“One Bite at the Apple”: Legislative Bargaining without Replacement*

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Abstract

I modify the many-player “divide-the-dollar” game in which previous proposers, players who were randomly selected in the previous rounds but failed to provide an accepted proposal, cannot propose again. This bargaining model without replacement captures the legislative process where each legislator has only one chance of opportunity, and yields a unique subgame perfect equilibrium which has two distinctive features: Under majority or unanimity, the first proposer keeps a constant share for herself *regardless* of the size of the legislature. Under unanimity, the first proposer keeps a *smaller* share than the nonproposers when the discount factor is sufficiently large. Because of these features, the behavioral factors that could be driving the bargaining outcomes in the laboratory, such as retaliation and a concern about fairness, can be identified. I find that proposers do not fully extract their rent, but that a concern about fairness is not a driving factor at all. Out-of-equilibrium observations suggest that retaliation and the fear thereof can be a driving factor.

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"What happened last November, when we lost the majority, we got ourselves in a position where we figured, gosh, we will have only one bite at the apple*, only one opportunity to allow the majority of the House to come together and address these issues."*

- Mr. Dreier, 1st session of the 110th Congress[1]

1 Introduction

Multilateral bargaining, a political process in which many agents with conflicting preferences try to divide an economic surplus ("pie") in a democratic way, is ubiquitous. For example, a politician attempts to steer the distribution of a budget in favor of her legislative district to the greatest extent possible by forming a coalition that supports her desired proposal or voting against undesirable ones. The six-party talks on North Korea's nuclear weapons program, climate change summits that are convened to set carbon dioxide emission levels, and deliberations by condominium boards to determine the use of the common areas are other examples of multilateral bargaining, to name just a few.

The typical many-player "divide-the-dollar" games capture the essential features of multilateral bargaining, which can be summarized as follows: One player is randomly selected, and that player proposes a division of the dollar. If the proposal is agreed to by a predetermined number of players, the division is implemented. Otherwise, the procedure is repeated. Assuming that the players are purely self-interested, the standard economic theory (the Baron–Ferejohn, henceforth BF, legislative bargaining model (Baron and Ferejohn (1989)) and many extensions thereof predict that a proposer offers to a minimum winning coalition (the minimum number of legislators, other than the proposer herself, who are required to vote for a proposal in order for it to be accepted) the minimum amount that, if rejected, would not make responders better off in the next round of the game. However, experimental studies on many-player divide-the-dollar games have consistently found that proposers do not take full advantage of being a proposer,[2] that is, they propose an amount smaller than

[1] Congressional Record—House, April 19, 2007, page H3571. [online]

[2] See Fréchette, Kagel, and Lehrer (2003), Diermeier and Morton (2005), Fréchette, Kagel, and Morelli (2005a,b,c), Kagel, Sung, and Winter (2010), Miller and Vanberg (2013), and Agranov and Tergiman (2014).

the theoretical prediction. I call this outcome *partial rent extraction*, as the proposers still enjoy an advantage by keeping more than an equal-split share.

My main goal is to understand whether, and to what extent, a concern about distributional fairness leads to the partial rent extraction: One possible, easy explanation about the partial rent extraction is that subjects in the laboratory are reluctant to extract the full rent, as it widens inequity between the payoff of the proposer and that of the others, which they are averse (Fehr and Schmidt (1999)). Even if a myopic[3] concern about fairness does indeed explain the partial rent extraction observed in the laboratory, the extent to which bargaining outcomes are affected by it is unclear. One theoretical feature of the BF model is that in their infinite-horizon game, virtually any distribution of feasible payoffs can be supported in an equilibrium.[4] Since there is a non-stationary equilibrium (among a continuum of equilibria) that could support the distribution of payoffs observed in the laboratory without relying on other behavioral factors, we cannot determine whether the stationary equilibrium, the solution concept that theory has focused on, is less suited than the others, or whether there are other factors, such as a concern about distributional fairness, which significantly affect behavior but have not been accounted for in the model.

It is important to check whether, and to what extent experiment participants' concern about fairness affected the bargaining outcomes, because a concern about fairness is not a constructive factor in relating our observations from the lab setting to actual multilateral bargaining situations: Such a concern may not exist—or it could be less distinctive—outside of the laboratory. In real life, an agent who engages in multilateral bargaining is likely to represent a particular social, cultural, or political group, in which case the representing individuals may want to suppress their concern about fairness, even if it does exist, for the benefit of their social group. If the experimental outcomes can be fully explained by particular laboratory-specific factors, then lab experiments are of little use in understanding actual multilateral bargaining or in suggesting new policies based on experimental evidence.[5]

[3]Montero (2007) shows that when every player in multilateral bargaining is fully rational but has inequity aversion preferences, the proposer advantage could be even larger than that which obtains under the assumption of risk-neutral self-interested preferences. Therefore, in order for the argument about concern for fairness to work, we must consider a certain short-sighted form of a concern about fairness.

[4]See Theorem 6.1. of Austen-Smith and Banks (2005), which can be understood as an example of a class of results known as "folk theorems."

[5]Besides the issue of multiple equilibria and the concern about fairness, the partial rent extraction may be driven solely by unobservable private reservation values: The standard legislative bargaining model has assumed that legislators accept a proposal if rejecting it doesn't make them better off. Even if this tie-breaking assumption is maintained, they might have a small but positive reservation value as a lower bound on acceptance of a proposal. That is, in any round of bargaining, if a player is offered less than some pre-established, small $\varepsilon > 0$, she might reject the proposal even if her continuation value is strictly less than ε.

In summary, identifying the main driving factor in the partial rent extraction is challenging with the BF model. Why does the proposer partially extract the rent which is her due? This could be explained in a number of ways: by another equilibrium without giving consideration to any other factors, by the proposers' concern about distributional fairness, or by other factors that have not been accounted for.

I claim that my model of a modified many-player divide-the-dollar game, which adopts random recognition *without* replacement as the proposer selection process, could help answer the aforementioned question. The idea of random recognition without replacement is closely related to the "one bite at the apple" principle that is often explicitly considered in legislative and judiciary processes. Broadly speaking, this principle means that each individual/agent/party has only one chance to take advantage of an opportunity.[6] Since being a proposer is a means of taking advantage of an opportunity, the random recognition process without replacement exactly captures the "one bite at the apple" principle: Members who are recognized as proposers (members who have already "bitten at the apple") cannot again be a proposer (cannot take another bite).

As a baseline[7] model, I consider sequential multilateral bargaining in which, within a given period of the legislature, if a randomly selected member proposes in the first round and her proposal is not accepted, she will not have another chance to propose. If the legislature has n members, then in the second round the other $n-1$ members have an equal chance to be recognized, in the third round (if the proposal in the second round fails) the remaining $n-2$ members have an equal chance to be recognized, and so on. The legislature adjourns after n rounds if no proposal wins, in which case the legislators receive nothing. I characterize the unique subgame perfect equilibrium of legislative bargaining under random recognition without replacement for any q-quota voting rule. That equilibrium has the following two notable properties: (1) Under the simple-majority rule, the first proposer's equilibrium strategy is to offer $\frac{\delta}{n-1}$ to each of $\frac{n-1}{2}$ randomly selected players, and to keep a constant share, $1-\frac{\delta}{2}$, for herself *regardless* of n, where δ is a common discount factor and n is the size of the legislature. (2) Under unanimity, the first proposer's share is $1-\delta$, and that of the other $n-1$ players is $\frac{\delta}{n-1}$, which is *larger* than the first proposer's share when the discount factor is sufficiently large.

Even in that case, theoretical predictions would not drastically change, because the players in the minimum winning coalition would receive a payoff strictly greater than ε if the proposal is accepted.

[6]For example, in a speech on the Senate floor on August 1, 2001, Mr. Bond said, "Under current law, you only get one incentive period, one bite at the apple. That's it." [online, page S8598]

[7]In a companion paper, I consider a more general model in which the idea of random recognition without replacement is extended to infinite-horizon bargaining.

My theoretical findings on legislative bargaining without replacement can serve as a tool for understanding the discrepancies between theory and experimental evidence in the literature on multilateral bargaining. Since the equilibrium is unique, my model is unconstrained in regard to the issue of equilibrium selection. Moreover, relaxing the assumption about the player's utility is manageable in this model. Standard legislative bargaining models assume that legislators are self-interested and willing to accept the proposal whenever rejecting it doesn't make them better off. Because of the simple structure of my model, it is easy to consider other factors such as inequity aversion.

Identification strategy for a concern about distribution fairness can be intuitively explained in the following manner: If a player's utility is a weighted average of the monetary payoff and the utility that captures myopic inequity aversion, the proposer's share should be between the full-rent share and an equal-split share within a coalition. If this model is correct, then in a situation where proposer *disadvantage* is expected, the proposer would keep an amount which is smaller than the equal-split share. However, if the accepted proposal involves the proposer's larger share than the equal-split share, then it clearly indicates that a concern about fairness does not lead to the partial rent extraction.

