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Are groups more rational, more competitive or more prosocial bargainers?*

Ulrike Vollstädt[†] Robert Böhm[‡]

August 2012

Abstract

In reality, it is often groups rather than individuals that make decisions. In previous experiments, groups have frequently been shown to act differently from individuals in several ways. It has been claimed that inter-group interactions may be (1) more competitive, (2) more rational, or (3) more prosocial than inter-individual interactions. While some of these observed differences may be due to differences in the experimental designs, it is still not clear which of the three motivations is prevailing as they have often been behaviorally confounded in previous experiments. We use Rubinstein's alternating offers bargaining game to compare inter-individual with inter-group behavior since it allows separating the predictions of competitive, rational and prosocial behavior. We find that groups are, on average, more rational bargainers than individuals.

KEYWORDS: alternating offers bargaining experiment, inter-group behavior, inter-individual behavior

JEL CLASSIFICATION: C78, D70

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1 Introduction

In reality, it is often groups rather than individuals that make decisions. For example, a group of European Union member states decides on changes in economic policy. Members of a political party negotiate whether they should form a coalition with another party. A board of directors decides on whether or not to buy another company. A family decides on where to go during the summer holidays. While the family holiday decision is an intra-group interaction, the coalition decision is an inter-group interaction. Inter-group interactions have already been investigated experimentally to a large extent, but with seemingly inconsistent results. In previous experiments, groups have frequently been shown to act differently from individuals in several ways. It has been claimed that inter-group interactions may be (1) more competitive, (2) more rational, or (3) more prosocial than inter-individual interactions. This paper aims to disentangle these three kinds of behavior.

According to early social psychological research (see Messick and McClintock, 1968; Kelley and Thibaut, 1978), the desire to maximize the *difference* between oneself and another party represents a competitive orientation. Most of the research on the so called inter-individual – inter-group discontinuity effect concludes that groups are “more competitive, or less cooperative” than individuals (see Wildschut et al., 2003; Wildschut and Insko, 2007). Using the prisoner’s dilemma game, it is shown that groups choose to “defect” more often than individuals which can be interpreted as groups being more competitive than individuals. In addition, Trötschel et al. (2010) find in two negotiation experiments that having a salient group rather than individual identity is enough to lead to inferior negotiation outcomes. These authors as well interpret their findings as groups being more competitive than individuals. Nevertheless, rational behavior is confounded with competitive behavior in these experiments. Consider, for example, the prisoner’s dilemma game. Choosing to “defect” can be interpreted as competitive *and* as rational behavior because it maximizes both the relative difference between parties (if the other player is expected to choose to “cooperate”) *and* the absolute outcome.

We use the term “rational” in the standard game-theoretic sense. Accordingly, rational behavior is motivated by the desire to maximize one’s *own* outcome (see von Neumann and Morgenstern, 1944; Kelley and Thibaut, 1978). Several papers on differences between inter-individual and inter-group behavior conclude that groups as opposed to individuals are more

rational players because group members may gain rational insight into the game's structure due to an intra-group discussion prior to the inter-group interaction. Therefore, group behavior may be closer to the subgame-perfect equilibrium prediction than individual behavior. For example, Bornstein and Yaniv (1998) find that groups demand more in the ultimatum game than individuals and are willing to accept even low offers. Similarly, it has been shown that groups exit the centipede game earlier (Bornstein et al., 2004), send less in the trust game (Kugler et al., 2007), and give less in the dictator game (Luhan et al., 2009) compared to individual players. Nevertheless, rational behavior is confounded with competitive behavior in these experiments as well because all observed differences in behavior increase both the relative difference between parties *and* the absolute outcome.

According to van Lange's integrative model of social value orientation (see van Lange, 1999), prosocial behavior is motivated by enhancing both joint outcomes (efficiency) as well as equality in outcomes (fairness). There are few papers that find groups to be more prosocial than individuals. Cason and Mui (1997) find that groups give on average *more* in the dictator game. Morgan and Tindale (2002) find that groups earn more points in a bargaining task. Müller and Tan (2011) find that groups choose lower quantities as first movers and higher quantities as second movers in a sequential Stackelberg game. Nevertheless, these experiments confound prosocial with rational behavior. For example, Morgan and Tindale's results of earning more points in a bargaining task not only increases efficiency, but also a party's own outcome. Unlike most other experiments which are one-shot, Müller and Tan (2011) run their experiment 15 periods (all of whom are paid). With a longer time-horizon, behaving prosocially may also be motivated by rationality as it increases efficiency and a party's own outcome.

One exception are Cason and Mui's results (1997) which show clearly more prosocial behavior that is not confounded with rationality or competitiveness. However, they have not been replicated so far. In contrast, as mentioned in the previous paragraph, Luhan et al. (2009) even find the opposite when attempting to replicate Cason and Mui's results, namely, that groups give less in the dictator game. According to Luhan et al. (2009), one reason for the different results may be differences in the experimental designs. Cason and Mui (1997) call members of one group to the front of the room (by numbers) before making their decision while most other experiments do not identify group members to other (out-group) participants. According to Bohnet and Frey (1999), identifying group members

to out-group participants (even without presenting decisions) may lead to higher transfers.

Apart from Cason and Mui (1997), there are more differences in the experimental designs which may explain some of the observed differences in inter-group behavior. For example, many psychological experiments on the discontinuity effect are not incentivized with money whereas economic experiments usually are. Not paying subjects may lead to more competitive or to more prosocial behavior (see, for example, Camerer and Hogarth, 1999, for an overview on the effects of financial incentives). Many experiments use groups that actually consist of several persons while, for instance, Trötschel et al. (2010) observe individuals with a salient group or individual *identity* instead. For the experiments where groups consist of more than one person, communication within groups also varies. Only if within group communication is allowed, may group members gain rational insight into the game's structure due to an intra-group discussion prior to the inter-group interaction.

Although these differences in experimental designs might partly account for the different results, it is still not clear which of the three motivations – competitive, rational or prosocial – is prevailing in inter-group interactions as they have often been behaviorally confounded in previous experiments. To our knowledge, there exists no experiment that clearly distinguishes between these three kinds of behavior in one game. We use Rubinstein's alternating offers bargaining game (Rubinstein, 1982) to compare inter-individual with inter-group behavior since it is possible to separate the predictions of competitive, rational and prosocial behavior in this game. Besides, we contribute to the existing literature on bargaining that has so far mainly focused on inter-individual negotiations.¹ Rubinstein's bargaining game is particularly suited because it captures important characteristics of a negotiation: a potential to reach a mutually beneficial agreement, but also a conflict of interests about which agreement to choose, and

¹Apart from Bornstein and Yaniv (1998), we are aware of few bargaining experiments in which at least one bargaining party consists of more than one person. Messick et al. (1997) investigate ultimatum games in which an individual interacts with a group of five persons. Hennig-Schmidt et al. (2002) and Hennig-Schmidt and Li (2005), for instance, compare alternating offers bargaining of 3-person-teams in Germany to 3-person-teams negotiating 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 playing ultimatum games. However, none of them directly compares inter-individual to inter-group behavior.

both parties' approval as a requirement to reach any agreement (see Nash, 1950). In contrast to simpler bargaining games like the ultimatum game, Rubinstein's bargaining game moreover allows to examine the process of a negotiation.

2 Rubinstein's bargaining game

Individual Rubinstein bargaining under complete information works as follows (see Rubinstein, 1982). There are two players: player 1 and player 2. They split a pie of size one between them. 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, round 2 starts and player 2 makes a counter-offer. If player 1 accepts this counter-offer, it is implemented and the game ends. If player 1 rejects, round 3 starts and player 1 makes a counter-offer, and so forth. The game continues like this 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 pie shrinks according to a player's discount factor.² The higher a player's discount factor, the more patient and thus stronger the player is. The stronger she is, the higher her share will be. The game also exhibits a first-mover-advantage and a second-mover-disadvantage. More precisely, game theory predicts that player 1 offers $(1 - d_2)/(1 - d_1d_2)$ for herself and $1 - (1 - d_2)/(1 - d_1d_2)$ for player 2 in round 1 and that this offer will be immediately accepted by player 2. Replacing the single players by groups of players that equally share the outcome of the negotiation does not change the strategic aspects of the game. Thus, the game-theoretic prediction remains the same in the case of inter-group bargaining.

3 Design, predictions and procedures

We design four treatments that differ with regard to player type – individual versus group – and relative bargaining power – stronger player 1 versus weaker player 1 (see table 1). The first two treatments are called “Ind0908” and “Group0908”, the second two are called “Ind0809” and

²The pie is multiplied with the discount factor.

