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RESEARCH ARTICLE

Recognition probability in legislative bargaining

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Abstract

In legislative bargaining, the proposer is often able to extract a greater proportion of the surplus. However, a higher likelihood of being selected as the proposer can backfire, as it may reduce the probability that the agent is included in a winning coalition. We experimentally test the theoretical prediction of potentially negative returns to recognition probability in two-period legislative bargaining noted in Baron and Ferejohn (1989). We find that higher recognition probability benefits subjects in all treatments, except one in which we automate the second period. It is because proposers often favor the member with the greater recognition probability as a coalition partner, and such tendency varies depending on the proposer's recognition probability, counter to the theoretical prediction. In all treatments, a vast majority of subjects exhibit a strict preference for higher recognition probability.

Keywords: legislative bargaining; recognition probability; laboratory experiment

JEL codes: C72; C78; C92

Introduction

Our paper studies an environment in which agents must bargain over a fixed surplus in the presence of a deadline. This specification is relevant, for instance, when countries bargain over international agreements. Brexit negotiations, which were multilateral and occurred under a tight deadline, represent a particularly salient example. Negotiations over the division of a country's budget also usually take place with known deadlines. Yet another example is the negotiations undertaken by firms with labor unions, which sometimes occur under the threat of an impending strike.

The canonical model of legislative bargaining is Baron and Ferejohn (1989) (hereafter referred to as BF). This model has been informative and influential in

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understanding bargaining across a myriad of political contexts ranging from the UN Security Council to the allocation of resources within a community. Within this framework, one of the key attributes that an agent possesses is the likelihood with which she gets to set the agenda (i.e., propose a distribution of the budget), also known as recognition probability.

Once an agenda is set, all members of the committee vote for or against it. If a majority votes yes, the agenda is enacted, and payoffs are realized; otherwise, the game continues. In two-period legislative bargaining, if no agenda is enacted at the end of the second period, all agents receive a payoff of zero. The theoretically optimal agenda is to form a minimal winning coalition, that is, one that offers positive allocations only to those agents from whom the agenda setter requires an affirmative vote. The agenda setter can exploit her position to ensure a higher payoff for herself. However, in the BF setup, having a higher recognition probability can also make the endowed agent less likely to become part of a minimal winning coalition formed by agents other than herself, because an agent with a high recognition probability would also demand more allocation for her vote. This means that recognition probability can act as a double-edged sword. As noted in BF in the two-period, three-player case, higher recognition probability can result in a discontinuous decrease in the expected payoff of agents. Power derived from other sources such as vote share or disagreement values have similar tensions and can result in similar negative returns.

Given the wide applicability of the BF setup, numerous experiments have tested different predictions of the BF model. However, many of those experiments focus on the infinite-period case, where the returns to higher recognition probability are predicted to be non-decreasing (Eraslan, 2002). Most experiments also assume symmetric recognition probability, which is not appropriate to test for the potentially adverse effect that higher recognition probability could have. Although most qualitative predictions of the BF model find support in these experiments, another robust finding is that the proposer offers more than the theory predicts (Baranski and Morton, 2022). Given that the negative value of recognition probability critically hinges on the proposer choosing a coalition partner that allows maximal rent extraction, such generous offers raise the question of whether the proposer would necessarily choose the coalition partner with the smaller recognition probability. Furthermore, the behavioral inconsistency with backward induction that is commonly found in finite several-period BF bargaining such as Diermeier and Morton (2005) naturally necessitates an experimental setup that minimizes concerns such as subjects' cognitive limitations and strategic uncertainty. Our shorter, two-period setup allows us to test for the phenomenon of negative returns to recognition probability under minimal concerns, and we add treatments to test the influence of non-equilibrium behavior within the multi-period bargaining environment. To the best of our knowledge, this paper is the first with a setup that facilitates and focuses on the study of potentially negative returns to recognition probability in the laboratory.