The experimental evidence from my study can be summarized as follows: First, I found that concern about fairness is not at all the major factor that was driving the partial rent extraction. Second, the proposers in my experiments kept a smaller share of the resources than the proposers in experiments that were conducted in previous studies of legislative bargaining, and proposers from previous rounds within a bargaining session were more likely to be excluded from the winning coalition. A significant proportion of this exclusion is explained by retaliation. Third, after observing rejection of an equal split among the members of a coalition and after experiencing the exclusion of previous proposers from the winning coalition in later rounds of bargaining, subjects tended to propose in a more egalitarian way. These three results suggest that the existence of a few subjects who reject rational proposals might have driven the entire process toward an equal split of the economic surplus among the members of a coalition.

The rest of this paper is organized as follows. In the following subsection I discuss the related literature. Section 2 describes the n-round legislative bargaining process and the equilibrium characterization of the model. In Section 3 I describe the experimental design and procedures. The experimental results are summarized in Section 4. In Section 5 I discuss in detail possible sources of the partial rent extraction and posit other explanations for the voting preferences exhibited in my experiments. Section 6 concludes. Proofs of all the lemmas and propositions that appear in the main text are provided in Appendix A. Sample instructions are provided in Appendix B.

1.1 Related literature

Theoretical modification of the random recognition process was considered by Yildirim (2007), who studies a sequential bargaining approach in which the probability that a given agent will be recognized as a proposer is proportional to the ratio of that agent's level of effort to the aggregate effort of all agents;[8] Breitmoser (2011), who considers a model allowing for priority recognition of some committee members; Bernheim, Rangel, and Rayo (2006), who focus on recognition orders where no individual is recognized twice in succession for pork barrel policies; and Ali, Bernheim, and Fan (2014), who assume that some players can be ruled out as the next proposer. It is worth comparing this study with Ali, Bernheim, and Fan (2014). In the case of the unanimity rule with no penalty for delay, in my model of finite-horizon (n-round) legislative bargaining without replacement the first proposer gets none of the economic surplus in equilibrium, which is a completely opposite prediction of another extreme case addressed by Ali, Bernheim, and Fan (2014), where in equilibrium the first proposer takes the entire economic surplus if the recognition procedure permits legislators to rule out some minimum number of proposers in the next round. My study has a common concern with Ali, Bernheim, and Fan (2014) in regard to the random recognition rule adopted in the BF model, and both studies illustrate that the proposer recognition procedure significantly affects equilibrium outcomes. I view their study as being complementary to mine. I consider a recognition rule in which no one is allowed to be the proposer in more than one round, while they consider a recognition rule in which there are d players that are not allowed to be the next proposer. In the former case the current proposer needs to win over the nonproposers who have a higher continuation value than she does, while in the latter case the current proposer exploits those who have a "cheaper" vote. Since random recognition without replacement is implicitly concerned about ex-ante fairness toward other legislators in terms of proposer opportunities, this study goes in the direction opposite that of studies which considered a persistent agenda setter, such as Diermeier and Fong (2011) and Jeon (2016).

In the sense that this paper investigates the finite-horizon version of the legislative bar-

[8] Evans (1997) also assumes that recognition probabilities depend on the players' effort levels, but considers a different game in which the members of the coalition that accepts a proposal leave the game and the remaining members continue to the next round.

gaining model, Norman (2002) is another closely related theoretical work. While Norman (2002) shows the existence of a continuum of subgame perfect equilibria with three or more rounds, legislative bargaining without replacement has a unique subgame perfect equilibrium in the finite-horizon version of the BF model. The key difference is that in my study the uncertainty surrounding proposer recognition gets smaller with each round of bargaining: In the final round, there is only one member eligible to be a proposer, and in the penultimate round, the recognized member knows who the next proposer will be. In contrast to that, Norman (2002) could be understood as a study that investigates a tighter sufficient condition for applicability of a folk theorem.

The argument that concern about fairness does not play an important role in multilateral bargaining is not new: Montero (2007) claims that inequity aversion cannot explain attenuated proposer power, by showing that the legislative bargaining game with rational players who have Fehr–Schmidt preferences predicts an even greater proposer advantage, which leads to greater inequity. Fréchette, Kagel, and Lehrer (2003), Fréchette, Kagel, and Morelli (2005a), and Fréchette, Kagel, and Morelli (2005b) claim that their regression results suggest that the self-interested utility function assumed in the BF model can be validated, because the voter's own share is the only significant dependent variable that explains the probability of accepting the offer. This paper adds a supporting argument, but in a different and rather simple manner.

Among many experimental studies on legislative bargaining,[9] the one most closely related to mine in terms of the experimental setup may be Diermeier and Morton (2005), who study a three-player "divide-the-dollar" game where subjects earn nothing if no proposal is accepted in five rounds of the proposal-voting process. Since I consider a scenario in which the legislative session ends after n rounds of sequential bargaining, the experimental evidence from my study might be compared to that from Diermeier and Morton (2005). I refer to the base treatment of Agranov and Tergiman (2014) as a benchmark study. The main finding of Agranov and Tergiman (2014) is that casual chatting over the computer interface significantly increases the proposer's rent. Although the chatting doesn't serve as a

[9] In the sense that the proposer in the final round of the bargaining period in my study makes a take-it-or-leave-it offer, this study could be compared to experimental studies of the many-player ultimatum game, such as Knez and Camerer (1995) and Alewell and Nicklisch (2009). However, since only a few groups in my experiment reached the final round, such a comparison has not been made here. Some studies adopt a random (or fixed) termination rule to induce a discount factor. Though the essential logic and qualitative properties from that model carry over, it may be worthwhile to compare experiments that allow infinitely many rounds of bargaining with those where the bargaining process is terminated exogenously. Zwick, Rapoport, and Howard (1992) examine how external termination affects subjects' behavior in two-person sequential bargaining.

commitment device per se, it decreases the uncertainty in the coalition members' willingness to accept, and facilitates the nonproposers' willingness to accept to decrease in the manner of war-of-attrition competitions, in order to be included in the winning coalition. However, even in the last bargaining period under the chatting treatment the median proposer's share is still below that which is predicted by theory, and it is unknown whether the gap is due to other factors that have not been accounted for. To allow for a more direct comparison of my experimental data with those of many previous similar studies, in this paper I did not consider a chatting treatment as in Agranov and Tergiman (2014) or Baranski and Kagel (2015).[10]

2 The Model

Consider a legislature consisting of n members indexed by $i \in \{1, 2, \ldots, n\} \equiv N$, where n is an odd number greater than or equal to 3. The legislature decides how to allocate a fixed economic surplus (normalized to 1) among themselves. In round 1, one of the members is randomly selected with equal probability to make a proposal. The proposal is immediately voted on. If the proposal is supported by a majority, the game ends and payoffs accrue according to the proposal. Legislator i's utility from the approved proposal p is $U^i(p) = p_i$. If, on the other hand, the proposal is not supported by a majority, the process is repeated in round 2, but the new proposer is selected at random from all the members except the first proposer. Delay is costly: In each round the utility is discounted by a common factor $\delta \in [0, 1]$. Formally, in round t, where $t = 1, 2, \ldots, n$, a randomly recognized player makes a proposal p^t, where p^t is a distribution plan $(p_1^t, \ldots, p_n^t)$ such that $\sum_{i=1}^n p_i^t = 1$ and $p_i^t \geq 0$ for all $i \in N$. If the proposal is supported by a majority, then the game ends and player i receives $\delta^{t-1} U^i(p^t)$, where $U^i(p^t)$ is player i's undiscounted utility from the approved proposal p^t. Players are assumed to be risk neutral and self-interested, so $U^i(p^t) = p_i^t$. If the proposal is not approved and $t < n$, then the proposer is excluded thereafter from the pool of potential proposers, and the game goes on to round $t + 1$. This process continues until a proposal is eventually supported by a majority or there is no further member available to propose. Payoffs are 0 if no proposal wins by the end of round n.

[10] de Groot Ruiz, Ramer, and Schram (2016) study many-player bargaining to examine how the formality of a bargaining procedure affects its outcome, and introduce an informal treatment where players can make proposals and vote on them in continuous time. I did not consider an informal treatment, but both a chatting treatment and an informal treatment as in de Groot Ruiz, Ramer, and Schram (2016) are worth considering as extensions of this study.

The solution concept for this n-round game is a symmetric subgame perfect equilibrium. Backward induction is applied. Player i's pure symmetric strategy is described by the distribution plan $p^t = (p_1^t, \ldots, p_n^t)$ she will propose if selected in round t and the cut-off x^t such that player i will vote to accept any proposal that gives her more than x^t. To figure out what a symmetric equilibrium looks like, consider the problem of the player selected to be a proposer at the beginning of round t. She obviously wants to get her proposal passed but to do so in a way that gives her district the largest share of the budget. She therefore needs to form a minimum winning coalition (MWC) consisting of herself and $(n-1)/2$ other players. One immediate prediction is that if the game moves to round $(n+1)/2$ or later, the proposer in such a round can keep the entire share of the resources. As is typical in the literature, I assume that a player votes for a proposal when she is indifferent between voting for it and voting against it.

Lemma 1. *In the subgame perfect equilibrium, the randomly selected proposer, player i, will propose $p_i^t = 1$ and $p_j^t = 0$ for all $j \neq i$ and all $t \geq (n+1)/2$.*

Proof: The fact that a game has reached round $(n+1)/2$ implies that there are $(n-1)/2$ previous proposers, who cannot be the proposer again and thus have lost their bargaining power. Thus there are at least $(n-1)/2$ legislators who will vote for a payoff of 0 in round $(n+1)/2$ or later. □

For terminological clarity, I divide the set of players other than the current proposer into two groups: The previous proposers comprise the *trivial coalition pool*, because they would accept any offer. The *nontrivial coalition pool* consists of the players who have not yet been selected as a proposer. In and after round $(n+1)/2$, the trivial coalition pool (plus the proposer) constitutes an MWC. Therefore, Lemma 1 shows that in and after round $(n+1)/2$, it is perfectly safe for the recognized member to propose keeping the entire economic surplus for herself.

