

Bargaining in the Shadow of Uncertainty ^{*}

Marina Agranov[†] Hülya Eraslan[‡] Chloe Tergiman[§]

April 24, 2020

Abstract

We experimentally study the efficiency properties of unanimity and majority voting rules in multilateral bargaining environments in which a committee decides how to allocate a stochastic surplus. We find that, irrespective of the distribution of the surplus, committees that use a unanimity rule obtain weakly higher efficiency levels compared with majority committees. This difference is especially pronounced and large in magnitude when the cost of a mistaken early agreement is high, i.e., when the expected gains from waiting are large. In parallel, we find that unjustified delays are rare under the unanimity rule. Our results highlight that in such bargaining environments, the advantages of using the unanimity rule exceed its potential costs.

^{*}We are grateful to Salvatore Nunnari for his careful reading and very helpful feedback.

[†]Department of Humanities and Social Science, California Institute of Technology. Email: magranov@hss.caltech.edu.

[‡]Department of Economics, Rice University. Email: eraslan@rice.edu.

[§]Smeal College of Business, Penn State. Email: cjt16@psu.edu.

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1 Introduction

Many important public decisions are made through bargaining among at least three parties. An important institutional design issue in such multilateral bargaining environments is the choice of the voting rule. Unlike bilateral bargaining situations where it is natural to require unanimous agreement by both parties on a proposal for its implementation, it is not clear what voting rule is optimal in multilateral bargaining situations. For decisions of great importance, the unanimity rule seems like a good starting point. However, one concern with the unanimity rule is the ability of a single person to hold others hostage. This view is the one expressed by Alexander Hamilton in *The Federalist* 22:

To give a minority a negative upon the majority (which is always the case where more than a majority is requisite to a decision), is, in its tendency, to subject the sense of the greater number to that of the lesser. The necessity of unanimity in public bodies, or of something approaching towards it, has been founded upon a supposition that it would contribute to security. But its real operation is to embarrass the administration, to destroy the energy of the government, and to substitute the pleasure, caprice, or artifices of an insignificant, turbulent, or corrupt junto, to the regular deliberations and decisions of a respectable majority.

These concerns were also at the heart of the move from a unanimity rule to a qualified majority voting rule in most policy areas in the Council of Ministers under the Treaty of Lisbon signed by the members of the European Union in 2007 and put into force in 2009.

At the same time the majority rule is not without criticism. Almost half a century before Alexis de Tocqueville coined the phrase the “tyranny of the majority” in his classic text “*Democracy in America*,” James Madison and other delegates at the Constitutional Convention created documents strongly influenced by the understanding that any majority of citizens would be tempted to redistribute wealth to infringe the rights of the minority.

In this paper we experimentally explore the optimal design of the voting rule in a stochastic bargaining framework using efficiency as the desired criteria.¹ This framework, developed by [Merlo and Wilson \(1995, 1998\)](#) under the unanimity rule and extended by

¹This is not to suggest that efficiency is the only desirable feature of an institution. Among other things, fairness is another important consideration. While we present evidence that the unanimity rule also leads to more equality in terms of distribution of earnings, we leave the experimental investigation of the optimal design of a fair voting rule to future research.

Eraslan and Merlo (2002) to the majority rule, captures complex bargaining environments where a complete contingent set of contracts are not available. Since the surplus to be allocated changes stochastically over time, delays can arise in equilibrium even under complete information. Because of its flexibility in explaining delays, stochastic bargaining models are used in a variety of applications including government formation (Merlo (1997), Diermeier, Eraslan, and Merlo (2002, 2003, 2007)), corporate bankruptcy reorganizations (Eraslan (2008)), sovereign debt renegotiations (see Ghosal, Miller, and Thampanishvong (2019) and the citations therein), and standard setting committees (Simcoe (2012)).

An advantage of the stochastic bargaining framework to tackle the question above is that it allows two kinds of mistakes: (i) “unjustified agreement,” that is, agreeing on the division of a surplus when the surplus is expected to grow to a sufficiently high level that it is optimal to wait; and (ii) “unjustified delay,” that is, not reaching agreement when there is no expected gain from waiting. Eraslan and Merlo (2002) show that the majority rule is prone to the first kind of mistake due to the tyranny of the majority, while the unanimity rule is not. In their analysis, the second kind of mistake, i.e., the unjustified delay, does not arise under either agreement rule as a result of sophisticated reasoning and the rationality of the players. Given the warnings of Hamilton, one might expect that, absent such idealized conditions, the unanimity rule would be more prone to the second kind of mistakes than the majority rule. We experimentally test these two hypotheses.

Our design consists of a series of bargaining experiments in which a committee with three members allocates a budget for a given voting rule and stochastic process that governs the evolution of the budget size. Specifically, we run six treatments that vary along two dimensions: (1) the voting rule which is either a simple majority (M) or a unanimity (U) rule; (2) the variation in the size of the budget: in the M24 and U24 treatments, the surplus to be divided (henceforth budget) is always 24; in the M48 and U48 treatments, the budget is 24 in the first bargaining round, but if an agreement is not reached in the first round, the budget can be either 24 or 48 with equal probabilities in each future round; in the M96 and U96 treatments, the budget is 24 in the first bargaining round, but if an agreement is not reached in the first round, the budget can be either 24 or 96 with equal probabilities in each future round. As we describe in detail in Section 3, the three parameterizations are used to create three qualitatively different situations, in which (a) both voting rules are expected to result in immediate agreement (U24 and M24 treatments), (b) both voting rules are expected to result in delays in the equilibrium (U96 and M96 treatments), and (c) only the unanimity rule is expected to create efficient

delays (U48 versus M48).

Our experimental results show strong support for the first hypothesis (that unjustified agreements are more likely under the majority rule) when the cost of a mistaken agreement is high, i.e., when the expected gains from waiting is high, and weak support for it when the cost of a mistaken agreement is sufficiently low. The data do not support the second hypothesis (that unjustified delays occur more frequently under the unanimity rule). Thus, overall, our results show that the unanimity rule performs weakly better than the majority rule in all treatments, and strictly better when the cost of mistaken agreements is sufficiently high.

We then turn to the individual level analysis. We find that in the unanimity treatments, the fraction of small budget proposals, i.e., allocations submitted for budgets of size 24, that are rejected by both non-proposers is 50.6% and 23.1% in the U48 and U96 treatments, respectively. This means that nearly 50% of mistaken agreements in the U48 treatment and over 75% of mistaken agreements in the U96 treatment are avoided thanks to a single person, showing that the unanimity rule is what prevents the first kind of mistake mentioned above.

But of course, under the unanimity rule, a single person can also hold others hostage resulting in the second kind of mistake discussed above (that they would unjustifiably delay the passage of a budget). Since we find no support for the second hypothesis, the main takeaway from our analysis is that the benefits of the unanimity rule exceed its cost.

The earliest theoretical research comparing the unanimity and majority rules from an efficiency perspective that we are aware of is [Wicksell \(1958\)](#). He considered the design of a voting mechanism to provision and finance public goods and concludes that the unanimity rule is the only voting rule that leads to Pareto efficient outcomes while all other voting rules lead to the “coercion of the minority.” Ruling out an absolute unanimity rule for practical reasons, he supported an “approximate” unanimity rule as the optimal voting rule. The seminal work of [Buchanan and Tullock \(1962\)](#) developed these ideas further and introduced an “external cost of collective decisions” as the cost associated with the coercion of the minority. The less inclusive a voting rule, the higher are these external costs. Buchanan and Tullock conclude that “the introduction of decision-making costs is required before any departure from the adherence to the unanimity rule can be rationally supported.” Like Wicksell, they support an approximate voting rule as the optimal voting rule. By contrast [Rae \(1969\)](#) and [Taylor \(1969\)](#) support the majority rule. [Mueller \(2003\)](#) provides an excellent summary of this literature and notes the importance of assumptions underlying different models favoring majority rule and unanimity rules.

Eraslan and Merlo (2002) compare the efficiency properties of the majority and unanimity rules in the context of legislative bargaining à la Baron and Ferejohn (1989). They show that the unanimity rule is the only agreement rule that is efficient when the surplus to be divided is stochastic.²

The experimental literature on legislative bargaining is extensive (see the surveys of Palfrey (2015) and Agranov (2019)).³ Therefore, we focus our review on the subset of papers that compare the performance of various voting rules. Miller and Vanberg (2013, 2015) study how different voting rules affect delay in bargaining in small and large committees. Contrary to the predictions of stationary equilibria, committees take longer to reach agreements under the unanimity rule compared with the majority rule. This is because under the unanimity rule, every member is de facto a veto player, as passing proposals requires agreement from everyone rather than a majority of committee members. Interestingly, delays under the unanimity rule are not responsive to the committee size. However, the situation changes when committee members can communicate with each other. Indeed, Agranov and Tergiman (2019) show that negotiations that precede the proposal stage eliminate wasteful delays that happen often under the unanimity rule without communication.