“Group0809”. “Ind” refers to the inter-individual case, “Group” refers to the inter-group case. The numbers refer to the discount factors. “0908” means that player 1 has a discount factor of 0.9 and player 2 has a discount factor of 0.8. “0809” means that player 1 has a discount factor of 0.8 and player 2 has a discount factor of 0.9. (In the experiment, we call player 1 “red” and player 2 “blue” to avoid that participants perceive an order of players according to the numbers 1 and 2.) In “Ind0908”, there is one player 1 with a discount factor of 0.9 and one player 2 with a discount factor of 0.8. In “Group0908”, there are three player 1s with a discount factor of 0.9 each and three player 2s with a discount factor of 0.8 each. “Ind0809” and “Group0809” have the same number of players as “Ind0908” and “Group0908”, respectively, but the discount factors and thus the relative bargaining power are switched.³

TABLE 1: The four treatments

Treatment	Players		Predictions of ...		
			competitiveness	rationality	prosocialness
Ind0908	player 1 (0.9)	player 2 (0.8)	($>0.5, <0.5$), > round 1	(0.71, 0.29), round 1	($\sim 0.5, \sim 0.5$), round 1
Group0908	3×player 1 (0.9)	3×player 2 (0.8)			
Ind0809	player 1 (0.8)	player 2 (0.9)	($>0.5, <0.5$), > round 1	(0.35, 0.65), round 1	($\sim 0.5, \sim 0.5$), round 1
Group0809	3×player 1 (0.8)	3×player 2 (0.9)			

Note: Discount factors are stated in parentheses after the respective player. The predicted shares of the pie (“*player 1’s share*”, “*player 2’s share*”) refer to round 1.

The predictions for the “0908” discount factor combination are as follows. A competitive player 1 wanting to be better than player 2 would demand more than 50% of the pie in round 1. If player 2 is also competitive, she would not accept this offer and an agreement would be reached later than in round 1. A perfectly rational player 1 would demand 71% of the pie for herself in round 1 and a perfectly rational player 2 would immediately accept the remaining 29% according to the subgame-perfect equilibrium

³More precisely, according to the subgame-perfect equilibrium predictions, player 1s and group 1s in the “0809” discount factor combination have slightly more bargaining power than player 2s and group 2s in the “0908” discount factor combination due to the first-mover-advantage/second-mover-disadvantage.

(see section 2 for the formulas used to calculate the equilibria). A prosocial player 1 would offer around 50% of the pie and a prosocial player 2 would immediately accept this offer because it is both fair and efficient. As mentioned above, these predictions are the same for the inter-individual and the inter-group case since they are strategically equivalent.

The “0908” discount factor combination is structurally similar to an ultimatum game as player 1s with a discount factor of 0.9 are in a stronger bargaining position than player 2s with a discount factor of 0.8. Similarly to an ultimatum game, it is also not possible to distinguish between rational and competitive behavior regarding first round offers because higher (but below the subgame-perfect equilibrium prediction) first round offers increase both the relative difference and a party’s own outcome. Nevertheless, we include the “0908” discount factor combination to see whether we can replicate Bornstein and Yaniv (1998).

In contrast, the “0809” discount factor combination allows to separate the predictions of rational and competitive as well as prosocial behavior even for first movers. The predictions for competitive and prosocial behavior are the same as for the “0908” discount factor combination. However, the prediction for rational behavior is different. According to the subgame-perfect equilibrium, player 1 would demand 35% for herself in round 1 and player 2 would accept this offer immediately. Of course, we do not expect to observe these point predictions but if groups in the “0809” discount factor combination demand less than individuals and less than 50%, this would clearly argue for rationality in the game-theoretic sense.

In November 2010, we conducted 20 experimental sessions in the video laboratory of the Max Planck Institute of Economics in Jena, Germany. The lab consists of 8 separate small rooms, which are soundproof and equipped with a video camera and one computer each. 8 persons participated in each inter-individual session, 24 in each inter-group session, adding up to a total of 320.⁴ Participants were invited using ORSEE (Greiner, 2004) and were informed in the invitation and at the beginning of the experiment that this experiment would be videotaped. According to registration information from ORSEE, our sample mainly consisted of students from Jena, aged 24 years on average. According to post-experimental

⁴See table 13 in appendix A for details.

questionnaire data, 53% women and 47% men participated (the three-person-groups always consisted of at least one female and one male participant). 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 Rubinstein 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 a cubicle number. Participants were then guided to the lab. During the group sessions, subjects learned that they would participate in a group experiment not until they entered their cubicle. At this moment, they also learned who their group members were. All participants were videotaped once entering the lab. We then distributed instructions⁵ and gave enough time to read them. Participants could ask questions, which were answered privately in their cubicle if applicable. Groups were encouraged to discuss questions with their group members. Between-group communication was not allowed except for the offers and accept-or-reject decisions, which were transmitted via computers.

The experiment was programmed and conducted with the software z-Tree 3.3.8 (Fischbacher, 2007).⁶ Participants were asked to answer four control questions first. In case a control question was answered incorrectly, the right answer was explained to the subject or group of subjects in error. After the control questions, subjects were randomly assigned to be player 1 or player 2 and maintained these roles during the whole experiment. We conducted one treatment per session. In the group treatments, we distributed questionnaires, one for each participant, to measure group identification. In both the group and individual treatments, we also distributed one sheet of paper with a table per cubicle where subjects could enter the results of each bargaining period so that subjects had a record of the experiment's history.

⁵The instructions can be found in appendix B.

⁶An example screenshot can be found in appendix C.

Subsequently, the bargaining periods started as the main task (see section 2). Each treatment was played for four periods.⁷ Cubicles were randomly rematched after each period; no subject or group, respectively, interacted more than one period with the same partner. To approximate the infinite horizon of the game as closely as possible, we did not explicitly limit the time for a bargaining period. Similarly to Rapoport et al. (1990), we told subjects that we planned enough time and that they could take their time. If they needed, however, “unexpectedly long”, the computer would interrupt the current period. In fact, the computer was programmed to interrupt a period if more than 16 minutes had passed or if all other groups had already reached agreement and the last group is already in round 8 or 9.⁸ After the bargaining periods, one period was randomly chosen for payment. The experiment ended with a questionnaire in which we asked for demographic data and participants’ motivation. Each cubicle was then payed in private and participants left. A session lasted on average one hour. Every participant received a 4 EUR show up fee plus the amount agreed upon (or calculated by the computer in case of break off) in the bargaining process. On average, a participant earned 11.56 EUR during a session.

4 Results

4.1 Descriptives

In this section, we will give an overview of two experimental results for each treatment: the first round demands and the number of rounds needed to reach an agreement or until participants were stopped. Whenever we refer to demand or share, we mean the percentage for player/group 1 if not stated otherwise. We write first round *demands* as they are made by player/group 1s.

⁷A period consisted of one or more rounds.

⁸The round was drawn as a random number.

TABLE 2: Summary statistics by treatment

	Ind0809	Ind0908	Group0809	Group0908
Mean first round demand (%)	53.76	56.71	50.86	55.8
Mean number of rounds	1.37	2.02	1.36	1.34
Stopped participants (%)	1.25	7.5	2.5	2.5

FIGURE 1: The cumulative distribution function of the first round demand

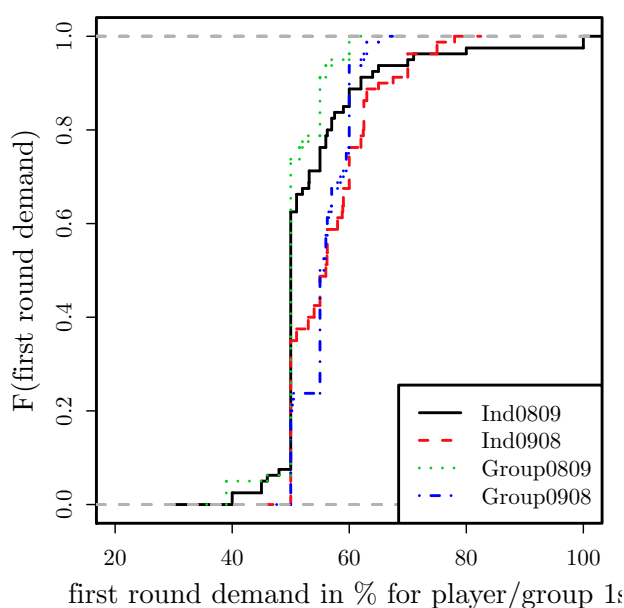


Figure 1 shows the empirical cumulative distribution function of the first round demand for each treatment. In all treatments, the majority of first round demands is between 50% and 60%. The dotted line for “Group0809” is closest to the equal split, the dashed line for “Ind0908” and the dotted-and-dashed line for “Group0908” are furthest away from the equal split, and the solid line for “Ind0809” is between these two extremes most of the time. Table 2 shows the mean first round demands for each treatment. It confirms the observation that the first round demands are, on average, lowest for “Group0809”, highest for “Group0908” and “Ind0908”, and intermediate for “Ind0809”.

FIGURE 2: The cumulative distribution function of the number of rounds

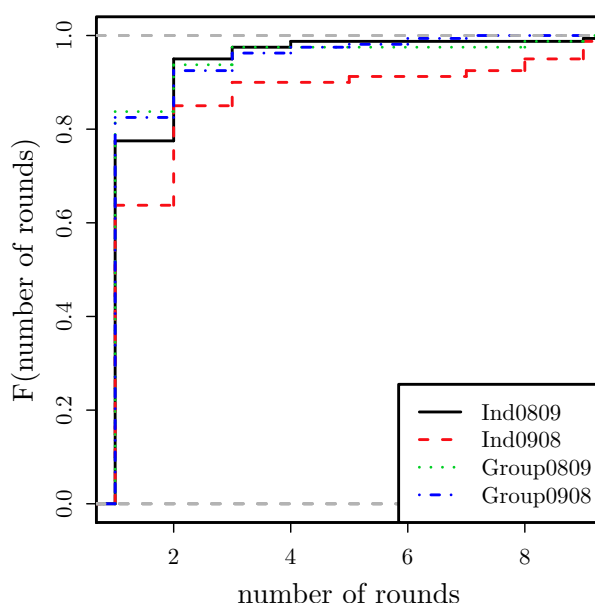


Figure 2 shows the empirical cumulative distribution function of the number of rounds needed to reach an agreement or until participants were stopped⁹ for each treatment. In all treatments, at least 60% of the participants reached an agreement immediately in round 1. The dashed line for “Ind0908” is always below the three other lines which are relatively close together, indicating that participants needed more rounds in “Ind0908” than in the other treatments. Table 2 summarizes the mean number of rounds for each treatment and confirms the observation that participants needed, on average, approximately the same number of rounds in “Ind0809”, “Group0809” and “Group0908”, and needed more rounds in “Ind0908”.

