

Group size and decision rules in legislative bargaining

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Abstract

We experimentally investigate the effects of group size on behavior and outcomes in a multilateral bargaining game. Using a Baron-Ferejohn protocol, our main interest is in the extent of costly delay (number of bargaining rounds needed to reach agreement). We investigate the effects of group size on delay under both majority and unanimity rule. Under both decision rules, we find that proposals more often fail in larger groups, leading to increased delay. Consistent with prior research, we also find that unanimity rule leads to more delay than does majority rule, in both small and large groups. Contrary to one of our initial hypotheses, we find that the latter effect is not more pronounced in larger groups. The higher rate of failure in larger groups and under unanimity rule is driven by a combination of three factors: (1) a larger number of individuals must agree, (2) an important fraction of individuals reject offers below the equal share, and (3) proposers demand more (relative to the equal share) in large groups.

Key words: Legislative Bargaining; Experiments; Group Size; Majority Rule; Unanimity Rule

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1 Introduction

How many members of a group or decision making body should be required to agree to an action that changes the status quo? One? Two? A Majority?

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Or perhaps all members of the group? Each of these rules (and others) are used in different real-world contexts. For example, the European Council currently uses either qualified majority rule or unanimity rule, depending on the category of legislation being considered. Whether a rule is ‘optimal’ in a given context depends on two considerations (see Buchanan and Tullock 1965). First, requiring the agreement of more members will tend to make it less likely that actions are taken which harm other members of the group. In the limit, a rule of unanimity guarantees that no person can be harmed by a decision taken, as each has the power to veto such an action. Second, requiring agreement of more members may increase the cost of decision making, for several reasons: more persons must be asked to state an opinion, the chance that all agree diminishes statistically as the required number grows, and the incentives for individuals to strategically withhold agreement may rise. The point at which this tradeoff balances out is likely to depend, among other factors, on the size of the decision making body.

We experimentally investigate the effects of group size on the costs of decision making under majority and unanimity rule. Using a Baron-Ferejohn (1989) legislative bargaining framework, we compare the extent of costly delay in groups of 3 and 7 players under both rules. Our design allows us to test two classic conjectures put forth by Buchanan and Tullock (1965). First, that decision making costs increase with group size under a given decision rule. Second, that decision making costs increase more sharply with the inclusiveness of the decision rule, the larger the group is.¹ In addition to these hypotheses, we will also be interested in testing equilibrium predictions of this game under the different decision rules imposed, as well as investigating how previously established deviations from these predictions are affected by our treatment conditions.

The remainder of the paper is organized as follows. Section 2 describes our experimental design and relates it to previous experimental literature. We derive equilibrium predictions for our experimental game and describes our hypotheses. Results are presented in Section 3, and Section 4 concludes.

2 Experimental design

Building on established experimental literature on multilateral bargaining going back to McKelvey (1991), we base our experimental design on the classic legislative bargaining game introduced by Baron and Ferejohn (1989). The

¹ The small group treatments also serve as a robustness check for the results obtained in Miller and Vanberg (2013), where we looked only at groups of 3 players. (See Section 2.3. for more details.)

Baron-Ferejohn game is an extension of the Rubinstein bargaining model to the case of more than two players. In our experiment, we will be implementing a finite horizon version of the game.

2.1 The (finite horizon) Baron Ferejohn Game

At the beginning of the game, a certain surplus (initially worth $P > 0$) is available to be divided among n players. The game consists of a sequence of bargaining rounds. In each round, one player is randomly chosen to propose a division of the available surplus. All players are informed of the proposed division and vote to accept or reject it. If the required majority votes to accept, the proposal passes, the game ends and each player receives his allocated share. Otherwise, the proposal fails. In this case the available surplus shrinks by a factor $\delta < 1$, and a new round begins. If agreement is not reached after T rounds, all players receive a payoff of zero.

Substantively, we can interpret this game as representing a situation in which a group of individuals faces an opportunity to take some action which can potentially generate benefits for all members of the group. The rules of the game assume that the ‘surplus’ resulting from this joint action is transferable. Taking the action therefore requires agreement, according to a given decision rule, on a division of the surplus. The surplus lost in case of delay represents resources (and time) invested in bargaining, as well as the possible deterioration of the opportunity that is under consideration. The realized sum of these losses constitutes the cost of reaching agreement.

2.2 Benchmark predictions and hypotheses

The Baron-Ferejohn (henceforth BF) game admits multiple Subgame Perfect Equilibria, both in the infinite horizon and the finite horizon version.² The theoretical and experimental literature has typically focused on symmetric, stationary equilibria, which are unique. The unique Symmetric Markov Perfect Equilibrium (SMPE) of the finite horizon game is characterized by three empirically testable features.³ First, proposers form minimum winning coalitions, allocating positive payoffs only to the number of players required to agree according to the decision rule. Second, the distribution of payoffs within the coalition is unequal, favoring the proposer. Third, the first proposal passes

² See Norman (2000) for a detailed analysis of the finite horizon BF game, including the establishment of a Folk Theorem.

³ The same features characterize the unique symmetric stationary subgame perfect equilibrium of the infinite horizon version of the game.

immediately. The specific proposals made under the parameter constellations used in the experiment ($\delta = 0.5$ and $n = 3, 7$) are presented in Table 1.

Table 1. Symmetric Markov Perfect Equilibrium proposals ($\delta = 0.5$)

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	give: 17% to 1 keep: 83%	give: 8% to 3 keep: 76%
unanimity rule	give: 17% to 2 keep: 66%	give: 8% to 6 keep: 52%

While these are the benchmark predictions assuming symmetric stationary equilibrium play, it is important to bear in mind that further Subgame Perfect Equilibria exist. Indeed, the multiplicity of equilibria is one of the reasons that experimental work on these games is interesting. And indeed, prior experiments have shown that human players deviate in systematic ways from the Markovian equilibrium predictions.

Experimental work on the BF game has established a number of consistent patterns in observed behavior (see Frechette et al. 2003; Frechette et al. 2005a; 2005b; Kagel et al. 2010; Miller and Vanberg 2013). The first is that proposers indeed often build minimum winning coalitions, but there are also a fair number of larger-than-minimum-winning coalitions. Second, proposers typically divide the available surplus more evenly and extract much smaller shares than theoretically predicted.⁴ Finally, a non-negligible fraction of proposals fail, leading to inefficient delays.⁵ In prior work involving groups of 3 players and a discount factor of $\delta = 0.9$, we found that such delays are significantly more frequent under unanimity rule (Miller and Vanberg 2013).

One aim of our experiment is to investigate how these established deviations from the standard benchmark predictions are affected by the number of players involved (small or large groups) and the decision rule used (majority vs unanimity rule). Thus we will investigate the extent to which proposers build larger than minimum winning coalitions, as well as the ‘fairness’ of the splits within those coalitions. Our main goal, however, is to test the conjecture that both delay (failure of a proposal according to the voting rule) and rejection (individuals voting ‘no’) are more likely to occur in larger groups and when

⁴ Agranov and Tergiman (2014) and Baranski and Kagel (2013) find that proposer power increases significantly when subjects can engage in cheap talk communication.

