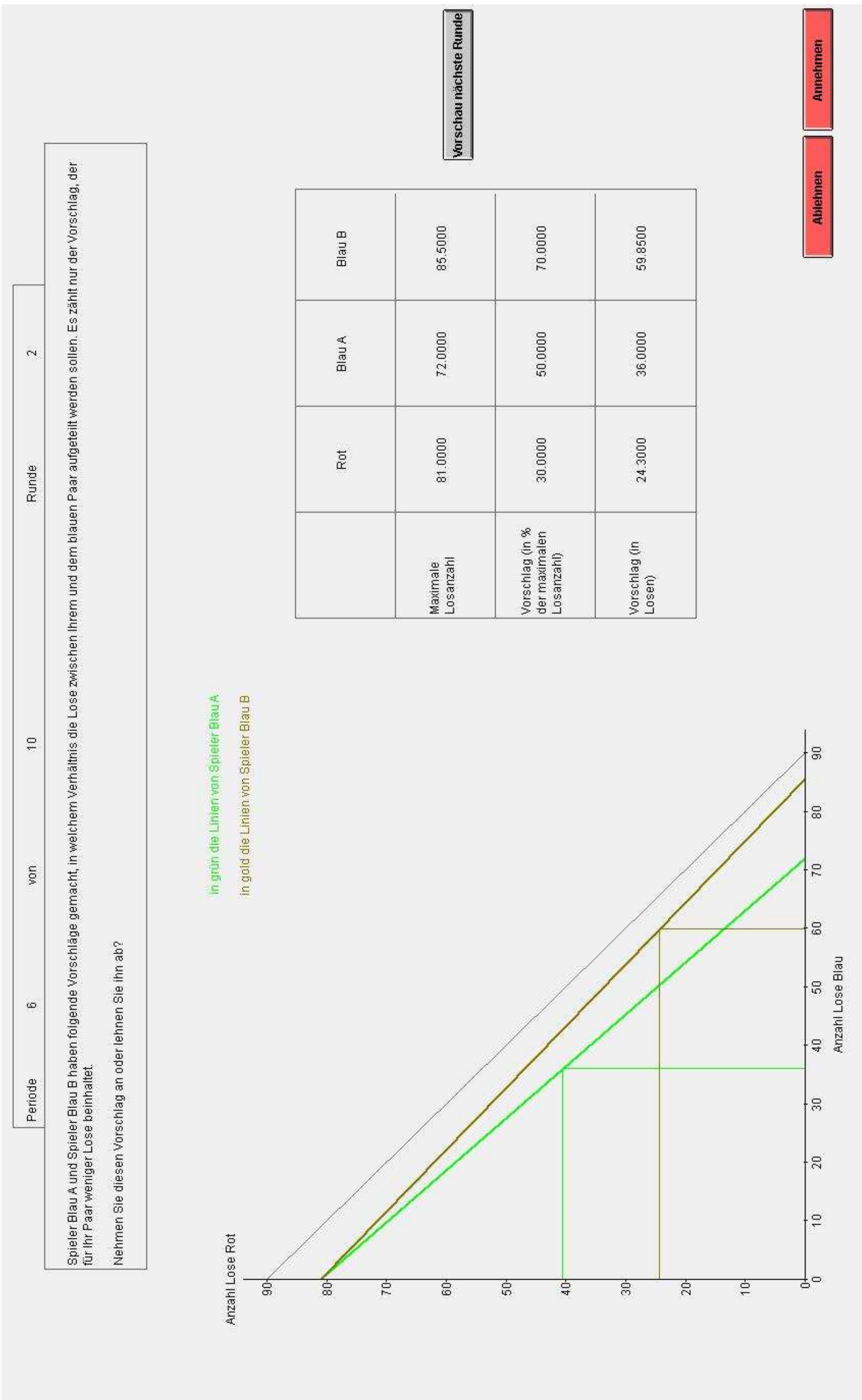
   The number of the sixth ball determines the fourth digit after the decimal point.

   For each pair consisting of Player Red and Player Blue it is checked in which interval the winning number is located. The player whose interval contains the winning number will receive one of the prizes of 10.00 €, the other will not. In case a winning number larger than 90 is drawn, a new winning number will be drawn. In case a winning number smaller or equal 90 is drawn but is is not in the range of neither Player Red's nor Player Blue's interval, no member of this couple will receive a prize. (This possibility exists since the number of available lottery tickets is reduced each round.)