Figure 3 shows how (a) the mean first round demands and (b) the mean number of rounds develop over time. The mean first round demands in

⁹In 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. This measure is not perfect since we do not know how long these participants would have continued their bargaining, but it does not underestimate the number of rounds as much as the round in which participants were stopped would do.

FIGURE 3: Interaction plots for (a) mean first round demands and (b) mean number of rounds

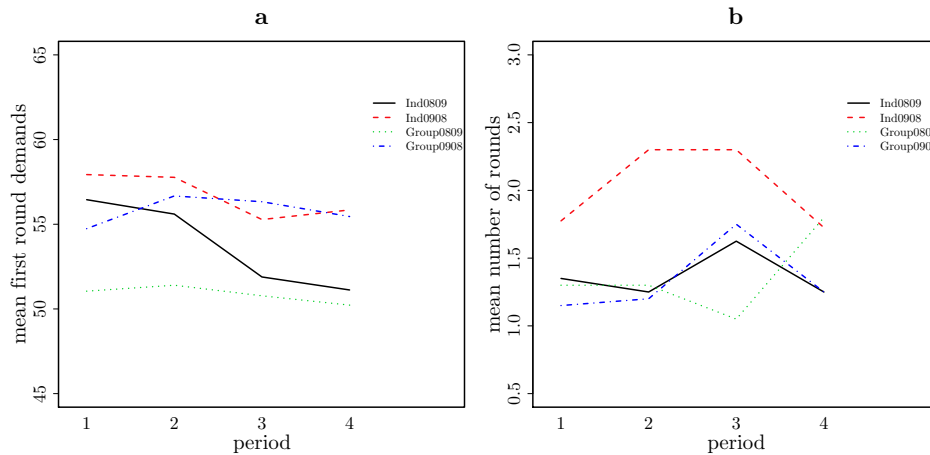


figure 3.a are relatively stable for “Ind0908”, “Group0908” and “Group0809”. For “Ind0809”, the first round offers seem to decrease over time. The mean number of rounds in figure 3.b do not seem to follow any clear trend over the periods.

Figures 1, 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 range from 1.25% to 7.5% and can be found in table 2.

In the following, we will first compare inter-individual to inter-group bargaining with stronger player 1s (“Ind0908” vs. “Group0908”). Subsequently, we will compare inter-individual to inter-group bargaining with weaker player 1s (“Ind0809” vs. “Group0809”). Finally, we will compare stronger to weaker player 1s (“Ind0908” vs. “Ind0809” and “Group0908” vs. “Group0809”).

4.2 Comparison of inter-individual and inter-group bargaining with stronger player 1s (“Ind0908” vs. “Group0908”)

This section focuses on the difference between “Ind0908” and “Group0908” to answer the question whether we can replicate Bornstein and Yaniv’s results (1998). As mentioned in section 1, they show that proposer groups demand more than individuals in a one-shot ultimatum game with only male participants, and that the responder groups are also willing to accept these higher demands.

Regarding the first round demands in our paper, table 2 and figure 1 already indicate that the difference between “Ind0908” and “Group0908” is very small. In this section, we estimate three different linear mixed effect models according to equations 1, 2 and 3 to check whether the difference is significant.

$$firstRoundDemand = \beta_0 + \beta_{Group0908} \cdot d_{Group0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (1)$$

$$firstRoundDemand = \beta_0 + \beta_{Group0908} \cdot d_{Group0908} + \beta_{period} \cdot period + \beta_{periodGroup0908} \cdot period \cdot d_{Group0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (2)$$

$$firstRoundDemand = \beta_0 + \beta_{Group0908} \cdot d_{Group0908} + \beta_{majMale} \cdot d_{majMale} + \beta_{majMaleGroup0908} \cdot d_{majMale} \cdot d_{Group0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (3)$$

Equation 1 simply regresses the first round demands on the treatments. The reference treatment is “Ind0908” and is captured by the intercept β_0 . The dummy $d_{Group0908}$ is one for “Group0908” and zero otherwise. Within a session, we cannot assume observations to be independent because subjects are rematched during a session and make their choices repeatedly. Therefore, this and all following models contain random effects for sessions ϵ_k and subjects ϵ_i . The residual is ϵ_{it} .

Equation 2 contains the interaction between period and treatment as an additional explanatory variable. Equation 3 includes the interaction between gender and treatment as an additional explanatory variable. The dummy $d_{majMale}$ is one if player 1 is male in “Ind0908” or if group 1 consists of one female and two male members in “Group0908”. It is zero otherwise.

We bootstrap p -values¹⁰ and report the results in tables 3, 4 and 5.¹¹ The coefficient “Group0908” captures the difference between “Ind0908” and “Group0908”. It is not significant in any of the models.¹²

TABLE 3: Linear mixed effects model with bootstrapped p -values according to equation 1, treatments: “Ind0908”, “Group0908”

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	56.7062	54.577	58.976	0.0002
Group0908	-0.9072	-4.027	2.127	0.5080

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: Linear mixed effects model with bootstrapped p -values according to equation 2, treatments: “Ind0908”, “Group0908”

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	58.8950	55.8867	61.8866	0.0002
Group0908	-3.5475	-7.6583	0.8431	0.0976
period	-0.8755	-1.7696	-0.0466	0.0468
periodGroup0908	0.1806	-0.6476	1.0706	0.6844

Regarding the number of rounds, table 2 and figure 2 indicate that participants in “Ind0908” need, on average, more rounds than participants in “Group0908”. In addition, we will present the results of four regression models in this section to show whether this effect is significant. As the number of rounds are discrete data and usually small numbers, a generalized linear mixed effects model under the assumption that the number of rounds follows a Poisson distribution could be adequate. Since bootstrapping p -values for such a model is computationally expensive, we rely on

¹⁰ 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.

¹¹The corresponding Q-Q normal plots of these and of all following estimated residuals can be found in appendix D.

¹²Neither do we find significant effects for gender. We do find a significantly negative coefficient for period in table 4 as we would expect from the downward sloping line for “Ind0908” in figure 3.a.

TABLE 5: Linear mixed effects model with bootstrapped p -values according to equation 3, treatments: “Ind0908”, “Group0908”

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	57.638	55.174	59.9100	0.0002
Group0908	-2.525	-5.657	1.1773	0.1696
majMale	-3.107	-5.884	0.7548	0.1064
majMaleGroup0908	1.523	-1.440	4.4933	0.3500

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.

Therefore, we estimate four simple models. One model regresses the natural logarithm of the number of rounds on the treatments (see equation 4). The other model contains the interactions of treatment and gender as additional explanatory variables (see equation 5).¹³

$$\log(\text{numberOfRounds}) = \beta_0 + \beta_{\text{Group0908}} \cdot d_{\text{Group0908}} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (4)$$

$$\begin{aligned} \log(\text{numberOfRounds}) = & \beta_0 + \beta_{\text{Group0908}} \cdot d_{\text{Group0908}} + \beta_{\text{majMale}} \cdot d_{\text{majMale}} \\ & + \beta_{\text{majMaleGroup0908}} \cdot d_{\text{majMale}} \cdot d_{\text{Group0908}} + \beta_{\text{majMale2}} \cdot d_{\text{majMale2}} \\ & + \beta_{\text{majMale2Group0908}} \cdot d_{\text{majMale2}} \cdot d_{\text{Group0908}} + \epsilon_k + \epsilon_i + \epsilon_{it} \end{aligned} \quad (5)$$

The other two models are along the same lines, but contain the number of rounds without taking the logarithm as the dependent variable (see equation 6 and 7). For the same reasons as in equation 1, 2 and 3, all four models contain random effects for sessions ϵ_k and subjects ϵ_i .

¹³The variable `majMale2` is one if player 2 is male in “Ind0908” or if group 2 consists of one female and two male participants in “Group0908”. It is 0 otherwise.