Backward induction process from round $t = \frac{n-1}{2}$ is summarized in Lemma 2.

Lemma 2. *When the $(q-l)$th proposer is randomly recognized, where $q = \frac{n+1}{2}$ and $l = 0, 1, \ldots, k-1$, in equilibrium she offers $\frac{\delta}{n-(q-l)}$ to l randomly selected players from the nontrivial coalition pool.*

Proof: See Appendix.

Lemma 2 clarifies what the symmetric subgame perfect equilibrium profile looks like. If some round later than the first round were reached, the randomly recognized proposer would offer a positive share of the resources to $\max\{q-1-\#\text{trivial coalition pool}, 0\}$ players randomly selected from the nontrivial coalition pool to form an MWC, and the offered amount is δ divided by the number of players who have not proposed yet.

Proposition 1 (Majority-rule Legislative Bargaining without Replacement)**.** *Each player's equilibrium strategy profile is described by* $\{x^k, \max\{\frac{n-1}{2}-k, 0\}\}_{k=1}^{n}$*, where the randomly recognized proposer for round* k *offers* $x^k = \frac{\delta}{n-k}$ *to* $\max\{\frac{n+1}{2}-k, 0\}$ *players randomly selected from those who have not proposed yet. In round* k*, previous proposers accept any offer, and the* $n-k$ *players who haven't proposed yet accept offers of at least* x^k*.*

Therefore, the randomly selected first proposer offers $\frac{\delta}{n-1}$ *to* $\frac{n-1}{2}$ *players, and she gets* $1-\frac{\delta}{2}$*.*

Proof: See Appendix.

There are several notable properties. Though the out-of-equilibrium strategies are described as a function of the number of players and the number of of previous proposers, in the symmetric equilibrium the initial proposer *always* claims a constant share $1-\frac{\delta}{2}$ regardless of n. The BF model predicts that a randomly selected proposer (with replacement) will claim $1-\frac{n-1}{2n}\delta$. As n goes to infinity, this converges to $1-\frac{\delta}{2}$. Thus, legislative bargaining without replacement attains the smallest possible proposer advantage of the BF model. The intuition behind the difference in the share claimed by the initial proposer in these two models, $\left(1-\frac{\delta}{2}\right)-\left(1-\frac{n-1}{2n}\delta\right) = -\frac{\delta}{2n}$, is fairly obvious. As the number of legislators gets larger, the probability that the current proposer is randomly selected in at least one later round decreases.

2.1 Unanimity rule

The equilibrium strategy profile under a unanimity rule can be provided analogously.[11]

Corollary 1 (Unanimity-rule Legislative Bargaining without Replacement)**.** *Each player's equilibrium strategy profile is described by* $\{x^k, n-k\}_{k=1}^{n}$*, where the randomly recognized proposer for round* k *offers* $x^k = \frac{\delta}{n-k}$ *to* $n-k$ *players randomly selected from those who have*

[11] Any q-quota voting rule can be described in a similar manner, which is considered in my companion paper.

not proposed yet. In round k, previous proposers accept any offer, and the $n-k$ players who have not proposed yet accept offers of at least x^k.

Therefore, the randomly selected first proposer offers $\frac{\delta}{n-1}$ to $n-1$ players selected at random, and she gets $1-\delta$.

Proof: See Appendix.

Under unanimity, the first proposer gets $1-\delta$. If $\delta > \frac{n-1}{n}$, the proposer's share is *strictly* smaller than that of the nonproposers. When $\delta = 1$, she gets *nothing*. This "proposer disadvantage" is not observed in the BF model, where under unanimity the first proposer gets $1 - \frac{n-1}{n}\delta$. In that model, she always gets a strictly larger share than the nonproposers if $\delta \in [0, 1)$, and an equal share if $\delta = 1$.

The theoretical prediction of the n-round, unanimity, no-discount bargaining game (i.e., that the first proposer gets nothing) is somewhat unintuitive, but this is the only subgame perfect equilibrium. To verify this claim, consider $n = 3$ and $\delta = 1$. For notational simplicity, a proposal is rearranged in such a way that the kth proposer's share is the value of the kth entity. In the third (last) round, the proposer offers (0,0,1). All the previous proposers accept this proposal because it is the final round. Knowing that the player who will be the proposer in the third round will reject any offer less than 1, the second-round proposer offers (0,0,1), which is approved by all the players. The first-round proposer, who knows that one of the players (the one who will *not* be selected as the proposer in the second round) will get the entire dollar, offers (0, 1/2, 1/2) so that the nonproposers' continuation value is the same as the amount being offered.

The intuition behind this observation can be explained by the nonproposers' increased negotiating power. This is in contrast to many existing studies, including Ansolabehere, Snyder, Strauss, and Ting (2005) and Ali, Bernheim, and Fan (2014), that report a formateur's significant negotiating power. In the infinite-horizon game, the random recognition process with replacement endows a proposer with negotiating power. However, in this finite-horizon game, nonproposers, especially players in the nontrivial coalition pool, share negotiating power, because if they reject the current proposal, they benefit from both a higher chance to be a proposer in a later round and a larger number of players in the trivial coalition pool in that later round.

Table 1 shows the theoretical predictions of several models when different recognition processes are applied.

Table 1: Theoretical Predictions of the Distribution When $\delta = 0.8$

Voting Rule	Protocol	Proposer's Share	Coalition Partner's Share	Proposer Advantage†
Majority, $n = 3$	BF	0.7333	0.2667	0.4
	1-Cycle	0.6	0.4	0.2667
Majority, $n = 7$	BF	0.6571	0.1143	0.5142
	1-Cycle	0.6	0.1333	0.4571
Unanimity, $n = 3$	BF	0.4667	0.2667	0.1333
	1-Cycle	0.2	0.4	-0.1333
Unanimity, $n = 7$	BF	0.3143	0.1143	0.1714
	1-Cycle	0.2	0.1333	0.0571

This table juxtaposes the theoretical predictions when the common discount factor, δ, is 0.8 (i.e., a penalty of 20% per delay) and the size of the legislature, n, is either 3 or 7. Under both the majority rule and the unanimity rule, one-cycle bargaining without replacement predicts a smaller share for the proposer than in the BF model, and that share is constant in the size of the legislature. For any size of the legislature, the proposer's share under the one-cycle recognition process is less than that under the Baron-Ferejohn protocol. Under unanimity, a notable feature arises when the bargaining protocol is one-cycle without replacement: When δ is sufficiently large, the proposer's share can be smaller than that of the nonproposers.
†: Proposer advantage is the proposer's share in equilibrium minus the ex-ante expected share.

3 Experimental Design and Procedures

I designed lab experiments not simply to test the theoretical predictions of my model but to address the gaps between previous theoretical and experimental studies. Previous experimental studies have consistently reported that the proposer advantage predicted by theory is less significant. Considering that one of the fundamental purposes of conducting laboratory experiments is to infer an individual's underlying reasoning from their observed behavior, it has not successfully advanced our understanding, because either uncertainty in the other subjects' type and willingness to accept an offer or a concern about distributional fairness, or both, could explain the partial rent extraction of the proposers. Furthermore, apart from any other factors that affect individuals' decisions, the observed allocation of the resources could be perfectly explained by another equilibrium.

To address those factors, I conducted a set of modified "divide-the-dollar" experiments. A typical three-player majority-rule divide-the-dollar game goes as follows: In each bargaining period, one randomly selected player proposes a division of a dollar, which is immediately voted on. If the proposal gets two votes, the bargaining period ends and they get paid according to the proposal. Otherwise, the bargaining proceeds to the second round, where the budget shrinks proportionally, a new proposer is randomly selected, and the new proposal is voted on. This process is repeated indefinitely, until a proposal is passed. n-player q-quota divide-the-dollar games proceed in an analogous manner. My main approach in the divide-the-dollar experiments was to modify the proposer selection process. Previous experiments allowed a legislator whose proposal has failed to have an equal chance to be a proposer again. In my experiments, only those who have not yet proposed are potential proposers in later rounds.

3.1 Experimental Procedures

All the experiments were conducted at the Experimental Social Science Laboratory (ESSL) at UC Irvine in 2016, four sessions in May and the other five sessions in October. The subjects were recruited from the general undergraduate population of UCI, and no subject participated in more than one experimental session. All the interactions between participants took place via computer terminals using Python and its Pygame application.[12] After reading the instructions, both printed and displayed on the screen, subjects answered six multiple-choice questions to check their understanding of the instructions. They repeated taking the quiz until they got all the answers correct, with help from the experimenter as needed. Those who passed the quiz played a demo version of the experiment with computer players, to familiarize themselves with the computer interface. In the demo game, it was made clear that they were playing with computer players who were making random proposals and casting random votes, and that the actions of the computer players were irrelevant to what actual subjects would do in the experiment.