⁵ Palfrey (2013) surveys the experimental literature on the BF game, emphasizing four main findings: (1) proposers receive larger shares, (2) they extract less than is predicted by theory, (3) there is some delay, though it becomes less with experience, and (4) proposers build minimum winning coalitions.

unanimity rule is used.⁶

At first sight, the conjecture that delay will increase with group size and when unanimity rule is used may seem rather ‘obvious’. After all, both factors imply that a larger number of individuals must agree in order for a proposal to pass. However this intuition is wrong for majority rule, and potentially misleading for unanimity rule.⁷ Most importantly, it neglects the fact that both the proposals being made as well as the likelihood that an individual votes ‘yes’ on a given proposal are likely themselves to depend upon the size of the group and the decision rule being employed. The first part of our conjecture states that despite (or perhaps because of) such effects on individual behavior, the likelihood that *proposals fail* will be greater when unanimity rule is used, and when more players are involved.

The second part of the conjecture is concerned with the impact of our treatment variables on the likelihood that an *individual voter rejects* a given proposal. It is based on the observation that players face different incentives to ‘act tough’ in the bargaining process under different decision rules and group sizes.⁸ Under a rule of unanimity, tough negotiators must be given larger shares in order to secure their vote. Under majority rule, they are likely to be excluded from winning coalitions. Therefore, being perceived as ‘tough’ is advantageous under unanimity rule, and harmful under majority rule. If rejection of proposals is used as a way to signal toughness, we might therefore expect more rejection (at the individual level) under a rule of unanimity. Further, as the size of the group increases, the likelihood of being pivotal decreases, making this signal of toughness ‘cheaper’. Therefore, we may also expect higher rejection rates in large groups.

2.3 Related Literature

Several experimental studies have implemented the BF game in the laboratory. Most of these studies have focused on testing the main features of the symmetric stationary equilibrium predictions: Minimum winning coalitions, proposer advantage, no delay. McKelvey (1991) finds that coalition partners received

⁶ These predictions are inconsistent with the SMPE benchmark, and they are *not* based on equilibrium analysis. Instead they constitute *empirical* conjectures concerning the actual behavior of human subjects.

⁷ As a thought experiment, suppose that each player votes ‘yes’ with some probability that is unaffected by the size of the group. Under this assumption, the likelihood of *failure* will increase with the size of the group when unanimity rule is used, but it will increase or decrease with group size when majority rule is used depending on whether the individual propensity to vote yes is less than or larger than one half.

⁸ These incentives were perhaps first discussed by Buchanan and Tullock (1962).

larger shares than predicted by theory, and (off equilibrium) proposals passed more often than predicted. Fréchet et al (2003) find that proposers form minimum winning coalitions and proposals pass immediately. However, distributions within the winning coalition are more equal than predicted. Fréchet et al (2005a) find that proposals are more likely to fail if there is no discounting, i.e. no cost associated with delay. Diermeier and Morton (2005) investigate the finite horizon version with no discounting. They find that proposers allocate more money to other players than predicted, and a significant percentage of first round proposals above the theoretical continuation value are rejected.

Two other papers are closely related to our own. Kagel et al. (2010) introduce a “veto player” into the interaction. As the term suggests, this player (who may be a proposer or a responder) has the right to block any decision that is passed by a majority. Their focus is on the extent to which veto players can successfully convert this asymmetry in power into a more favorable bargaining outcome. One of their main results is that veto players indeed receive larger shares, both as proposers and as non-proposers. Another result of interest in our context is that introducing a veto player results in greater delay and therefore less efficient outcomes. In Miller and Vanberg (2013), we work with groups of size 3 and find that individual subjects are more likely to reject offers under unanimity rule. This increased rejection rate, as well as the requirement that all subjects agree, leads to more costly delay under unanimity rule. The experiment reported on here builds on our prior work by varying the size of the bargaining group. Another difference to our previous experiment is that here we use a smaller discount factor of 0.5 rather than 0.9. This has the advantage that the theoretically predicted offers in small groups differ significantly from equal splits. Thus, in addition to investigating the effects of group size, we are able to see how robust our previous finding is to these variations.⁹

2.4 Experimental Procedures

The experiment consisted of 8 experimental sessions involving a total of 101 subjects. All sessions were conducted at the Nuffield Centre for Experimental Social Sciences at the University of Oxford. Participants were undergraduate and graduate students from different disciplines at the University of Oxford, recruited using the online recruitment system ORSEE (Greiner 2004).

We implemented a 2x2 treatment design, varying group size ($n = 3$ and $n = 7$)

⁹ We have found no direct experimental test of the effect of group size on legislative bargaining. However, at least two papers increase the numbers of decision makers indirectly. Drouvelis et al (2010) have tested experimentally the effect of the enlargement of a committee. Bradfield and Kagel (2014) study legislative bargaining with teams.

and decision rule (majority and unanimity). The initial amount to be divided was 20 GBP in small and 50 GBP in large groups. Each of the four treatments was implemented in two experimental sessions. Small group sessions involved 12 subjects, large group sessions involved 14 subjects.¹⁰ Upon entering the laboratory, participants were randomly assigned to visually isolated computer terminals. All interactions occurred via these terminals, ensuring anonymity.

Within a given bargaining round, we elicited decisions using a modified strategy method (Selten 1967). First, each subject in a group made a proposal. Next, all submitted proposals were voted on. Finally, one proposal was chosen randomly for votes to be counted.¹¹ If the chosen proposal passed, bargaining ended. If it failed, the pie shrank and a new round of bargaining began. Bargaining ended if the amount remaining to be distributed fell below two GBPs. After each round of bargaining, subjects received feedback that consisted of the three (seven) submitted proposals, the number and identity -A, B or C in three-person groups, and A, B, C, D, E, F or G in seven-person groups- of participants that accepted/rejected each proposal, whether the proposals had been passed, as well as which proposal had been selected randomly for votes to count.

The bargaining game was repeated 15 times (plus one ‘practice period’)¹², with random rematching of groups between periods. Within a given period, subjects were identified by a label (a letter) that remained fixed for the duration of that period. At the end of a session, one period was randomly chosen for cash payment. Sessions lasted one hour, on average. Including a 4 GBP participation fee, earnings ranged from 4 GBP to 31.50 GBP, with an average of 10.05 GBP and a standard deviation of 3.88 GBP. The experimental software was programmed using z-Tree (Fischbacher 2007). Instructions are reproduced in the Appendix.

¹⁰ Due to subjects failing to show up, one of the small group sessions involved only 9 subjects.