The papers discussed above consider bargaining with a fixed rather than a stochastic budgets.⁴ This is an important distinction since delay in bargaining with a fixed budget leads to a for sure loss of efficiency for impatient bargainers. The setup we study here, i.e., bargaining with stochastic budgets is different since efficiency balances the two opposing forces: the desire of the committee to wait for the realization of a large budget and the cost of such delay.

²Other papers comparing majority and unanimity rule in legislative and multilateral bargaining include Ali (2006), Yildirim (2007), Yildirim (2018), Bond and Eraslan (2010) and Cardona and Rubí-Barceló (2014). All but Ali (2006) conclude that unanimity rule is more efficient than majority rule.

³The first experiments of Baron-Ferejohn model are McKelvey (1991), Frechette, Kagel, and Lehrer (2003), and Diermeier and Morton (2005).

⁴There also exists a small experimental literature on dynamic bargaining. Most related to our study is Battaglini, Nunnari, and Palfrey (2012). The authors present a legislative bargaining model in which public and private goods are decided in each period over an infinite horizon. They show that the unanimity rule leads to higher long-run public investment than the majority rule. Thus, like us, they find support for the unanimity rule from an efficiency perspective. See also Battaglini, Nunnari, and Palfrey (2019) who study a two-period model with public and private goods with the possibility of accumulation of public debt. In this setting, the budget in the second period depends on the committee decision in the first period, and, moreover, the opportunity cost of borrowing from the future is stochastically determined. It is unclear how to compare their results to ours given the substantive differences between the settings.

2 Design

All experimental sessions were conducted at the University of California, San Diego.⁵ Subjects were recruited from a database of undergraduate students. Twenty four sessions were conducted with 4 sessions per treatment and 12 subjects in each session, for a total of 288 subjects. Each subject participated in only one session. The experiment lasted about 90 minutes and average earnings were \$25.7, including a \$12 show up fee.

We conducted six different treatments that varied along two dimensions: (1) the voting rule, which was either a simple majority (M) or a unanimity (U) rule; (2) the variation in the size of the budget: in the M24 and U24 treatment, the budget was always 24; in the M48 and U48 treatments, the budget was 24 in the first bargaining round, but if the game continued, in each of the next rounds the budget would be either 24 or 48 with equal chance (i.i.d. draws). In other words, the budget could double. In the M96 and U96 treatments, the budget was 24 in the first bargaining round, but if the game continued, in each of the next rounds the budget would be either 24 or 96 with 50% chance of each. In other words, the budget could quadruple. We refer to the M24 and U24 treatments collectively as the “Baseline” treatments, to the M48 and U48 treatments collectively as the “Double” treatments, and to the M96 and U96 treatments collectively as the “Quadruple” treatments. We refer to the U24, U48 and U96 treatments as the “Unanimity” treatments, and to the M24, M48 and M96 as the “Majority” treatments.⁶

In each experimental session, three subjects played twelve repetitions of the complete bargaining game with random re-matching between games (i.e. between repetitions). Each bargaining game consisted of an unknown number of bargaining rounds. The bargaining protocol was the standard [Baron and Ferejohn \(1989\)](#) protocol. At the beginning of each bargaining round, the committee members learned the size of the budget for the round and one of the three committee members was randomly selected to be the proposer. The proposer could either submit an allocation proposal (a vector of non-negative payments to all three members that sums up to the budget in the current round) or, alternatively, the proposer could choose to bypass the round and move straight to the next bargaining round without making a proposal.⁷ If the proposer chose to submit

⁵We are grateful to the UCSD Economics department for allowing us to use their experimental lab to conduct our experiments.

⁶In Appendix F we present the instructions for the U96 treatment. The only differences with the other treatments are: (1) the potential size of the future budget; and (2) whether unanimity or majority is needed to pass a proposal.

⁷As we discuss in the next section, theoretically allowing the proposer to bypass making a proposal should not make a difference because the proposer can count on the other members rejecting the proposal when it is optimal to wait. But, in practice, it is efficient to bypass the proposal, even without taking into account the possibility of other committee members making mistakes (because it does not change

an allocation proposal, then all committee members observed it and voted on it. If the allocation received the required number of votes, then the bargaining game was over and the committee members received the payoffs specified in the allocation that passed. If the allocation did not receive the required number of votes or if the proposer chose to bypass the round, then the current bargaining round was over. In this case, there was a 20% probability that the bargaining game was over, in which case all group members received payoffs of zero. With the remaining 80% chance the bargaining game continued to the next bargaining round where the proposer was once more randomly selected. That is, all committee members faced common discount factor of $\delta = 0.8$. After the proposer was selected at the beginning of a round but before she made her choice, committee members had the opportunity to communicate with each other using the unrestricted chat tool.⁸

At the end of the experiment, one of the twelve games that the subjects played was randomly chosen for payment and subjects were paid the amount they earned in this randomly selected game (see [Azrieli, Chambers, and Healy \(2018\)](#)). In addition, after the twelve games, subjects played two investment games which can be used to elicit subjects risk attitudes.⁹ Finally, all subjects received \$12 for participating in the experiment and completing it.

To summarize, the Baseline treatments (U24 and M24) are settings without uncertainty regarding the size of the budget. These are the standard games considered by many previous experimental papers with the only difference being that proposers were allowed to bypass making a proposal, which should be irrelevant in these two treatments since it should never be used on equilibrium path. We use these treatments to compare behavior observed in our experiment with those reported in the literature. All the other treatments feature stochastic budgets governed by a simple process according to which committees who face a small budget expect to face a higher average budget in the future. The anticipation of the possible increase in the budget size might be tempting enough for a committee to delay dividing a small budget in hopes of getting the large budget in the future, despite the fact that delays are costly (as captured by the discount factor of $\delta = 0.8$).

the outcome and saves everybody time). Allowing the proposer to bypass making a proposal makes it possible for us to disentangle whether deviations from theoretical predictions were due to proposing behavior or voting behavior.

⁸See instructions presented in the Appendix for the description of the chat tool.

⁹Appendix G presents summary statistics for the two tasks across treatments. Since there are no statistical differences across treatments in this game, we reject that treatment differences are due to differences towards risk as measured in this game.

3 Theoretical Predictions

In this section, we provide a brief discussion of the theoretical predictions for the extensive form game described in the previous section.¹⁰ We focus mainly on the qualitative rather than quantitative predictions, since these predictions can speak to a general quest of understanding the key forces governing behavior in bargaining settings with uncertainty. These qualitative predictions will serve as a basis of our empirical analysis.

Denote by q the number of votes required to pass a proposal. When $q = n$, agreement rule is the unanimity rule. When n is odd and $q = \frac{n+1}{2}$, agreement rule is the majority rule. In each bargaining round, the committee faces either a high budget, denoted by \bar{y} , or a low budget, denoted by $\underline{y} < \bar{y}$. The probability of facing a low budget is given by p . The committee members have an identical, single date, von Neumann-Morgenstern payoff function that is linear in their own share of the budget, and discount the future at a rate $\delta \in (0, 1)$. In the event that agreement is never reached, all committee members receive a payoff of zero.

It is well known that in multilateral bargaining games like the one considered here there is a continuum of subgame perfect equilibria even under unanimity rule (e.g., Sutton, 1986). However, it has also been recognized that stationarity is typically able to select a unique equilibrium (e.g., Baron and Ferejohn (1989); Merlo and Wilson (1995)). Thus, we restrict attention to stationary subgame perfect (SSP) equilibria. In addition, given that the members are symmetric, we further restrict attention on symmetric and pure SSP equilibria in which all members use identical pure strategies. Given our focus on symmetric SSP, all members have the same continuation payoff which we denoted by v^q . Also, given symmetry, conditional on not being the proposer, and conditional on agreement being reached, each player is included in a winning coalition with the same probability. This probability is equal to $\frac{q-1}{n-1}$ since each proposer needs to choose $q - 1$ other players to include in his coalition out of $n - 1$ remaining players. There are two cases to consider:

- (i) Delay is so costly that the members are willing to split the small budget instead of waiting for the large budget to materialize. Assuming without loss of generality a member accepts a proposal when indifferent,¹¹ this happens when $\underline{y} - (q-1)v^q \geq v^q$. In this case, the equilibrium continuation payoffs must satisfy

$$v^q = \frac{1}{n} \left[p(\underline{y} - (q-1)\delta v^q) + (1-p)(\bar{y} - (q-1)v^q) \right] + \frac{n-1}{n} \frac{q-1}{n-1} \delta v^q,$$

¹⁰See Eraslan and Merlo (2002) for a general treatment of the model.