TABLE 6: Linear mixed effects model with bootstrapped p -values according to equation 4, treatments: "Ind0908", "Group0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	0.4082	0.2453	0.5674	0.0002
Group0908	-0.2356	-0.4712	-0.0200	0.0388

$$P(\text{numberOfRounds} = n) \sim \text{Poisson}(n | \lambda = \beta_0 + \beta_{\text{Group0908}} \cdot d_{\text{Group0908}} + \epsilon_k + \epsilon_i) \quad (6)$$

$$\begin{aligned} P(\text{numberOfRounds} = n) \sim \text{Poisson}(n | \lambda = & \beta_0 + \beta_{\text{Group0908}} \cdot d_{\text{Group0908}} \\ & + \beta_{\text{majMale}} \cdot d_{\text{majMale}} + \beta_{\text{majMaleGroup0908}} \cdot d_{\text{majMale}} \cdot d_{\text{Group0908}} \\ & + \beta_{\text{majMale2}} \cdot d_{\text{majMale2}} + \beta_{\text{majMale2Group0908}} \cdot d_{\text{majMale2}} \cdot d_{\text{Group0908}} \\ & + \epsilon_k + \epsilon_i) \end{aligned} \quad (7)$$

The results for the first model are reported in table 6. The coefficient Group0908 captures the difference between the treatments "Ind0908" and "Group0908". It is negative and significant at the 5% level which indicates that groups need, on average, fewer rounds to reach an agreement. The results for the second model are reported in table 7. This model shows that the treatment effect becomes insignificant when controlling for gender. It seems that male player 2s in "Ind0908" are driving the effect that more rounds are needed.¹⁴ All results are robust to estimating a generalized linear mixed effects model under the assumption that the number of rounds follows a Poisson distribution (see table 14 and 15 in appendix E for details).

To summarize, we do not find that participants make higher first round demands in "Group0908" than individuals in "Ind0908" as shown by Bornstein and Yaniv (1998) in an ultimatum game. However, we do find that groups need fewer rounds to reach an agreement than individuals. This effect seems to be driven by male player 2s in "Ind0908". From this, we

¹⁴One explanation why we do not find gender effects for groups may be that the groups always consisted of at least one male and one female participant (as mentioned in section 3).

TABLE 7: Linear mixed effects model with bootstrapped p -values according to equation 5, treatments: "Ind0908", "Group0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	0.3502	0.1409	0.5521	0.0024
Group0908	-0.1502	-0.4419	0.1563	0.3068
majMale	-0.2447	-0.5228	0.0187	0.0792
majMaleGroup0908	0.0263	-0.2132	0.2707	0.8496
majMale2	0.2628	0.0331	0.5011	0.0232
majMale2Group0908	-0.0981	-0.3499	0.1380	0.4240

can conclude that groups are, on average, not more competitive than individuals because being competitive would mean making higher first round demands and needing more rounds than individuals. Nevertheless, it is not yet clear whether groups are more prosocial or more rational than individuals as needing fewer rounds can be interpreted both as more rational and as more prosocial behavior.

4.3 Comparison of inter-individual and inter-group bargaining with weaker player 1s ("Ind0809" vs. "Group0809")

This section focuses on the difference between "Ind0809" and "Group0809" to answer the question whether we find similar results for the second discount factor combination in which player 1s are in a weaker bargaining position than player 2s. Regarding the number of rounds, figure 2 and table 2 already show that the number of rounds is almost equal. We therefore refrain from estimating regression models.

Regarding first round demands, figure 1 and table 2 indicate that participants in "Group0809" demand, on average, less than participants in "Ind0809". In addition, we will present the result of three regression models according to equation 8, 9 and 10 to show whether this effect is significant.

TABLE 8: Linear mixed effects model with bootstrapped p -values according to equation 8, treatments: "Ind0809", "Group0809"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	53.764	51.462	56.103	0.0002
Group0809	-2.902	-6.102	0.382	0.0708

Note: AIC 1087.521, BIC 1102.897

TABLE 9: Linear mixed effects model with bootstrapped p -values according to equation 9, treatments: "Ind0809", "Group0809"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	58.6900	54.931	62.7301	0.0002
Group0809	-7.0530	-12.237	-1.2988	0.0120
period	-1.9703	-3.324	-0.7615	0.0016
periodGroup0809	-0.3098	-1.565	1.0037	0.6412

Note: AIC 1080.932, BIC 1102.458

$$firstRoundDemand = \beta_0 + \beta_{Group0809} \cdot d_{Group0809} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (8)$$

$$firstRoundDemand = \beta_0 + \beta_{Group0809} \cdot d_{Group0809} + \beta_{period} \cdot period + \beta_{periodGroup0809} \cdot period \cdot d_{Group0809} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (9)$$

$$firstRoundDemand = \beta_0 + \beta_{Group0809} \cdot d_{Group0809} + \beta_{majMale} \cdot d_{majMale} + \beta_{majMaleGroup0809} \cdot d_{majMale} \cdot d_{Group0809} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (10)$$

Equation 8 simply regresses the first round demands on the treatments. The reference treatment is "Ind0809" and is captured by the intercept β_0 . The dummy $d_{Group0809}$ is one for "Group0809" and zero otherwise. Equation 9 contains the interaction between period and treatment as an additional explanatory variable. Equation 10 includes the interaction between gender and treatment as an additional explanatory variable. The dummy $d_{majMale}$ is one if player 1 is male in "Ind0809" or if group 1 consists of one female and two male members in "Group0809". It is zero otherwise.

The results are reported in table 8, 9 and 10. The Group0809 coefficient

TABLE 10: Linear mixed effects model with bootstrapped p -values according to equation 10, treatments: "Ind0809", "Group0809"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	55.868	52.802	59.6564	0.0002
Group0809	-5.989	-11.351	-1.8729	0.0088
majMale	-3.825	-8.648	-0.7655	0.0276
majMaleGroup0809	2.186	-1.296	5.8531	0.2324

Note: AIC 1088.086, BIC 1109.612

captures the difference between the two treatments. It is negative in all tables, marginally significant in table 8, significant at the 5% level in table 9 and significant at the 1% level in table 10. The model presented in table 9 is best in terms of the model fit criteria AIC and BIC. This indicates that participants in "Group0809" make, significantly lower first round demands than participants in "Ind0809".¹⁵

To summarize, unlike in section 4.2, we do not find a difference in the number of rounds for the "0809" discount factor combination, but we do find a difference in the first round demands. Participants make lower first round demands in "Group0809" than participants in "Ind0809". From this, we can conclude as in section 4.2 that groups are, on average, not more competitive than individuals because being competitive would mean making higher first round demands and needing more rounds than individuals. Since the groups' first round demands are, however, not clearly below the equal split¹⁶, it is not yet clear whether they are more prosocial or more rational than individuals.

¹⁵Besides, the estimated coefficient Ind0809:period is negative as expected from figure 3.a and significant at the 1% level. This indicates that participants in "Ind0809" decrease their first round demands over time. Once more, we find a significant gender effect for the "Ind" treatment only.

¹⁶A possible explanation may be that participants perceive the first-mover-advantage as quite strong (see also Roth, 1995, p. 266) and are reluctant to deviate from the prevalent norm of an equal split.

4.4 Comparison of stronger and weaker player 1s (“Ind0908” vs. “Ind0809” and “Group0908” vs. “Group0809”)

Until now, we concluded that groups are not more competitive than individuals but could not clearly distinguish whether they are more prosocial or more rational. To answer this question, this section focuses on the difference between first round offers in “Ind0809” and “Ind0908” and on the difference between “Group0809” and “Group0908”. Table 2 shows that participants in “Ind0908” make higher first round demands than participants in “Ind0809” as we would expect according to the game-theoretic prediction. We also find this direction for the “Group” treatments. Moreover, the difference seems to be even larger for groups. When estimating a model in which the treatments are regressed on the first round demands (see equations 11 and 12), we do find a significant difference between the “Group” treatments (see table 11), but not between the “Ind” treatments (see table 12).¹⁷

$$firstRoundDemand = \beta_0 + \beta_{Group0908} \cdot d_{Group0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (11)$$

$$firstRoundDemand = \beta_0 + \beta_{Ind0908} \cdot d_{Ind0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (12)$$

We would expect a more rational party to react stronger to game-theoretic parameters like discount factors than a more prosocial party. Since we find that groups react significantly to their relative bargaining position, but do not find such an effect for individuals, we conclude that groups are more rational bargainers than individuals.

¹⁷These results are robust to different model specifications (see tables 16, 17, 18 and 19 in appendix E for details).

TABLE 11: Linear mixed effects model with bootstrapped p -values according to equation 11, treatments: "Group0809", "Group0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	50.862	49.506	52.341	0.0002
Group0908	4.937	2.901	6.787	0.0004

TABLE 12: Linear mixed effects model with bootstrapped p -values according to equation 12, treatments: "Ind0809", "Ind0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	53.764	50.865	56.639	0.0002
Ind0908	2.942	-1.036	7.009	0.1484

5 Discussion and conclusion

In this paper, we compared inter-individual with inter-group behavior in Rubinstein's alternating offers bargaining game. We designed four treatments to answer the question whether groups are more rational, more competitive or more prosocial bargainers than individuals. For the "0908" discount factor combination, where first movers are stronger and second movers are weaker, we could not replicate Bornstein and Yaniv's result (1998) of higher first round demands for groups compared with individuals. However, we did find that groups need fewer rounds to reach an agreement than individuals. For the "0809" discount factor combination, where first movers are weaker and second movers are stronger, we did not find a difference in the number of rounds, but a difference in first round demands. Groups make lower first round demands than individuals.