¹¹ The advantage of this procedure is that we observe three (seven) proposals being made and voted on in each round, rather than just one. This procedure does not affect the SMPE predictions. One could expect that the strategy method would cause faster convergence of proposals, in the sense that proposals would become more similar over time, since participants can learn which proposals are accepted and which not. However, we do not observe such a trend in our experiment. As we show in the next section, there is only limited evidence of learning in our experiment. For instance, proposers’ demands are as disperse in the last five periods of the experiment as they are in the first five periods.

¹² The practice period is exactly the same as any other period, but it was not incentivized. In other words, when we select a period for the payment, the practice period was not included.

3 Results

3.1 The data

The data comprise 8 experimental sessions involving a total of 101 subjects. Each session lasted for 15 periods. 24 subjects participated in the majority-small group condition, 21 in the unanimity-small group condition, 28 in the majority-large group condition and 28 in the unanimity-large group condition. Our empirical analysis will focus entirely on the first bargaining round within each period.¹³ In each of the 15 periods, every subject makes one first round proposal and votes on $n - 1$ proposals made by others.¹⁴ It follows that the raw numbers of observations from our experiment break down as shown in Table 2.¹⁵

Table 2. Treatments, subjects and observations

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	2 sessions 12 + 12 subjects 360 proposals 720 voting decisions	2 sessions 14 + 14 subjects 420 proposals 2520 voting decisions
unanimity rule	2 sessions 9 + 12 subjects 315 proposals 630 voting decisions	2 sessions 14 + 14 subjects 420 proposals 2520 voting decisions

¹³ Although behavior in later bargaining rounds is potentially interesting to study, the relevant observations occur only if previous proposals have failed. Therefore the number of relevant observations is smaller and unbalanced across treatments. Further, these observations are less comparable to one another as each occurs after a different history of play. For these reasons, the experimental literature on the Baron-Ferejohn game has typically focused on round 1 behavior only.

¹⁴ Subjects also vote on their own proposals. However we will look only at voting on others' proposals.

¹⁵ Naturally, these numbers include multiple observations from the same sessions and subjects. We will take this into account in our empirical analysis.

3.2 Rate of passage

Table 3 reports the proportion of all 3 (or 7) proposals which passed in round one, pooling the data from all 15 periods. The effect of group size can be assessed by comparing columns. Under majority rule, the rate of passage falls from 88% in small to 75% in large groups.¹⁶ Under unanimity rule, it falls from 74% in small to 67% in large groups. Comparing rows, we see that the rate of passage is lower when unanimity rule is used, for both small and large groups.

Table 3. Rates of passage - All first round proposals

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	88%	75%
	[.84, .91]	[.71, .79]
unanimity rule	74%	67%
	[.69, .79]	[.62, .71]

95% confidence intervals in brackets

In Table 4, we test treatment differences using regression analysis. Model 1 reports marginal effects from a probit model; in model 2, we cluster observations at the session level.¹⁷ Clustering at the session level increases the size of the standard errors, and consequently decreases the significance level. Nevertheless, interacting in a larger group and requiring unanimous consent significantly decrease the passage rate.¹⁸

¹⁶ The passage rate in small groups is similar to those reported in previous experiments involving three subjects. For instance, Frechette et al. (2005a) find an 89% rate of passage with a discount factor of $\delta = 0.5$, as in our setup. Miller and Vanberg (2013) find a rate of 87% with a discount factor of $\delta = 0.9$. Somewhat surprisingly, these figures appear to suggest that the discount factor has no effect on the rate of passage in small groups.

¹⁷ In the experiment, the number of groups in each session is small and session effects might be an issue (Frechette 2012). We try to control for session effects by clustering standard errors at the session level. Given the small number of sessions, we use block (session) bootstrapped standard errors. We construct 100 bootstrap samples by randomly resampling sessions. For a general discussion of bootstrap with clustered errors, see Cameron et al (2009).

¹⁸ For Logit and Probit models, Ai and Norton (2003) have shown that the estimated coefficients on interaction terms can be difficult to interpret. Roughly, the problem is that the effect of the interaction term may vary across the range of predicted values of the dependent variable. In our case, this applies to the interaction of *Unanimity* and *Large Group*. We use the STATA command *inteff* to estimate the

Table 4. Regression analysis of the rate of passage (first round proposals)

Dependent variable: "Rate of passage"		
	(1)	(2)
<i>Unanimity</i>	-0.153*** (0.035)	-0.153* (0.087)
<i>LargeGroup</i>	-0.141*** (0.031)	-0.141*** (0.036)
<i>UnanimityxLargeGroup</i>	0.073* (0.041)	0.073 (0.085)
<i>Period</i>	0.003 (0.003)	0.003 (0.012)
Observations	1515	1515
Number of subjects	101	101

The unit of analysis is passage of a proposal; marginal effects from a probit regression presented; standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Result 1: *Under both majority and unanimity rule, first round proposals are passed more often in small groups than in large groups. As a consequence, costly delay occurs more often in large groups.*

Result 2: *For both small and large groups, first round proposals more often pass under majority rule than under unanimity rule. As a consequence, costly delay occurs more often when unanimity rule is used.*

The observed differences in aggregate *voting outcomes* (Results 1 and 2) are consistent with two types of effects. The first one could call purely 'statistical' (how votes are counted), while the second are genuine effects on individual behavior (proposals made and votes cast). The latter may either complement or counteract the former, depending on how behavior is affected.

By 'statistical' effects we mean that a higher rate of failure under unanimity rule may be driven, at least in part, by the simple fact that a larger number of

correct magnitude and standard error of the corresponding coefficient (see Norton et al 2004). We find that it is always positive but not significant.

individuals must agree. If proposals and voting decisions were held constant, unanimity rule would *by definition* result in higher rates of failure. Similar reasoning implies that failure rates will increase with group size when unanimity rule is used. When majority rule is used, the direction of the ‘statistical’ effect of group size will depend on the individual likelihood of voting ‘yes’.¹⁹

Though our aggregate results are consistent with these mere statistical effects, they are unlikely to tell the whole story concerning the observed efficiency losses associated with larger group size and the use of unanimity rule. As we will see, the proposals made under the different treatment conditions differ from one another. In addition, we have hypothesized that individual voting decisions on a given proposal will differ depending on the size of the group and the rule being used. Therefore we want to know more about the effects of our treatment variables on the proposals made and the likelihood that an individual player accepts or rejects a given proposal. Our main interest is in testing the hypothesis that individual voters may act ‘tougher’ when unanimity rule is employed and when the group is large.

To get a first impression, Table 5 shows the fraction of non-proposers voting ‘yes’ on all first round proposals under the four treatment conditions. Comparing columns, we see that the size of the group has different effects on the overall acceptance rate under majority and unanimity rule: under majority rule the proportion of ‘yes’ votes is smaller in large groups, while under unanimity rule it is larger. Comparing rows we can see that the proportion of ‘yes’ votes is smaller under majority rule than under unanimity rule. As we will see, this difference is driven mainly by the fact that proposers build minimum winning coalitions, so that fewer voters are ‘included’ under majority rule. Although these raw numbers hide interesting details, they reveal the simple point that considering the purely *statistical* effects of group size and decision rules is insufficient if we want to understand the mechanisms underlying the increased rate of proposal failure under unanimity rule and in large groups.