¹¹See footnote 7 in Eraslan and Merlo (2017) for an explanation of why this assumption is without loss of generality.

$$= \frac{p\underline{y} + (1-p)\bar{y}}{n}.$$

This case is possible if and only if $\bar{y} \leq c_1 \underline{y}$ where $c_1 = \frac{n-\delta qp}{(1-p)\delta q}$, that is, when the large budget is not that much larger than the small budget.

- (ii) Delay is not so costly, and therefore, the members are willing to wait for the large budget to materialize instead of reaching agreement on the small budget. This happens when $\underline{y} - (q-1)\delta v^q < \delta v^q$. In this case, the equilibrium continuation payoffs must satisfy

$$v^q = \frac{1}{n} \left[p\delta v^q + (1-p)(\bar{y} - (q-1)\delta v^q) \right] + \frac{n-1}{n} \left[p\delta v^q + (1-p)\frac{q-1}{n-1}\delta v^q \right].$$

Collecting terms and rearranging, we obtain $v^q = \bar{y} \frac{1-p}{n(1-\delta p)}$. This case is possible if and only if $\bar{y} > c_2 \underline{y}$ where $c_2 = \frac{n(1-\delta p)}{(1-p)\delta q}$, that is, when the large budget is sufficiently higher than the small budget.

When the committee uses unanimity voting rule, i.e. when $q = n$, we have $c_1 = c_2 = \frac{1-\delta p}{(1-p)\delta}$. Consequently, either the necessary and sufficient condition for case (i) is satisfied, or the necessary and sufficient condition for case (ii) is satisfied, but they cannot be satisfied simultaneously. As such, equilibrium is unique for all possible values of $\bar{y}, \underline{y}, \delta$ and p under unanimity rule. In this unique equilibrium, the committee never delays when the value of large budget is relatively small, i.e., $\bar{y} < \frac{1-\delta p}{(1-p)\delta} \underline{y}$ and otherwise committee delays bargaining until the large budget is realized. However, when committee uses any other voting rule with $q < n$, multiple equilibria might be supported since $c_1 > c_2$. Interestingly, the expected equilibrium payoffs do not depend on the voting rule used by the committee, and only depend on the parameters of stochastic process that governs evolution of budget, i.e., $(p, \underline{y}, \bar{y})$ and the discount factor δ .

For the parameters used in our experimental sessions, we obtain $c_1 = c_2 = 1.5$ for the unanimity treatments and $(c_1, c_2) = (2.75, 2.25)$ for the majority treatments. We have deliberately chosen the sizes of the large budget to be (\$24, \$48, \$96) so that there exists a unique equilibrium in all treatments. Table 1 summarizes the theoretical predictions for each of our treatments taking into account the fact that all committees started with the small budget in the first bargaining round.

Notice that the theory is silent regarding the mechanics of how delay in bargaining occurs. It can happen in one of two ways. In the first, the proposer can choose to forgo making a proposal, in which case the current bargaining round ends irrespective of the desires of other committee members. In the second, the proposer can submit an

Table 1: Theoretical Predictions.

Voting rule	Unanimity			Majority		
	U24	U48	U96	M24	M48	M96
Highest possible budget	24	48	96	24	48	96
Delay when budget is small	no	yes	yes	no	no	yes
Delay when budget is large	no	no	no	no	no	no

allocation proposal, which can then be struck down by the committee members. In that case the current bargaining round ends following other members’ behavior rather than because of the unilateral decision of the proposer. While theoretically these two ways of inducing delay are identical in terms of the eventual outcomes they produce, there may be large behavioral differences across them. Our experimental design allows us to examine this point and investigate whether different voting rules tend to affect the ‘type’ of the delay.

4 Results

4.1 Efficiency and Unjustified Agreements

We start by evaluating efficiency in each of the treatments as measured by the average dollar amount appropriated by committees.¹² Table 2 shows the average number of dollars that were distributed (with standard errors in parentheses), as well as the breakdown of outcomes in each treatment. A game can only end in one of three ways: it terminates early, a small budget is passed, or, a large budget is passed. The last two columns show how frequently early termination occurs and how frequently small budget are passed.^{13,14}

Efficiency is not statistically different across our Baseline treatments, which is expected given that committees have nothing to gain by delaying the decision and delay is costly.¹⁵ This is no longer the case when there is uncertainty regarding the size of future budgets. Committees that require unanimity to pass allocations achieve *weakly higher* levels of efficiency compared with committees use majority vote: when the future budget

¹²This number is positive if the committee passed a budget and zero if the committee was terminated before reaching the agreement.

¹³The fraction of large budgets that pass simply equals 100 minus these last two columns.

¹⁴Given our design, each of these is the result of 192 observations (12 bargaining games, times 4 groups per game, times 4 sessions for each treatment).

¹⁵This result is consistent with [Agranov and Tergiman \(2019\)](#) who show that delays in reaching agreements are rare under both voting rules when committee members can communicate with each other.

Table 2: Efficiency and Distribution of Outcomes, by treatment.

Treatment	Mean # Dollars Distributed	Fraction of Termination	Fraction Small Budget Passed
M24	23.63 (0.24) ($p = 0.143$)	1.6% ($p = 0.409$)	98.4% ($p = 0.079^*$)
U24	22.75 (0.52)	5.2%	94.8%
M48	26.50 (0.82) ($p = 0.813$)	15.1% ($p = 0.143$)	59.4% ($p = 0.001^{***}$)
U48	26.13 (1.43)	30.2%	30.7%
M96	47.13 (0.69) ($p < 0.001^{***}$)	22.4% ($p = 0.273$)	38.0% ($p < 0.001^{***}$)
U96	56.25 (1.25)	34.4%	9.4%

Notes: The standard errors were obtained using linear regressions, clustering at the session level. For each budget distribution we compare the outcomes in the Majority and Unanimity treatments using regression analysis, in which we regress the variable of interest on the constant and an indicator for one of the treatments, while clustering standard errors by session. We report the p -value associated with estimated coefficient on the dummy for one of the treatments. The symbols *** , ** , and * indicate significance at 1%, 5%, and 10% levels, respectively.

can potentially double (as in U48 and M48 treatments), there is no significant difference between efficiency levels in the two voting rules, while the difference is significant and large in magnitude when the future budget can potentially quadruple (U96 versus M96 treatments).

Two opposing forces determine the overall efficiency and their ranking in these treatments. Under the majority rule, committees pass small budgets more often and large budgets less often than committees under unanimity rule, which gives unanimity rule committees an advantage compared with majority rule committees. While not statistically different, committees are, on average, terminated less often under the majority rule than under the unanimity rule. Empirically, in the M48 and U48 treatments, these two forces happen to exactly offset each other, which is why we observe similar efficiency levels in the two voting rules. In the M96 and U96 treatments on the other hand, where the gains from waiting to reach a round with a higher budget are the highest, the first force dominates the second, and the unanimity rule outperforms the majority rule.

Comparing efficiency levels with those predicted by theory, we note that our data are consistent with the qualitative features of equilibrium predictions in the sense that the Unanimity treatments achieve similar or higher efficiency compared with Majority treatments, irrespective of the size of the future budgets. However, quantitatively, the theory fails to predict the outcomes we observe in our experiment.

Finally, we observe that our first hypothesis, that unjustified agreements happen more often in the majority rule, holds strongly in the data. This is the case even when it shouldn't according to the theory. Indeed, we should observe no treatment differences across the Quadruple treatments. However, when the budget can quadruple, the majority rules continues to lead to significantly more small budgets passing.

Result 1: (1) Committees that use the unanimity rule obtain weakly higher efficiency compared with committees that use the majority rule. The difference is significant and large in magnitude when the budget can potentially quadruple, that is when gains from waiting for a large budget are the highest. (2) Under the majority rule, we observe more unjustifiable agreements than under the unanimity rule.

4.2 Game Dynamics and Unjustified Delays

In what follows, we concentrate on treatments where there is uncertainty regarding the size of the future budget, i.e. the Double and Quadruple treatments. To understand how groups arrive at the outcomes described in the previous section, we present Table 3.¹⁶

The left panel of Table 3 shows statistics on the frequency with which the groups did not implement small budget proposals over the course of different rounds. The p-values pertain to the comparison of the treatments directly above and below the stated p-value.

Table 3: Rejection rate of small budgets by bargaining rounds; Aggregate rejection rates of small and big budget proposals.