From these four results, we could infer that groups are not more competitive than individuals since being more competitive would mean making higher first round demands and needing more rounds than individuals in both discount factor combinations. Nevertheless, it was not clear whether the observed behavior was more rational or more prosocial. As a last step, we compared "Ind0908" with "Ind0809" and "Group0908" with "Group0809". We did find a significant difference in first round offers for

the “Group” treatments, but not for the “Ind” treatments. Since we would expect a more rational party to react stronger to game-theoretic parameters like discount factors than a more prosocial party, we conclude that groups are more rational bargainers than individuals.

Our results might have been clearer regarding first round demands in the condition with weaker first movers, had we not simply switched the discount factors between conditions, but had we switched the subgame-perfect equilibrium predictions and adjusted the discount factors accordingly. Recall that we found significantly lower first round demands for groups compared to individuals, but that these first round demands were not below 50%. First round demands below 50% would have been even stronger evidence for more rational behavior. Nevertheless, the equal split may simply be a far too strong norm to let first movers – even if they have lower discount factors – deviate from it. Still, this alternative design may be one direction for further research.

Another interesting direction for further research is to find out how robust this effect is to different experimental conditions. For example, group size could play a role. The presence or absence of monetary incentives might also be important. Inter-group communication and/or face-to-face interaction could influence the effect as well. Finally, constant costs of delay instead of discount factors could be used to see whether the result is robust to a different cost structure.

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A Number of sessions and participants

TABLE 13: Number of sessions and participants

	Ind0908	Group0908	Ind0809	Group0809	Total
Sessions	5	5	5	5	20
Participants	40	120	40	120	320

B Instructions¹⁸

Welcome to this experiment!

By participating, you support our research and you can earn money in return. It is important to read the following instructions very carefully in order to understand how the experiment will proceed. You are in the video laboratory of the Max Planck Institute of Economics and will be filmed during the entire experiment. All data will be treated confidentially and will be used exclusively for research.

General rules Please do not communicate with participants in *other* cubicles and do 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 four periods. Each *period* can consist of several *rounds*. In the end, all participants will receive a show-up fee of 4.00 € irrespective of the decisions they will have made during the experiment. In addition, you can earn money during the experiment. The amount you will earn depends on your and on the other participants' decisions during the experiment and will be explained in the following paragraphs. Apart from the participants in your cabin, none of the other participants will receive information on your payment.

¹⁸This is a translated version of the instructions for "Group0908". In the experiment, they were used in German. The instructions for "Group0809" were identical except that the discount factors were switched. The instructions for "Ind0809" and "Ind0908" differed in the following ways. "Group" was replaced by "player" or "participant". "Please do not communicate with participants in other cubicles": "Other" was printed in normal, not in italic type. "Apart from the participants in your cabin, none of the other participants will receive information on your payment": The first part of the sentence was left out. "There are three participants in each cubicle. From period 1 to period 4, these three participants form a group that is allowed to communicate among each other and that will take decisions collectively." was completely left out. "Should you have questions, please try to answer them within your group first. If this is not possible, please raise your hand." was reduced to "Should you have questions, please raise your hand."

Periods 1 to 4 There are three participants in each cubicle. From period 1 to period 4, these three participants form a group that is allowed to communicate among each other and that will take decisions collectively. There are two roles: Group Red and Group Blue. First, the computer will determine randomly which groups will become red and which will become blue. You will keep these roles during the entire experiment. That means, if you were red in the first period, you will stay red in the following periods and if you were blue in the first period, you will stay blue in the following periods. In each period, every two groups play together: one red and one blue group. At the beginning of each period, the computer matches you anonymously and randomly with another group. *You will not interact with any group for more than one period.* Your task is to divide an amount of (initially) 16 € between your and another group.

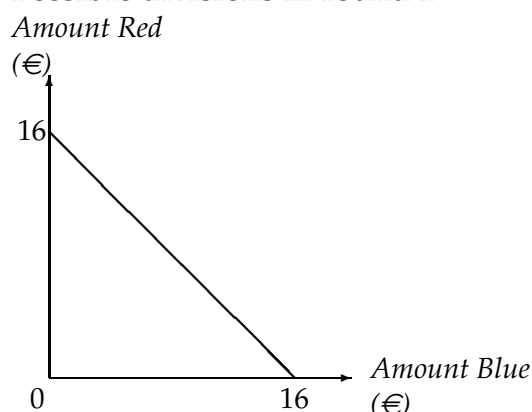
The first period starts with round 1 and the red group proposes a proportion how to divide the 16 € between herself and the blue group, that means $x\%$ of the maximum amount of 16 € for herself and $(100 - x)\%$ of the maximum amount of 16 € for the blue group. *These proposals in % always add up to 100%.* It is not mandatory to propose integer numbers, also fractions can be divided. The blue group can now accept or reject the proposal. If she accepts, the 16 € will be divided accordingly and the first period will end in round 1.

However, if the blue group rejects the proposal, a new round starts. At the beginning of each new round, the maximum amount available for a group is reduced at different rates. In round 1, the maximum amounts available for the red and for the blue group are still the same, namely 16 €. In the following rounds, this will change.

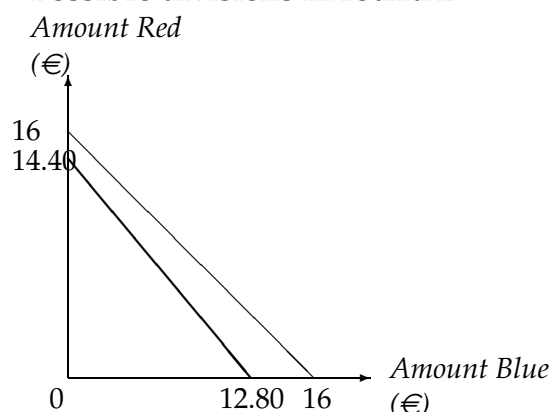
In round 2, the maximum amount available for the red group is reduced by 10%, for the blue group by 20%. Hence, the maximum amount available is 14.40 € for the red group and 12.80 € for the blue group (see the following two graphs as an illustration). The *blue* group now makes a counterproposal according to which proportion the remaining money is to be divided, i.e. $y\%$ of the *new* maximum amount for blue (12.80 €) for herself and $(100 - y)\%$ of the *new* maximum amount for red (14.40 €) for the red group. As previously, the proposals in % add up to 100%. The maximum amounts

that the percentages apply to are, however, different for red and blue. Subsequently, the red group can accept or reject the proposal. If she accepts, the money is divided accordingly and the first period ends in round 2.

Possible divisions in round 1



Possible divisions in round 2



The graphs illustrate the possible divisions in round 1 and in round 2. In round 1, the maximum amount available is 16 € for the red as well as for the blue group. In round 2, the maximum amount available is 14.40 € for the red group and 12.80 € for the blue group. The points *on* the bold lines represent all possible divisions. Example: In round 2, the red group could receive 100% of her maximum amount of 14.40 €, consequently, the blue group would receive 0% of her maximum amount of 12.80 €. Or the red group could receive 0% of her maximum amount of 14.40 €, consequently, the blue group would receive 100% of her maximum amount of 12.80 €. All divisions in between that add up to 100

If the red group rejects the blue group's proposal, round 3 starts and the maximum amounts of money are reduced like in the previous round: by further 10% for the red group, by further 20% for the blue group. The *red* group then makes a counterproposal according to which proportion to divide the remaining money. Subsequently, the blue group can accept or reject this proposal like in round 1 and so on. The maximum amounts of money available are reduced by 10% for the red group and by 20% for the blue group 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) 16 € between your and another group.

We have planned enough time for each period and you can take your time to reach an agreement with the other group. 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 amount of money 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 proportion.

Payoff-relevant period When all four periods are over, the computer will determine randomly one of the four periods which will be payoff-relevant for all participants. The other periods will not be considered when paying you. At the end of the experiment, each participant will receive the show-up fee of 4.00 € as well as the amount of money that his group agreed upon with the other group in the payoff-relevant period. Example: A red group has agreed on x € for herself and y € for the blue group. In the end, *each* member of the red group will receive $4.00 \text{ €} + x \text{ €}$; *each* member of the blue group will receive $4.00 \text{ €} + y \text{ €}$. If applicable, the amounts will be rounded up to a multiple of 0.10 € *at the end* of the experiment.

Questions Should you have questions, please try to answer them within your group first. If this is not possible, please raise your hand. We will come to you and answer. The experiment will start on the computer as soon as all participants will have finished reading the instructions and all questions are answered.

We wish you success in the experiment!

C Example screenshot

Periode

1

von

4

Runde

2

Sie haben den Vorschlag von Gruppe Rot abgelehnt. Bitte machen Sie einen Gegenvorschlag, in welchem Verhältnis das verbleibende Geld zwischen Ihrer Gruppe und Gruppe Rot aufgeteilt werden soll.

Sie haben für diese Entscheidung ca. fünf Minuten Zeit. Auf das Ende der fünf Minuten werden wir Sie ggf. durch eine Durchsage aufmerksam machen.

in schwarz: die Aufteilungsmöglichkeiten der aktuellen Runde
in grau: die Aufteilungsmöglichkeiten aus Runde 1

Vorschau nächste Runde

Anzeigen

Bestätigen

	Betrag Rot	Betrag Blau (Ihre Gruppe)
Maximaler Geldbetrag	14.40	12.80
Vorschlag (in % des maximalen Geldbetrages)	45.0000	55
Vorschlag (in EUR)	6.48	7.04

Hilfe

Klicken Sie auf "Anzeigen", um sich Vorschläge im Diagramm anzeigen zu lassen.
Klicken Sie auf "Vorschau nächste Runde" um zu sehen, wie sich die maximalen Geldbeträge in der nächsten Runde verringern wurden.
Klicken Sie auf "Bestätigen", wenn Sie einen Vorschlag bestätigen möchten.