We design and conduct an experiment that consists of four treatments. Our baseline treatment implements a two-period BF game, the simplest setup that allows us to test whether the theoretical prediction of negative returns to recognition probability holds in the lab. We group subjects into sets of three and endow them with, respectively, 36%, 33%, and 31% probabilities of being recognized as the proposer. The BF model predicts expected payoffs that decrease in recognition probability under those parameters. Random re-matching allows us to study the theoretical prediction of this setup while avoiding the strategic concerns associated with reputation and repeated play. In the second half of the 30-round experiment, we elicit the subject's preference for recognition probability through a novel incentive-compatible mechanism in which they pay money to increase the likelihood of being assigned their preferred recognition probability.

In the second treatment, we increase the asymmetry in recognition probability in the second bargaining period while keeping the same ordering of expected payoffs between the players with the highest and second-highest recognition probabilities. This treatment is intended to provide stronger disincentives for suboptimal coalition partner choice due to approximation. Motivated by the previous experimental findings of failure of backward induction predictions in bargaining and other strategic interactions, our third treatment effectively reduces the two-period bargaining to a single-period by automating equilibrium play in the second period. In particular, if a group rejects the proposal in the first period, the full budget is allocated to one agent, who is chosen at random according to the recognition probabilities. The fourth treatment, by automating the equilibrium payoff-maximizing votes, but not proposals, specifically rules out the rejection of offers not predicted by backward induction. As in the baseline treatment, we elicit preferences for recognition probability in the second half of all treatments.

Contrary to the theoretical prediction of a negative value of recognition probability in all treatments,[1] we find that higher recognition probability results in higher payoffs for agents, in all treatments except that with second-period automation. Despite the lower payoff for the highest recognition probability in comparison to the middle recognition probability in this exceptional treatment, a vast majority of subjects pay money to secure the highest recognition probability in all treatments. Further analyses show that the proposers often favor the member with the greater recognition probability as a coalition partner, and such tendency varies depending on the proposer's recognition probability. As a result, members with the lower recognition probabilities are not more likely to be included in the winning coalition. In the treatment with second-period automation, the member with the middle value of recognition probability is the most likely to be included, which explains her high mean allocation in the treatment.

Because the BF model is widely used in political economy, we deem it crucial to understand subject behavior in a simple two-period version of this game that has stark predictions regarding the negative returns to recognition probability. This paper, to the best of our knowledge, is the first to test the hypothesis that higher recognition probability can hurt subjects in the two-period BF game. We also allow subjects to pay for changing their likelihood of being assigned particular roles, and optimally, subjects should pay money to be allocated lower recognition probability. In light of recent papers such as Pikulina and Tergiman (2020), it is crucial to understand if subjects will pay money to have less power.

[1]In the second treatment, in which the second-period recognition probability is modified, the equilibrium prediction is that the agent with the middle recognition probability should have the highest expected payoffs. In all other treatments, theory predicts that the agent with the lowest recognition probability earns the most, while the agent with the highest recognition probability earns the least.

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Related literature

The workhorse model for legislative bargaining is developed in Baron and Ferejohn (1989) (BF), which in turn builds upon the political structure of Romer and Rosenthal (1978), and the equilibrium structure in Rubinstein (1982). For the infinite-horizon BF bargaining model, Eraslan (2002) shows that the stationary subgame perfect equilibrium (SSPE) payoffs are non-decreasing in recognition probability. In particular, given any distribution of recognition probabilities, the agent with a greater recognition probability earns a (weakly) higher expected payoff than the agent with a smaller recognition probability. On the other hand, we experimentally test the opposite prediction that, in finite-horizon bargaining that is otherwise similar to the Eraslan (2002) setup, the agent with a greater recognition probability might earn a strictly lower equilibrium payoff. Montero (2022) shows that, in infinite-horizon bargaining, an agent might increase her SSPE payoff by donating part of her recognition probability to another agent. The reasoning behind this result is similar to the one that underlies our finite-period prediction; the donation reduces the donor's continuation value relative to the other agents, which increases the donor's chance of inclusion in the winning coalition. Other theoretical studies that investigate the value of recognition probability include Plott and Levine (1978), Bendor and Moe (1986), Knight (2005), and Sethi and Verriest (2020).