I conducted four main treatments, which differed in two dimensions: the voting rule used to pass the proposal (majority or unanimity) and the size of the legislature (3 or 7). By the majority treatment, I mean the four sessions that adopted a simple majority rule, two with $n = 3$ and the other two with $n = 7$. The unanimity treatment is defined similarly. When a distinction in the group size is necessary, I abbreviate the four treatments by M3 (majority treatment with $n = 3$), M7, U3, and U7. 54 subjects participated in M3, 48 subjects for U3, 56 subjects for both M7 and U7 each.

The structure of all four treatments is the same: For each of 15 bargaining periods, subjects are randomly divided into groups of $n \in \{3, 7\}$ members and assigned ID numbers from 1 to n. At the beginning of each period, every member proposes a division of $50 * n$

[12]The software used in the experiments is available upon request.

tokens, by indicating the share for each member.[13] After everyone submits his/her proposal, one proposal is chosen at random with equal probability. All members vote after observing the proposal and the proposer's ID. If the proposal receives q or more votes, then it passes, players earn the number of tokens prescribed by the proposal, and the bargaining period ends. Under majority and unanimity, q is $\frac{n+1}{2}$ and n, respectively. If the proposal fails, the budget shrinks by 20% and the bargaining continues with random selection but excluding the first proposer. That is, in the second round of a bargaining period, every member except the first proposer submits another proposal (i.e., a proposal for division of $50*n*0.8$ tokens,) one proposal is selected at random, and then every member of the group votes on it. If the second-round proposal within a bargaining period fails and the game proceeds to the third round, then the bargaining involves dividing $50 * n * 0.8^2$ tokens, and so on. This process is repeated for at most n rounds. If no proposal wins within n rounds, the game ends and no one earns anything. After each bargaining period, the subjects are shuffled to form new groups. Since a new group is formed and new IDs are assigned per period, they were unable to identify their group members. At the end of the experiment, the tokens earned are converted to US dollars at the rate of $0.02/token.

Another experimental session with 24 participants was conducted to provide supplementary evidence. I abbreviate this treatment by M3R2 because its structure is identical to the M3 treatment starting the second round. Specifically, at the beginning of each period, all the members of a group are informed that one randomly selected member will be unable to make a proposal during the period, and the ID number of the randomly selected member is disclosed. The other two members make a proposal to divide 150 tokens. After two members submit their proposals, one proposal will be chosen at random, with equal probability. The chosen proposal will be voted on by all the three members in the group. If the proposal is accepted, members will earn tokens according to the proposal, and move to the next period. If the proposal is rejected, then they move to round 2 of the period. In the second round, the member whose proposal was not chosen in the first round makes another proposal. The amount of tokens to be divided will be reduced to 120 tokens. If the proposal is rejected in the second round, then all the three members of the group will receive nothing for that period. Thus, the first round in the M3R2 treatment is structurally identical to the second

[13] To maximize the number of observations from the experiment, I use the strategy method (Fréchette, Kagel, and Lehrer (2003)) to elicit budget proposals from all members of the group. The main difference between the strategy method and the bargaining protocol considered in the model is the timing at which the proposer is selected. It has been established that there is no qualitative difference in outcomes in terms of the timing of the choice of the proposer (Agranov and Tergiman (2014)).

round in the M3 treatment. The only difference is that the randomly selected member who does not make a proposal during the period is not the one who failed to pass a proposal. More details regarding the M3R2 treatment will be followed in the discussion section. Including 24 subjects in the M3R2 treatment, a total of 238 subjects participated in the main experiment.

Table 2 summarizes the details of the experiments.

Table 2: Experimental Design

Treatment	**Group Size**	**#Bargaining Periods**	**Total Subjects**	**Each Period Ends in**	**Voting Rule**
M3	3	15	54 (27+27)	3 rounds	Majority
M7	7	15	56 (28+28)	7 rounds	Majority
U3	3	15	48 (21+27)	3 rounds	Unanimity
U7	7	15	56 (21+35)	7 rounds	Unanimity
M3R2	3	15	24	2 rounds	Majority

Except M3R2, each treatment was conducted in two sessions. Each session consists of 21 to 35 subjects.

The main theoretical predictions are as follows:

1. For any treatment, there is no delay.

2. In both the majority and unanimity treatments, the proposer's share is constant in the size of the group.

3. In U3, the proposer keeps a smaller share than the nonproposers, while the proposer keeps a larger share in U7.

4. In all treatments, the proposer's share is smaller than what is predicted by the BF model.

5. When the bargaining period reaches the second round or later, the previous proposers are offered a share of little or nothing.

6. The observations in the second round of M3, if any, are the same as the observations in the first round of M3R2.

Since the model associated with these treatments has a unique symmetric subgame perfect equilibrium, it directly tests whether subjects behaved in a strategically correct way.

If all the theoretical predictions are supported, then we could assert that players behaved rationally and that a simple modification of the recognition process could reduce the variance of the difference between the ex-ante expected earnings and the ex-post earnings.[14] If experimental evidence from legislative bargaining without replacement is similar to that with replacement, it may imply that subjects did not strategically respond to changes in the proposer recognition process.[15] If observed behaviors are inconsistent with any of the theoretical predictions, we may want to give greater consideration to the validity of the behavioral assumptions, including social preferences. In particular, the proposer disadvantage in the U3 treatment should be observed if the partial rent extraction from previous studies was due to a myopic concern about fairness.

4 Results

Each session was designed to last one hour, and took less than 70 minutes, including the tutorials at the beginning and the survey at the end. Including the show-up payment of \$7, subjects earned \$20.98 on average, and the aggregated earnings distribution was unimodal around \$20.92. Each treatment except M3R2 was repeated twice, and I pooled two sessions by treatment as the two-sample Kolmogorov–Smirnov test results do not reject the null hypothesis that the two earning distributions are from the same distribution.[16] Each earnings distribution per treatment was also unimodal, and Shapiro–Wilk W test results do not reject the null hypothesis that the data are normally distributed. In sum, there are no noticeable features in terms of the earnings.

I report the results of the experiments by focusing on three aspects of the theoretical predictions. First, I examine whether subjects form a minimum winning coalition. Second, I check whether there are delays in reaching an agreed-upon proposal, and I investigate the delays. Third, I examine how the proposer's share varies with the voting rule and the size

[14]The relative proposer advantage under majority rule is minimal when the size of the legislature is small. Therefore, if a large social group is divided into several smaller groups and each group adopts random selection without replacement, the ex-ante standard deviation of a member's payoff can be significantly reduced.

[15]However, this doesn't necessarily mean that subjects did not respond strategically. I find some evidence that they strategically investigated the proportion of subjects who were responding with bounded rationality. See Section 5.

[16]In the first session of the U3 treatment, there was one subject who consistently rejected all proposals which were not made by him. As a result, he earned the lowest earnings of \$16.3 among all the subjects and the average earning of the session, \$19.36, was the lowest among all the sessions. The two-sample KS test for two sessions in the U3 treatment was performed after excluding this subject and subtracting the mean of each session.

of the legislature.

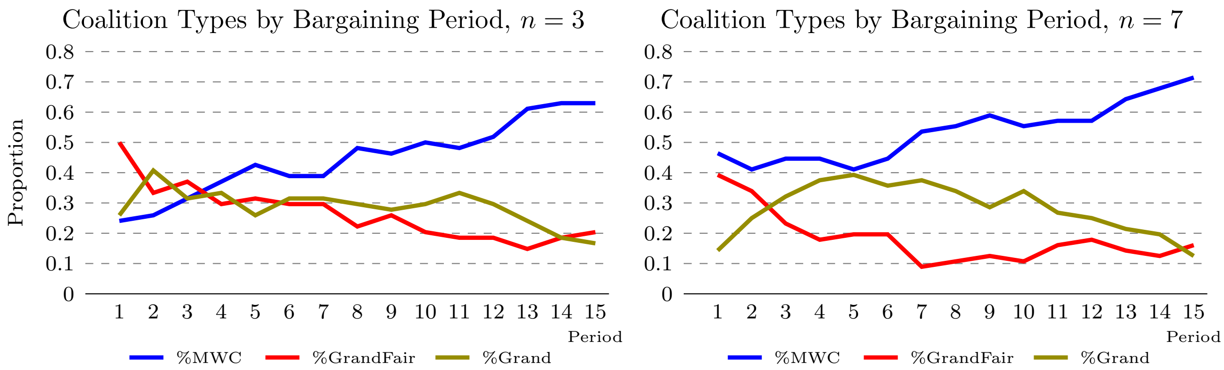

Figure 1: Coalition Types in Majority Treatments
Blue lines: the proportion of MWC-type proposals for each bargaining period. Red lines: the proportion of proposals that divide the tokens evenly among all the members. Green lines: the proportion of proposals that cannot be classified as either of the other two types, mostly allocating positive shares to all members in an unequal manner.

First, the minimum winning coalition is the most frequently observed coalition type.[17] As in previous studies, the "grand coalition" (unequal split but no one was offered fewer than 10 tokens) and the "grand fair coalition" (equal split) are also observed. The proportions of both the grand coalition and the grand fair coalition generally decreased over 15 periods (Figure 1).