	% Rejected in First Round	% Rejected in Second Round	% Rejected in Third Round	% Small Budget Rejected	% Big Budget Rejected
M48	52.1%	61.5%	50.0%	53.9%	2.0%
U48	($p < 0.001^{***}$) 82.8%	($p = 0.068^*$) 80.6%	($p = 0.676$) 45.0%	($p < 0.001^{***}$) 79.6%	($p = 0.159$) 8.5%
M96	75.5 %	65.5%	72.2%	73.0%	3.8%
U96	($p < 0.001^{***}$) 96.4%	($p < 0.001^{***}$) 95.4%	($p = 0.270$) 89.2%	($p < 0.001^{***}$) 94.8%	($p = 0.772$) 2.7%

Focusing first on the comparison of behavior in the first bargaining rounds in the Double treatments, we observe large and statistically significant differences in rejections of small budgets, as qualitatively predicted by the theory. Indeed, in the U48 treatment, when the budget can double, more than 80% of groups in the first bargaining round

¹⁶We conduct a similar game dynamics analysis breaking down the data between the first and second half of the games in Appendix C and show no notable differences with pooling all the data together as we do in the main text.

do not agree on a proposal dividing a small budget and instead choose to move to the second bargaining round. In contrast, only about half of the groups in the M48 treatment behave that way. Quantitatively, the theory predicts rates of 100% and 0%, respectively. While the 82.8% rate in the U48 treatment is close to the rate predicted, most groups reject small budgets in the M48 treatment, and so behave at odds with the theory.

Comparing the first bargaining rounds in the Quadruple treatments, we note that the percentage of rejections of small budgets increases in both treatments compared with the Double treatments, and reaches 96.4% in the U96 treatment, which is close the theoretically predicted level of 100%. However, there should be no difference between the rejection rates in the two treatments. Instead, we observe that only about 75% of subjects in the M96 treatment reject small budgets, which is statistically significantly smaller than the 96.4% in the U96 treatment. This indicates that the majority rule lags in terms of efficiency where it shouldn't be the case.

We next do a within-treatment comparison across bargaining rounds. Theoretically, the stationarity refinement used to derive the theoretical predictions implies that we should observe no differences in behavior across rounds in which subjects are faced with a small budget. We find strong support for this aspect of the theory. Indeed, empirically, this holds true in all treatments aside from the U48 treatment where there is a drop in rejection in groups that reach the third bargaining round (though no difference across the first two bargaining rounds).

The right panel of Table 2 (last two columns) shows that this behavior is specific to small budgets. The penultimate column shows the aggregate rejection rates of small budgets across all rounds, while the last column shows those same statistics when budgets are large. We see that rejections are not uniformly applied, but are significantly more likely to happen when budgets are small: large budgets are rarely rejected, and at rates that are no different across treatments. This is in contrast with what happens across treatments when the budget is small. This shows that the voting rule *per se* is not what drives behavior, but the voting rule in combination with facing a small budget.

Finally, there are no differences across voting rules in the Double or Quadruple treatments in terms of delays when the budgets are large. We therefore reject the unjustified delays hypothesis. Indeed, the unanimity rule is no more likely to lead to the rejection of these efficient budgets compared with the majority rule.¹⁷

Result 2: (1) *Under the unanimity rule subjects are more likely to attempt to reach*

¹⁷Additional support for these statements are in Appendix D where we complete individual-level analyses via panel Probit regressions.

later bargaining rounds compared with under the majority rule; (2) In situations where the budget can quadruple (the M96 and U96 treatments), the majority rule hinders the implementation of a large budget, unlike what would be expected given the theory; (3) The unanimity rule does not lead to more unjustified delays than the majority rule.

4.3 The Origins of Delays

We next focus on why small budgets are rejected. In the game we analyze, not implementing a budget can come from one of two reasons: either the proposer decides to forgo submitting a proposal, and consequently moves the group to the next bargaining round without a voting stage; or, a proposal is submitted but does not receive the required number of votes. The figures presented in the tables above do not distinguish these two scenarios. In Table 4 we present statistics on the origins of delays. The second column shows the fraction of rounds in which proposers bypassed making a proposal when the budget was small, and moved directly to the next bargaining round. The third column shows the fraction of rounds in which a proposal rejected by voters in the various treatments conditional on the proposer making an offer.

Table 4: Aggregate statistics on delays and rejections of small budgets.

Treatment	% Rounds the Proposer Delayed	% Rounds a Proposal Rejected by Voters
M48	50.6% ($p = 0.815$)	6.6% ($p < 0.001^{***}$)
U48	51.6%	57.9%
M96	68.2% ($p = 0.015^{**}$)	15.1% ($p = 0.002^{***}$)
U96	83.4%	68.4%

Starting with the M48 and U48 treatments, we see that proposers behave no differently: they are equally likely to delay in both voting treatments when the budget is small (about half of the time). However, when the proposer submits a proposal dividing the small budget, the proposal fails to pass close to 60% of the time under the unanimity rule. On the other hand, once proposed, a proposal dividing the small budget fails to pass only seldomly under the majority rule. Interestingly, this points to the fact that departures from theory in the M48 treatment are largely due to proposers' choices, not voter behavior.

When the future budget can potentially quadruple, proposers are significantly more likely to forgo making a proposal under unanimity rule than under majority rule: 83.4%

of the proposers delay under the U96 treatment compared with 68.2% under the M96 treatment.¹⁸ When proposals dividing the small budget *are* submitted, they fail to pass in the U96 treatment close to 70% of the time, while they fail to pass only 15.1% of the time in the M96 treatment. That is, in the U96 treatment, in a large majority of groups, voters “correct” mistakes that proposers might make (submitting a small budget proposal). On the other hand, under the majority rule, in the M96 treatment, voters fail to correct these mistakes.¹⁹

While the unanimity rule is often seen as risky in the sense that one voter can impede the smooth functioning of a committee, what the data in our experiment point to is that it also only takes one committee member to (potentially) reach a larger budget. Specifically, if the proposer fails to bypass making a proposal, that single voter can rectify the situation. This is not the case under the majority rule. Our data show that small budget proposals are rejected by a single deciding vote in 49.4% and 76.9% of the cases in the U48 and U96 treatments, respectively.

Although the proposals dividing the small budget are not necessarily the same under the majority and unanimity rules, this distinction is not crucial in understanding the aggregate statistics on rejection of proposals dividing the small budget. Indeed, proposals dividing the small budget are rejected by voters not because of the proposals *per se* (for example, they offer voters too little) but because of the possibility that the next bargaining round’s budget might be large. In order to show this we focus on cross-treatment differences in terms of how *identical* small budget proposals are treated by voters.

Table 5 shows the passage rate of “Equal Split” proposals, either of size 2 or size 3.²⁰ The data clearly reveal that there are strong differences in terms of the passage rates of proposals that are *identical* across treatments: proposals where the budget is divided equally between coalition members. In the Baseline treatments, for coalitions of size three, these are the proposals in which all three members receive 8 dollars, and for coalitions of size two, these are the proposals in which proposals consist of two members receiving 12 dollars each.²¹

There are large treatment differences across voting rules for a given possible large pie

¹⁸We present the distribution of how frequently proposers delay in each treatment in Appendix E.

¹⁹We hypothesize, given prior experimental work (see Agranov et al. (2020)), that perhaps these voters anticipate that rejecting a proposal can lessen their chances to be included in any future budget proposal.

²⁰In Table 6 in Appendix A we show the types of proposals that were made when the budget was small. “Equal Split” proposals (whether of size 2 or size 3) represent 73.0%, 55.8%, 68.6% and 89.5% of the small budget proposals in the M48, M96, U48 and U96 treatments, respectively.

²¹In Table 7 in Appendix B, we expand Table 5 to include pass rates for proposals that distribute the budget unequally among members.

Table 5: Fraction of accepted equal split proposals of size 2 or size 3 dividing the small budget.

Treatment	Coalition Size 2 (Equal Split)	Coalition Size 3 (Equal Split)
M24	97.6% (.)	98.6% ($p = 0.398$)
U24	na	96.6%
M48	100% (.)	95.7% ($p < 0.001^{***}$)
U48	na	57.3%
M96	88.9% (.)	96.7% ($p < 0.001^{***}$)
U96	na	35.3%

size: the fraction of passage rates of small budget proposals that equally split the budget among three members is significantly smaller in the unanimity treatments than in the majority treatments.²² These results are even more striking given that these equal split proposals are overwhelmingly accepted in our two baseline treatments, and that there are no cross-treatment differences in these settings.

Further, in the majority treatments, holding fixed the coalition size, when a budget dividing the small budget equally among the coalition members is proposed, there are few differences across treatments in terms of how likely that proposal is to be rejected.²³ In addition, the pass rate is very high in these treatments, ranging from 88.9% to 100% for size 2 coalitions and from 95.7% to 98.6% for size 3 coalitions.

The data give a different message across the Unanimity treatments where we see stark differences. In particular, subjects are significantly less likely to vote in favor of an equal split small budget proposal in the U48 and U96 treatments compared with the U24 treatment.^{24,25}

Result 3: (1) In the Quadruple treatment, far fewer subjects in the Majority treatment behave according to theory than in the Unanimity treatment. (2) Voters in the Unanimity treatment are more likely to reject proposals when they should. In the Majority treatment, voters only rarely reject proposals, even when they should. (3) Rejection

²²In other words, 95.7% and 57.3% are significantly different, as are 96.7% and 35.3%.