Please wait until all participants have finished reading the instructions. We will announce the start of the experiment.

We wish you success in the experiment!

C. Example screenshot



D. Q-Q plots

FIGURE 4: Q-Q normal plots of the estimated residuals of table 3

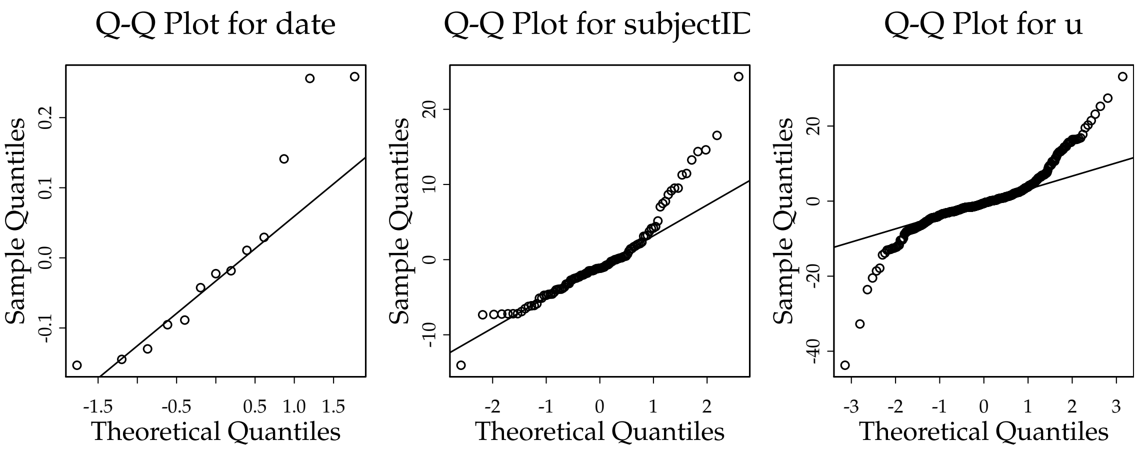


FIGURE 5: Q-Q normal plots of the estimated residuals of table 4