Second, subjects agreed on the chosen proposal without delay for 86.67% of the periods in all the majority treatments (as shown in Figure 2). In the unanimity treatments, the proportions of proposals that passed without delay are 71.67% with a group size of 3 and 63.33% with a group size of 7. In the U3 treatment, 10 groups out of 240 could not reach agreement by the final round, and earned no tokens for that bargaining period, and in the U7 treatment, one group out of 120 reached no agreement. Due to the nature of the unanimity rule, a tiny number of subjects could account for nearly a third of all the delays,[18] hence it was straightforward in that in general, it is harder to reach agreement among a larger number of individuals. This loss of efficiency under unanimity is also observed in Kagel, Sung, and Winter (2010) and Miller and Vanberg (2013).

[17]As in previous studies, I used a "soft boundary" to determine whether a member is included as a coalition partner. If a proposer offered another member less than 10 tokens, I assume that the member was not considered as a coalition partner. For example, I coded a proposal (80,62,8) as an MWC type.

[18]In the U7 treatments, a total of 44 groups moved to the second round of bargaining. Only two subjects out of 56 accounted for 14 delays out of the 44. In the U3 treatments, 4 subjects out of 49 lead to 21 delays out of 68.

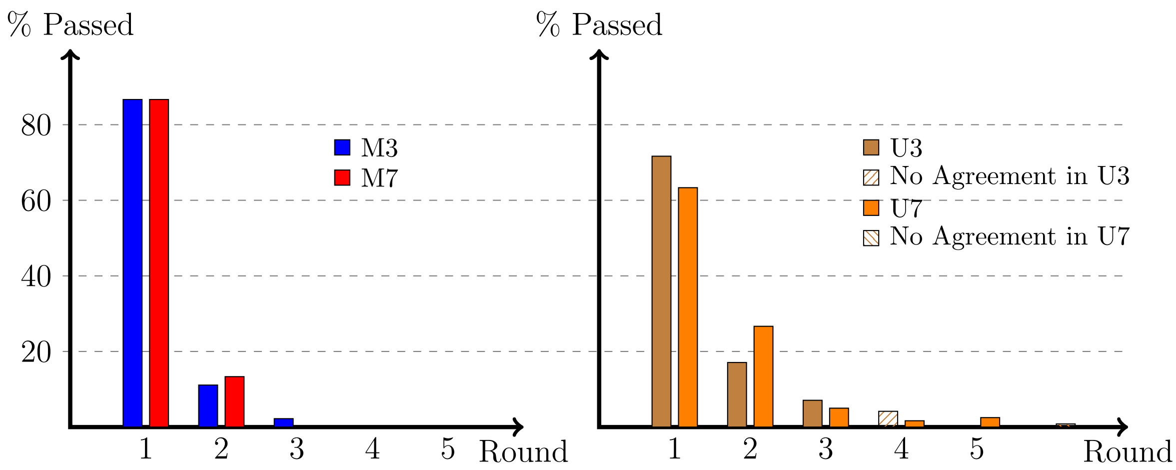

Figure 2: % Proposals Passed by Round

These bar charts illustrate the proportion of proposals accepted in each proposal round. In the majority treatments, 86.67% of the chosen proposals were accepted without delay. In the unanimity treatments, smaller proportions of the chosen proposals were accepted in round 1. In the U3 treatment, nine groups could not reach agreement by the final round, while one group could not reach agreement in the U7 treatment.

Third, the proposer's share is inconsistent with the theoretical prediction for legislative bargaining without replacement. For every treatment, the null hypothesis that the average proposer's share is equal to the proposer's equilibrium share is rejected at the 1% significance level. In the Majority treatment, when looking at the average proposer's share of the MWC-type proposals in the M3 treatment, which is closest to the theoretical prediction, t-statistics is 8.2491 (n =348, cluster-robust standard error= 0.2220). An equal split within the minimum winning coalition seems to describe subjects' behavior at least in the Majority treatment. See Figure 3. Yet it is not the evidence to support Gamson's law: In the Unanimity treatment, the average proposer's share (Figure 4) is statistically different from the equal-split share at the 1% level (U3: t-stat=4.8795, n = 653, cluster-robust standard error= 0.1217, U7: t-stat=6.0961, n = 799, cluster-robust standard error= 0.0668). Altogether with the high frequency of the MWC-type proposals, the high efficiency, and the partial rent extraction, this evidence is by and large consistent with the past experimental studies examined legislative bargaining with replacement. Also, this evidence could also confirm that there are some important factors that have not been accounted for in the model, which will be investigated further in the following subsection.

Last but not least, another interesting observation is that even when the "proposer disadvantage" was expected in the U3 treatment, subjects proposed to keep strictly more than an

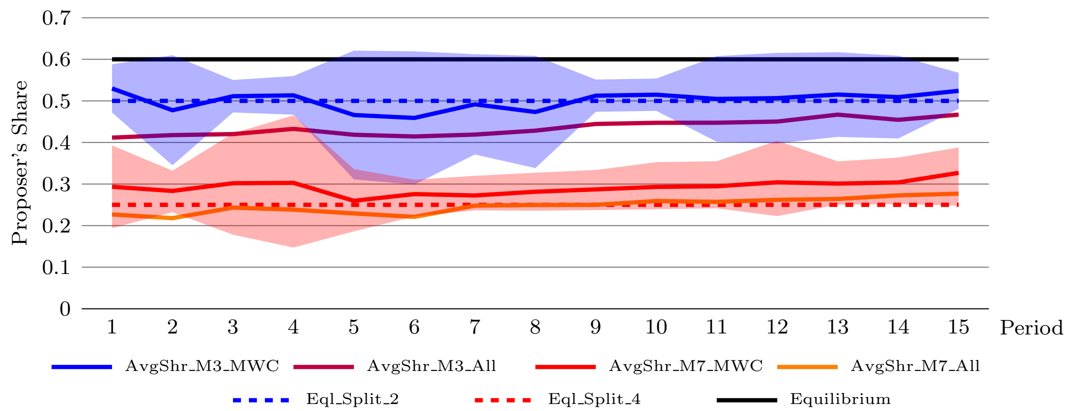

Figure 3: Average Proposer Share by Bargaining Period, Majority

First-round proposals that were rejected are excluded. The blue and red lines are for the proposals that allocated resources only to a minimum winning coalition. The dashed lines are for hypothetical proposals in which there would be an equal split within a minimum winning coalition. The areas shaded in blue and red depict the standard error around the average proposer's share of the MWC-type proposals in the M3 and M7 treatments, respectively.

equal-split share for themselves, on average, across all the fifteen periods. This implies that concern about fairness is not the main driving force behind their behavior. This argument is further explained in the following discussion section, but the intuition is straightforward. If the proposer's partial rent extraction consistently observed in previous studies and my study stems from a mixture of their own self-interest and a myopic concern about fairness which could be captured by inequity aversion (Fehr and Schmidt (1999)), then the proposer's share should be between the theoretical prediction and an equal-split share. It implies that in the U3 treatment, where the equilibrium proposer share is *smaller* than an equal-split share, observed proposer's share must be smaller than an equal-split share, but larger than the proposer's share in equilibrium. In the U3 treatment, however, only 5.44% of all proposals (48 out of 882) involved the proposer receiving a strictly smaller share than the equal-split share. Excluding observations that are highly likely to be due to a misunderstanding or a mistake, the proportion of proposals indicating the proposer disadvantage is much lower.[19] Therefore, though the average proposer share seems to be close to the equal-split share, proposers'

[19]A few subjects occasionally proposed to keep $1/3 - x$ for themselves, offer one member $1/3 - x$, and offer the other member $1/3 + 2x$, where $x \in (0, 1/3)$. Except for one or two "mistakes," those subjects consistently proposed to keep $1/3 + 2x$ for themselves. One subject seems to have consistently confused the number of the desk at which he sat with the ID numbers assigned to each of the bargaining periods in the experiment. Excluding all those actual or possible mistakes, only 16 proposals from two subjects consistently offered a smaller share to the proposer.

rent-seeking behavior is obvious. By merely examining Figure 4, one could mistakenly claim that distributional fairness is the one and only factor explaining the experimental evidence because the average proposer share is close to an equal-split share; however, this is not the case. Besides the fact that few proposers seem to have made a point of keeping a smaller share than other members, if this claim were true within the maintained interpretation of the myopic concern about fairness, the distaste for advantageous inequity should have been greater than that for disadvantageous inequity, which is not true in general. Moreover, even if we admit that in the unanimity treatments subjects cared about distributional fairness for all members of the group, as seemingly observed, it can be shown that there is no set of parameters that admits the observations in the majority treatments. See the discussion section. All in all, concern about fairness is not the driving force behind the experimental evidence.