²³ The exception is that in M96 treatment subjects are marginally less likely to reject equal minimum winning coalitions than in the M24 treatment ($p = 0.096$).

²⁴The p-values are both less than 0.001.

²⁵Separately, in Appendix A we present data on how unequal (or equal) outcomes are within groups. See Figure 1 for example for Gini coefficients across treatments for example.

of small budget proposals are not due to the proposals per se but to the possibility of a larger budget to come.

5 Conclusion

In this paper we experimentally explore the performance of majority and unanimity voting rules in multilateral bargaining environments with uncertainty. In our setting, the budget to be allocated changes stochastically over time. Because the size of a future budget can be large relative to the present one, delays can be efficient even under complete information with impatient bargainers. However, whether it is an equilibrium to wait for larger budget to be divided depends on the voting rule: if it is worth delaying the decision under the majority rule, it is also true in the unanimity rule, but the opposite direction does not hold. Furthermore, under the unanimity rule, the outcome is always efficient. In other words, the unanimity rule achieves weakly higher efficiency levels compared with the majority rule.

Using efficiency (measured by the average dollar amount earned by the committee) as the criterion along which we rank the two voting rules, we find that the unanimity rule leads to better outcomes. Indeed, efficient delays occur more frequently under the unanimity rule than under the majority rule, even when the theory predicts that both rules should lead to equally efficient outcomes. The difference in the voting rules is especially large in magnitude when reaching agreements too soon entails large efficiency losses. Under the majority voting rule, both current proposers and coalition partners vote in favor of small budget proposals, perhaps out of fear of being excluded from the coalition in the future. Indeed, under the majority rule, minimum winning coalitions do not include all the committee members and our results highlight its failure to lead to efficient outcomes even when the potential future budget is so large that efficiency is theoretically predicted. On the contrary, under the unanimity voting rule, this fear is absent as no proposal can pass without unanimous agreement, which guarantees that all members will be allocated positive share of surplus.

While the unanimity rule has been viewed with suspicion because it gives “a minority a negative upon the majority” (Hamilton, *The Federalist* 22), our results show little support for the hypothesis that under unanimity a minority imposes costly delays on the majority. Instead, we find that under the unanimity rule, outcomes are more efficient and that the net benefits of using this rule are higher than those of the majority rule.

References

- Agranov, M. (2019). Legislative bargaining experiments, *Working paper*. California Institute of Technology.
- Agranov, M., C. Cotton, and C. Tergiman (2020). Persistence of power: Repeated multilateral bargaining with endogenous agenda setting authority. *Journal of Public Economics* 184.
- Agranov, M. and C. Tergiman (2019). Communication in bargaining games with unanimity. *Experimental Economics* 22(2), 350–368.
- Ali, S. N. M. (2006). Waiting to settle: Multilateral bargaining with subjective biases. *Journal of Economic Theory* 130(1), 109–137.
- Azrieli, Y., C. P. Chambers, and P. J. Healy (2018). Incentives in experiments: A theoretical analysis. *Journal of Political Economy* 126(4), 1472–1503.
- Baron, D. P. and J. A. Ferejohn (1989). Bargaining in legislatures. *American Political Science Review* 83, 1181–1206.
- Battaglini, M., S. Nunnari, and T. Palfrey (2019). The political economy of public debt: A laboratory study. *Journal of the European Economic Association*.
- Battaglini, M., S. Nunnari, and T. R. Palfrey (2012). Legislative bargaining and the dynamics of public investment. *American Political Science Review* 106(2), 407–429.
- Bond, P. and H. Eraslan (2010). Strategic voting over strategic proposals. *The Review of Economic Studies* 77(2), 459–490.
- Buchanan, J. M. and G. Tullock (1962). *The Calculus of Consent*, Volume 3. University of Michigan press Ann Arbor.
- Cardona, D. and A. Rubí-Barceló (2014). On the efficiency of equilibria in a legislative bargaining model with particularistic and collective goods. *Public Choice* 161(3-4), 345–366.
- Diermeier, D., H. Eraslan, and A. Merlo (2002). Coalition governments and comparative constitutional design. *European Economic Review* 46(4-5), 893–907.
- Diermeier, D., H. Eraslan, and A. Merlo (2003). A structural model of government formation. *Econometrica* 71, 27–70.

- Diermeier, D., H. Eraslan, and A. Merlo (2007). Bicameralism and government formation. *Quarterly Journal of Political Science* 2(3), 227–252.
- Diermeier, D. and R. Morton (2005). Experiments in majoritarian bargaining. In *Social choice and strategic decisions*, pp. 201–226. Springer.
- Eraslan, H. (2008). Corporate bankruptcy reorganizations: Estimates from a bargaining model. *International Economic Review* 49(2), 659–681.
- Eraslan, H. and A. Merlo (2002). Majority rule in a stochastic model of bargaining. *Journal of Economic Theory* 103, 31–48.
- Eraslan, H. and A. Merlo (2017). Some unpleasant bargaining arithmetic? *Journal of Economic Theory* 171, 293–315.
- Frechette, G. R., J. H. Kagel, and S. F. Lehrer (2003). Bargaining in legislatures: An experimental investigation of open versus closed amendment rules. *American Political Science Review* 97(2), 221–232.
- Ghosal, S., M. Miller, and K. Thampanishvong (2019). Waiting for a haircut? a bargaining perspective on sovereign debt restructuring. *Oxford Economic Papers* 71(2), 405–420.
- McKelvey, R. D. (1991). An experimental test of a stochastic game model of committee bargaining. *Laboratory research in political economy*, 139–168.
- Merlo, A. (1997). Bargaining over governments in a stochastic environment. *Journal of Political Economy* 105(1), 101–131.
- Merlo, A. and C. Wilson (1995). A stochastic model of sequential bargaining with complete information. *Econometrica* 63, 371–399.
- Merlo, A. and C. Wilson (1998). Efficient delays in a stochastic model of bargaining. *Economic Theory* 11(1), 39–55.
- Miller, L. and C. Vanberg (2013). Decision costs in legislative bargaining: an experimental analysis. *Public Choice* 155(3-4), 373–394.
- Miller, L. and C. Vanberg (2015). Group size and decision rules in legislative bargaining. *European Journal of Political Economy* 37, 288–302.
- Mueller, D. C. (2003). *Public choice III*. Cambridge University Press.

- Palfrey, T. R. (2015). Experiments in political economy. handbook of experimental economics, vol. 2.
- Rae, D. W. (1969). Decision-rules and individual values in constitutional choice. *American Political Science Review* 63(1), 40–56.
- Simcoe, T. (2012). Standard setting committees: Consensus governance for shared technology platforms. *American Economic Review* 102(1), 305–36.
- Taylor, M. (1969). Critique and comment: Proof of a theorem on majority rule. *Behavioral Science* 14(3), 228–231.
- Wicksell, K. (1958). A new principle of just taxation. In *Classics in the theory of public finance*, pp. 72–118. Springer.
- Yildirim, H. (2007). Proposal power and majority rule in multilateral bargaining with costly recognition. *Journal of Economic Theory* 136(1), 167–196.
- Yildirim, M. (2018). Legislative bargaining with a stochastic surplus and costly recognition. *Economics Letters* 163, 102–105.

Appendices

A Distribution of Proposal Types

Table 6: Distribution of proposal types (small budget proposals).

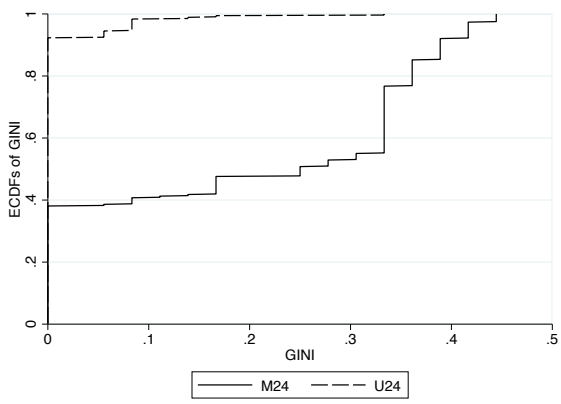
Treatment	Coalition Size 2		Coalition Size 3	
	Equal Splits	Unequal Split	Equal Split	Unequal Split
M24	20.0%	25.4%	35.6%	19.0%
M48	35.3%	23.0%	37.7%	4.1%
M96	20.9%	27.9%	34.9%	16.3%
U24	2.4%	1.6%	70.73%	25.2%
U48	0%	0.7%	68.6%	30.7%
U96	0%	1.8%	89.5%	8.8%

Notes: Equal split coalitions of size 2 are proposals in which two members receive the exact same amount while the third receives nothing. Equal split coalitions of size 3 are proposals in which all three members receive the exact same amount.

