Multilateral Bargaining with Proposer Selection Contest*

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Abstract

This paper experimentally investigates the competition to be selected as the proposer of the subsequent many-player ultimatum bargaining game. The experimental environment varies in two dimensions: reservation payoffs (homogeneous/heterogeneous) and the information of how much resource each subject spent in the competition (public/private). In the public-heterogeneous treatment, proposers put the most generous allocation to the vote and the average amount of resources spent in the competition was closest to the empirically optimal investment level. In the public treatments, the proportion of the proposals being rejected was smaller. Altogether, the surplus was distributed least inefficiently and least unequally when the reservation payoffs were heterogeneous and subjects were informed of who had spent how much in the competition. This study contributes to the literature by demonstrating which formal rules are more effective in establishing more efficient informal norms.

Keywords: Multilateral bargaining, Contest, Public choice, Laboratory experiments

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1 Introduction

When a group of people negotiate over some economic surplus, the one who makes a proposal often obtains a greater share than others. Consequently, the participants of a negotiation may be willing to take costly measures to influence decisions of the one(s) with the power or to be recognized as the proposer himself/herself. If the rent for the proposer is expected to be substantial, a competition among the participants may be inevitable. Examples of such competitions are commonplace, from relatively small organizations such as a condominium board and a student council to a large corporation, a government agency, and an international organization such as United Nations. (See Yildirim (2007) and the reference therein for more detailed examples.) Moreover, in the process of recognition, resources are often spent unproductively (e.g., lobbying other agents, hiring a professional negotiator or other experts, etc.).

In search of the conditions for efficient multilateral bargaining, this paper experimentally examines the competition to win the proposal right for the subsequent bargaining procedure. In particular, we introduce a lottery contest (Tullock, 1980) which determines the proposer of the subsequent bargaining game to see (i) how the existence of the contest influences the allocation of the surplus and (ii) how the prospect of an (un)equal division affects the intensity of the competition. In this regard, we follow Yildirim (2007) who theoretically analyzes multilateral bargaining over infinite-time horizon. However, we depart from his model by employing a many-player ultimatum bargaining game instead. This is to avoid the multiple equilibria problem which often complicates the interpretation of the experimental outcomes and to focus on the consequences of the competition in the simplest setup.[1]

More specifically, we examine a two-stage game where the players first choose an investment level independently to increase the chance of being selected as the proposer, and then vote on the plan about how to allocate the given economic surplus, which is proposed by the player selected in the first stage. The experimental environment varies in two dimensions: reservation payoffs and the information of how much resource each subject spent at the contest stage. First, We examine the effect of heterogeneity in the reservation payoffs, which is comparable with the effect of heterogeneous (im)patience in the infinite-horizon bargaining.

[1]The source of inefficiency most widely discussed in the literature is asymmetric information which may result in an unnecessarily delayed agreement (see Palfrey (2016) for an overview of the literature). We do not discuss the welfare cost of delays as we consider ultimatum bargaining games. Nevertheless, we do examine under which condition a rejection of a proposal is more likely at the end of Section 5.

Suppose that one's reservation payoff is larger than the others'. It means that his/her vote is more expensive than the others', and thus he/she is more likely to be excluded from the coalition to pass the proposal. Expecting this, the one with the highest reservation payoff will be more eager to win the competition, which in turn will affect the others' decisions on how much resource to spend. This type of strategic consideration does not exist when the reservation payoffs are homogeneous, because then there is no reason for the proposer to favor one player over another. The second dimension of our design is whether or not the information of resource spending is publicly revealed. More precisely, in a set of treatments, we inform the subjects of both who is selected as the proposer and how much investment each participant made in the contest before the bargaining game takes place, whereas in the other treatments, we inform the subjects only of the selected proposer. The theory does not provide any particular predictions along this dimension, because rational agents do not care about the past expenditures. However, previous experimental studies suggest that such information may influence the proposal by altering the reference point or the norms of who deserves how much and what is fair (Hoffman and Spitzer, 1985; Konow, 2000).

We find that in all treatments, most proposers indeed took a greater share of the surplus than the others. At the same time, however, the offered proposals were quite generous in comparison with the theoretical benchmark, which is in line with what has been documented in the bargaining literature. This does not imply that the subjects were naïve and irrational: More than 75% of the whole proposals form a minimum winning coalition, and less than 20% of those were rejected, as predicted by theory. Also, taking the observed generous proposals into account, we show that the level of resource spending was significantly higher than the expected-payoff-maximizing level, which is consistent with the results found in previous experimental studies of contests.[2] Interestingly, proposers who had spent more resource in the contest tended to less generously treat the non-proposers, and when the information on resource spending at the contest stage is publicly disclosed, the proposals are less rejected by the members. This entitlement effect might give an additional incentive for subjects to over-invest in the public treatment.

Furthermore, we find that efficiency and equity go hand in hand: In the environment where the surplus was (expected to be) distributed more equally, the efficiency loss due to the wasteful resource spending was smaller. This might be because as the theory predicts, subjects had weaker monetary incentives to win the contest when the social norm limited

[2]The average level of investment in the contest was lower than the 'equilibrium' level predicted by the theory which assumes that (1) whenever indifferent between accepting and rejecting the offer, the non-proposer will vote for the proposal, and (2) the proposer will fully exploit the rent in the second stage.

the rent extraction more tightly. In particular, it turns out that the average level of resource spending and that of inequality in the distribution of the surplus were significantly lower under two conditions. Given the majority voting rule, both levels of resource spending and inequality were particularly low when (i) the investment levels were publicly revealed and (ii) the reservation payoffs were heterogeneous. In the heterogeneous treatments, one subject (coded “Blue” in the experiment) was endowed with a greater reservation payoff, and as argued above, had a greater incentive to win the proposal right than the others (“Red” and “Green”). Knowing this, the others might be willing to let Blue subject win the contest on condition of a generous proposal. Thus, in a sense, the subjects might be able and willing to form a gift-exchange relationship in which Red and Green subjects yielded up the proposal right, and in return Blue subject offered a generous proposal to the voters. This relationship might be sustained because Blue proposers believed that once the relationship or the norm was formed, an unequal (or unfair) proposal would be rejected with a high probability. In summary, the public information, on one hand, facilitates forming such a gift-exchange relationship by making it easy to detect any significant deviation from the norm, and the heterogeneity in reservation payoff, on the other hand, facilitates coordination among subjects. To correctly appreciate this condition, it may be worth noting that the effect of public information substantially differed across the heterogeneous treatments. In particular, when the reservation payoffs were heterogeneous, the level of resource spending was lower in the public information treatment than in the private information treatment as noted above. In contrast, when subjects were endowed with the same reservation payoff, they spent resources in the public treatment as much as they did in the private one. This means that neither the heterogeneity nor the public information alone was sufficient to reduce the inefficiency, but together they could.

Over the recent years, economists in various fields have come to agree on the necessity of good institutions for economic prosperity. Here, institutions include informal norms of behavior and shared beliefs as well as written laws, formal rules and social conventions (North, 1990). Despite its importance, however, studies on the conditions for efficient institution building are rather rare, which is partly because studying institution building within the rational agent framework is not straightforward, and especially difficult when the institutions refer to informal norms and beliefs. For instance, our game-theoretical benchmark does not distinguish between the public and the private information treatments, although such information often has a nontrivial impact on the outcome because the notions of what is fair and who deserves how much depend on it. We contribute to the discussion by experimentally showing which formal rules can establish more efficient informal norms.

The rest of this paper is organized in the following way. In the following subsection we discuss the closely related literature. Section 2 sets up the model, and Section 3 presents some theoretical benchmarks. Next, in Section 4, we describe the design and procedure of the experiments, and Section 5 highlights the main experimental results. Section 6 discusses the findings of this study more, and Section 7 concludes.

1.1 Literature Review

We build upon the models of legislative bargaining with endogenous proposer selection. Yildirim (2007) extends the model of Baron and Ferejohn (1989) by allowing the agents to exert effort to be the proposer. Key results include: (i) The agents compete more fiercely under majority rule than under unanimity rule since the value of being the proposer is higher when a smaller coalition suffices for the proposal to pass. (ii) Those who are more patient are likely to be excluded from the winning coalition, so they exert more effort to be the proposer. Yildirim (2010) also analyzes the competition to be recognized as the proposer, but with one modification; the recognition is persistent. The analysis reveals that the distribution of surplus becomes more unequal as the recognition becomes more persistent. Ali (2015) considers the situation where the agents compete in the manner of all-pay auction, instead of a lottery contest. Because in an all-pay auction, expected rents are fully dissipated, the continuation value is expected to be zero in equilibrium. Therefore, the entire surplus is taken by the first proposer. Suh and Wen (2009) model multilateral bargaining as a multi-agent bilateral bargaining. A pair of agents negotiate over who will go on bargaining and how much will be given to the one who steps out, and the negotiation process is over when everybody but one agent steps out. In this process the proposer, the one who keeps on negotiating, is endogenously determined. Güth et al. (2004) endogenize the order of moves so that a player self-selects to be the proposer (i.e., the first mover) or the two players move simultaneously to end up playing the Nash demand game. The authors show that under a certain condition, the unique subgame perfect equilibrium exists, where each player makes a demand and the payoffs approximately correspond to the Nash bargaining solution.