D Q-Q plots

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

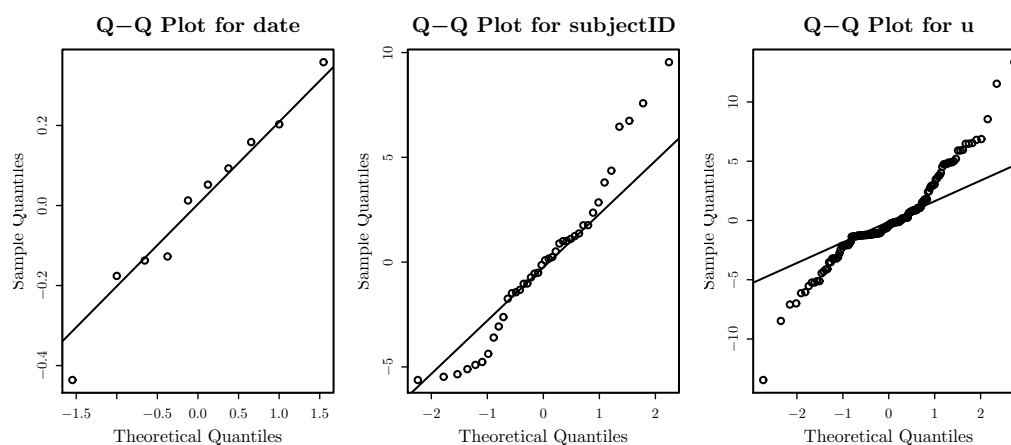


FIGURE 5: Q-Q normal plots of the estimated residuals of table 4

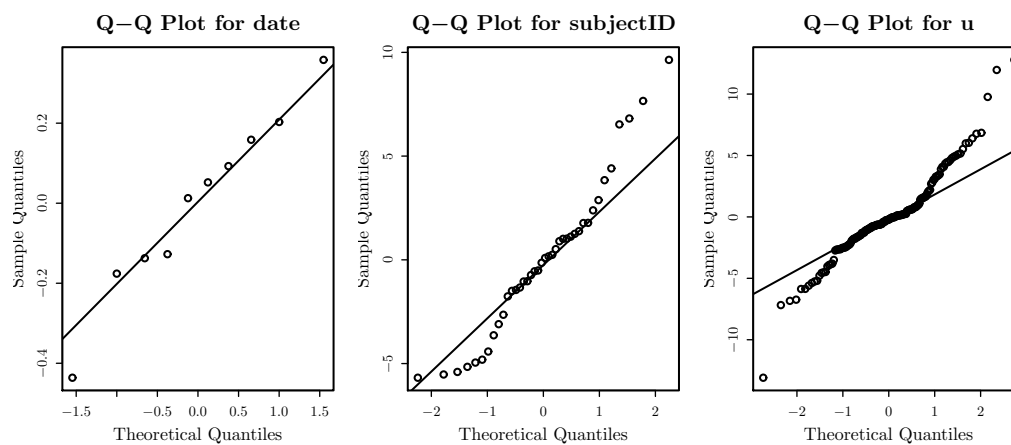


FIGURE 6: Q-Q normal plots of the estimated residuals of table 5

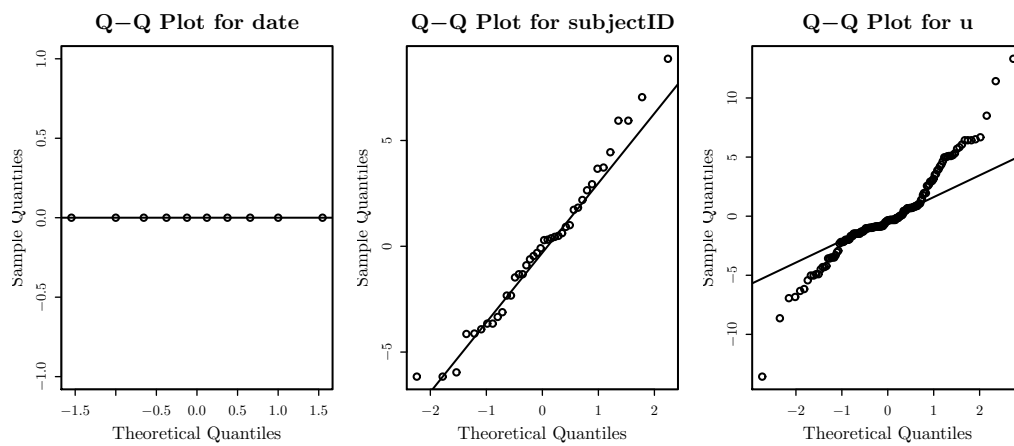


FIGURE 7: Q-Q normal plots of the estimated residuals of table 14

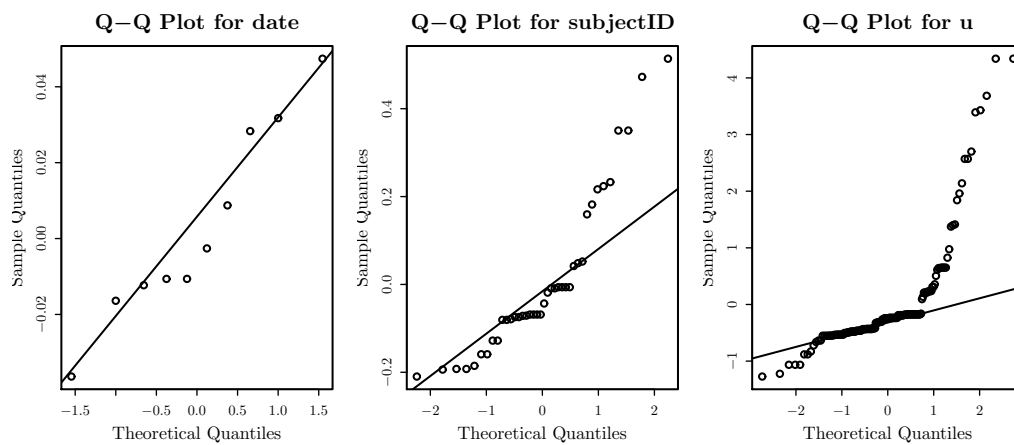


FIGURE 8: Q-Q normal plots of the estimated residuals of table 15

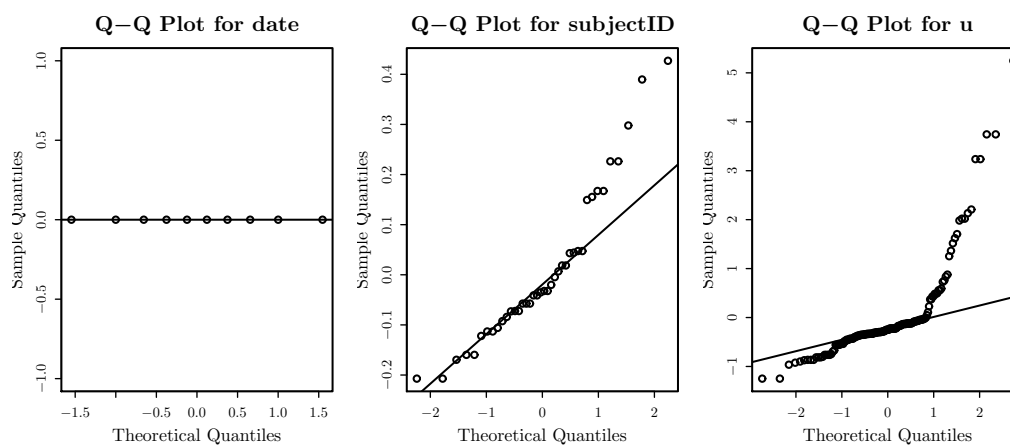


FIGURE 9: Q-Q normal plots of the estimated residuals of table 6

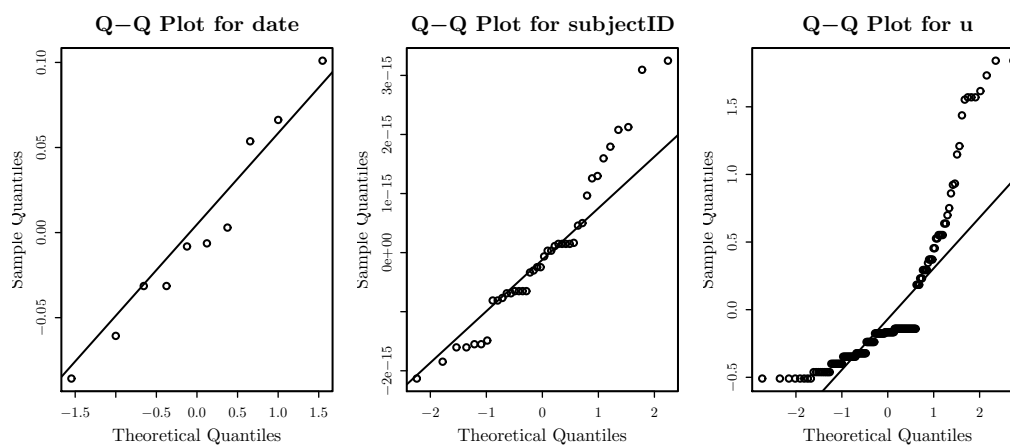


FIGURE 10: Q-Q normal plots of the estimated residuals of table 7

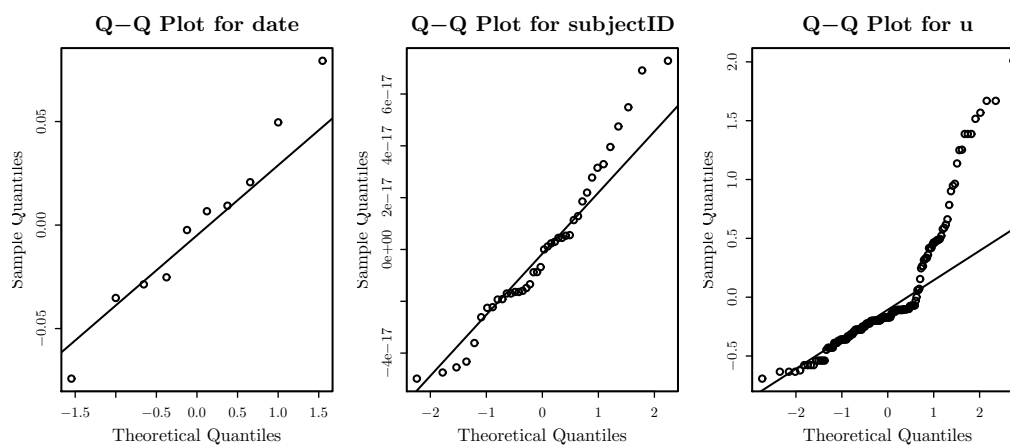


FIGURE 11: Q-Q normal plots of the estimated residuals of table 8

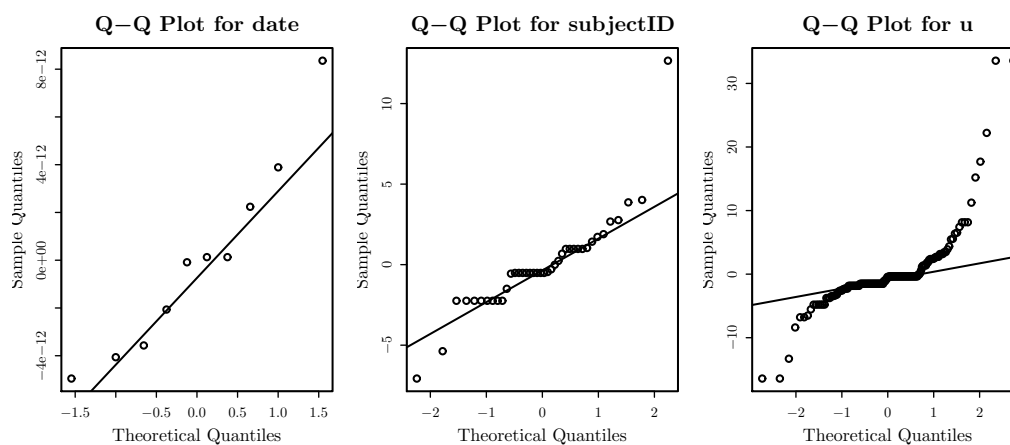


FIGURE 12: Q-Q normal plots of the estimated residuals of table 9

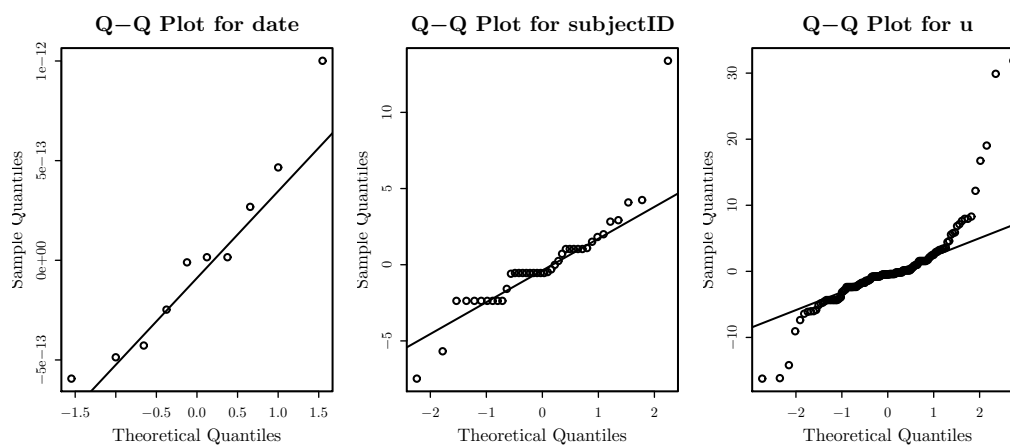


FIGURE 13: Q-Q normal plots of the estimated residuals of table 10

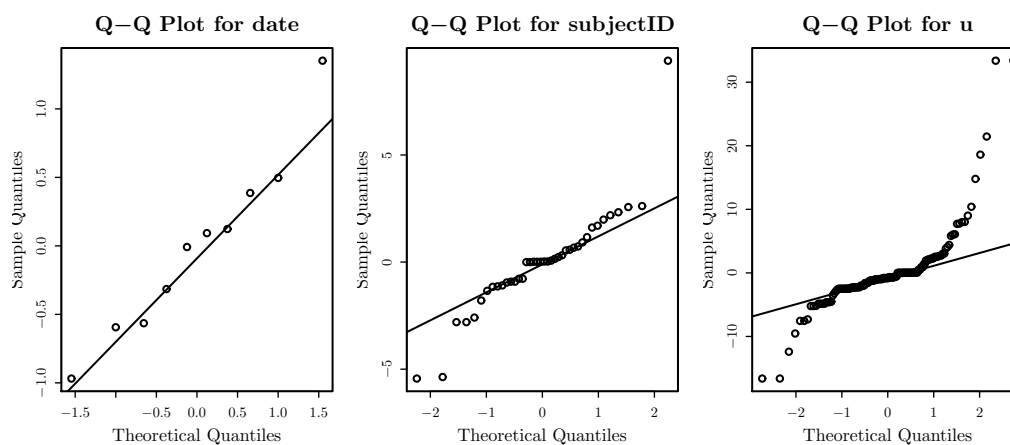


FIGURE 14: Q-Q normal plots of the estimated residuals of table 11

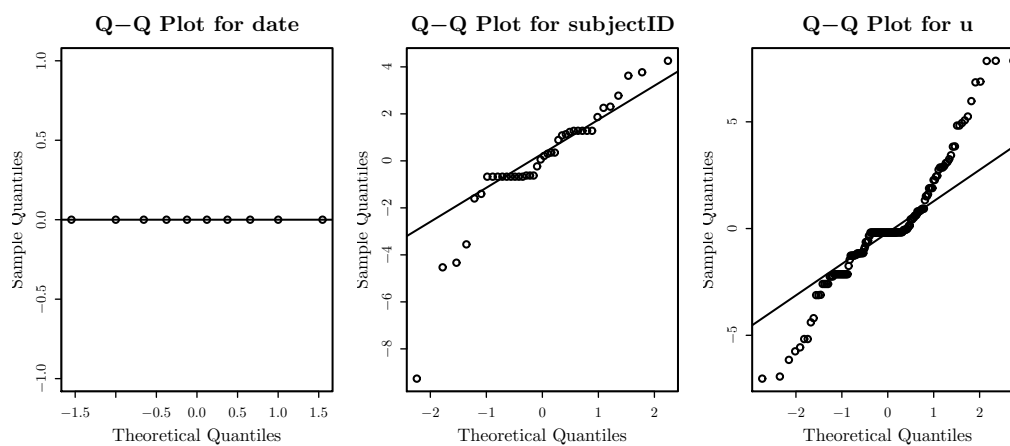


FIGURE 15: Q-Q normal plots of the estimated residuals of table 16

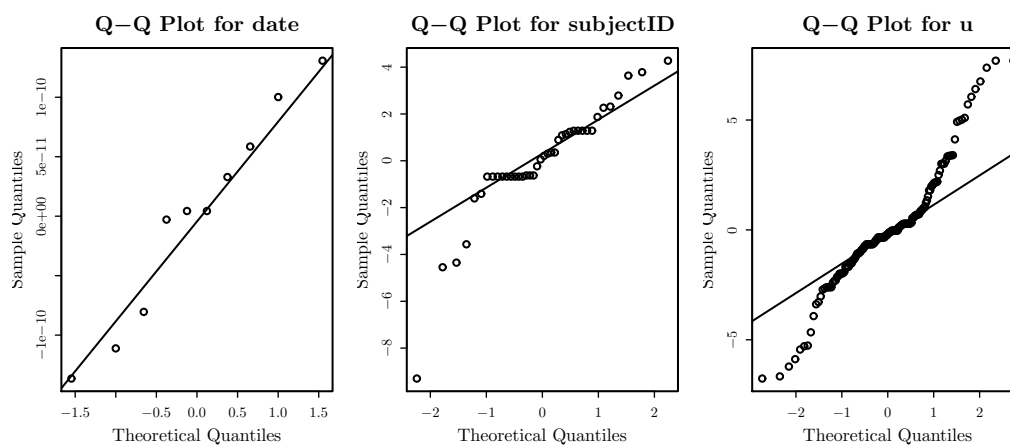


FIGURE 16: Q-Q normal plots of the estimated residuals of table 17