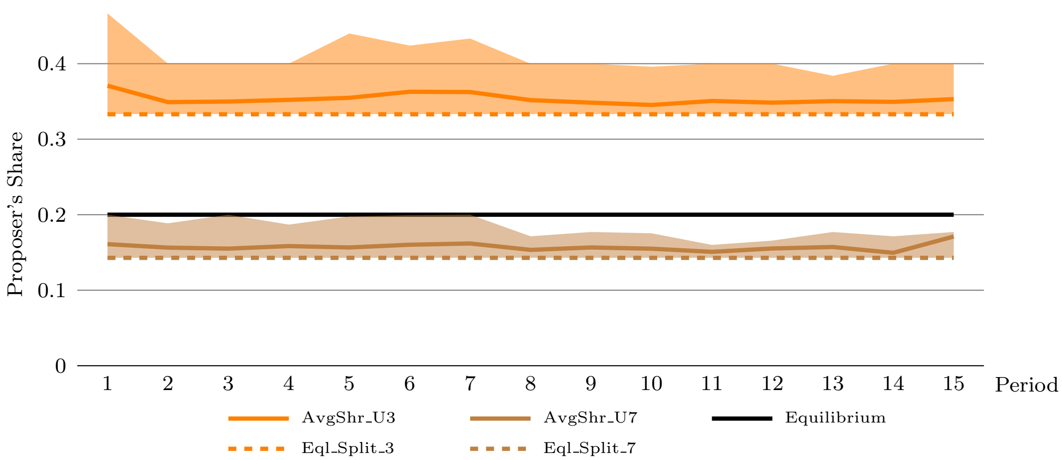

Figure 4: Average Proposer Share by Bargaining Period, Unanimity

First-round proposals that were rejected are excluded. The dashed lines are for hypothetical proposals in which there would be an equal split. Shaded areas in orange and brown depict 10%–90% percentile proposer's share in the U3 and U7 treatments, respectively. In the U3 treatment, there are few proposals which involve the proposer disadvantage.

Although concern about fairness has been discussed across many contexts in the analysis of experimental evidence, it is not a constructive factor in relating our observations from the lab setting to actual multilateral bargaining situations, because it may not exist—or it could be less distinctive—outside of the laboratory. In real life, an agent who engages in multilateral bargaining is likely to represent a particular social, cultural, or political group, in which case the representing individuals may want to suppress their concern about fairness, even if it does exist, for the benefit of their social group. For example, a politician who attempts to steer the distribution of a budget in favor of her legislative district to the greatest extent possible would not vote for a proposal simply because it looks fair to many politicians involved. Representatives at the six-party talks on North Korea's nuclear weapons program would not agree on any proposal simply because of its being considered fair by all the countries involved. Climate change summits are often futile because each country seeks to maximize its own advantage, even though they recognize that seeking for the cooperative actions would give fairer outcomes with a greater social welfare. My observation that concern about fairness is not the driving factor behind the results of my laboratory experiments is positive and desirable in relating experimental evidence to real-life multilateral bargaining.

5 Discussion

In this section I mainly discuss the partial rent extraction.

5.1 A Model with Inequity Aversion of Myopic Agents

One of the robust observations in previous experimental studies is the proposer's partial rent extraction, which is also observed from my experiment. Though Montero (2007) shows that inequity aversion may work in the opposite direction of explaining the attenuated proposer advantage, the results are based on the following implicit assumption: Every player is rational enough to fully internalize the fact that other players would have their own inequity aversion. I claim here that even when players are myopically concerning for fairness, inequity aversion doesn't play a role. By myopic, I mean that players concern for distributional fairness but do not consider other players' inequity aversion. Under the assumption of myopic agents, players would find the optimal allocation of the resources with taking into account their inequity aversion, after calculating the equilibrium strategy profile with the self-interested utility. Following Fehr and Schmidt (1999), suppose that player i's payoff from accepting proposal p is

$$p_i - \alpha \frac{\sum_{j \neq i} \max\{x_j - x_i, 0\}}{n-1} - \beta \frac{\sum_{j \neq i} \max\{x_i - x_j, 0\}}{n-1},$$

where $\alpha > \beta > 0$, and $\beta < 1$. Below I characterize the set of parameters that admits the experimental regularity observed in the M3 and U3 treatments. This approach is sufficient to show that there is no parameter of α that is consistent with the following observations: (1) In the M3 treatment, the proposer, in general, keeps the half of the entire budget, and give the remaining half to one of the other members. (2) In the U3 treatment, the proposer keeps an equal-split (or a slightly larger than an equal-split) share. First I show that α should be greater than $\frac{2}{3}$ to be consistent with (1). In the M3 treatment, the first proposer solves the following maximization problem.

$$\max_{x\in[0,0.1]}(0.6-x)-\alpha\frac{((0.6-x)-(0.4+x))+(0.6-x)}{2}=(1-\alpha)(0.6-x)+\alpha\frac{0.4+x}{2},$$

where the first term captures the proposer's selfish payoff, the first term of the numerator captures the disutility from advantageous inequity between the proposer and the coalition member, and the second term of the numerator captures the disutility from advantageous inequity between the proposer and the other member who is offered zero. The discount factor, δ is set to be 0.8. The amount that the proposer is willing to give others for relieving the disutility from advantageous inequity, x, would be chosen in $[0, 0.1]$ because for $x > 0.1$ the proposer would get a smaller share than the coalition member, which is never observed.[20] Since the objective function is linear, it has corner solutions. Solving for x, we find that $x = 0.1$ if $\alpha > \frac{2}{3}$. Thus, the range of parameters admits the experimental evidence from the M3 treatment is $\alpha > \frac{2}{3}$.

Next, I claim that α should be less than $\frac{2}{3}$ to be consistent with (2). In the U3 treatment, the first proposer solves the following maximization problem.

$$\max_{x\in[0,0.8]}(0.2+x)-\alpha\left(0.2+x-\left(0.4-\frac{x}{2}\right)\right)\mathbb{1}_{x\geq 2/15}-\beta\left(0.4-\frac{x}{2}-(0.2+x)\right)\mathbb{1}_{x<2/15},$$

where $\mathbb{1}$ is an indicator function. Check if $x < 2/15$ could be a solution for the problem. If the proposer tries to keep a smaller share than the other two members, the first order condition $1+\beta+\beta/2$ which is always positive, so $x = 0.8$, which contradicts the supposition of $x < 2/15$. Now consider $x \geq 2/15$. The first order condition is $1-\alpha-\alpha/2$. Thus, $x = 2/15$ is the optimal choice when $1-\alpha-\alpha/2 > 0$, or $\alpha < \frac{2}{3}$.

Therefore, provided that α, aversion parameter to advantageous inequity, is the same for two treatments, it clearly illustrates that the inequity aversion is not the driving factor at all. To recap the intuition behind this claim, if the proposer's partial rent extraction in the M3 treatment were to be explained by the concern about distributional fairness, the proposer's "partial disadvantage transfer" would have been observed when the proposer disadvantage is expected in equilibrium.

[20] Even if we allow that x could be larger than 0.1, it can be shown that as long as β, the parameter captures the degree of disadvantageous inequity, is smaller than α, $x > 0.1$ can never be optimal.

In the following subsections I report some other experimental findings that help us understanding the proposer's partial rent extraction.

5.2 Retaliation, or Hedging?

Another interesting observation from the out-of-equilibrium paths is that subjects seem to "retaliate" against previous proposers. When forming a minimum winning coalition in round 2, the first-round proposer is more likely to be excluded. In the M3 treatment, 30 of the 36 (83.33%) second-round proposals that offered one member almost no tokens involved splitting the remaining tokens with a nonproposer from round 1. Furthermore, subjects allocated almost no tokens to the first-round proposer in many cases where they were not treated badly[21] (19 out of the 30) or were even favored[22] (12 out of the 19) in the first round. Since the previous proposer had lost his/her bargaining power, that is, the previous proposer is "cheaper," it is rational to include the previous proposer in the minimum winning coalition. This is clearer in the M3 treatment. With the tie-breaking assumption that members will vote for a proposal when they are indifferent between accepting it and rejecting it, the second-round proposer may want to propose keeping all the resources for herself, because the first proposer (who will earn nothing regardless of whether he/she accepts the offer or when the game moves on to the third round) will accept the second-round proposer's offer of 0. Even if the assumption about tie-breaking is relaxed, choosing the previous proposer as a coalition partner is the ideal way to obtain the largest share of the resources in general. Formally, suppose that a nonproposer's decision rule is to accept an offer of x only when $x \geq v + \varepsilon$, where v is a continuation value, and ε is the "tiny-more" term which captures any general tie-breaking rule. Consider that the size of the legislature is 3 and a simple-majority rule is applied. In the final round, the proposer will keep $1 - \varepsilon$ and offer one randomly selected member ε, because the nonproposer's continuation value is 0. In the second round, the previous proposer's continuation value is $\delta\frac{\varepsilon}{2}$, while the other member who has not proposed has a continuation value of $\delta(1 - \varepsilon)$. When $\varepsilon < \frac{2}{3}$, $1 - \varepsilon$ is greater than $\frac{\varepsilon}{2}$. Therefore the second-round proposer can be better off by choosing the first-round proposer as a coalition partner if ε is reasonably small.

Yet we cannot hastily conclude that their actions can be viewed as retaliation against the previous proposer, because it is rational to offer the previous proposer few tokens, or

[21] For notational simplicity, denote three members of the group as the first-round proposer, member i, and member j for notational simplicity. Member i is not treated badly by the first-round proposer if $p_i^1 \geq p_j^1$.

[22] Member i is favored by the first-round proposer if $p_i^1 > p_j^1$.

nothing in theory. However, the naturally followed question within this interpretation is that why the second-round proposer, who knows that the previous proposer will accept an offer of few tokens, allocates a significant amount of tokens to the other member. One possible explanation is that the second-round proposer may want to hedge the possibility of getting rejected by the previous proposer: Since the previous proposer's ε term is unknown, it could be possible that the offered amount of tokens can be less then $\delta\frac{\varepsilon}{2}+\varepsilon$, and she may want to make a hedge by winning over the other member for her proposal to be accepted.