Our experiment is motivated by Yildirim (2007), but we adopt an ultimatum bargaining instead of the bargaining with infinite time horizon, which connects our experiment to the vast literature on the ultimatum bargaining experiment. There have been quite a few experiments where the proposal right was not randomly granted but had to be earned somehow. For instance, Hoffman and Spitzer (1985) conducted an experiment in which a randomly selected subject decided whether to go on to an ultimatum bargaining as the proposer or to opt out. If opting out, the subject could leave the experiment with some money, while the matched subject was given nothing at all. Therefore, in some sense, the proposal right was 'bought' at the price of the foregone money. In the experiments of Hoffman et al. (1996) and Gächter and Riedl (2005), subjects acquired the proposal right or a claim by winning a quiz. It is commonly reported that the proposer tended to take a greater share when the proposal right was earned than when it was randomly granted.

Probably the most important difference between those studies and ours is that they are mainly interested in the effect of earning a right (or a claim) on the distribution in the bargaining process, whereas our interest lies not only in the distribution but also in the competitive behavior to earn the right. We analyze the competitive behavior to identify the conditions under which the competition is particularly intense, and ultimately, to learn how to lower the unnecessary social cost.

Also very closely related to our experiment are Güth and Tietz (1985, 1986). They assigned the rights to participate in bargaining games using the second-price sealed-bid auction. They find the proposers in their experiments tended to offer less to the responder than those in the ultimatum bargaining experiments without the auction stage. Such a tendency was particularly strong when the bid of the auction winner was high, which we also find in our data. Shachat and Swarthout (2013) allowed the subject to coordinate by providing information of the (average) price of the other player.

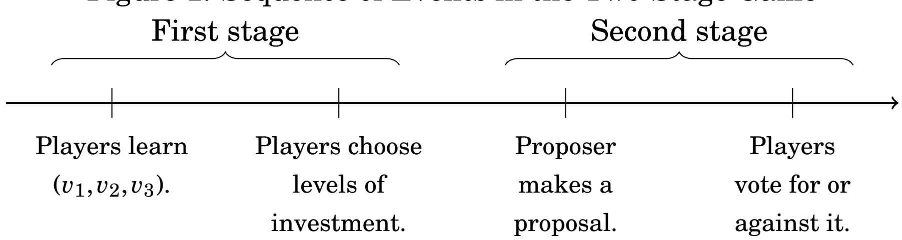
Our experiment differs from theirs in several aspects. (i) We consider multilateral bargaining games as opposed to the bilateral bargaining. (ii) We adopt a lottery contest whereas they used the second price auction. (iii) We assign non-zero reservation payoffs, and vary them to see its effect on the competition. (iv) In our design, even if lost in the competition stage, subjects still participate in the bargaining game as a non-proposer. In their experiment, on the other hand, losing an auction means non-participation. The roles were assigned by the experimenter, and the subjects competed to participate in the bargaining, given the roles. (v) We consider both cases with and without the biding information being publicly available.

2 A Model

Consider a two-stage game with three players who first compete to be selected as a proposer, and then decide how to allocate a fixed amount of the economic surplus (normalized to 1). To model the competition for the proposal right, we employ the contest à la Tullock (1980) where player $i \in \{1,2,3\}$ makes an irreversible investment, $e_i \geq 0$, and then is selected as the proposer with probability $e_i / \sum_{j=1}^{3} e_j$.

At the beginning of the second stage, the proposer announces a non-wasteful allocation of the surplus, indicating which player may receive how much. $P = \{(p_1, p_2, p_3) | \sum_{i=1}^{3} p_i = 1$, and $p_i \geq 0 \ \forall i\}$ is the set of feasible proposals and $\Delta(P)$ is the set of probability measures on P. Let (a_i, x_i) denote a feasible action of player i in the second stage where $a_i \in \Delta(P)$ is the (possibly mixed) proposal offered by player i as a proposer, and $x_i \in [0,1]$ is the voting decision threshold (or the minimum acceptable offer) of player i as a non-proposer. Given the announced proposal, players cast their votes sincerely, i.e., player i votes for the proposal if and only if $p_i \geq x_i$. Given q-quota voting rule[3], if the proposal is supported by more than or equal to q players including the proposer himself/herself, the payoffs accrue according to the proposal. If, on the other hand, it gets fewer than q votes, player i receives his/her reservation payoff, v_i. (v_1, v_2, v_3) is public information. Figure 1 summarizes the timing of events.

Figure 1: Sequence of Events in the Two-Stage Game



We adopt the ultimatum bargaining game instead of an infinite-horizon bargaining game that most of previous theoretical studies employ (Baron and Ferejohn, 1989; Eraslan, 2002; Yildirim, 2007, 2010; Ali, 2015) for a couple of reasons. First, while there has been a natural focal point of the theoretical discussions, the stationary subgame perfect Nash equilibrium (SSPE), there exist a continuum of other equilibria in infinite-horizon multilateral bargaining models.[4] So, when a systematic deviation from the SSPE is observed in the lab, we are unable to tell whether the discrepancy is due to the subjects playing a different equilibrium or other important factors (e.g., social preference, reference dependence and social

[3] In the bargaining with three players, $q = 2$ means the majority rule, and $q = 3$ means the unanimity rule.

[4] One theoretical feature of the Baron-Ferejohn model is that in their infinite-horizon game, virtually any distribution of feasible payoffs can be supported in an equilibrium. See Proposition 2 of Baron and Ferejohn (1989), which can be understood as an example of a class of results known as "folk theorems."

norm) that have not been properly accounted for. Since the model we consider in this study generates an essentially unique subgame perfect Nash equilibrium, we are free from the concerns related to equilibrium selection, and thus the interpretation of experimental outcomes would be clearer. Second, if the proposer selection contest is repeated in case of the initial proposal being rejected as in Yildirim (2007), the expected outcomes at round t may be affected both by the outcome of the contest at t (because more often than not, people are backward-looking) and by the prospect of the contests at $t+1$, $t+2$ and so on (because they are forward-looking as well). Therefore, in such a complicated experiment, we are likely to observe confounded effects of the proposer selection contest. We believe that a simpler case must be analyzed before such a complex one is to be considered. Third, this modification connects our experiment to the literature on the ultimatum bargaining experiment, which provides abundant findings comparable to ours.

Also note that although much simplified, our model keeps the essence of the infinite-horizon bargaining model. One of the key predictions of the multilateral bargaining model is that without asymmetric information, there should be no delay in making a collective decision: The proposer calculates the other members' continuation value, i.e., the expected payoff of moving on to the next round of bargaining, and offers the continuation value to the members of a minimum coalition that would pass the proposal in the first round. Having the reservation payoff v_i as a reduced-form proxy of the continuation value in the infinite-horizon bargaining, our model yields an almost identical set of theoretical predictions. It is a plus that we prevent subjects from miscalculating the continuation value, which typically is a complicated function of the subjective discount factors, the voting rule, and the number of negotiators.

3 Theoretical Benchmark

A symmetric subgame perfect Nash equilibrium exists, and it is unique.[5] We focus on two particular cases: one with homogeneous reservation payoff, and the other with hetero-

[5]There are asymmetric equilibria with homogeneous reservation payoff v in which players coincidentally believe a particular asymmetric coalition formation pattern. For illustration, consider three players with homogeneous v, negotiating under the simple majority voting rule. If player 1 always chooses player 2 as a coalition member, vice versa, and player 3 chooses one of the other members with equal probability, player 3 would invest more than the other members because otherwise he cannot have a positive share in the bargaining stage. In general, if we allow any sort of asymmetric mixing strategies in forming a minimum winning coalition, there will be a continuum of equilibria. We claim this asymmetric type of equilibrium cannot be a proper ground for the experiment where every round subjects are randomly re-matched and the identity codes are reassigned.

geneous ones. In the case with heterogeneous reservation payoffs, one (high-type) player has a distinctively greater reservation payoff than the other two (low-type) players have. We consider these two cases separately because when forming a coalition, the proposer may want to choose the one with the lower reservation payoff if the responders are heterogeneous, but there is no reason for the proposer to do so if homogeneous. To exclude trivial corner solutions, we restrict our attention to the cases where $v_i \leq 1/3$ for all i. Otherwise, player i may refuse to get into the negotiation process in the first place.[6]

3.1 Homogeneous Reservation Payoff

First, suppose that every player's reservation payoff has the same value v. The following proposition describes the symmetric SPNE.

Proposition 1. *Consider three players with homogeneous reservation payoff v. Under q-quota voting rule, the equilibrium investment level for the proposer selection contest is $e^* = [2-3(q-1)v]/9$. The proposer randomly selects $(q-1)$ coalition members, and offers v to each of them who then accept the proposal. The proposer's equilibrium share is $1-(q-1)v$. The expected payoff of each player is $1/3-e^*$ in equilibrium.*

Proof: See Appendix A.

The proposition implies that the equilibrium investment level under the majority rule is $(2-3v)/9$, and under the unanimity rule, it is $(2-6v)/9$. Proposition 1 meets our intuition well. If q is larger, each individual invests less. That is, when there are more members that need to be included in the winning coalition, the advantage of being the proposer gets smaller, which decreases the level of resource spending. Note also that the expected payoff is the ex-ante expected share minus the investment level. In equilibrium, each member invests the same amount, and eventually one of the members is selected as a proposer with equal probability. Thus, the expected payoff is that in bargaining with random proposer selection (1/3) minus the resource spending (e^*). Hence, the social inefficiency due to the proposer selection contest is $3e^*$.

[6] As we will see shortly, the expected equilibrium payoff is the equal-split share, 1/3, minus the equilibrium investment level. Thus, unless the equilibrium investment level is zero, player i with $v_i > 1/3$ is always better off by not participating in the bargaining process.