Table 5. Non-proposer acceptance rates

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	67%	59%
	[.64, .71]	[.57, .61]
unanimity rule	84%	91%
	[.82, .87]	[.90, .92]

95% confidence intervals in brackets

¹⁹ If this likelihood is greater than $1/2$, the probability that a proposal will fail using majority rule will actually *decrease* with group size.

3.3 Types of Proposals

In this section, we investigate the effects of our treatment variables on the proposals made. We begin by looking at the size of the proposed coalitions (are they minimum winning or larger?). Then we will look at the proposed division of the surplus within the proposed coalitions (are they equal or do they favor the proposer?). As above, the analysis focuses entirely on behavior in round 1 of each of our experimental games.

Regarding coalition size, the question of interest is whether proposers allocate positive shares to all members of the group, or only the number of people required to pass a proposal. Miller and Vanberg (2013) found a significant time trend away from the first and towards the second of these types of coalitions being proposed. We observe a similar pattern in the present setting. However, only 30% of proposals suggest *true* minimum winning coalitions in the sense that one voter is being offered zero. Instead, a large number of subjects propose what one could call an ‘approximate’ Minimum Winning Coalition: allocating a significant share to one person, and giving the other ‘peanuts’ (less than 20% of the pie).²⁰ If we consider both the strict and the non-strict definitions of MWC, about 50% of proposals are classified as MWCs.

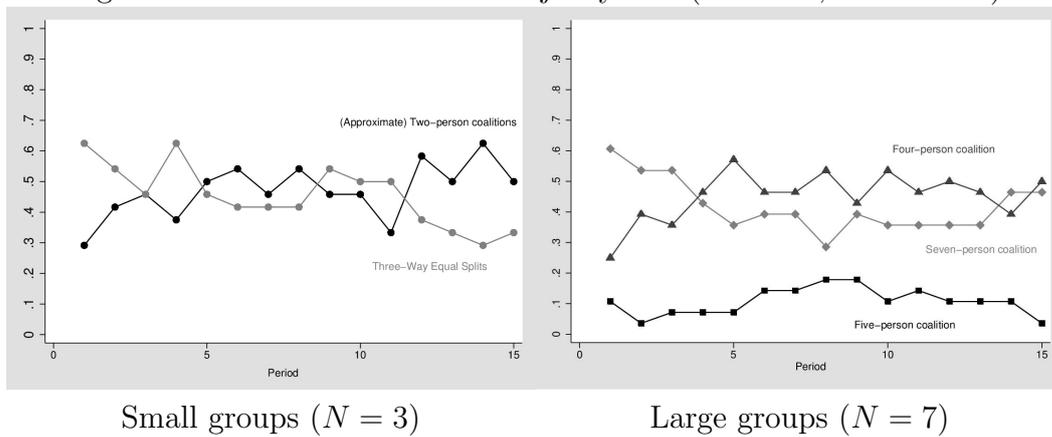
Figure 1 (left) shows the proportion of Minimum Winning Coalitions thus defined, as well as of roughly equal splits (proposals where all the three subjects receive at least 30%), over the 15 periods in small groups.²¹ These two types of offers represent 90% of the proposals in every period. In the first period, approximately two out of three proposals suggest three-way equal splits, and only 30% propose (approximate) Minimum Winning Coalitions. In the last 5 periods, one in two proposals suggests a Minimum Winning Coalition, and only one in three calls for a three-way equal split. Thus, it appears that many subjects were initially inclined to propose three-way equal splits. Over time, they learned that it is possible (or came to find it ‘acceptable’) to instead form a Minimum Winning Coalition. However, the pattern is less clear than in Miller and Vanberg (2013).²²

²⁰ After the zero-offer, the most common offers to outsiders in this type of coalitions are 15%, 5% and 10%. A reasonable interpretation of this behavior would seem to be that the small amount given to the outsider is charity, in the sense that proposers do learn and understand that it is enough to build a MWC but choose to give the outsider something as well. Alternatively, proposers may fear rejection of their proposal by “fair” members of the MWC and therefore “insure” themselves by allocating some money to non-MWC members.

²¹ While almost half of all proposals in the majority small group condition conform to this definition, there are only 25% of true equal splits in which all the group members receive at least the equal share.

²² The difference to our previous result indicates that a smaller discount factor

Figure 1. Coalition sizes under majority rule (Round 1, All Periods)



In seven-person groups (Figure 1, right), we define a k -person coalition be one in which k participants receive a positive share of the surplus, and $7 - k$ participants receive nothing. Then we observe mainly two types of coalitions. Across all periods, 45% are four-person, and 42% are seven-person coalitions.²³ As in the small group case, the number of ‘grand’ (seven-person) coalitions decrease over time, going from 61% in period 1 to 46% in period 15. In contrast, minimum winning (four person) coalitions are twice as frequent in period 15 as in period 1.

Result 3: *Under majority rule, two types of coalitions are proposed: grand coalitions, in which all players receive a significant share (close to the equal split), and minimum winning coalitions, in which only the minimum number of voters required to pass a proposal are offered a significant share.*

Under unanimity rule, virtually all proposals (95%) offer a significant share to all members of the group. That is, all proposals suggest a grand coalition, which in this case is equivalent to a minimum winning coalition. Thus the only difference between proposals under unanimity rule is in the share being allocated to the members of the all-inclusive coalition.

Result 4: *Under unanimity rule, all proposals allocate positive shares to all members of the group.*

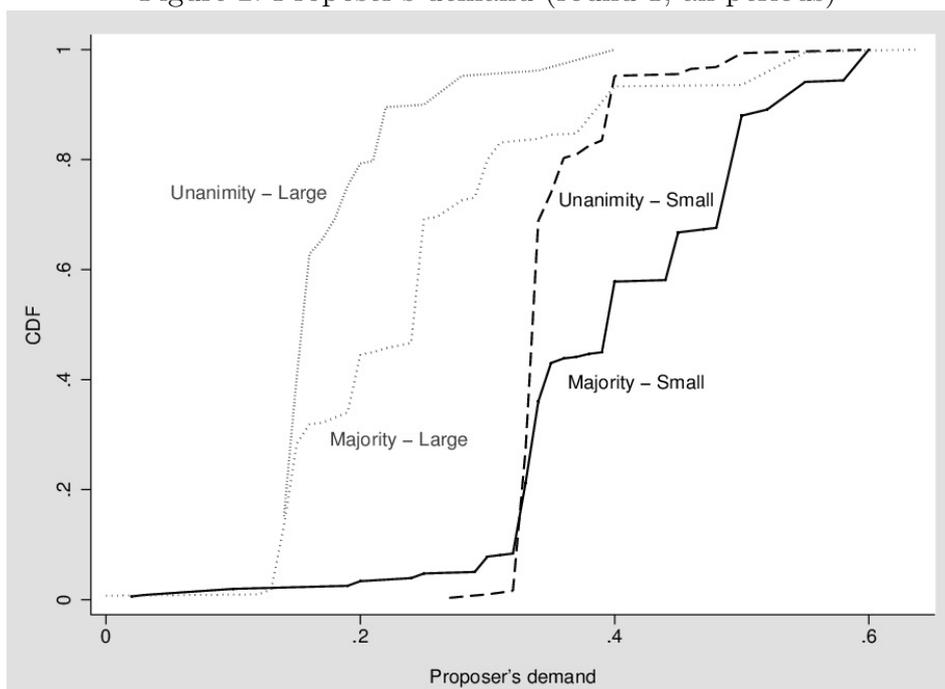
Next, we look at the distribution of the surplus within the coalition, focusing on the share proposers allocate to themselves. We will call this the proposers’ ‘demands’. Figure 2 displays the cumulative distribution functions of proposer demands under the four treatment conditions. Consider first the demands made in small groups.