The supplementary experimental session of the M3R2 treatment helps to examine whether the second-round proposer retaliates against the first-round proposer by offering no or few tokens, or whether the second-round proposer who is unsure about the previous proposer's decision rule wins over the other member. The structure of the game in the M3R2 treatment is identical to the subgame starting from the second round of the M3 treatment. The only difference is the way how the member who completely lost his/her bargaining power within the period, which I call the "cheaper" member, is determined: In the M3R2 treatment, the cheaper member is randomly selected, while in the M3 treatment, the cheaper member is the first-round proposer. If the proportion of the MWC-type proposals that exclude the cheaper member in the M3R2 treatment is similar to that in the M3 treatment, then we could conclude that retaliation is not the driving factor. If all the MWC-type proposals in the M3R2 includes the cheaper member, then we could conclude that retaliation is the only driving factor.

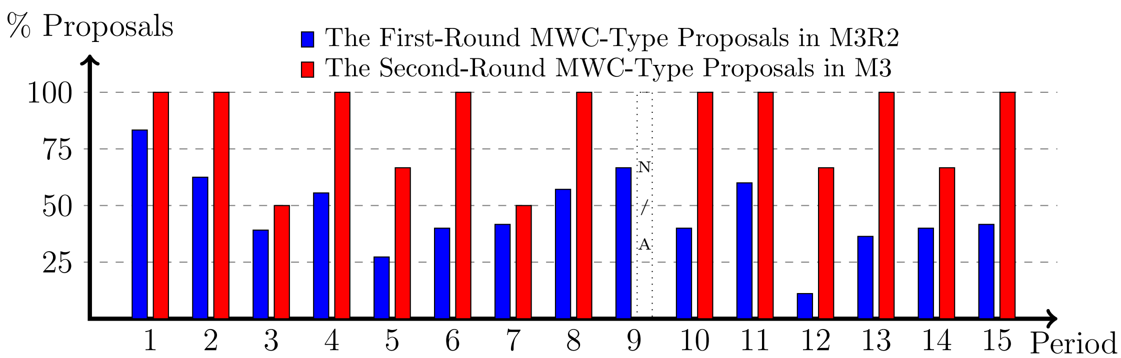

Figure 5: Retaliation Against the Previous Proposer

This bar chart illustrates the proportion of the MWC-type proposals that exclude the "cheaper" member. In the second round of the M3 treatment, the cheaper member is the first-round proposer, while the cheaper member is randomly selected in the M3R2 treatment. In periods 9 in the M3 treatment, every group agreed on the first proposal so no data for the second round was available. A larger proportion of the proposals involves exclusion of the cheaper member in the M3 treatment than in the M3R2 treatment.

The result supports the claim that the second-round proposers' actions can be partly understood as retaliation against the previous proposer. In the M3R2 treatment, 46.10% of the first-round MWC-type proposals (65 out of the 141 proposals) excluded the cheaper member, while the proportion was 82.85% in the M3 treatment. During the later periods where the MWC-type proposals were more frequently observed, from period 10 to period 15, the proportion decreased to 38.71% (24 out of the 62). In addition, subjects in the M3R2 treatment clearly understood that the member who is known to be unable to propose has a lower continuation value than the other member who could be the ultimatum proposer in the second round. When choosing the cheaper member as their coalition partner, subjects offer a significantly smaller amount of tokens (60.65) than what they offer to the other member (65.78) on average (t-statistics: 3.0916, $n_1 = 76$, $n_2 = 65$). These evidence clearly indicate that in the M3 treatment, subjects try to retaliate against the first-round proposer for offering them no or few tokens.

It is interesting because there is no point in acting out of retaliation: In every new period, subjects are shuffled to form new groups. Even if the first-round proposer in the previous period is included in the current group, there is no way to identify him/her because new ID numbers are assigned. However, the subjects who were retaliated against in previous periods are more likely to propose an equal split within a minimum winning coalition.

5.3 Behavioral experimentation

One of the typical patterns observed in the experimental sessions is depicted in Figure 6. Subjects seemed to experiment to get a sense of the rationality of the other players: By observing the results of the votes on proposals which could have been accepted if every member had acted rationally, they updated their beliefs about the type of population in each session and then modified their proposals accordingly.

The following illustration will clarify how a rational subject might decide to stick with an equal split within a coalition. Suppose that in M3, three subjects (A, B, and C) each submit a provisional plan (s^j_A, s^j_B, s^j_C), where s^j_i is the number of tokens allocated to subject $i \in \{A, B, C\}$ according to the proposal submitted by subject $j \in \{A, B, C\}$. Suppose that in round 1, subject A submits the equilibrium proposal, (90,60,0), and that subject B, who proposes (0,75,75), is the recognized proposer. Though subject A, who was offered no tokens, will vote against the proposal, she expects that subject C will accept the offer because 75 is strictly greater than 60, the number of tokens that subject A would have accepted if she had been offered them. If subject B's proposal is rejected, subject A would learn that subject

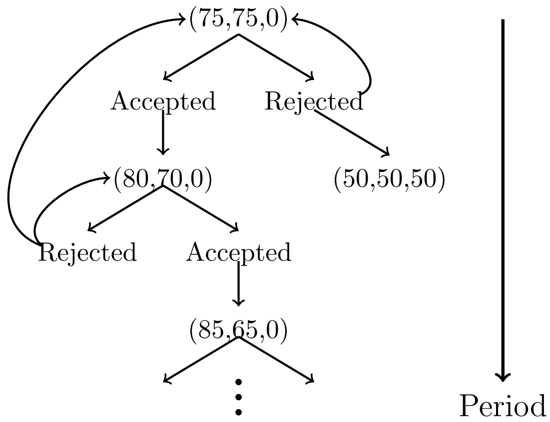

Figure 6: A Typical Pattern of Proposal Changes, M3 Treatment

The first of the three numbers in parentheses (e.g., 80 in (80, 70, 0)) represents the proposer's share, in terms of tokens, and the other two entities are the shares offered to the other two players. In the early periods, subjects tended to offer an equal split within an MWC, and it seems that they updated their beliefs about the population on the basis of members' previous actions. If an equal split within a minimum winning coalition or a similar proposal was made by another member of the group and was accepted, they tended to make a proposal to extract a slightly larger portion of their rent. If such a proposal was rejected, however, some subjects switched to offering an equal split among all the members, while others again proposed an equal split within a minimum winning coalition.

C is definitely not as rational as she expected. Then in the second round, what subject A would do is based on the relative weights she assigns to two pieces of new information from round 1: (1) subject B wanted an equal split within a minimum winning coalition, and (2) subject C did not want an equal split within a minimum winning coalition, even if he was included as a coalition partner. If subject A focuses more on (1), then she might propose (60,60,0) in the hope that subject B would accept the same type of offer that he proposed in the previous round. If she is more concerned about (2) and interprets subject C's voting decision as a signal that he prefers an equal split, subject A might propose (40,40,40). At the very least, subject A would know that a proposal of (60,0,60) will not be accepted by subject C, because if subject C would accept (60,0,60) in round 2, he should have accepted (0,75,75) in round 1. Even when the bargaining period ends and all subjects are shuffled to form new groups, subject A would recognize that there is at least one subject who wants an equal split within a winning coalition, and another subject who may want a more egalitarian split, and that those two might be assigned to the same group in a later period within the session. This type of experimentation helps subjects to update the type distribution of the subject pool, and their proposals in the later periods will reflect their beliefs about that.

6 Concluding Remarks

This paper examines how we can decipher the proposer's partial rent extraction observed in the laboratory, by modifying the proposer selection rule from random recognition to random recognition without replacement. In the existing legislative bargaining literature, random recognition allows the current proposer to be recognized again in the following rounds, while the model considered here prohibits recognition of any player as the proposer in more than one round. The unique symmetric subgame perfect equilibrium is characterized, and in equilibrium a smaller proposer advantage than that of the BF model is predicted. Under majority, in equilibrium the first proposer keeps a deterministic share, $1 - \frac{\delta}{2}$, for herself, *regardless of* the size of the legislature. Under unanimity, the first proposer keeps $1 - \delta$ for herself and offers $\frac{\delta}{n-1}$ to all the nonproposers, which means that if $\delta = 1$, the first proposer keeps *nothing* for herself.

Due to these theoretical features, the behavioral factors, such as fairness concern and retaliation, which could derive the bargaining outcomes in the laboratory can be identified in a clearer manner. Although distributional fairness may have been considered as one of the important factors resulting in partial rent extraction, it does not affect subjects' decisions, even with considering myopic agents who cares for their own inequity aversion. I find that the main factors which prompt proposers not to extract their full rent are the uncertainty in the amount that a coalition member is willing to accept and the uncertainty in the degree of rationality that would be exercised by other members. Out-of-equilibrium observations suggest that retaliation and the fear thereof is another driving factor. By comparing the second-round proposals in the M3 treatment with the first-round proposals in the M3R2 treatment, I found that the second-round proposers spend more resources than what they could have spent, to retaliate against the previous proposer at their own expenses. This needs to be investigated further, because retaliatory behavior, especially in a situation where subjects are randomly rematched at the beginning of each bargaining period, doesn't help subjects to increase their earnings. A theoretical investigation of type variation or learning of types could be worthwhile.