Our study belongs to the substantial body of experimental literature that tests the theoretical predictions of the Baron-Ferejohn model. Our experiment confirms many common patterns in previous experiments, as identified in Baranski and Morton (2022)'s meta-analysis: experienced subjects propose minimal winning coalitions and reach an agreement without delay as predicted, although the within-coalition allocations are more equal than predicted.

Despite the large number of BF bargaining experiments, to the best of our knowledge, no existing study addresses the potentially negative value of recognition probability or provides a suitable setup to test that hypothesis. A majority of BF bargaining experiments focus on infinite-horizon cases (McKelvey, 1991; Fréchette et al., 2003, 2005a, 2005b, 2005c; 2009; Miller et al., 2018), which are irrelevant to the negative value prediction. Our baseline treatment considers the minimal number of periods within finite multi-period bargaining (i.e., two-period) to minimize dynamic inconsistency caused by a longer horizon (J. G. Johnson and Busemeyer, 2001). Miller and Vanberg (2015), Diermeier and Morton (2005), Drouvelis et al. (2010), and Miller and Vanberg (2013) respectively study 4-, 5-, 20-, and 22-period bargaining, and most of them assume only symmetric recognition probability. The asymmetric recognition probability assumed in Diermeier and Morton (2005) does not allow us to test our negative value hypothesis. Other experimental studies consider asymmetric disagreement value or voting weight. Diermeier and Gailmard (2006) and Kim and Kim (2022) show that a high disagreement value might induce unfavorable offers from other agents, which can result in lower expected payoffs (Miller et al. 2018). Maaser et al. (2019) find that inexperienced subjects' bargaining behavior is sensitive to the nominal differences in voting weights, when there is no difference in real bargaining power defined by pivotality.

The design of our other experimental treatments is motivated by the findings from previous experiments on bargaining and extensive form games. For example,

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our implementation of the reduced-form, single-period equivalent of the two-period bargaining is motivated by the failure of backward induction observed in various experimental contexts (McKelvey and Palfrey, 1992; Busemeyer et al., 2000; Costa-Gomes et al., 2001; J. G. Johnson and Busemeyer, 2001; E. Johnson et al., 2002). In particular, compared to the subjects in multi-period bargaining experiments, such as Diermeier and Morton (2005), the subjects in single-period bargaining experiments (Kim and Kim, 2022; Diermeier and Gailmard, 2006) seem more likely to make favorable offers to members with lower continuation values as predicted by the BF model – a pattern crucial to attaining the negative value of recognition probability. By directly comparing the baseline and the single-period treatment, we intend to determine the share of non-equilibrium outcomes and behavior that can be attributed to the multitude of interactions. Similarly, our Automated Vote treatment was designed to rule out the frequent rejection of offers above their continuation value by the non-proposer, a commonly observed behavior in bilateral bargaining (e.g., Güth and Tietz, 1985; Ochs and Roth, 1989; Forsythe et al., 1994) as well as multilateral bargaining.

Finally, our elicitation of subjects' preference for recognition probability in our paper relates to theoretical and experimental studies that endogenize recognition probability, for example, through contests (Baranski and Reuben, 2023; Kim and Kim, 2022; Yildirim, 2007, 2010), all-pay auctions(Ali, 2015), voluntary contribution (Baranski, 2016), and history dependence in recognition probability (Yildirim, 2010; Agranov et al., 2020). In bilateral bargaining, Güth and Tietz (1986) find that paying for proposal rights makes the subjects' bargaining behavior closer to the theoretical prediction. We also relate our finding of suboptimal investment in high recognition probability to an intrinsic preference for power/decision rights documented in previous experiments (Bartling et al., 2014; Pikulina and Tergiman, 2020).