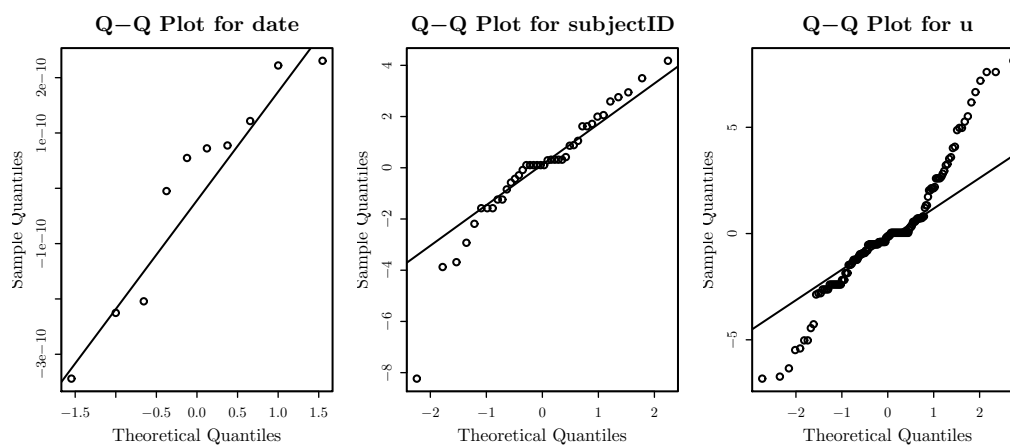


FIGURE 17: Q-Q normal plots of the estimated residuals of table 12

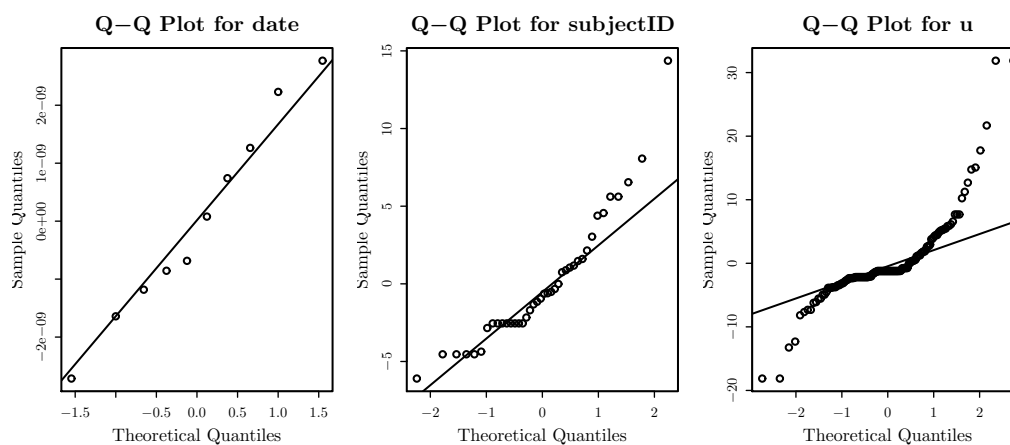


FIGURE 18: Q-Q normal plots of the estimated residuals of table 18

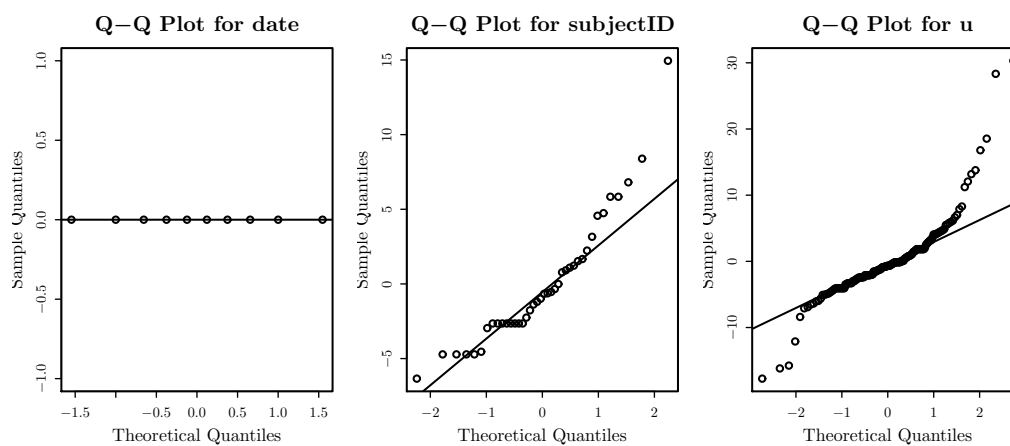
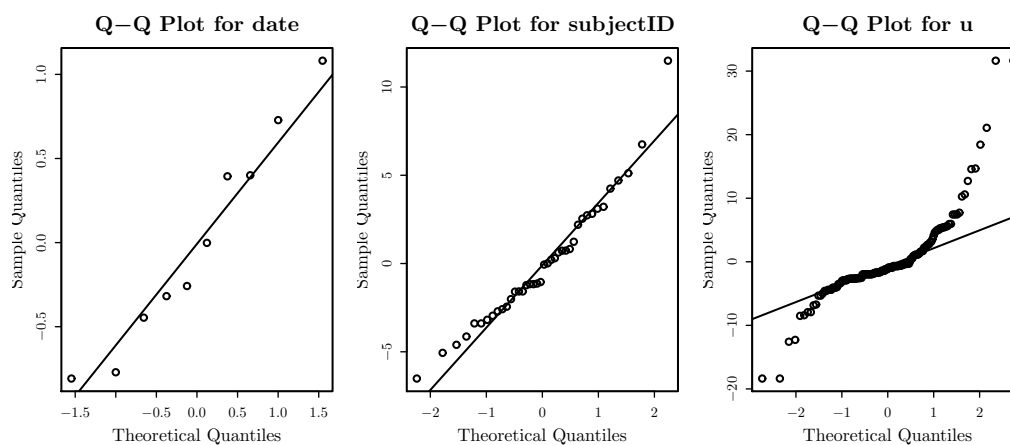


FIGURE 19: Q-Q normal plots of the estimated residuals of table 19



E Additional regressions

TABLE 14: Generalized linear mixed effects model assuming a Poisson distribution according to equation 6, treatments: "Ind0908", "Group0908"

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	0.6382	0.1107	5.7644	0.0000
Group0908	-0.3841	0.1661	-2.3127	0.0207

TABLE 15: Generalized linear mixed effects model assuming a Poisson distribution according to equation 7, treatments: "Ind0908", "Group0908"

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	0.5031	0.1540	3.2680	0.0011
Group0908	-0.2203	0.2330	-0.9451	0.3446
majMale	-0.3798	0.2318	-1.6383	0.1014
majMaleGroup0908	0.1013	0.2296	0.4413	0.6590
majMale2	0.4495	0.1662	2.7050	0.0068
majMale2Group0908	-0.1800	0.2085	-0.8632	0.3880

$$firstRoundDemand = \beta_0 + \beta_{Ind0908} \cdot d_{Ind0908} + \beta_{period} \cdot period + \beta_{periodInd0908} \cdot period \cdot d_{Ind0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (13)$$