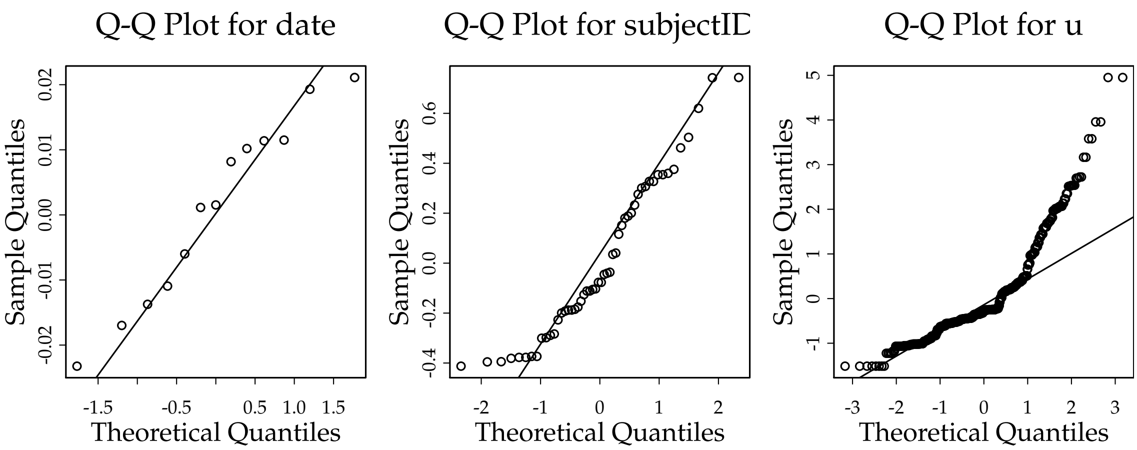


FIGURE 6: Q-Q normal plots of the estimated residuals of table 5

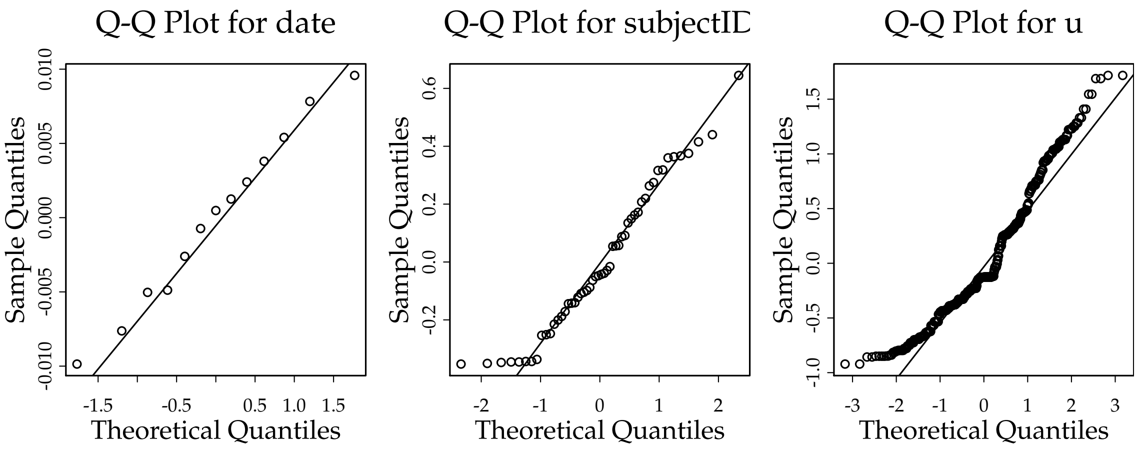


FIGURE 7: Q-Q normal plots of the estimated residuals of table 6

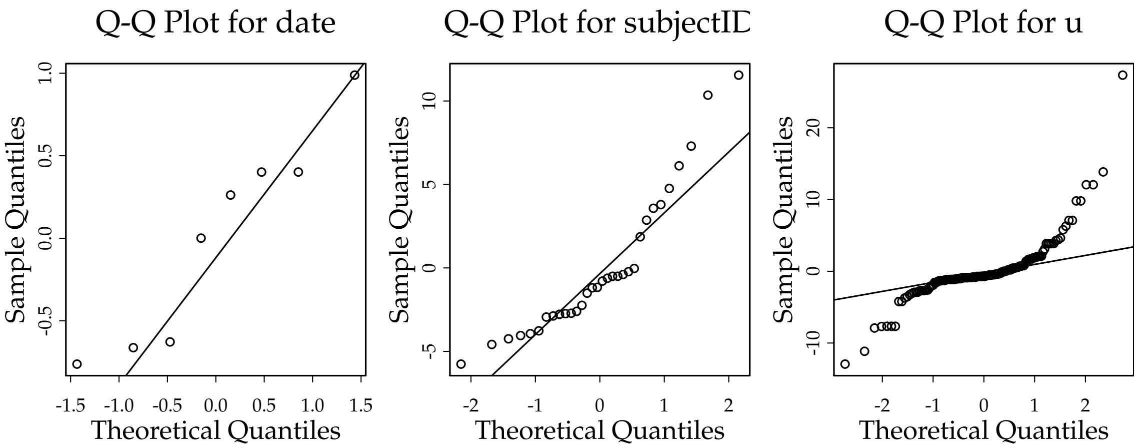


FIGURE 8: Q-Q normal plots of the estimated residuals of table 7