Model

We consider a two-period, three-player version of the BF model with a simple majority rule. The players, indexed in decreasing order of their recognition probability, $i \in \{1, 2, 3\}$, must divide a budget of b among themselves. Let X denote the set of feasible allocations, that is, $X = \left\{x \in \mathbb{R}^3_+ : \sum_{i=1}^3 x_i \leq b\right\}$, where x_i is the amount allocated to player i. Each player's utility is simply the amount allocated to her. The players are assumed to be perfectly patient, with a discount factor equal to one.

Each player gets recognized in either period according to her recognition probability $p_i^t \in [0, 1]$. In each period, we require that the recognition probabilities add up to one. $\sum_i p_i^t = 1$ for all $t \in \{1, 2\}$. Note that we allow agents to have different recognition probabilities in each period. However, we require that the order of the recognition probabilities in either period is descending according to the index of the player, that is, $p_3^t < p_2^t < p_1^t$ for each $t \in \{1, 2\}$. We denote the profile of recognition probabilities in the two periods as $p = (p_i^1, p_i^2)_{i \in \{1,2,3\}}$.

The timing of the game is such that in each period, one agent is selected randomly according to her recognition probability to propose a feasible allocation. All players vote for or against the proposal. A proposal is accepted if and only if it receives at least two affirmative votes. If a proposal is accepted, all players receive the allocation proposed for them, and the game ends. If a proposal is not accepted in the first period, the process is repeated in the second period. If a proposal is not accepted in the second period, the game ends with all players receiving a payoff of zero.

The solution concept we use is proposer-optimal subgame perfect equilibrium.[2] In the second period, a player is chosen according to the recognition probability distribution, $\left(p_1^2, p_2^2, p_3^2\right)$, to propose a division of the budget, b. If that proposal is voted in by a majority of players, the allocations are disbursed and the game ends. If the proposal fails to receive the required votes, all agents receive zero and the game ends. In the second period, the unique proposer-optimal subgame perfect strategy is for an agent to vote to accept any proposal. The proposer in the second period would optimally allocate herself the full budget and offer the other agents zero.[3] In the second period, then, it is clearly valuable to be endowed with higher recognition probability. After the first period ends (assuming the proposal is rejected in the first period), and before the second period begins, each player's continuation value is $p_i^2 b$.

Since the agents are risk-neutral, in the first period, no agent would vote for a proposal that offers her less than $p_i^2 b$. The proposer in the first period needs only one vote other than her own in order to get her proposal passed. Therefore, the dominant strategy in the first period is for the proposer to offer the amount $p_i^2 b$ to the non-proposing agent with the lower recognition probability, and to offer zero to the non-proposing agent with the higher recognition probability. The optimal minimal winning coalition is, therefore, the coalition between the proposer and the non-proposing agent with the lower recognition probability.

This tension clearly highlights the dual nature of the value of recognition probability. It endows the agent with a higher continuation value, but it also may make the agent a less popular coalition partner. Based on the strategies described above, we can calculate the expected payoffs of the agents as a function of their recognition probabilities in each period.

$$V_1(p) = \left[p_1^1 \cdot \left(1 - p_3^2\right) + p_2^1 \cdot 0 + p_3^1 \cdot 0\right] \cdot b \tag{1}$$

$$V_2(p) = \left[p_1^1 \cdot 0 + p_2^1 \cdot \left(1 - p_3^2\right) + p_3^1 \cdot p_2^2\right] \cdot b \tag{2}$$

$$V_3(p) = \left[p_1^1 \cdot p_3^2 + p_2^1 \cdot p_3^2 + p_3^1\left(1 - p_2^2\right)\right] \cdot b \tag{3}$$

As is evident in the equations above, the equilibrium prediction is that the game ends in the first period. If player 1 is selected as the proposer, which happens with probability p_1^1, she offers $p_3^2 \cdot b$ to player 3 and nothing to player 2. Similarly, if player 2 is selected as the proposer, she offers $p_3^2 \cdot b$ to player 3 and nothing to player 1. Finally, the chance that player 3 is selected as the proposer is p_3^1, and, as the proposer, she offers $p_2^2 \cdot b$ to player 2 and nothing to player 1. In each case, the proposer allocates the residual amount to herself.