3.2 Heterogeneous Reservation Payoffs

Now, we consider the case where $v_1 = v_2 = v - \alpha$ and $v_3 = v + 2\alpha$, where $\alpha \in (0, v)$. By keeping the sum of reservation payoffs the same, we are making this case comparable to that with homogeneous reservation payoffs. For notational simplicity, let v_l denote $v - \alpha$ and v_h denote $v + 2\alpha$. We call the player with v_h is the high type, and the other players are the low type.

Proposition 2. *Consider three players with heterogeneous reservation payoff v_i. Under the simple-majority voting rule, the equilibrium investment levels in the proposer selection contest are $e_h^* = (2 - 3v_l)/[9(1 - v_l)]$ for the high-type player, and $e_l^* = [(2 - 3v_l)^2]/[18(1 - v_l)]$ for the low-type players. When the high-type player is selected as the proposer, he randomly selects a coalition member, and offers v_l. When the low-type player becomes the proposer, he deterministically chooses the other low-type player, and offers v_l. The coalition member accepts the proposal. The proposer's equilibrium share is $1 - v_l$, regardless of his reservation payoff. The expected payoff of each player is $1/3 - e_i^*$ in equilibrium.*

Proof: See Appendix A.

The high-type player invests more to attain a higher probability of being a proposer, $e_h^* = (2 - 3v_l)/[9(1 - v_l)] > [(2 - 3v_l)^2]/[18(1 - v_l)] = e_l^*$. This is because the only way for the high-type player to get a strictly positive payoff is to become a proposer: Since the simple-majority voting rule does not require everybody's favorable vote, the proposer has an incentive to form a minimum winning coalition, that is, to "buy" only one vote which is the cheapest. Therefore, the high-type player would never be selected as a coalition member because $v_h > v_l$.[7] Another observation worth mentioning is that the expected payoff is, again, the equal-split share minus the equilibrium investment level. The expected payoff the high-type player is smaller than that of the low-type player, and this is solely driven by the different investment decisions.

Next, we compare the resource spending in the case with homogeneous reservation payoffs with that in the heterogeneous case. It may be natural for the player with v_h to invest more than a player with v does, that is, $e_h^* > e^*$, because the high-type player is to be excluded from the winning coalition when not chosen as a proposer. An interesting observation is that e_l^* is also *greater* than e^* as long as α is not too small. To state this formally, we define

[7]Because of the difference in choosing minimum winning coalition members, the homogeneous reservation payoff case cannot be nested in the heterogeneous case at $\alpha = 0$.

a threshold:

$$\alpha^* := \frac{6v - 4 + \sqrt{(3v-8)(3v-2)}}{9}$$

which can be shown to be strictly smaller than v.

Proposition 3. *e_l^* is greater than e^* for $\alpha \in (\alpha^*, v)$.*

Proof: See Appendix A.

For example, if $v = 0.15$, then for any $\alpha \in (0.0357, 0.15)$, $e_l^* > e^*$. An increase of α generates two different effects. On one hand, a positive α makes the players asymmetric. Because the high-type player is to be excluded from the winning coalition when lost, he spends more resources to win the proposal right, while a low-type player is to be picked as a coalition member with a high probability, which altogether lowers the low-type players' incentive to make a greater investment. On the other hand, as α increases, the rent for a proposer grows larger (recall that a proposer offers $v - \alpha$ to a coalition member), so does the incentive to make a larger investment. Proposition 3 states that as long as α is not too small, the latter incentive dominates the former.

4 Experimental Design and Procedure

The basic procedure of an experimental session was as follows: Each subject was endowed with 400 tokens in his/her account where 1 token was equivalent to €0.015 (1.5 eurocents). A session consisted of 15 bargaining rounds. In each round, each subject was randomly assigned to a group of three and then was randomly assigned a color (Red, Green, or Blue) as an ID. Then, a group was given 150 tokens which were to be divided among them. Each subject could spend up to 40 tokens to increase the chance to be selected as a proposer, and the tokens spent in the contest were subtracted from his/her account. Subject i's probability to win the proposal right was $e_i/(e_R + e_G + e_B), i \in \{R, G, B\}$, where e_i is the amount of tokens that subject i spent. When no one spent, one member was selected at random with equal probability. The selected subject proposed a non-wasteful allocation of 150 tokens. Observing the proposal, all members voted for or against it to determine the allocation. Under a simple majority rule, if the proposal received two or more votes, then it was accepted, and the members earned tokens according to the proposal. When the proposal was rejected, each member of the group received his/her reservation payoff. At the end of

Table 1: Experimental Design

		Reservation payoffs	
		Homogeneous	**Het**erogeneous
Information	**Pub**lic	PubHom	PubHet
	Private	PriHom	PriHet

Each session consisted of 15 rounds. In each round, 150 tokens were given to be divided among a group of three. Each subject could spend up to 40 tokens to increase the chance to be selected as a proposer. When the proposal obtained more than or equal to the required number of votes, it was implemented. Otherwise, each member earned his/her own reservation payoff.

each round, they were randomly re-assigned to a new group of three and assigned a new color ID for the next round. At the end of a session, subjects were asked to fill out a survey.

We tailor our experiments to investigate the following questions: What are the effects of the contest on bargaining and vice versa? More specifically, how does the proposer's own spending affect the proposed allocation? Does the information of the other players' investment levels matter in bargaining? If so, does the impact of the information depend on the heterogeneity in reservation payoffs? How does the prospect of an (un)equal division affect the intensity of competition? Under which condition is the wasteful spending minimized and the proposal less rejected?

In total we have four treatments, which are summarized in Table 1. The four treatments differ in two dimensions: the heterogeneity of the reservation payoffs and whether or not the levels of resource spending at the contest stage are publicly disclosed. Each of those treatments is respectively called PubHom (**Pub**lic information of resource spending + **Hom**ogeneous reservation payoffs), PubHet (**Pub**lic + **Het**erogeneous), PriHom (**Pri**vate information + **Hom**ogeneous), and PriHet (**Pri**vate + **Het**erogeneous). PubHom and PubHet are collectively called the public treatments, and PubHet and PriHet are called the heterogeneous treatments. The private treatments and the homogeneous treatments are defined analogously.

In the public treatments, the amount of tokens that each member of the group spent was disclosed with the announcement of the proposer, while in the private treatments, only the proposer was announced. In the homogeneous treatments, each member's reservation payoff was 25 tokens, i.e., $(v_R, v_G, v_B) = (25, 25, 25)$. So, when the proposal was rejected, every group member got 25 tokens minus his/her spending in the proposer selection contest. In the heterogeneous treatments, the "Blue" subject's reservation payoff was 45 tokens, while the other two members' was 15 tokens, i.e., $(v_R, v_G, v_B) = (15, 15, 45)$.[8] Each member's reservation payoff was publicly known. Table 4 summarizes some relevant theoretical predictions.

Table 2: Treatments and the Corresponding Theoretical Benchmarks

Treatment	(e^*_R, e^*_G, e^*_B)	Pr(Coalition)	Proposer's Payoff
PubHom PriHom	(25.0, 25.0, 25.0)	$(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$	125
PubHet PriHet	(26.8, 26.8, 31.5)	$(1, 1, 0)$	135

e^*_i is player i's equilibrium investment level in tokens. Pr(Coalition) is the conditional probability that each player is included as a coalition member (presented in the order of (Red, Green, Blue)) given that he/she is not selected as a proposer. Proposer's share is the amount of tokens that the proposer obtains in equilibrium.

All the experimental sessions were conducted at the Mannheim Laboratory for Experimental Economics (mLab) at the University of Mannheim on April 2018.[9] The participants were drawn from the mLab subject pool. A total of 153 subjects participated in one of the sessions. Python and its application Pygame were used to computerize the games and to establish a server–client platform. After the subjects were randomly assigned to separate desks equipped with a computer interface, the instructor read the instructions for the experiment out loud. Subjects were also asked to carefully read the instructions again before they took a quiz to prove their understanding of the experiment. Those who failed the quiz were asked to read the instructions and to take the quiz again until they passed. An instructor answered all questions until every participant thoroughly understood the experiment. Whenever a private question is raised, the instructor repeated the question out loud and answered it so that every subject was equally informed.

Although new groups were formed every round, there was no physical reallocation of the subjects, and they only knew that they were randomly shuffled. They were not allowed

[8]Note that the sum of the reservation payoffs was always 75, the half of the 150 tokens. Although Blue subjects in the heterogeneous treatments had a larger reservation payoff for the round, ex-ante no subject was favored or discriminated, since in each round every subject was randomly assigned a new color ID.

[9]Pilot experiments were conducted at the Experimental Social Science Laboratory (ESSL) at UC Irvine on September 2017, and the data is available. Although the observations from the pilot experiments are qualitatively similar to what we report in this paper to large extent, we did not combine two dataset because each of sample sets represents a different population, and the payment scale was different. Perhaps one distinction of the main dataset from the pilot one is that the observed behaviors seem to be less irrational, in the sense that subjects made more consistent choices and did make less choices that do not make sense at all. We conjecture that this might be along with the foreign-language effect (Keysar et al., 2012), but it is beyond of what we examine in this paper.

to communicate with other participants during the experiment, nor allowed to head up to look around the room. It was also emphasized to participants that their allocation decisions would be anonymous. At the end of the experiment, they were asked to fill out a survey asking their gender and age as well as their degree of familiarity with the experiment. In addition, we asked how well they would perform if they were asked to participate in a similar experiment again. The subjects' risk preferences were also measured. The total amount of tokens that each subject earned was converted into Euros at the rate of €0.015/token.[10] Payments (€11.88 on average) were made in private, and subjects were asked not to share their payment information.