Under majority rule, demands are concentrated in two distinct ranges. Approximately half lie between 30% and 40%. Overall, 96% of these demands are part of proposals which allocate more than 20% to all three coalition members. The most frequently observed demand within this range is 34%. Approximately 40% of all demands fall in the range from 44% to 60%. Overall, 95% of these demands are associated with proposals that constitute approximate minimum winning coalitions as defined above. In this range, the most commonly observed demand (as well as the most common demand overall) is 50%. Only two proposals demand more than 60%. Recall that in this case the equilibrium prediction was a demand of 83%. Under unanimity rule, 95% of demands

($\delta = 0.5$ instead of $\delta = 0.9$) induces slightly more inclusive proposals. However it is not clear why this should be the case.

²³ Interestingly, the third most common coalition includes five persons (10% across all periods). Such supermajority coalitions are predicted by Groseclose and Snyder (1996), albeit in a different strategic setting. In our context, a plausible rationale is that proposers are insuring themselves by allowing for a single no vote.

Figure 2. Proposer's demand (round 1, all periods)



are in the range of 30% to 40%, and no demand is close to the equilibrium prediction of 66%. By far the most commonly observed demand is equal to 34%, followed closely by 33%. Together, these two demands account for more than two thirds of all proposals under unanimity rule. In sum, proposals in small groups are less favorable to the proposer than predicted by the theory, under both rules. Many proposers demand only an equal share for themselves, especially under unanimity rule. Under majority rule, the most common demand is 50%, which corresponds to an equal share within a minimum winning coalition.

Now, consider proposers' demands in large groups. Under majority rule, three types of demands can be distinguished. Many proposers demand 14%, which corresponds to a seven-person equal split. By far the most commonly observed demand is for a 25% share, corresponding to an equal split within a four-person minimum winning coalition. Finally, we also frequently observe demands above 25%, among which the most commonly observed demands are 30%, 40%, and 55%. Under unanimity rule, all demands lie within the 14%-40% range and by far the most common demand is for 15%. Demands between 14% and 16% (corresponding to roughly equal splits) account for nearly two thirds of all proposals. Overall, proposers in large groups often demand more than an equal share (overall, or within a coalition), under both rules. However, their demands are far below the equilibrium predictions of 52 and 76 percent under unanimity and majority rule, respectively.

Result 5: *Under both decision rules and in both small and large groups, proposers demand a larger share than they allocate to non-proposers. This pattern*

is more pronounced in large groups. However, proposers demand substantially smaller shares than suggested by the SMPE prediction.

To assess the differences in proposer demands between the treatment conditions, we conduct a series of random effect linear regressions (Table 6). The dependent variable in all columns is the proposer's demand. In order to make demands comparable across different group sizes, we normalize them by dividing by the equal share, i.e., by $1/3$ in small groups and by $1/7$ large groups (last two columns).²⁴ Columns one and two show that proposers demand significantly smaller shares under unanimity rule in both small and large groups. This is not surprising, given that they must build a larger coalition. Columns 3 and 4 demonstrate the more interesting result that proposers demand significantly more (relative to an equal share) in larger groups, under both majority and unanimity rule. Under majority rule, the average proposer demand is 1.21 times the equal share in small groups and 1.75 times the equal share in large groups. Under unanimity rule, the average demand is 1.07 times and 1.28 times the equal share in small and large groups, respectively.²⁵

²⁴ Other ways to normalize shares include dividing by the equal share within a minimum winning coalition or the equilibrium predicted demands. Dividing by the equal share within a minimum winning coalition does not affect the results reported in table 6. However, if we divide the proposer demand by the equilibrium prediction, the coefficient of the "Large Group" variable turns negative and significant. This means that proposers deviate less from the equilibrium prediction in large groups than in small groups.

²⁵ The differences between majority and unanimity rule emerge over time. Specifically, demands increase over time under majority rule, but remain constant under unanimity rule. (The difference between the average demand in period one and period 15 is 11% and 8% for small and large groups, respectively. In contrast, we do not observe a similar change in proposers' demands under majority rule.) A possible interpretation is that proposers learn over time that they can demand larger slices of the pie, and still get their proposals passed under majority rule. Another explanation is that an initial norm of group egalitarianism erodes and is replaced by a norm of in-coalition egalitarianism.

Table 6. Regression analysis of proposer demands

Dependent variable: Normalized proposed demand				
	Group size:		Decision rule:	
	small	large	majority	unanimity
<i>Unanimity</i>	-0.165*** (0.022)	-0.481*** (0.018)		
<i>LargeGroup</i>			0.545*** (0.030)	0.229*** (0.016)
<i>Period</i>	0.008*** (0.001)	0.024*** (0.002)	0.027*** (0.002)	0.013*** (0.001)
Observations	1346	5040	3236	3150
Number of subjects	45	56	52	49

The unit of analysis is the normalized proposer demand; marginal effects from a random-effects linear regression presented; standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

3.4 Individual acceptance given types of proposals

Given the significant differences between proposals made under the different treatment conditions, the raw rates of acceptance among non-proposers (Table 5) reveal little about the effects of the treatments on individual voting behavior. Especially the differences between the rows are driven at least in part by differences in the proposals being made. In order to investigate the hypothesis that the treatment variables affect how ‘tough’ individual voters behave, we would ideally like to hold constant the kinds of proposals that are being voted on under each of the conditions. Perhaps the most salient property that we would like to hold constant is the share that the voter is being offered under the proposal being considered.

Table 7. In-coalition acceptance rates

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	75%	80%
	[.72, .79]	[.78, .82]
unanimity rule	85%	91%
	[.82, .87]	[.90, .92]

95% confidence intervals in brackets

As a first step, Table 7 compares individual acceptance rates among those individuals included in the coalition in the sense that they are allocated a positive share. We see suggestive evidence *against* the hypothesis that individuals behave ‘tougher’ under unanimity rule and in large groups. On the contrary, both of the treatment variables are associated with *larger* acceptance rates among those who are included in the proposed coalitions.