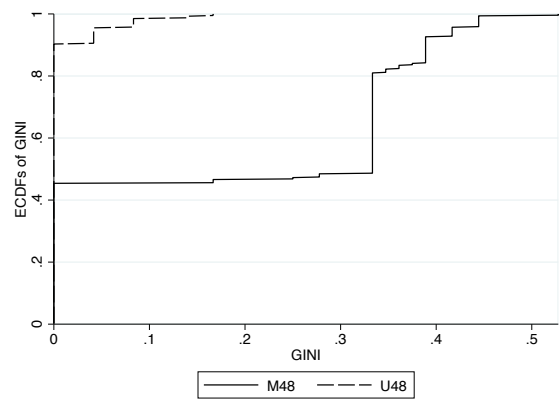
Table 6 shows which types of proposals are made when the budget to be split is of size 24 in each treatment. In all of the Majority treatments, the modal proposal is an equal split among all three members of the group (this fraction is between 34.9% and 37.7%), though roughly half of the proposals are of size 2, and the other half of size 3. In the Unanimity treatments, a substantial majority of proposals provide an equal split of resources among all three members of the group.

Cross-treatment differences in terms of proposal types have strong implications on inequality within groups. Below in Figure 1 we present the empirical CDF of the Gini coefficient across groups in our various treatments.

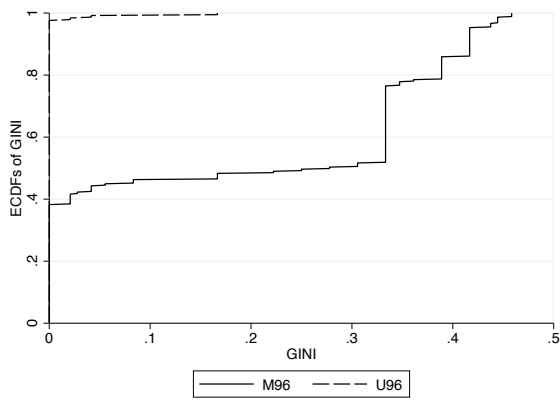
Figure 1: Empirical CDF of the Gini coefficient across treatments.



(a) Baseline Treatments



(b) Double Treatments



(c) Quadruple Treatments

B Type of Accepted Small Budget Proposals

Table 7 below shows how frequently small budget proposals are accepted in each treatment, by the type of proposal. In the Majority treatments, regardless of the type of small budget proposal, a large majority pass (the fraction ranges from 66.7% to 100%). Strikingly, these fractions remain high even when delaying is an equilibrium, as in the M96 treatment. In the unanimity treatment, however, the fraction of small budget proposals that pass range from 0% to 96.6%, and, in line with the theoretical predictions, far fewer of these proposals pass when the cost of early agreement is high, as in the U48 and U96 treatments.

Table 7: Fraction of accepted proposals dividing the small budget.

Treatment	Equal Splits		Unequal Splits	
	Coalition Size 2	Coalition Size 3	Coalition Size 2	Coalition Size 3
M24	97.6%	98.6%	82.7%	87.2%
M48	100%	95.7%	78.6%	100%
M96	88.9%	96.7%	66.7%	85.7%
U24	na	96.6%	na	22.6%
U48	na	57.3%	na	9.3%
U96	na	35.3%	na	0%

Notes: Equal split coalitions of size 2 are proposals in which two members receive the exact same amount while the third receives nothing. Equal split coalitions of size 3 are proposals in which all three members receive the exact same amount. We report data for which we have at least 10 observations.

C Time Trends in Game Dynamics

Here we replicate material from the main text, but breaking it down by first and second half of the games. We note no fundamental differences: small budgets are more likely to be rejected in the Unanimity treatments compared with the Majority ones (this is also generally true if we break it down by bargaining rounds). There is no cross-treatment differences in how large budgets are treated. This aligns with the conclusions obtained when grouping the data from all games together as we did in the main text.

Table 8: First half of games: rejection rate of small budgets by bargaining rounds; aggregate rejection rates of small and big budget proposals.

	% Rejected in First Round	% Rejected in Second Round	% Rejected in Third Round	% Small Budget Rejected	% Big Budget Rejected
M48	50.0%	52.9%	50.0%	51.2%	0.0%
	($p = 0.003^{***}$)	($p = 0.005^{***}$)	($p = 0.656$)	($p < 0.001^{***}$)	(.)
U48	83.3%	86.1%	42.9%	81.3%	9.8%
M96	65.6 %	70.8%	72.7%	67.4%	3.2%
	($p < 0.001^{***}$)	($p = 0.061^*$)	($p = 0.028^{**}$)	($p < 0.001^{***}$)	($p = 0.974$)
U96	93.8%	92.5%	94.7%	93.5%	3.4%

Table 9: Second half of games: rejection rate of small budgets by bargaining rounds; aggregate rejection rates of small and big budget proposals.

	% Rejected in First Round	% Rejected in Second Round	% Rejected in Third Round	% Small Budget Rejected	% Big Budget Rejected
M48	54.2%	68.2%	50.0%	56.4%	3.9%
	($p = 0.007^{***}$)	($p = 0.587$)	($p = 1.00$)	($p < 0.025^{**}$)	($p = 0.593$)
U48	82.3%	75.0%	50.0%	77.9%	7.3%
M96	85.4%	61.3%	71.4%	78.3%	4.2%
	($p = 0.002^{***}$)	($p < 0.001^{***}$)	($p = 0.635$)	($p < 0.001^{***}$)	($p = 0.597$)
U96	99.0%	97.8%	83.3%	96.0%	1.9%

D Determinants of Voting in Favor of a Proposal

Below we present the results of regressions that highlight individual level behavior. These regressions complete the data presented in the main text and provide additional support to the conclusions therein.

In the Double treatments, we see that voting in favor of a proposal is strongly influenced by the fraction of the budget one is offered, more likely in the M48 than in the U48 treatment, and that it is strongly negatively correlated with the budget size being small.

In the Quadruple treatments, similar conclusions hold (while the coefficient on the Majority rule is negative, it is compensated by the large positive coefficient on the cross-indicator term “Indicator for Majority Rule x Indicator Small Budget”). In addition the fraction of the budget appropriated by the proposer is negatively related to voting in favor of it.

Table 10: Determinants of voting across voting rules by how much the budget can grow.

	Double Treatments	Quadruple Treatments
Proposer Share %	-4.063 (2.752)	-4.628 (1.453)***
Own Share %	16.108 (4.079)***	8.509 (0.888)***
Indicator Majority Rule	0.719 (0.423)*	-1.151 (0.655)*
Indicator Small Budget	-1.381 (0.433)***	-3.002 (0.887)***
Indicator Majority Rule x Indicator Small Budget	-0.055 (0.430)	2.219 (0.873)**
Bargaining Game	0.031 (0.028)	0.016 (0.042)
Bargaining Round	0.283 (0.118)**	0.115 (0.119)
Constant	-2.433 (1.764)	2.065 (0.900)**
Number of observations	786	662
Number of groups	96	96

Notes: This Table presents the coefficients from panel Probit regressions of voting in favor of a proposal in the Double treatments and in the Quadruple treatments. Standard errors are clustered at the session level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

E Distribution of Proposer Delays

As is the case when we compare treatment averages in the main text, there are no differences in proposer behavior in the M48 and U48 treatments (the p-value on a Kolmogorov Smirnov test is 0.518), but large statistical differences when we compare the M96 and U96 treatments (the p-value on a Kolmogorov Smirnov test is less than 0.001).²⁶

Figure 2: Distribution of average individual proposer delay rates in the M48 and U48 treatments.