5 Result

5.1 Summary

We begin the analysis by presenting a summary of the data in Table 3. Resource Spending refers to the average level of tokens spent by a subject in the contest game. Proposer's Share is the percentage taken by the proposer from the entire surplus, 150 tokens. Rejected proposals are excluded when calculating the proposer's average share. MWC refers to the proportion of the proposals that explicitly excluded one member to form a minimum winning coalition (MWC). More precisely, we count a proposal as a MWC proposal if it gave someone less than his/her reservation payoff. Rejection is the proportion of rejected proposals.

Table 3: Data Summary

Treatment	Number of Participants	Resource Spending	Proposer's Share (accepted, %)	MWC (%)	Rejection (%)
PubHom	39	20.24	63.16	82.56	8.72
PubHet	39	18.38	64.59	73.33	10.26
PriHom	39	20.68	65.98	78.46	12.31
PriHet	36	24.44	73.88	80.56	17.22

Resource spending refers to the average investment levels per subject across the whole session. Proposer's Share is the percentage of tokens taken by the proposer from the entire surplus, 150 tokens. MWC refers to the proportion of the proposals that explicitly excluded one member to form a minimum winning coalition (MWC). Rejection is the proportion of rejected proposals.

A few observations, which are detailed in the following subsections, are worth noting:

[10] We instructed subjects that the currency exchange should not be a concern as it would be handled by the server computer.

1. *Treatment Effects*: At least either the behavior in the contest or that in the bargaining game substantially differed across treatments.

2. *Under-investment* (compared with the equilibrium level): In all treatments, the average amount of tokens spent in the contest (18.4–24.4 tokens) was lower than the theoretical benchmark (25–31.5 tokens).

3. *Varying Effect of Information*: When the reservation payoffs were heterogeneous, the level of resource spending was lower in the public information treatment than in the private information treatment. When subjects had the same reservation payoff, they spent resource in the public treatment as much as in the private one.

4. *Generous Proposal*: Most proposers took a greater share of the surplus (63.2–73.9%) than the others. However, the proposer's share was significantly smaller than the theoretical benchmark (83.3–90%).

5. *Equity–Efficiency*: In treatments where the proposer's share was smaller (i.e., more equal distribution), the average resource spending tended to be lower (i.e., less wasteful spending).

6. *MWC*: More than three quarters of the proposals involve attempts to form a minimum winning coalition.

7. *Rejections*: In the public treatments a smaller proportion of the proposals were rejected.

In the following analysis, we also document:

8. *Over-investment* (compared with the empirically optimal level): Given the generous proposals, the amount of tokens spent in the contest turns out to be significantly higher than the empirically optimal level.

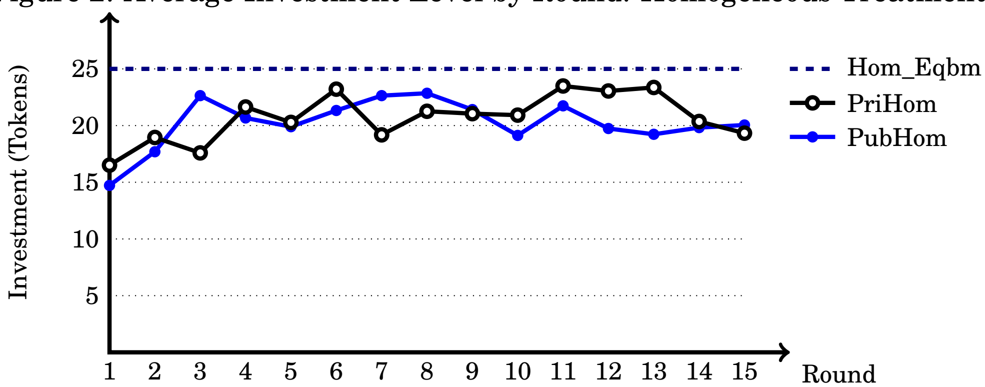
9. *Entitlement*: A proposer who had spent more at the contest stage offered a smaller amount of tokens to non-proposers.

10. *Individual Characteristics*: Gender, age, familiarity with the game were not significant factors determining the outcomes in both the contest stage and the bargaining stage. Risk preferences were significant factors in decreasing investment levels and the amount of tokens allocated to themselves as a proposer.

5.2 Competition for the Proposal Right

We first scrutinize the competitive behavior of subjects in different treatments. Figure 2 shows the average investment level in the public treatments over time. The investment behavior turns out to be quite stable over the rounds at least at the aggregate level. The dashed line marks the theoretical predictions under the majority rule (25 tokens). It is clear that the actual levels of spending were significantly lower than the theoretical benchmarks at the 5% level of significance. The average investment level of PubHom is 20.24 tokens while that of PriHom is 20.68 tokens. There is no significant difference between PubHom and PubHet, as predicted. Recall that the theory does not distinguish the private information treatment from the public information one: Because a rational agent is completely forward-looking in an environment without any remaining uncertainty, the information of the past expenditure should not affect the decisions in the bargaining.

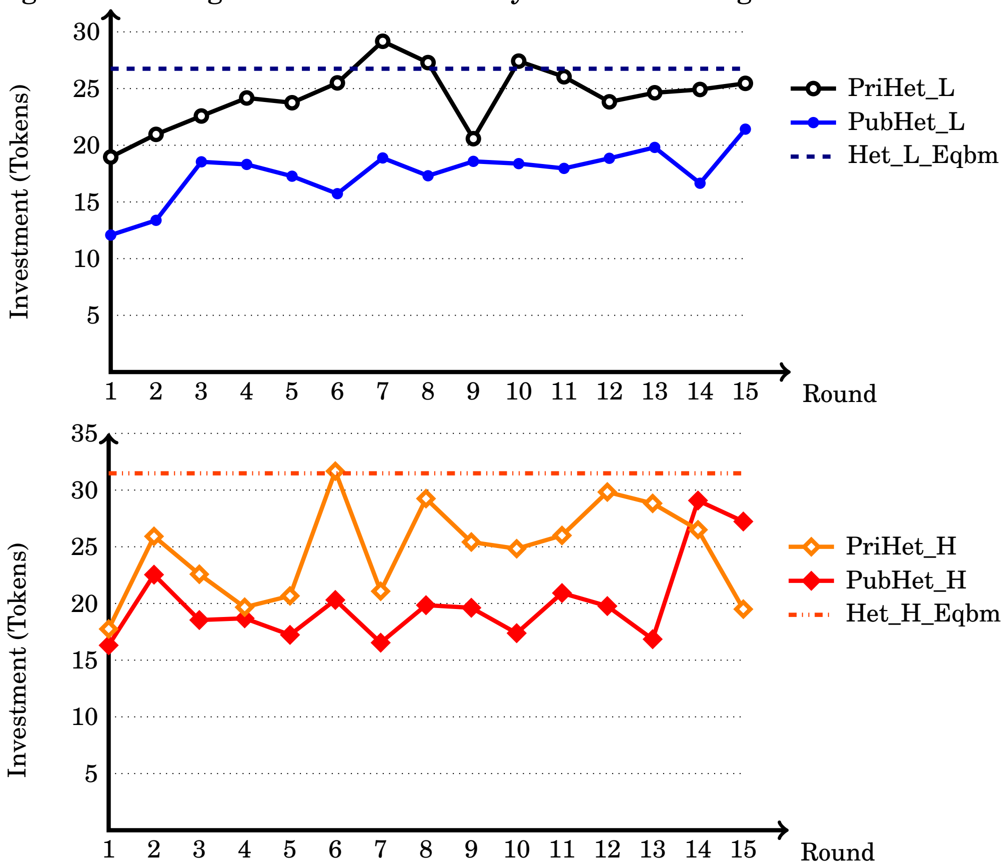
Figure 2: Average Investment Level by Round: Homogeneous Treatments



However, we find that subjects did care about the past expenditure when the reservation payoffs are heterogeneous. Figure 3 shows the average investment levels in the heterogeneous treatments over time. The investment behavior in the heterogeneous treatments appears to be less stable than that in the homogeneous treatments, which is partly because we separate the sample into two subsamples, the sample of the high-type (Blue) subjects and that of the low-type (Red and Green) subjects. For instance, PubHet_H is the trajectory of the average resource spending of the high-type subjects in PubHet, and PubHet_L is that of the low-type subjects. Again, the dashed lines mark the theoretical predictions for the high-type subject (31.5 tokens) and for the low-type subject (26.75 tokens). As before, the actual levels of spending were significantly lower than the theoretical benchmarks except for the case of the low type in PriHet: The average investment level of the low type in Pub-

Het is 17.54 tokens, and that in PriHet is 24.35 tokens. The average investment level of the high type in PubHet is 20.06, and that in PriHet is 24.63.

Figure 3: Average Investment Level by Round: Heterogeneous Treatments



To sum up, in every treatment most subjects spent less than the equilibrium level, which may appear to contradict previous studies reporting over-investment in contest experiments (Chowdhury et al., 2014; Dechenaux et al., 2015). We, however, claim that this seeming under-investment was likely driven by the prospect of a "fair" division of the surplus, and that taking the generous empirical proposals into account, subjects actually spent too much in the contest (i.e., over-investment). To see this, recall that a non-proposer in the SPNE accepts any offer greater than (or equal to) one's reservation payoff, so the proposer offers an amount marginally greater than the reservation payoff to maximize his/her own share. Expecting this large rent, the players compete fiercely to win the proposal right. In the experiment, however, the benefit of being selected as a proposer was not so large, because responders often rejected "unfair" proposals, and thus proposers had to offer a generous division.