Perhaps a more appropriate way to investigate the issue of ‘toughness’ is to focus on the behavior of individuals who are being offered a positive but relatively *small* share of the available surplus. A challenge in conducting such an analysis is to define what is to be considered ‘small.’ One possible reference point is the *equal share* (33% in small and 14% in large groups). Table 8 shows acceptance rates among persons being offered a positive share below this reference point. Here again the evidence does not support our prior hypotheses concerning ‘toughness’ in bargaining. What we observe instead are very similar acceptance rates under all conditions except when *both* unanimity rule is used and the group is large. In this case, contrary to our hypothesis, we actually observe a higher rate of acceptance (i.e. less ‘tough’ behavior) than under the other treatment conditions.

Table 8. Acceptance rates when $0 < \text{own share} < \text{equal share}$

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	54%	51%
	[.48, .61]	[.44, .57]
unanimity rule	57%	75%
	[.50, .64]	[.72, .78]

95% confidence intervals in brackets

Given the prevalence of minimum winning coalitions, even offers significantly above the equal share might be considered small, if they fall short of an equal

share *within a minimum winning coalition*. In Table 9 we therefore look at acceptance rates among those individuals being offered a positive share that is less than this alternative benchmark. (By definition, this makes a difference only for the majority rule treatments.) Using this benchmark, acceptance rates are actually quite similar across all treatment conditions except the small group unanimity rule treatment. Here, it appears that there is some support for the hypothesis that unanimity rule is associated with increased toughness, albeit only in small groups.

Table 9. Acceptance rates when $0 < \text{own share} < \text{equal share}$ in MWC

	Small group ($n = 3$)	Large group ($n = 7$)
majority rule	74%	78%
	[.70, .78]	[.76, .80]
unanimity rule	57%	75%
	[.50, .64]	[.72, .78]

95% confidence intervals in brackets

Figure 3 displays all of the results just discussed in one place. In particular it shows average acceptance rates and confidence intervals as a function of the offer being received.

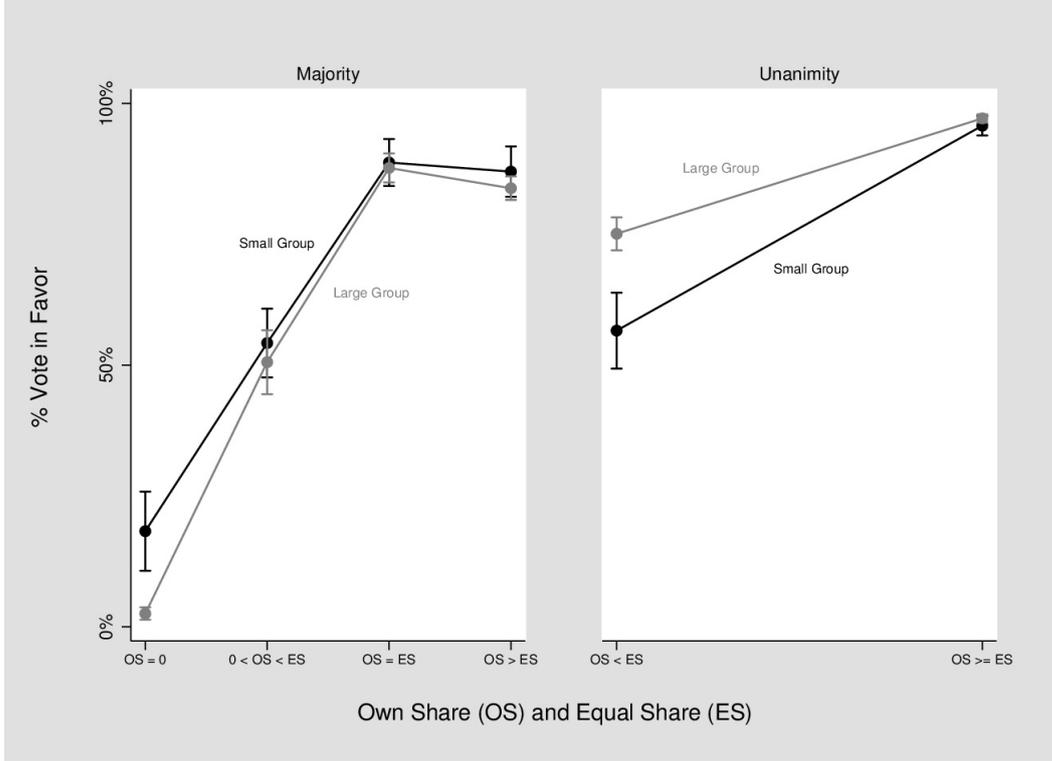
Although we did find some evidence that unanimity rule leads to more rejection of offers lower than the equal share in a minimum winning coalition in small groups, the overall evidence does not seem to support the hypothesis that either group size or unanimity rule have an impact on acceptance rates at the individual level. Thus we are lead to formulate the following negative result.

Result 6: *Controlling for the type of proposal being made, neither the size of the group nor the decision rule being used have a significant effect on the likelihood of voting yes.*

As above, we complement the descriptive statistical approach above with regression analyses that take into account the fact that our observations are not statistically independent. We therefore estimate the effects of the decision rule and the group size on individual voting decisions, using a random effects probit regression. Specifically, we estimate the following equation:

$$vote_{it} = 1 \left\{ \beta_0 + \beta_1 U_i + \beta_2 L_i + \beta_3 (U_i \cdot L_i) + \beta_4 OS_{it} + \beta_5 PS_{it} + \beta_6 P_t + \beta_7 P_t^2 + \alpha_i + \nu_{it} \geq 0 \right\}, \quad (1)$$

Figure 3. Accepted and Rejected Offers in Round 1



where we estimate the effect of the unanimity rule (U_i) and the large group (L_i), as well as their interaction ($U_i \cdot L_i$), on the probability of “voting yes” ($vote_{it}$), controlling for linear effects of the voter’s share (OS_{it}) and the proposer’s share (PS_{it}),²⁶ as well as linear and quadratic effects of the period (P_t and P_t^2). α_i and ν_{it} are a subject specific and an idiosyncratic error term, respectively.