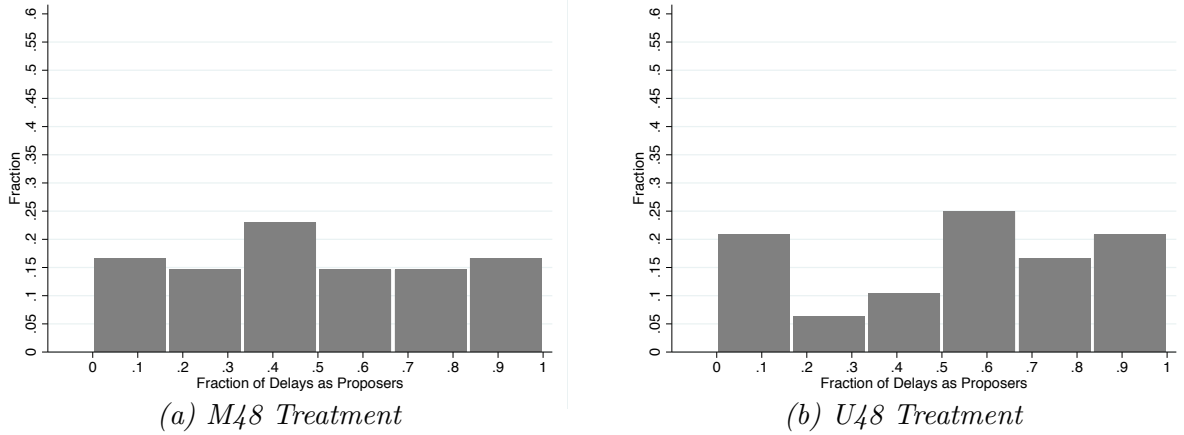
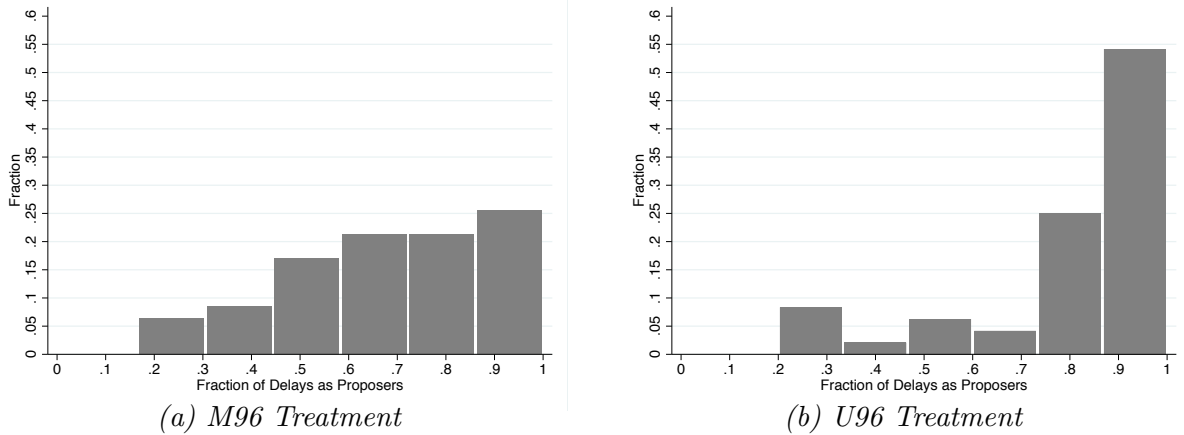


Figure 3: Distribution of average individual proposer delay rates in the M96 and U96 treatments.



²⁶To construct these graphs we start by looking at how frequently each individual delayed making a proposal when they were proposer and plot the resulting distribution. For the Kolmogorov Smirnov test we therefore use only one observation per subject.

F Instructions for U96 treatment

This is an experiment in the economics of decision making. The instructions are simple, and if you follow them carefully and make good decisions you may earn a CONSIDERABLE AMOUNT OF MONEY which will be PAID TO YOU IN CASH at the end of the experiment. In addition to what you will earn in the experiment, you will get a \$12 participation fee if you complete the experiment.

In this experiment you will play 12 Matches. At the start of each Match you will be randomly divided into groups of 3 members each. In any Match you will not know the identity of the subjects you are matched with and your group-members will not know your identity. At the start of each Match, each member of the group will be assigned an ID number (from 1 to 3), which is displayed on the top of the screen. Since ID numbers will be randomly assigned prior to the start of each Match, all members are likely to have their ID numbers vary between Matches. In addition, since you will be randomly re-matched to form new groups of 3 at the start of each Match, it is impossible to identify subjects using their ID numbers.

Each Match consists of one or more Rounds. Your ID number will stay the same during all the Rounds of a Match. However, once the Match is over, you will be randomly re-matched to form new groups of 3 members each and you will be assigned a (potentially) NEW ID. Please make sure you know your ID number when making your decisions.

In each Match, each group will decide how to split a sum of money (the budget). One of the 3 members in your group will be randomly chosen to be the proposer. Each member has the same chance of being selected to be the proposer. The proposer can take one of two actions. The proposer can either submit an allocation proposal of how to split the budget among the 3 members, or the proposer can hit a delay button. In the first Round of a Match, the budget available to be split will be 24 dollars. We will describe the budget available in other Rounds as well as what happens if the proposer chooses to hit the delay button shortly.

Suppose the proposer chooses to make an allocation proposal. After the allocation proposal is submitted, it will be posted on your computer screens with the allocation to you and the other members clearly indicated. You will then have to decide whether to accept or reject the allocation proposal. Allocation proposals will be voted up or down (accepted or rejected) by unanimity rule. That is, if all three members approve the allocation proposal, the match ends and the earnings from this match are given by the approved allocation proposal. If at least one of three members rejects the allocation proposal, it is voted down.

If the allocation proposal is voted down (that is at least one member of your group

votes against it), then one of two things can happen:

- With 20% chance the Match ends and all members of your group will earn 0 dollars for this Match.
- With 80% chance you move on to the next Round of this Match. In this case, one of the 3 members in your group will be randomly chosen to be the proposer for this round. After the proposer has been chosen, he will have the choice between hitting the delay button, or making an allocation proposal on how to split the budget. However, budget will either be 24 dollars or 96 dollars, with 50/50 chance of each. In other words, there is 50% chance that the proposer in Round 2 will be dividing 24 dollars between group members and 50% chance that the proposer in Round 2 will be dividing 96 dollars. The proposer in Round 2 and all group members will know the size of the budget available for division before making any decisions. If the proposer submits an allocation proposal and it is voted down, then again with 20% chance the Match ends and all members of your group will earn 0 dollars for this Match, and with 80% chance you will move on to the next Round of this Match. If the group moves on to the next Round, then, again, one of the 3 group-members will be randomly chosen to either hit the delay button, or make an allocation proposal on how to split budget among the 3 members with each member equally likely to be chosen as a proposer. The budget size will either be 24 dollars or 96 dollars, with 50/50 chance of each. In fact, for all Rounds after the first Round, the budget will either be 24 dollars or 96 dollars, with 50/50 chance of each. This process repeats itself until a Match ends, either because of the 20% chance it ends between Rounds, or because an allocation proposal has passed.

Recall that instead of submitting an allocation proposal, a proposer can choose to delay. If a proposer chooses delay, then the group goes through the same stages as if a proposal is rejected. That is, if a proposer chooses delay then with 20% chance the Match ends and all members receive 0 dollars for this Match. With 80% chance the group moves on to the next Round within the Match, one member of your group is randomly chosen to be the next proposer and the amount of money to split is either 24 dollars or 96 dollars with 50/50 chance of each etc.

To summarize, in any given round, if an allocation proposal is rejected, or if the proposer chooses delay, then with 20% chance the Match ends and members of the group earn 0 dollars for this Match. With 80% chance a new Round starts, one member of your group is randomly chosen to be the proposer and the budget to be split is either 24 or

96 dollars, each with 50/50 chance. This continues until a Match ends, either because of the 20% chance it ends between rounds, or because an allocation proposal passes.

Communication: In each Round, after one voter is selected to propose a split but before he/she submits his/her allocation proposal, members of a group will have the opportunity to communicate with each other using chat boxes. The communication is structured as follows. On the top of the screen, each member of the group will be told her ID number. You will also know the ID number of the member who is currently selected to make a proposal. Below you will see three boxes, in which you will see all messages sent to either all members of your group or to you personally. You will not see the chat messages that are sent privately to other members. If you would like to send the message that will be delivered to the entire group, please type your message underneath the first chat box and hit SEND. If you would like to send a private member of your group, please type your message underneath the chat box that indicates the chat with that member and hit SEND.

There is a 20 second period of time at the start of each Round during which the proposer cannot submit his/her allocation or choose delay. During this time, any person in the group can choose to use the chat function on his/her screen. The chat option will be available as soon as the Round starts, and for at least 20 seconds. The chat option will become unavailable when the proposer either submits his allocation proposal or hits delay. You are not to communicate in any other way with any other subject while the experiment is in progress. This is important to the validity of the study.

Remember that in each Match subjects are randomly matched into groups and ID numbers of the group-members are randomly assigned. Thus, while your ID number stays the same during all the Rounds in a Match, your ID number is likely to vary from Match to Match, and therefore it is impossible to identify your group-members using your ID number.

At the conclusion of the experiment we will randomly select one of the 12 Matches to count for payment. The \$12 participation fee will be added to your earnings in that randomly selected Match.

Review. Let's summarize the main points:

1. The experiment will consist of 12 Matches. There may be several Rounds in each Match.
2. Prior to each Match, you will be randomly divided into groups of 3 members each. Each subject in a group will be assigned an ID number.

3. At the start of each Match, in Round 1, one subject in your group will be randomly selected to be a proposer in this Round. The proposer can choose either to submit an allocation proposal or to delay. The size of the budget in Round 1 is 24 dollars. Before the proposer chooses his/her action, all members of the group can use the chat box to communicate with each other. You may send public messages that will be delivered to all members of your group as well private messages that will be delivered to specific members of your group.
4. Proposals to each member must be greater than or equal to 0 dollars.
5. If all 3 members accept the allocation proposal, the Match ends.
6. If one or more members reject the allocation proposal, or if the proposer chose to hit the delay button, then one of two things can happen:
 - With 20% chance the Match ends and all members of the group earn 0 dollars.
 - With 80% chance the Match continues. In this case, one member of the group will be randomly selected to be the proposer in Round 2. The budget available for division in Round 2 will be either 24 or 96 dollars, each with 50/50 chance. The proposer can choose either to delay or to submit an allocation proposal, etc
7. The process in step 6 repeats itself until a Match is over, either because of the 20% rule, or because an allocation proposal has passed. At the end of the experiment, the computer will randomly select one of the 12 Matches you played, and your earnings in this selected match will be paid to you in cash together with the participation fee of \$12.