Figure 4: Average Proposer's Share by Treatment (All, Last 5)

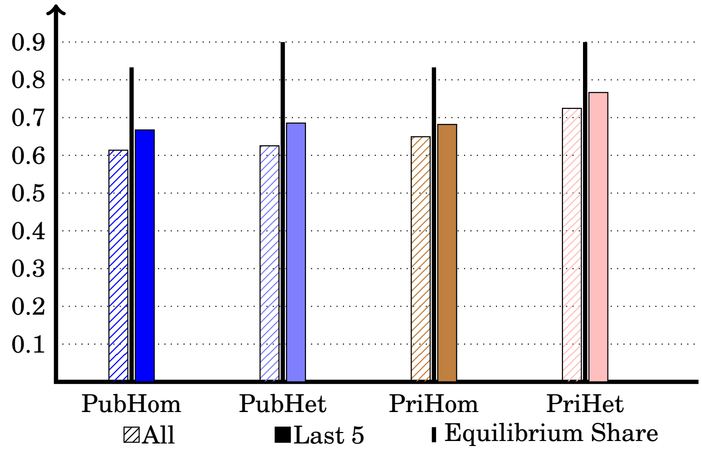


Figure 4 shows the proposer's average share in the accepted proposals. Consistent with the observations in previous studies of multilateral bargaining, in all treatments, proposers did not fully extract their rent.[11] To take this partial rent extraction into consideration, we construct another benchmark, which we call 'empirically optimal investment', in the following way:

(i) Calculate the expected earnings of a proposer and a non-proposer using the data where

$$\begin{aligned}\text{Expected earning} =& Pr(\text{Accepted}) \times E(\text{Proposed payoff} \mid \text{Accepted}) \\ &+ Pr(\text{Rejected}) \times (\text{Reservation payoff}).\end{aligned}$$

(ii) Taking the difference in the expected earnings as the value of the prize, find the equilibrium investment level of the contest game.

Table 4 reports the average earnings of proposers and non-proposers, and the empirically optimal investment levels.[12] If we compare the data with the theoretical benchmark ((D)−(T)), we will have to conclude that subjects spent too little. If, however, we compare

[11] See Palfrey (2016) for the experimental studies reporting partial rent extraction in multilateral bargaining.

[12] The empirical expected earning may be different from what subjects actually expected. However, the observed behavior seems to suggest that subjects did take the expected earning into account when making an investment. This might be either because they learned what to expect over time or because they had more or less correct prior beliefs from the beginning.

it with the empirically optimal level ((D)−(O)), the conclusion will be completely reversed: Subjects spent too much in all treatments. Since we believe that the empirically optimal investment is a more relevant benchmark for the contest experiment, we claim that over-investments are unequivocally observed, which is consistent with the results of previous experimental studies on contests.

Table 4: Empirically Optimal Investment and Over-investment

Treatment	**Expected Earning**		**(O) Optimal**	**(T)**	**(D)**	**(D)−(T)**	**(D)−(O)**
	Proposer	**Non-Proposer**	**Investment**	**Theory**	**Data**		
PubHom	88.67	27.40	13.62	25.00	20.24	-4.76***	6.62***
PubHet_L	84.75	26.89	11.82	26.75	17.54	-9.21***	5.72***
PubHet_H	97.71	25.52	17.67	31.48	20.06	-11.42***	2.38
PriHom	89.86	25.45	14.31	25.00	20.68	-4.32**	6.37***
PriHet_L	94.13	23.13	14.81	26.75	24.35	-2.40	9.54***
PriHet_H	99.18	14.97	20.32	31.48	24.63	-6.85***	4.31**

Expected Earnings are the empirical average earning of proposers and non-proposers. Optimal Investment refers to the empirically optimal investment level based on the empirical average earnings. *, **, and *** indicate statistical significances at the 10% level, 5% level, and 1% level, respectively.

By comparing the values across the treatments, we add a few more observations. First, the theory predicts that resource spending in the homogeneous treatments is smaller than that in the heterogeneous treatments, i.e., $e_h^* > e_l^* > e^*$. In the private treatments, the order appears as predicted, that is, $e_h^{Pri} \geq e_l^{Pri} > e^{Pri}$. In the public treatments, however, the subjects spent too many tokens when they were homogeneous, that is, $e^{Pub} \geq e_h^{Pub} > e_l^{Pub}$. Second, the empirically optimal level of investment is lower in the public treatments than in the private treatments. This is because the surplus was more equally distributed in the public treatments. Third, the degree of over-investment (i.e., (D)−(O)) is the smallest in PubHet. Because the empirically optimal level of investment reflects the empirical allocation of the surplus, this observation means that in PubHet where the surplus was more equally distributed, the efficiency loss due to the wasteful resource spending was lower. Also, it may suggest that subjects indeed took the bargaining outcomes into consideration when making the investment decision.

We test whether the actual investment level is statistically different from the empirically optimal level. In all subsamples except for the high-type of PubHet, they are statistically different at least 95% confidence level. Then, why did the subjects over-invest in the contest? Previous studies have attributed over-bidding in rent-seeking games to judgmental biases or a non-monetary utility for winning (see Dechenaux et al. (2015) for a more detailed discussion). Our experiment differs from the standard contest experiment in that the value of the prize (or the size of the rent) is not exogenously given but endogenously determined. Therefore, there might be a different incentive for over-bidding. More precisely, the resource spending in the contest might influence the bargaining outcome by changing the informal institutions (i.e., norms and beliefs) of what is fair and who deserves how much. Subjects might put more tokens in the contest than the optimal level, expecting it to be justifying their rent-seeking behavior when selected as the proposer. To study this issue, we regress the amount of tokens offered to a non-proposer on the amounts spent by himself/herself and by the selected proposer. Additionally, for the heterogeneous treatments, we include a dummy variable indicating whether the responder was a Blue (i.e., high-type) player. Table 5 reports the results.

Table 5: Amount Offered to a Non-proposer

	All	PubHom	PriHom	PubHet		PriHet	
				Blue	Non-Blue	Blue	Non-Blue
Own	0.0313	0.1062	-0.0303	0.1339	0.0994	-0.0289	0.0537
	(0.0347)	(0.1056)	(0.0676)	(0.1080)	(0.1030)	(0.0759)	(0.0415)
Proposer's	-0.4911***	-0.4918***	-0.5019***	-0.5026***	-0.5001***	-0.5002***	-0.5056***
	(0.0279)	(0.0633)	(0.0496)	(0.1277)	(0.0692)	(0.0899)	(0.0736)
Blue	-8.5803***				-11.403***		-18.185***
	(1.2354)				(2.3677)		(1.363)
R^2	0.2534	0.1837	0.1669	0.3115	0.3181	0.2589	0.4821
N	1530	390	390	140	250	132	228

The dependent variable is the amount of tokens offered to a non-proposer. Own is the amount of tokens spent in the proposer selection contest by the non-proposer, and Proposer's is that by the selected proposer. Blue is a binary variable indicating whether the non-proposer was a Blue (i.e., high-type) player. SEs are in parenthesis. *, **, and *** indicate statistical significances at the 10% level, 5% level, and 1% level, respectively.

The first column shows the results of the estimation with the entire sample, and the rest shows the results by treatment. Furthermore, for the heterogeneous treatments, we separate the sample with Blue proposers from that with Non-Blue (that is, Red and Green) ones. Note first that the proposers who invested more to win the competition assigned a smaller share for others and a greater share for themselves. Interestingly, such a tendency was very stable in all treatments regardless of whether their investment level is publicly observable or not. This suggests an entitlement effect: The proposers justify themselves compensating their own loss at the contest stage. Note also that the proposers do not offer more/less tokens to one who spent more at the contest stage for all treatments. This implies that the resource spending at the contest stage does not help non-proposers to be compensated by receiving a more generous offer.

Since the high-type player is offered zero surplus in SPNE, the coefficient of Blue is predicted to be negative, which is indeed the case in all subsamples.[13] However, the size of estimates differs substantially: In the private treatment, Blue player was offered on average 18.19 fewer tokens than the others (recall that the reservation payoff of Red and Green players was 15 tokens), whereas those in the public treatment was offered 11.4 fewer tokens. This means that the distribution of the surplus was more egalitarian in PubHet than in PriHet.

5.3 Proposal types

In the previous subsections, we find that the average amount of tokens taken by a proposer was significantly smaller than the theoretical benchmark in all treatments (see Figure 4), and the PubHet treatment involves the smallest resource spendings and the least unequal allocations. We further investigate how the remaining surplus was distributed *among the non-proposers*. One of the strong theoretical predictions is that the proposer will form a MWC that guarantees the just enough number of 'yes' votes for the proposal to be accepted, i.e., under the majority rule, the proposer offers an amount smaller than the reservation payoff or nothing at all to one of the three voters. We find experimental evidence strongly consistent with the theoretical prediction. Figure 5 shows the proportion of the MWC-type proposals. The MWC-type proposals are observed most frequently across all treatments. In all treatments, more than three quarters of the proposals were the MWC proposals, especially in the last five rounds.

Figure 6 shows what other types of proposals were made.[14] In PubHet, the proposal pattern of the subjects with the larger reservation payoff (i.e., Blue) was a bit different from that of the others, so we look at them separately. PubHet_H denotes the case where a Blue subject became the proposer, and PubHet_L denotes the other cases. We categorize the proposals in the following way:

- A *MWC* proposal allocates fewer tokens than the reservation payoff to one member. For example, $(p_R, p_G, p_B) = (100, 50, 0)$ excludes the Blue subject from the coalition to

[13] Similarly, Miller et al. (2018) report that the player with the highest reservation payoff was more likely to be excluded from a MWC in an infinite-horizon bargaining experiment.