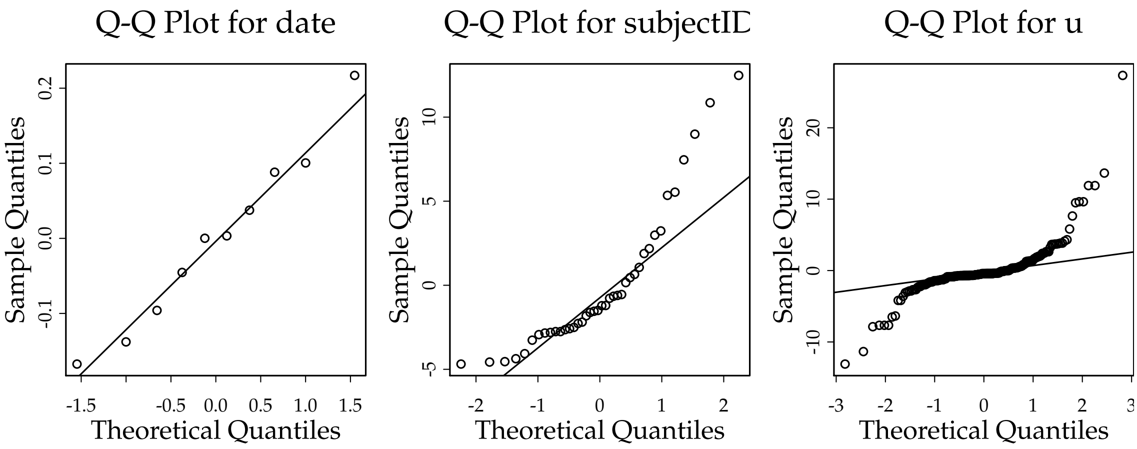


FIGURE 9: Q-Q normal plots of the estimated residuals of table 8

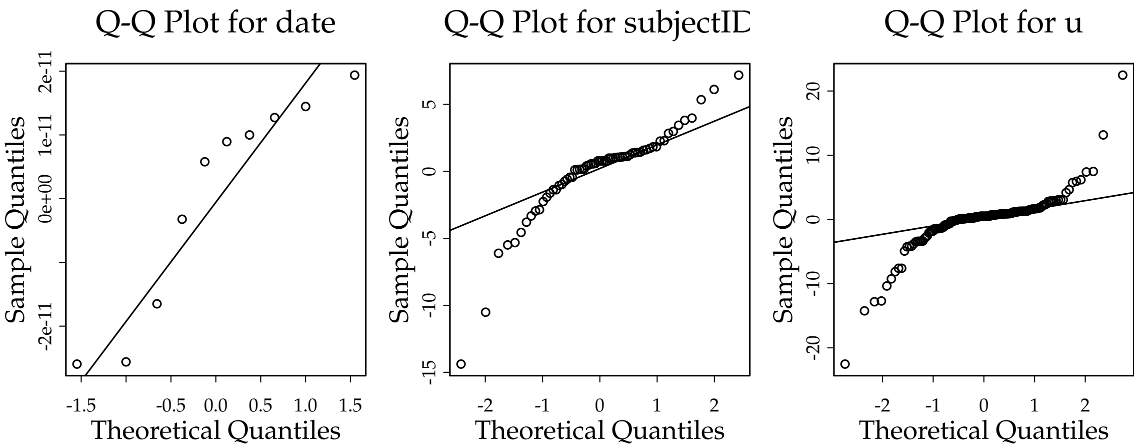


FIGURE 10: Q-Q normal plots of the estimated residuals of table 9

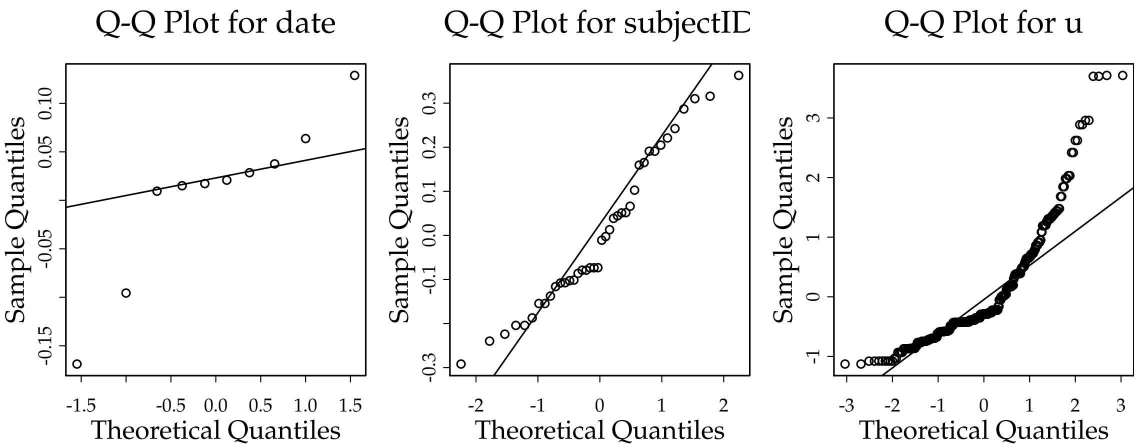


FIGURE 11: Q-Q normal plots of the estimated residuals of table 10