Are there any questions?

Before starting the experiment, we will show you a few screenshots so that you can familiarize yourself with the interface. After that, we will start the experiment, in which you will play 12 Matches. Please note that the numbers and decisions from the screenshots below are just examples and are not meant to indicate what you should do in this experiment.

The screenshot in [Figure 4](#) is a typical screenshot that proposers see.

Propose

This is Match 1.

YOU ARE MEMBER 1.

This is round 1

The proposer is member 1

Bargaining Round	Budget	Proposer	Proposal	Votes
1	24	1	--	--

Group Chat	Chat with Member 2	Chat with Member 3
<div></div> <div><input type="text"/></div> <div>Send</div>	<div></div> <div><input type="text"/></div> <div>Send</div>	<div></div> <div><input type="text"/></div> <div>Send</div>

The budget in this round is 24. Please propose how to divide this budget or click Delay.

Proposer (Me)

Member 2

Member 3

Submit

Delay

Figure 4: Screenshot of the Proposer

Please take a look at the bottom part of the screen depicted in [Figure 5](#):

The budget in this round is 24. Please propose how to divide this budget or click Delay.

Proposer (Me)	Member 2	Member 3
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="button" value="Submit"/>	<input type="button" value="Delay"/>	

Figure 5: Bottom Part of Screenshot of the Proposer

Notice that there are three boxes labeled with the ID numbers of the members. This is where the proposer writes his/her allocation, corresponding to the amounts to members 1, 2 and 3, respectively. The proposer is the only member of the group who can choose to submit an allocation or delay. When you are done choosing an allocation, hit submit. If you choose to delay, hit Delay.

Lets look at the rest of the screen. On the top left side you will be able to see the history of the current Match depicted in [Figure 6](#):

Bargaining Round	Budget	Proposer	Proposal	Votes
1	24	1	--	--

Figure 6: History of Current Match

Take a moment to look at that. It will show you the budget size for each Round of the Match, the ID number of the proposer for that Round, and once the proposal has been submitted votes have taken place you will see those too. If the proposer chose to delay then you will see DELAY in the space under proposal.

Below the Match-history box, you will see the chat boxes depicted in [Figure 7](#). The left chat box shows the group conversations, while the middle and the right box show the private conversations with the other two members. Below each chat box are the boxes you will use to send messages if you choose to do so.

Group Chat	Chat with Member 1	Chat with Member 2 (Proposer)
<p>Member 3 (Me) hello!</p>	<p>Member 3 (Me) hi there</p>	
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="button" value="Send"/>	<input type="button" value="Send"/>	<input type="button" value="Send"/>

Figure 7: Chat Box

Below in Figure 8 is a screenshot of the non-proposers. It is identical to the proposer screens except for the right hand side since only proposer can choose to submit an allocation or delay.

Please wait

This is Match 1.
YOU ARE MEMBER 2.
This is round 1
The proposer is member 1

Bargaining Round	Budget	Proposer	Proposal	Votes
1	24	1	--	--

Group Chat	Chat with Member 1 (Proposer)	Chat with Member 3
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="button" value="Send"/>	<input type="button" value="Send"/>	<input type="button" value="Send"/>

You can chat while waiting for the proposer to decide.

Figure 8: Screenshot of the Non-Proposer

Below is another example of a within Match history (see Figure 9). In this particular example, the proposer in Round 1 was member 1 and he/she chose to Delay. The match continued to the next round. In Round 2, the proposer was member 2, the budget was 96 dollars and the proposer chose to submit an allocation according to which member 1 gets 2 dollars, she (member 2) gets 50 dollars and member 3 gets 44 dollars. The proposal was rejected since it didnt not receive all 3 yes votes. The match continued to the next round. In Round 3, member 2 was again randomly chosen to be the proposer and she submitted another allocation according to which member 1 gets 90 dollars, member 2 (herself) gets 6 dollars and member 3 gets 0 dollars. Notice that in this table you can always see the size of the budget as well as who was proposer in every round, what action they took (propose an allocation or delay) and the results of the votes.

Bargaining Round	Budget	Proposer	Proposal	Votes
1	24	1	Delay	None
2	96	2	2 50 44	No Yes No
3	96	2	90 6 0	--

Figure 9: Match History

If a proposer submits an allocation, all members of the group see the screen like the one in Figure 10. The proposal is clearly indicated, and your payoff if the proposal is approved is highlighted in red. You can then vote yes or no to the proposal. Please note that the numbers here are just examples and are not meant to indicate what you should do in this experiment.

The proposer for this round was member 1.

The proposer chose [2 22 0], which is displayed below.

Your payoff is shown in **red**

	Member 1	Member 2	Member 3
Allocation Proposal	2	22	0

Please click the button below corresponding to your vote on this proposal and click Next:

☒ Yes ☐ No

Next

Figure 10: Voting Screen

After members vote all members see the screen like the one in Figure 11:

The votes were (Yes, Yes, Yes).

The Allocation Proposal passed.

	Member 1	Member 2	Member 3
Allocation Proposal	2	50	44
Your earnings from this round:	44		

Next

Figure 11: Summary of Votes

Your earnings are always highlighted in red. If the match randomly ends because of the 20% rule you, you will see the messages shown in Figure 12 on the right hand side of your screen.

The match has been randomly terminated (20 percent rule).

Next

Figure 12: Termination Message

ARE THERE ANY QUESTIONS?

Investment Task 1

You are endowed with 200 tokens (or \$2) that you can choose to keep or invest in a risky project. Tokens that are not invested in the risky project are yours to keep.

The risky project has 50% chance of success:

- If the project is successful, you will receive 2.5 times the amount you chose to invest.
- If the project is unsuccessful, you will lose the amount invested.

Please choose how many tokens you want to invest in the risky project. Note that you can pick any number between 0 and 200, including 0 or 200.

Investment Task 2

You are endowed with 200 tokens (or \$2) that you can choose to keep or invest in a risky project. Tokens that are not invested in the risky project are yours to keep.

The risky project has 40% chance of success:

- If the project is successful, you will receive 3 times the amount you chose to invest.

- If the project is unsuccessful, you will lose the amount invested.

Please choose how many tokens you want to invest in the risky project. Note that you can pick any number between 0 and 200, including 0 or 200.

In the experiment, one of the two investment tasks was randomly chosen to count for payment.

G Investment Tasks Summary Statistics

Table 11 presents summary statistics for Investment Task 1 across treatments (see Appendix F for the description of the tasks). There are no statistical differences across treatments in this game. We therefore reject that treatment differences are due to differences towards risk as measured in this game.²⁷

Table 11: Aggregate statistics regarding Investment Task 1 across treatments.

Treatment	Mean Investment	Median Investment	Standard Deviation
M24	121.5 ($p = 0.544$)	100 ($p = 1.00$)	54.8
U24	111.7	100	58.9
M48	125.4 ($p = 0.364$)	100 ($p = 1.00$)	54.6
U48	113.5	100	59.7
M96	117.4 ($p = 0.593$)	100 ($p = 1.00$)	66.0
U96	125.6	100	58.3

Notes: In this investment task, subjects were endowed with 200 tokens (worth \$2) and chose how many of them to invest in the risky project which paid out 2.5 times the invested amount with probability 50%. The tokens not invested had a one-to-one return.

Table 12 presents summary statistics for investment choices in the Investment Task 2. There are no statistical differences across treatments in this game. We therefore reject that treatment differences are due to differences towards risk as measured in this game.²⁸

²⁷The p-values are the result of OLS and quantile regressions with clustering at the session level.

²⁸The p-values are the result of OLS and quantile regressions with clustering at the session level.

Table 12: Aggregate statistics regarding Investment Task 2 across treatments.

Treatment	Mean Investment	Median Investment	Standard Deviation
M24	107.5 ($p = 0.983$)	100 ($p = 1.00$)	54.8
U24	107.8	100	58.9
M48	100.8 ($p = 0.671$)	100 ($p = 1.00$)	54.6
U48	108.1	100	59.7
M96	118.4 ($p = 0.252$)	100 ($p = 1.00$)	66.0
U96	125.6	100	58.3

Notes: In this investment task, subjects were endowed with 200 tokens (worth \$2) and chose how many of them to invest in the risky project which paid out 3 times the invested amount with probability 40%. The tokens not invested had a one-to-one return.