[14] In total four proposals are not included in the pie charts as they are unclassified: Two proposals in PubHom offer both non-proposers who happen to spend the same amount of tokens for competition more than the reservation payoffs in an asymmetric manner, and one proposal in PubHom and one proposal in PubHet offer both non-proposers smaller than the reservation payoffs. Those proposals did not fit into our classification.

Figure 5: Proportion of MWC-Type Proposals (All, Last 5)

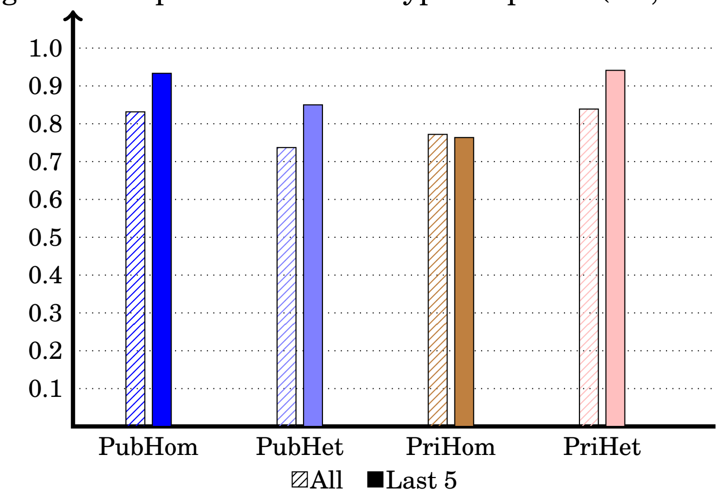
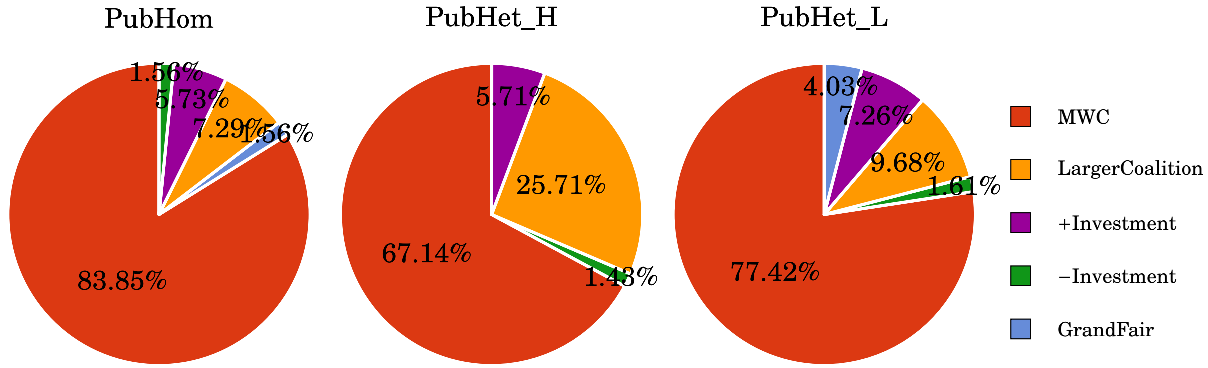


Figure 6: Proposal Types in Public Treatments



A MWC proposal allocates fewer tokens than the reservation payoff to one member. A GrandFair proposal divides the surplus (almost) equally. A LargerCoalition proposal allocates the same additional amount—but smaller than the proposer's— to the non-proposers' reservation payoffs. A +Investment proposal allocates more tokens to the non-proposer with the greater investment, and a −Investment proposal is defined in a similar manner.

pass the proposal.

- A *GrandFair* proposal divides the surplus equally or nearly so. Precisely, if the difference between the maximum and the minimum amounts is smaller than or equal to 6 tokens, for example $(p_R, p_G, p_B) = (52, 49, 49)$, we code such a proposal as GrandFair.

- A *LargerCoalition* proposal allocates the same "top-up" amount—but smaller than the proposer's— to both of the non-proposers. That is, if a proposer offers both non-proposers $v_i + x$, we call it LargerCoalition proposal. For example, $(p_R, p_G, p_B) == (70, 40, 40)$ in PubHom is coded as a LargerCoalition proposal. $(20, 20, 110)$ in PubHet when Blue is the proposer, and $(20, 80, 50)$ when Green is the proposer are also coded as LargerCoalition proposals.

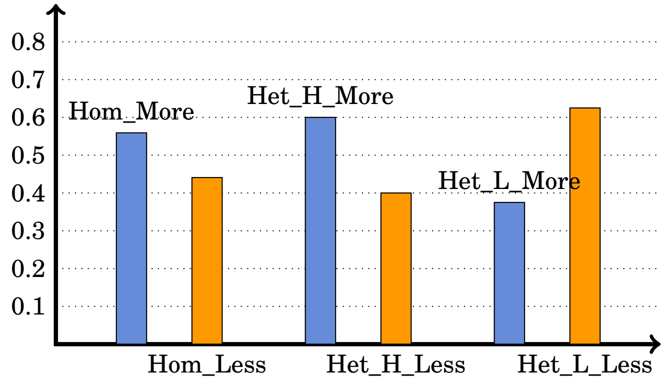
- A *+Investment* proposal allocates more tokens to the non-proposer with larger investment. For instance, if Red subject is the proposer and Green spent more than Blue did, $(p_R, p_G, p_B) = (70, 50, 30)$ is coded as +Investment.

- A *−Investment* proposal is defined similarly. For example, if Green spent more than Blue did, $(p_R, p_G, p_B) = (70, 30, 50)$ is coded as −Investment.

It turns out that LargerCoalition is the second-most frequent type of the proposals, and GrandFair and −Investment were the least popular ones. In addition, there is a noticeable difference between the behavior of Blue proposers in PubHet and that of the others: Blue proposers made MWC-type proposals less often and instead, LargerCoalition-type proposals were made more frequently. This is mostly because offering both of them more than the reservation payoff does not cost too much. Since the reservation payoff of the low type was 15 tokens, offering both members 15 tokens would cost the proposers 30 tokens in total, which is closer to 25 tokens, the reservation payoff of one member in the homogeneous treatments.

One may want to know whom a proposer would choose as a coalition partner if the proposer comes to know that one member spent more resource at the contest stage than the other member. The theory does not provide any prediction for the question of who should be the coalition member, but behavioral justification could work in both ways: On one hand, the proposer may want to infer from the investment levels how eager each member was to be a proposer and how demanding he/she will be. Since the one who spent more is likely to have a high reference point, the proposer may want to choose the member who spent less. On the other hand, the proposer may want to strategically exploit the fact that the member with the larger investment knows that he/she may lose even more unless included in the coalition. Or, the proposer may want to pick the one who spent more as a coalition member without any strategic consideration but simply out of compassion to compensate the loss of the member.

Figure 7: Choice of MWC Member in Public Treatments



Hom_More refers to the proportion of MWC members in PubHom who invested more than the other member. Het_H_More refers to the proportion of MWC members in PubHet who invested more than the other member, when the proposer was of high type.

In the previous subsection, we show that the offers to non-proposers are not affected by their own investment level (Table 5). This tendency is found again in the choice of the MWC member. Although proposers prefer to choose a member who spent more in the contest stage as a coalition member, no significant patterns were observed. Figure 7 shows the proportions of proposals which select the one who spent more as a coalition member and of those which select the other. Hom_More refers to the proportion of MWC members in PubHom who invested more than the other member. Similarly, Het_H_More refers to the proportion of MWC members in PubHet who invested more than the other member, when the proposer was of high type (i.e., Blue). In PubHet, the low-type proposers (i.e., Green and Red) chose the one who spent less at the contest stage, but this observation is compound because the one who spent more is more likely to be Blue whose reservation payoff is higher than the other non-proposer. In the public treatments, spending the tokens at the contest stage was beneficial in two—one distinct and one subtle—ways: It increased the chance to win the proposal right and marginally increased the chance to be included in the winning coalition.

5.4 Efficiency in Bargaining

To see under which condition the surplus can be shared at a lower cost, we construct two (in)efficiency measures, the aggregate spending at the contest stage and the probability of rejection at the bargaining stage.

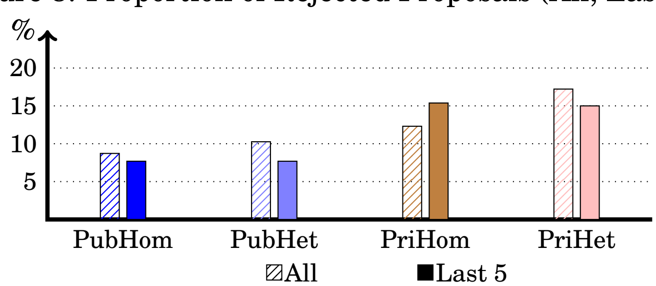
Let us first consider the aggregate investment. Recall that while the resources spent at the contest stage are wasted, at the bargaining stage, the entire surplus is shared among the players upon agreement. Therefore, $\sum_i e_i$ is the amount of the social cost that could have been avoided if the players collectively decided not to compete. Table 6 compares the empirical social cost to the theoretical benchmark.