Results of this analysis are reported in Table 7. As in the preceding analysis, we find no evidence to support the hypothesis of a negative effect of group size or unanimity rule on acceptance. On the contrary, we find that unanimity rule is associated with significantly higher probability of acceptance in large groups (column 2). Holding constant the use of unanimity rule, we find that group size in fact has a positive effect on acceptance rates (column 4). In sum, the results in Table 8 confirm Result 6 formulated above, in that we find no evidence to support our prior hypothesis concerning the effects of the

²⁶ Obviously, individual shares are smaller in large groups, so we need to normalize shares in order to make them comparable. In the regression equation, OS_{it} and PS_{it} are z -scores calculated from the distributions of voter’s share and proposer’s share in small and large groups. Alternative methods of normalizing OS_{it} and PS_{it} across treatments provide qualitatively similar results.

treatment variables on ‘toughness’ in voting.²⁷

Table 7. Random-effects probit regression marginal effects

Dependent variable: “Voting yes”					
	Group size:		Decision rule:		
	small	large	majority	unanimity	Pooling
Unanimity	0.213 (0.297)	1.101*** (0.262)			0.126 (0.305)
Large Group			-0.351 (0.241)	0.974** (0.433)	-0.341 (0.271)
Unani*Large					0.984** (0.402)
Own Share	0.988*** (0.070)	1.078*** (0.039)	0.995*** (0.033)	1.749*** (0.396)	1.065*** (0.034)
Proposer’s Share	-0.401*** (0.056)	-0.607*** (0.031)	-0.429*** (0.028)	-1.107*** (0.131)	-0.562*** (0.027)
Period	0.026 (0.049)	0.073** (0.029)	0.057* (0.031)	0.004 (0.043)	0.059** (0.024)
Period ²	0.001 (0.003)	-0.003* (0.001)	-0.002 (0.001)	0.003 (0.002)	-0.001 (0.001)
Observations	1346	5040	3236	3150	6386
Number of subjects	45	56	52	49	101

The unit of analysis is individual acceptance behavior; marginal effects from probit regressions presented; standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

²⁷ This analysis is robust to the introduction of a number of important covariates that behave in the expected direction. The probability of accepting a proposal increases with the voter’s own share and decreases with the proposer’s share. Individual acceptance rates increase with time as well. For the reasons explained in footnote 18, the coefficient on the interaction of Unanimity and Large (column 5) can be difficult to interpret. Again, we use STATA’s *inteff* command and find that the corrected coefficient is always positive and significant.

4 Conclusion

In their seminal contribution to the analysis of decision rules, Buchanan and Tullock (1965) hypothesized that more inclusive decision rules (e.g. unanimity) will be associated with larger costs of decision making than less inclusive rules (e.g. simple majority rule). Further, they hypothesized that decision costs will tend to be larger, and increase more sharply with the inclusiveness of the decision making rule, in larger groups. The latter hypothesis is particularly relevant for real decision making bodies, such as the European Council, since it implies that the enlargement of the Council will increase the decision making costs.²⁸

The experiments described in this paper were designed to test these hypotheses in a controlled laboratory setting. Following an established experimental literature on multilateral bargaining, we employed a version of the Baron-Ferejohn bargaining model as a framework. Although this is a rather stylized environment within which to test the hypotheses under consideration, it allows us to vary the group size and the decision rules while holding all other aspects of the interaction constant.

An additional advantage of employing this experimental framework is that our experiments extend previous experimental research testing the predictions of the Baron Ferejohn game. Contrary to game-theoretic predictions, previous experiments have found a positive amount of (inefficient) delay under simple majority rule. In a previous experiment involving groups of size 3, we found increased delay under unanimity rule as compared to majority rule. The experiment reported on here extends these results by varying both the size of the bargaining group and the decision rule.

Looking at rates of passage under the different treatment conditions, our main finding is that first round proposals are more likely to fail in large groups than in small groups, holding the type of decision rule constant. We also replicate our earlier result, finding significantly more delay under unanimity rule than under majority rule. The new evidence suggests that this result is robust to differences in the discount factor, and that it occurs in both small and large groups. Contrary to our initial hypothesis, however, we do not find that the latter effect is more pronounced in large groups.

These main results concerning the effects of our treatments on the rate of passage can conceivably be driven by two (compatible) factors. The first is

²⁸ Montero et al (2008) and Drouvelis et al (2010) have modeled theoretically and experimentally the effect of the enlargement of the European Council. The latter paper shows using a laboratory game that members of a committee can even gain power by adding new members to the committee.

that both the large group and the unanimity rule condition require a larger number of voters to accept a proposal in order for it to pass. The second are genuine effects on individual behavior (proposals made and vote cast).

Our results on types of coalitions and proposals confirm and extend those of previous studies. In particular, we find that proposers demand more than they offer, but less than predicted according to theory. Under both rules, a common pattern is that proposers build either a minimum winning or a grand coalition, and then distribute the surplus equally among its members. Interestingly, proposer demands differ significantly between three-person and seven-person groups. We compare deviations of proposer demands from the equal split and find that the amount above the equal split demanded is larger in large groups than in small groups.

When we look at individual acceptance rates, and control for the type of proposal being made, we find that neither the size of the group nor the decision rule being used have a significant effect on the likelihood of voting yes. This contradicts our ex ante hypothesis that individual voters act more ‘tough’ in large groups and under unanimity rule. However, as a secondary result, we confirm our previous result (Miller and Vanberg, 2013) that unanimity rule leads to more rejections of low offers in small groups.

Given the above results, we conclude that the higher rate of failure in large groups and under unanimity rule is driven by a combination of the ‘statistical’ effect -a larger number of individuals must agree-, the fact that a large proportion of voters reject offers below the equal share, and the fact that proposers demand more (relative to the equal share) in large groups.

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Appendix: Instructions

The following pages contain a reproduction of the instructions for the majority rule, large group treatment. Instructions for all other treatments were identical

except for wording related to the number of players and the number required for a proposal to pass.

Page 1:

Page | 1

Dear participants,

Welcome and thank you for participating in this experiment. Before we describe the experiment, we wish to inform you of a number of rules and practical details.

Important rules

- The experiment will last for about **90 minutes**.
 - Your participation is considered **voluntary** and you are free to leave the room at any point if you wish to do so. In that case, we will only pay you the show-up fee of £4.
 - **No writing**: You are not allowed to use a pen or take notes during this experiment.
 - **Silence**: Please do remain quiet from now on until the end of the experiment. Those who do not respect the silence requirement will be asked to leave the experimental room. You will have the opportunity to ask questions in a few minutes.
-

What will happen at the end of the experiment

Once the experiment is finished, please remain seated. We will need around 10 minutes to prepare your payment. You will be called up successively by the number on your table; you will then receive an envelope with your earnings and you will be asked to sign a receipt.

Description of the experiment

The experiment consists of **15 periods**. At the beginning of each period, **groups of seven participants** will be randomly formed. Thus, you will be randomly grouped with six other participants in this room. **New groups are formed in each period**, i.e. you will be interacting with a different set of participants in each period. No participant will know with whom he or she has been grouped during the experiment.

Each period consists of several rounds. Since new groups are formed at the beginning of each period, **you will be interacting with the same six participants for the duration of each period**, i.e. your group will remain fixed for all rounds within a given period.

After all groups have completed a given period, new groups are formed and a new period begins. After all 15 periods have been completed, the computer will randomly choose one period to be paid. Your earnings in the experiment will consist of the show-up fee (£4) plus your earnings in the period chosen for payment.