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Appendix A: Omitted Proofs

Proof of Lemma 2: Let's first consider trivial cases. When $l = 0$ for any n, that is, when kth round is reached, the proposer will keep the entire budget by Lemma 1. When $n = 3$, the randomly selected proposer in round 2 will get the entire budget. Therefore, the proposer selected in the first round would offer x to one of the two other players, and one who received the offer will accept it only when x is greater than $\delta/2$, which is the expected gain when rejecting the offer: He will obtain 1 in the next round with probability 1/2 being recognized as a proposer, and 0 with another probability 1/2 being not recognized, and the next round is discounted by δ. Thus if the first proposer offers $\frac{\delta}{2}$ to one of the two other players, the proposal is approved by majority and the game ends. I now consider $n \geq 5$.

Since the equilibrium strategy isn't stationary, backward induction has to be adopted. First, let's check if the $(k-l)$th proposer offers $\frac{\delta}{n-k+l}$ to one player when $l = 1$. By the fact that there are $k-2$ previous proposers in the trivial coalition, she wants to offer some nonnegative payoff, x, to only one additional player to form a MWC. The player received an offer x would accept it only when his continuation value is not as great as accepting x. If he rejects the offer, he would have 1 in the next round with probability $\frac{1}{n-(k-1)}$ being a proposer, and zero otherwise by Lemma 1. His expected payoff in the next round, $\frac{1}{n-(k-1)}$ is discounted by δ, so he will accept x if it is greater or equal to $\frac{\delta}{n-(k-1)}$. Now suppose the claim holds for some $l = 1, \ldots, k-2$. That is, the $(k-l)$th proposer offers $\frac{\delta}{n-k+l}$ to l randomly selected players from the nontrivial coalition pool. I want to show this will also hold for $l = k-1$. The $(k-l)$th proposer, or the first proposer, needs to offer some nonnegative payoff, x, to l players from the nontrivial coalition pool. Each of players who received the offer x would accept if it is greater than the continuation value. When one offered player rejects the offer, he would expect to earn $1-(k-2)\frac{\delta}{n-2}$ with probability $\frac{1}{n-1}$ being a proposer, and earn $\frac{\delta}{n-2}$ with probability $\frac{k-2}{n-1}$ being in a nontrivial MWC. Thus the expected payoff in the next round is $\frac{1}{n-1}\left(1-\frac{k-2}{n-2}\delta\right)+\frac{k-2}{n-1}\frac{\delta}{n-2} = \frac{1}{n-1}$. Since the continuation value for the next round is discounted by δ, the nonproposers will accept if $x = \frac{\delta}{n-1}$. □

Proof of Proposition 1: By Lemma 1, when $\frac{n-1}{2} - t < 0$, that is, in round $\frac{n+1}{2}$ or after, any proposer in round t will get the entire budget. When $\frac{n-1}{2} - t > 0$, that is, in round

$\frac{n-1}{2}$ or before, Lemma 2 can be directly applied. The round t is equivalent to round $k-l$, where $k = \frac{n-1}{2}$ and $l = 0, 1, \ldots, k-1$. The round t proposer will offer $\frac{\delta}{n-(k-l)} = \frac{\delta}{n-t}$ to $l+1 = \frac{n-1}{2} - t + 1$ randomly selected players. $\square$

Proof of Corollary 1: The proof for Proposition 1 can be analogously applied: By the same logic of Lemma 1, in round $t = n$, a randomly selected proposer i will propose $p_i^t = 1$ and $p_j^t = 0$ for all $j \neq i$. By the same logic of Lemma 2 the $(n-l)$th proposer, where $l = 0, 1, \ldots, n-1$, offers $\frac{\delta}{n-(n-l)}$ to l randomly selected players from the nontrivial coalition pool. $\square$

Appendix B: Sample Instructions

SAMPLE INSTRUCTIONS FOR MAJORITY ONE-CYCLE WITH N=7

This is an experiment in group decision making. Please pay close attention to the instructions. You may earn a considerable amount of money which will be paid in cash at the end of the experiment. The currency in this experiment is called 'tokens'. The total amount of tokens you earn will be converted into US dollars at the rate of 2cents/token. In addition, you will get a $7 participation fee if you complete the experiment.

After the instructions, you will take a quiz about the instructions. The reason for having a quiz is to make sure that you understand how the experiment works.

Overview:

The experiment consists of 15 group decision-making 'Periods'. In each Period, you and six other subjects decide how to divide 350 tokens. The details follow.

How the groups are formed:

In each Period, all subjects will be randomly assigned to groups of seven. For example, if there are 28 subjects, there will be four groups of seven members. In any Period you will not know who your group members are. Your group members will not know who you are either. Each member of the group will be assigned an ID number (from 1 to 7), which will be displayed on the top of the screen. Once the Period is over, you will be randomly re-assigned to a new group of seven, and you will be assigned a new ID for the next Period. Note that your ID number will vary across Periods. Since member IDs will be randomly assigned each

Period, no one can identify subjects using ID numbers.

How the tokens are divided:

Each Period (a session dividing 350 tokens) may consist of several 'Rounds'.

In Round 1, every member in your group will make a proposal to divide 350 tokens. You can allocate 0 tokens to some members, but all allocations must add up to 350 tokens. After everyone submits his/her proposal, one proposal will be chosen at random, with equal probability. The chosen proposal will be voted on by all members in the group. We use a simple majority rule. If the proposal gets 4 or more votes, it is accepted: Members will earn tokens according to the proposal, and move on to the next Period. If the proposal is rejected, that is, gets less than 3 votes, your group will move to Round 2 of the Period.

In Round 2, the six members EXCEPT the one who made the proposal chosen in Round 1, will make new proposals. However, the amount of tokens to be divided will be reduced by 20% of the amount of tokens in the preceding Round. Thus, if the proposal in Round 1 is rejected, the new proposal in Round 2 will involve dividing 280 tokens. After one of the six proposals will be randomly chosen, all the seven members will vote to accept or reject it.

If it is accepted in Round 2, the Period ends. If it is rejected in Round 2, then in Round 3, the five members whose proposal has NOT been chosen yet will submit new proposals to divide 224 tokens. If accepted, the Period ends. If rejected, the four members who haven't been chosen yet will propose to divide 179 tokens in Round 4, and so on.

If the proposal in Round 7 is rejected, all members of your group will receive ZERO tokens for that period of the experiment.

In short, whenever eligible, make a proposal of dividing the current amount of tokens, and then vote to accept or reject the chosen proposal. If your proposal has been chosen for one of the previous Rounds and rejected, you can NOT propose any more during the Period.

Summary of the process:

1. The experiment will consist of 15 Periods. There may be several Rounds in each Period.

2. Prior to each Period, all subjects will be randomly assigned to groups of seven participants. Each member of the group will be assigned an ID number.

3. At the beginning of each Period, everyone will submit a proposal to divide 350 tokens. One of the proposals will be randomly chosen, with equal probability.

4. If 4 or more members in the group accept the chosen proposal, the Period ends. Members will earn tokens according to the proposal, and move to the next Period.

5. If the proposal is rejected, then the proposer can NOT propose any more for the Period. Members whose proposal hasnt been chosen yet will make new proposals in following Rounds.

6. The amount of tokens is decreased by 20% following each rejection of a proposal in a given Period. When a proposal in Round 7 is rejected, every member in the group earns nothing.

We are now ready to conduct a quiz on these instructions. Are there any questions before the quiz?

SAMPLE QUIZ FOR MAJORITY ONE-CYCLE WITH N=7

The purpose of this quiz is to make sure that you understand the experiment. If you don't understand, feel free to ask questions.

Question 1. In each Period, you will be assigned to a group of (A) members. Each group will decide how to divide (B) tokens. What are (A) and (B)?

Question 2. Suppose that in Period 1, your ID number is 3, and member 1's proposal is chosen in Round 1. Which of the followings is NOT TRUE?

1. If member 1's proposal is rejected, member 1 cannot be a proposer in following Rounds.
2. Even if I reject the proposal, it could be accepted by majority.
3. In the next Period, my ID number must be 3 again.
4. If the current Period moves on Round 2, my ID number is unchanged.

[Hint: A new ID number will be assigned in each Period.]

Question 3. Suppose you are in Round 1. There are 350 tokens. Which of the following proposals is plausible?

1. (100, 50, 0, 50, 150, 0, 0)
2. (10, 10, 10, 10, 10, 10, 10)
3. (350, 50, 50, 50, 50, 50, 50)
4. (-50, 400, 0, 0, 0, 0, 0)

[Hint: Allocations must be between 0 and 350. The sum of all allocations must be 350.]

Question 4. The amount of the tokens shrinks by 20% following each rejection of a proposal in a given Period. When a proposal in Round 7 is rejected, what will happen with the 92 tokens?

1. The 92 tokens are extinguished. No one in the group earns for that Period.
2. The 92 tokens are randomly assigned to one member.
3. The 92 tokens are randomly distributed to each member.
4. The 92 tokens are added to the tokens for the next Period.

Question 5. We use a simple majority rule. Assuming that you will vote for your proposal, what's the smallest number of additional votes you need to have your proposal passed? (There are 6 members except you.)

Figure 7: Screenshot for a proposer in Round 1 of Period 1