Table 6: Aggregate Expenditure in the Proposer Selection Contest (in Tokens)

Treatment	Data	Theory	Data/Theory
PubHom	60.72	75	0.8096
PubHet	55.14	84.98	0.6488
PriHom	62.04	75	0.8272
PriHet	73.32	84.98	0.8628

The social costs due to the competition were lower than the benchmark in all treatments. It is worth noting that the data/theory ratio is particularly low in PubHet. PubHet is the treatment that involves the largest amount of the theoretical social cost, 84.98 tokens, but the actual expenditure was the lowest, even in level, among all the treatments, 55.14 tokens.

Figure 8: Proportion of Rejected Proposals (All, Last 5)



The rejection rate is another measure of (in)efficiency in that once a proposal was rejected, the total surplus shank down to a half. Recall that the sum of reservation payoffs was 75 tokens. Also, notice that the reservation payoffs in our model corresponds to the continuation values in an infinite-horizon bargaining model. Similarly, a rejection in this study is comparable with a delay in an infinite-horizon bargaining, which many previous studies have used as the measure of inefficiency. Figure 8 shows the proportion of rejected proposals by treatment. As predicted by theory, the vast majority of proposals were accepted. The rejection rate at the last five rounds was significantly lower in the public treatments than in the private treatment. This could also be related to the entitlement effect of the proposers: As shown in Table 5, the proposer who spent 1 additional token at the contest stage tends to offer 0.5 tokens less to the non-proposer. This behavior could be justified when the amount of resource spending is informed in the public treatments, but the proposer's rent-seeking behavior is less persuasive in the private treatments.

5.5 Individual Characteristics

In this subsection, we test whether the individual characteristics had any impact on the outcomes of the experiment. Table 7 reports some regression results. The dependent variable in the first regression is the amount of tokens spent at the contest stage. For the next two columns, the amount of tokens earned at successful bargaining is the dependent variable. To produce the second column, we use the sample of proposers, and for the third, we use that of non-proposers. Some explanatory variables are from the post-experiment survey. In the survey, we gave the subjects an option to disclose their age and gender. Familiarity is a subjective assessment of how familiar he/she was with experiments. The subjects' risk preferences were measured by the dynamically optimized sequential experimentation (DOSE) method (Wang et al., 2010), where we asked subjects to answer at most two questions, which enables us to categorize a subject into one of seven types in terms of risk preference. As control variables, we include treatment dummies, the investment level, and an indicator of "Blue player" in the heterogeneous treatments. In all regressions, Pub-Het is set to be the baseline treatment. Since the individual choices are positively correlated across rounds, cluster-robust standard errors at the individual level are used.

Age and familiarity did not make any significant impact on the investment decision or in bargaining. We found females and more risk-averse subjects spent a smaller amount of resources at the contest stage, and more risk-averse subjects tried to take a smaller amount of tokens in the bargaining stage. Comprehensibility of the experiment affected neither the investment level nor the bargaining behavior: We compared those who failed to pass the quiz at least once with those who passed the quiz on their first try, and no interesting differences were observed.

Table 7: Individual Characteristics

Dep.Var.	Investment	Tokens taken by a proposer	Tokens given to a non-proposer
Age	0.0538	-1.4922	0.0568
	(0.8046)	(1.1509)	(0.6111)
Gender	-3.2718**	2.0042	0.2150
	(1.4596)	(2.1239)	(0.9929)
Familiarity	-0.9947	-2.2009	-0.0043
	(0.8545)	(1.4257)	(0.7059)
Risk	-2.9176**	-5.4491***	0.5424
	(1.1735)	(1.8954)	(0.8684)
PubHom	3.8400**	-1.9808	-2.4865
	(1.9529)	(3.7311)	(1.7760)
PriHom	4.1965*	-0.0525	-4.6901***
	(2.3186)	(3.7961)	(1.6613)
PriHet	6.4141***	6.8738**	-7.3479***
	(2.0119)	(3.4695)	(1.6427)
Blue	2.0664*	1.1174	-10.348***
	(1.2122)	(2.4073)	(1.8264)
Investment		0.4097***	0.0584
		(0.0871)	(0.0433)
Clustered SE	Yes	Yes	Yes
Individual RE	Yes	Yes	Yes
R^2	0.0711	0.1701	0.0522
N	2295	673	1346

SEs are in parenthesis. *, **, and *** indicate statistical significances at the 10% level, 5% level, and 1% level, respectively.

6 Discussions

6.1 Conditions for efficient bargaining

PubHet is the treatment in which the social cost due to the competition was lowest, and at the same time, the surplus was least unequally distributed. PubHet is also one of two treatments of which rejection rate of the proposals was low. These findings are particularly interesting since the theory predicts that the social cost will be largest in the heterogeneous treatments. We again resort to an alternative explanation. For a starter, recall that when proposers' own resource spending at the contest stage is larger, they claimed to have more resources in the bargaining stage, and as a consequence, the distribution was more unequal. Thus, the information of others' expenses could be a factor that relaxes the competition for the proposal right, and in turn reduces the social cost. However, both the amount of over-investment (i.e., actual investment – empirically optimal investment) and the rejection rate in PubHom show that relaxing the competition was not always so straightforward. Then, how could PubHet, but not PubHom, be an environment facilitating efficient negotiations? We conjecture that the heterogeneity in reservation payoff helped coordination among the subjects.

Let us consider the following scenario. As documented in Brown (2011), the presence of a superstar (like Tiger Woods in golf) may discourage the other players from trying hard to win. Similarly, Blue subjects in the heterogeneous treatments were expected to make a greater amount of investment, thus to win the contest with a higher probability. Therefore, the other subjects might find that it was in their interest to let Blue subject win the contest with smaller investment, which in turn leads to a generous proposal to the non-proposers. This could improve everybody's welfare if successful. In such a sense, the subjects might be willing and able to form a gift-exchange relationship in which Red and Green subjects yielded up the proposal right, and in return Blue subject put a generous proposal to the vote. This might be a reason why LargerCoalition proposals were frequently offered by Blue proposers in PubHet. In the experiment, the public information might also facilitate forming such a gift-exchange relationship by making it easy to detect any significant deviation from the norm. Note lastly that even when such a relationship was successfully formed, it was not optimal for Red or Green subject to make no investment, because the rent for a non-Blue proposer was substantial.

6.2 Comparison to infinite-horizon bargaining

Since we often compare our design and results with those of infinite-horizon bargaining, one may wonder how exactly they can be compared. We designed the experiment to ensure a sufficient number of rejections because we were interested in using the rejection rate as a meaningful measure of inefficiency. Also, we wanted the heterogeneity of players in the relevant treatments to be non-trivial. For these purposes, we set the reservation payoffs much higher than the continuation values in the infinite-horizon bargaining game of Yildirim (2007). In the infinite-horizon game, the continuation value does not exceed 0.1, or 15 tokens in the context of the experiment even when the players are extremely patient, for example, when the discount factor, δ, is 0.99. This is because at the beginning of each round, subjects spend resources again to increase the chance to be a proposer in the new round. If we assume $\delta = 0.8$ as in many previous studies[15], the continuation value in the corresponding infinite-horizon bargaining game will be even smaller than 15 tokens. Because we assumed high reservation payoffs, the cost of rejecting a unfair proposal was rather low, and therefore, the high acceptance rate in our data is a strong result.

7 Concluding Remarks

In this paper, we investigate when the surplus is less unequally and less inefficiently distributed in multilateral bargaining with a proposer selection contest. Given the majority rule, when the reservation payoffs were heterogeneous and the amounts spent for the competition were publicly disclosed, the amount of resource wasted for competition was smallest, and the surplus was distributed in the least unequal manner, while more than 90% of proposals were accepted. In contrast, when the reservation payoffs were homogeneous, the public information of resource spending did not significantly help reduce the social costs.

We also find that in all treatments, the average amount of resource spent in the contest was lower than the theoretical benchmark. However, taking the generous proposals into consideration, we show that subjects actually spent too much at the contest stage. For all treatments, a proposer who had spent more at the contest stage claimed to have a greater share of the surplus, and when the resource spending is publicly known, the proposal is rejected less. Both evidence imply that subjects form a consensus that those who spent more

[15] For example, Agranov and Tergiman (2014), Fréchette et al. (2003), and Fréchette et al. (2012) used $\delta = 0.8$, Battaglini et al. (2012) used $\delta = 0.75$, and Kagel et al. (2010), Fréchette et al. (2005), and Miller et al. (2018) used $\delta = 0.5$ for some treatments.

at the contest stage are entitled to have more in the bargaining stage. This entitlement effect seems to be a major reason why subjects over-invested. The heterogeneous reservation payoffs, along with the public information on the resource spending, create a room for coordination among subjects, which eventually drive all of them better off. Policymakers who want to allocate the resources in a less unequal and less inefficient manner, may want to consider the rule of the bargaining similar to the public-heterogeneous treatment.