$$firstRoundDemand = \beta_0 + \beta_{Ind0908} \cdot d_{Ind0908} + \beta_{majMale} \cdot d_{majMale} + \beta_{majMaleInd0908} \cdot d_{majMale} \cdot d_{Ind0908} + \epsilon_k + \epsilon_i + \epsilon_{it} \quad (14)$$

TABLE 16: Linear mixed effects model with bootstrapped p -values according to equation 2, treatments: "Group0809", "Group0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	51.6370	49.5683	53.7179	0.0002
Group0908	3.7105	0.7104	6.5936	0.0108
period	-0.3099	-0.9623	0.3039	0.3304
periodGroup0908	0.1806	-0.4351	0.8326	0.5824

TABLE 17: Linear mixed effects model with bootstrapped p -values according to equation 3, treatments: "Group0809", "Group0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	49.863	48.3115	51.622	0.0002
Group0908	5.250	2.9660	7.549	0.0002
majMale	2.220	0.0536	4.288	0.0460
majMaleGroup0908	1.523	-0.5841	3.499	0.1732

TABLE 18: Linear mixed effects model with bootstrapped p -values according to equation 13, treatments: "Ind0809", "Ind0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	58.6900	54.319	63.2851	0.0002
Ind0908	0.2050	-5.997	6.6355	0.9648
period	-1.9702	-3.421	-0.6137	0.0040
periodInd0908	-0.8755	-2.232	0.5777	0.2256

TABLE 19: Linear mixed effects model with bootstrapped p -values according to equation 14, treatments: "Ind0809", "Ind0908"

	Estimate	HPD95lower	HPD95upper	pMCMC
(Intercept)	55.798	52.181	60.4581	0.0002
Ind0908	1.783	-4.133	6.6787	0.6324
majMale	-3.698	-9.036	0.2576	0.0548
majMaleInd0908	-2.915	-6.971	1.9011	0.2632