In each period, you will interact with six participants. Each participant will be randomly assigned an ID ("A", "B", "C", "D", "E", "F" or "G"). These ID's will remain fixed for all rounds throughout the period.

You will be acting as members of a committee that will bargain over the allocation of funds between them. The seven members of the group decide how to split a "pie" initially worth £50 among them. Decisions are made by majority rule, using the following procedure.

First, **every participant makes a proposal** as to how much "A", "B", "C", "D", "E", "F" and "G" will receive. Next, **each proposal is voted on**. Finally, **one proposal is randomly chosen to be counted**. If a majority has voted yes on the chosen proposal, it **passes** and the period ends. In case this period is later chosen for payment, each member of the group is paid the amount allocated to her by the chosen proposal. If a majority has rejected the randomly chosen proposal, it **fails**. In this case, the "pie" to be distributed shrinks by 50% and a new round of bargaining begins. I.e. each member makes a new proposal, etc. Thus, if the first proposal is rejected, the next round will involve splitting £25 among the 7 members. And if this proposal is rejected in round 2, then in round 3 £12.5 will be split, etc. Once a simple majority approves a proposal and it is chosen to be counted, the bargaining phase ends and the accepted proposal is implemented. The period will also end if the amount remaining to be distributed falls below £2.

The following pages provide more detailed information about the computer program used during the experiment.

Here is an example of what you will see on the **proposal screen**:

- Displayed on the top part of the screen are the period, your type and the pie size.
- Below, you will find seven boxes into which you must type your proposal. You must type the share of the pie (%) you wish to allocate to "A", the share of the pie (%) you wish to allocate to "B", the share of the pie (%) you wish to allocate to "C", the share of the pie (%) you wish to allocate to "D", the share of the pie (%) you wish to allocate to "E", the share of the pie (%) you wish to allocate to "F" and the share of the pie (%) you wish to allocate to "G".

The screenshot shows a web interface for submitting a proposal. At the top, it displays 'Period: 1', 'Your ID: A', and 'Pie Size (GBP): 50.00'. Below this is the title 'PROPOSAL SCREEN' and a paragraph of instructions: 'Please submit a proposal. After all proposals are submitted, you will be asked to vote on each. The computer will then randomly choose one proposal for which the submitted votes will be counted. Enter the percentage share of the currently available pie (see above) allocated to each subject. The sum of the allocated shares may not exceed 100%.' Underneath, it says 'Your proposal:' followed by seven input fields labeled '% to C:', '% to B:', '% to D:', '% to F:', '% to A:', '% to G:', and '% to E:'. Each field contains a small blue box for text entry. A red 'OK' button is located at the bottom right of the form area.

After all seven participants in the group have submitted a proposal, you will move to the **voting screen**.

Here is an example of what you will see on the **voting screen**:

- The top part of the screen contains the same information as the proposal screen.
- Below, you will now see the submitted proposals displayed both numerically and graphically.
- To the left of each proposal, you will find the buttons used to vote on the proposals.
- After selecting yes or no for a proposal, click submit to cast your votes.

Period: 1 Your ID: G Pie Size (GBP): 50.00

VOTING SCREEN

Proposal B

To C:	To B:	To D:	To F:	To A:	To G:	To E:
12 %	12 %	12 %	12 %	10 %	12 %	12 %

VOTE ON PROPOSAL

Proposal made by Subject: B

The proposal is displayed on the right. Please vote yes or no and then click submit.

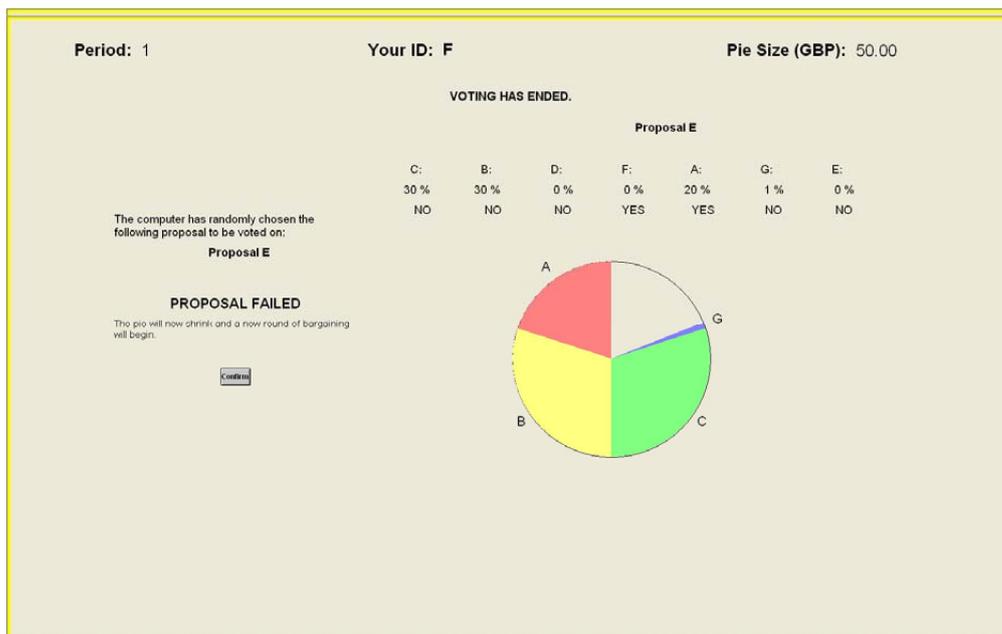
VOTE NO YES

A pie chart with seven segments labeled A through G. Segment A is red, B is yellow, C is green, D is cyan, E is blue, F is purple, and G is grey.

After all participants have voted, you will move to the **results screen**.

Here is an example of what you will see on the **results screen**:

- On the results screen there is information on the randomly selected proposal. Recall that only one proposal is randomly chosen to be counted. In this screen there are two new pieces of information: the number of participants that accepted/rejected the selected proposal and whether the proposals have been passed



If the selected proposal is passed, the period ends. In this case you will see a waiting screen until all groups have finished the period and new groups are formed. If the selected proposal is rejected, you will move back to the proposal screen for a new round of bargaining. In this case, the "pie" to be distributed will shrink by 50%. (Recall that you can always see the current size of the pie in the upper right hand corner.)

Your total earnings

Your total earnings in this experiment comprise the amount allocated to you in the bargaining and the £4 of the show-up fee.

$$\begin{array}{c} \boxed{\text{Total}} \\ \boxed{\text{earnings}} \end{array} = \begin{array}{c} \text{THE PERIOD} \\ \text{CHOSEN FOR PAYMENT} \\ \boxed{\text{Amount allocated}} \\ \boxed{\text{to you in the}} \\ \boxed{\text{period chosen for}} \\ \boxed{\text{payment}} \end{array} + \begin{array}{c} \text{SHOW-UP FEE} \\ \boxed{\text{£4}} \end{array}$$

If you have any questions, please raise your hand now and wait for the experimenter to come to you.

Please leave these instructions on your table when you leave the room.

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