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Appendix: Omitted Proofs

Proof of Proposition 1: Given that all the $n-1$ players choose e^*, the equilibrium investment level under the q-quota voting rule would be

$$e^* = \arg\max_{e\in\mathbb{R}_+} -e + \frac{e}{(n-1)e^* + e}(1-(q-1)v) + \frac{q-1}{n-1}\frac{(n-1)e^*}{(n-1)e^* + e}v,$$

where the last term of the objective function is the expected payoff when the player is selected as one of $q-1$ coalition members. The derivative with respect to e is

$$-1+\frac{1-(q-1)v}{(n-1)e^*+e}-\frac{e(1-(q-1)v)}{((n-1)e^*+e)^2}-\frac{q-1}{n-1}\frac{(n-1)e^*v}{((n-1)e^*+e)^2}.$$

In symmetric equilibrium it must be equal to zero at $e=e^*$.

$$\frac{1-(q-1)v}{ne^*}-\frac{1-(q-1)v}{n^2e^*}-\frac{(q-1)v}{n^2e^*}=1.$$

Solving this, we obtain

$$e^*=\frac{n-1-n(q-1)v}{n^2}.$$

To calculate the expected payoff in equilibrium, plug e^* into the objective function so that we have

$$-e^*+\frac{1-(q-1)v}{n}+\frac{(q-1)v}{n}=\frac{1}{n}-e^*.$$

□

Proof of Proposition 2: The player with v_h chooses the investment level e_h with knowing that he will never be chosen as a coalition member.

$$e_h^*=\arg\max -e+\frac{e}{2e_l^*+e}(1-v_l)$$

The first order condition is

$$1=(1-v_l)\left(\frac{1}{2e_l^*+e_h^*}-\frac{e_h^*}{(2e_l^*+e_h^*)^2}\right)=\frac{(1-v_l)2e_l^*}{(2e_l^*+e_h^*)^2}. \tag{1}$$

Rearranging (1), we get

$$(2e_l^*+e_h^*)^2=(1-v_l)2e_l^*. \tag{2}$$

The player with v_l chooses the investment level e_l with knowing that they will be for sure selected as a coalition member when they are not selected as a proposer. Similarly, when the player is chosen as a proposer, he must choose the other player with v_l.

$$e_l^*=\arg\max -e+\frac{e}{e_l^*+e_h^*+e}(1-v_l)+\frac{e_h^*}{e_l^*+e_h^*+e}\frac{1}{2}v_l+\frac{e}{e_l^*+e_h^*+e}v_l$$

The first order condition is

$$1=(1-v_l)\left(\frac{1}{2e_l^*+e_h^*}-\frac{e_l^*}{(2e_l^*+e_h^*)^2}\right)-\frac{v_l}{2}\frac{e_h^*}{(2e_l^*+e_h^*)^2}-v_l\frac{e_l^*}{(2e_l^*+e_h^*)^2}. \tag{3}$$

Rearranging (3), we get

$$(2e_l^*+e_h^*)^2=(1-v_l)(e_l^*+e_h^*)-\frac{v_le_h^*}{2}-v_le_l^*. \tag{4}$$

Plugging (4) into (2),

$$\begin{aligned}&(1-v_l)2e_l^*=(1-v_l)(e_l^*+e_h^*)-\frac{v_le_h^*}{2}-v_le_l^*\\ \Leftrightarrow&(1-v_l)(e_h^*-e_l^*)=\frac{v_le_h^*}{2}+v_le_l^*\\ \Leftrightarrow&e_l^*=e_h^*\left(1-\frac{3}{2}v_l\right).\end{aligned} \tag{5}$$

Plugging (5) into (1),

$$(e_h^*(2-3v_l)+e_h^*)^2=(1-v_l)e_h^*(2-3v_l). \tag{6}$$

Solving (6) for e_h^*, we have

$$e_h^*=\frac{2-3v_l}{9(1-v_l)} \tag{7}$$

and with (5),

$$e_l^*=\frac{(2-3v_l)^2}{18(1-v_l)} \tag{8}$$

In equilibrium, the expected payoff for the player with v_h is $\frac{e_h^*}{2e_l^*+e_h^*}(1-v_l)-e_h^*=\frac{1}{3}-e_h^*$ and that for the player with v_l is $\frac{e_l^*}{2e_l^*+e_h^*}(1-v_l)+\frac{e_l^*}{2e_l^*+e_h^*}v_l+\frac{e_h^*}{2e_l^*+e_h^*}\frac{v_l}{2}-e_l^*=\frac{1}{3}-e_l^*$. □

Proof of Proposition 3: $e_l^*>e^*$ if

$$\frac{(2-3(v-\alpha))^2}{18(1-v+\alpha)}>\frac{2-3v}{9}.$$

Multiplying by $18(1-v+\alpha)$, we have

$$(2-3(v-\alpha))^2>(2-3v)(2-2v+2\alpha).$$

Rearranging with respect to α,

$$9\alpha^2 + (8 - 12v)\alpha + 3v^2 - 2v > 0.$$

When $\alpha = 0$, the inequality doesn't hold since $3v^2 - 2v < 0$. The inequality holds if $\alpha < \frac{6v-4-\sqrt{(3v-8)(3v-2)}}{9} < 0$ or $\alpha > \frac{6v-4+\sqrt{(3v-8)(3v-2)}}{9} > 0$, but we restrict our attention to the positive domain.

Next we want to show $\frac{6v-4+\sqrt{(3v-8)(3v-2)}}{9}$ is strictly smaller than v, so the range of such α is well defined.

$$\begin{aligned}
&\frac{6v - 4 + \sqrt{(3v-8)(3v-2)}}{9} < v \\
\Leftrightarrow\, & 6v - 4 + \sqrt{(3v-8)(3v-2)} < 9v \\
\Leftrightarrow\, & \sqrt{(3v-8)(3v-2)} < 3v + 4 \\
\Leftrightarrow\, & (3v-8)(3v-2) = 9v^2 - 30v + 16 < 9v^2 + 24v + 16 = (3v+4)^2.
\end{aligned}$$

□

Appendix B: Sample Instructions

Sample Instructions for PubHom

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 Euros at the rate of €0.015/token. (The server computer will calculate the final payment. Please don't worry about this calculation.) In the beginning, you are endowed with 400 tokens.

There will be a quiz after the instructions, to make sure you understand how the experiment works.

Overview:

The experiment consists of 15 group decision-making 'rounds'. In each round, you and two other subjects will receive 150 tokens as a group, and decide how to divide the 150 tokens. The details follow.

How the groups are formed:

In each round, all subjects will be randomly assigned to groups of three. For example, if there are 21 subjects in this lab, there will be seven groups of three subjects. There will be no physical reallocation. Only the server computer knows who are grouped with whom. That is, in any round you will not know who your group members are. Your group members will not know you either.

Each member of the group will be assigned a color (Red, Green, or Blue) as an ID, which will be displayed on the top of the screen.

Once the round is over, everyone will be randomly re-assigned to a new group of three, and will be randomly assigned a new color ID for the next round. The group and color ID assignments are purely random: No previous happenings will affect the random assignments whatsoever.

How the tokens are divided:

Each round consists of (1) a proposer selection stage, (2) a proposal stage, and (3) a voting stage.

(1) Proposer Selection: A server computer will determine the proposer. Every member in the group can spend up to 40 tokens to increase the chance to be the proposer in the current round: The more tokens you spend, the larger chance you could have. Specifically, your probability of being a proposer is the following ratio:

$$\frac{\text{the number of tokens you spent}}{\text{the total number of tokens your group spent}}.$$

For example, if Blue spent 2 tokens and Red and Green spent 1 token each, Blue will be the proposer with 50% of chance, and the other two will be the proposer with 25% of chance each. If Green spent 1 token but the other two didn't spend tokens, Green will be the proposer for sure. If no one spends any token, each one's chance will be the same as 1/3. You will know who the proposer for the round is, as well as know how many tokens each member spent.

(2) Proposal: If you are selected as a proposer, you will make a proposal to divide 150 tokens. You can allocate 0 tokens to some members, but all allocations must add up to 150 tokens. If you are not selected, you will wait until the selected member submits his/her proposal.

(3) Voting: The proposal will be voted on by all members in the group. If the proposal gets 2 or more votes, it is accepted: Members will earn tokens according to the proposal, and move on to the next round. If the proposal is rejected, that is, gets 1 vote or less, each member in your group will earn 25 tokens and move on to the next round.

In every new round, your new group will repeat the processes above: (1) proposer selection, (2) proposal, and (3) voting. Please note that tokens spent in the previous rounds are NOT counted. If you want to increase the chance of being a proposer for the current round, you should spend tokens again.

Summary of the process:

1. The experiment will consist of 15 rounds.

2. Prior to each round, all subjects will be randomly assigned to groups of three members. Each member of the group will be assigned a color (Red, Blue, or Green) as an ID.

3. In the proposer selection stage, spending tokens increases the probability of being a proposer. You may decide to spend 0 to 40 tokens. If no one spends any token, one will be randomly selected, with equal probability. You will know who spent how much.

4. In the proposal stage, a selected member will submit a proposal to divide 150 tokens.

5. In the voting stage, if 2 or 3 members in the group accept the proposal, members will earn tokens according to the proposal, and move to the next round. If the proposal is rejected, then each group member will earn 25 tokens and move to the next round.

Quiz for PubHom

Q1. In each round, you will be assigned to a group of (A) members. Each group will decide how to divide (B) tokens. What are (A) and (B)?

Q2. Suppose that in round 1, your color is Blue, and Green is selected as a proposer. Which of the followings is NOT true?

   1. If Green's proposal is rejected, each of the group members earns 25 tokens.
   2. Even if I reject Green's proposal, it could be accepted if Green and Red accept it.
   3. In the next round, my color must be Blue again.

4. In round 2, I will have new group members and a new color ID.

Q3. In each round are 150 tokens. Which of the following proposals is NOT feasible?

1. Red: 100 // Blue: 100 // Green: 100
2. Red: 100 // Blue: 50 // Green: 0
3. Red: 50 // Blue: 50 // Green: 50
4. Red: 25 // Blue: 25 // Green: 100

Q4. Suppose you are Blue, you spent 4 tokens, Red spent 1 token, and Green didn't spend any token. What's your probability of being a proposer?

Q5. Suppose you are Blue, you spent 5 tokens, Red spent 2 tokens, and Green spent 13 tokens. What's your probability of being a proposer?