[2]If the budget is perfectly divisible, the subgame perfect equilibrium is unique, requiring proposer optimality allows us to select a unique equilibrium if the budget is not perfectly divisible.

[3]Any offer of $\varepsilon > 0$ would be strictly preferred by each of the non-proposing agents. Therefore, the limiting allocation (as $\varepsilon \to 0$) for the proposing agent is b (the complete budget).

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Negative returns to recognition probability: From the expected payoff calculated above, it is easily shown that the returns to recognition probability need not be positive for the entire parameter space. For some parameter values, the effect on expected payoffs can be negative. For instance, suppose that the recognition probability of agents is constant over time, that is, $p_i^1 = p_i^2 = p_i$ for all $i \in \{1, 2, 3\}$. Then $V_1(p) < V_2(p) < V_3(p)$ simply implies that $p_1(1 - p_3) < p_2 < p_3(1 + p_1)$, which can hold for a substantial subset of parameters.[4] The simplicity of these expected payoffs and the simple conditions for negative returns are due to the fact that we are considering a two-period game. Similar non-monotonic returns may exist in other finite-period versions of the BF model; however, with more periods, calculating the expected payoffs and evaluating the non-monotonicities in returns gets exponentially more difficult.[5] The potentially negative returns to recognition probability in this setup were first noted in Baron and Ferejohn (1989). Therefore, even though the BF model is primarily about the infinite-period version of the game, we refer to this result of non-monotonic returns to recognition probability as the **BF prediction**.

Experiment design

The experiment was conducted at the Center for Research in Experimental Economics and Political Decision-making at the University of Amsterdam. A total of 198 subjects recruited from the student subject pool participated in eight experimental sessions. Table 1 shows the number of subjects in each session. The experiment was coded on Otree (Chen et al., 2016) based on the codes written by Nunnari (2019).

The experiment has a between-subject design with four treatments: Baseline, Modified Period 2, Automated Period 2, and Automated Vote treatments.

Baseline treatment

Each session in the baseline treatment is divided into two parts, each consisting of 15 bargaining rounds (i.e., 15 repetitions of the experimental game). Each bargaining round consists of up to two proposal periods.

At the beginning of each round, subjects are randomly assigned to groups of three members. In each group, the members are randomly assigned three roles that are labeled as colors – green, orange, or purple – as well as recognition probabilities – 36%, 33%, or 31%.[6] The subjects are shown their own assigned colors

[4]See Appendix A for a graph depicting this region.

[5]In the two-period model, this non-monotonicity occurs around a recognition probability of one-third. This is because, if all players have a recognition probability equal to one-third, then each of them expects to receive one-third of the surplus ex-ante. If one of the players is endowed with slightly more recognition probability, her continuation value at the beginning of the second period becomes slightly larger, but that discontinuously reduces her likelihood of being in the winning coalition. Such a tension likely exists in finite-period models with greater time horizons, but it is more tedious to calculate.

[6]We refer to the player assigned the highest recognition probability as player 1. Player 2 has the middle recognition probability, while player 3 has the lowest recognition probability.

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Table 1. Number of subjects

Treatment	Session 1	Session 2	Total
Baseline	27	21	48
Modified Period 2	27	27	54
Automated Period 2	24	24	48
Automated Vote	24	24	48
Total			198

and recognition probabilities, but they do not see any identifying information for the other members.

In each proposal period, all three members submit a proposal on how to allocate €60 among the three members. The allocated amounts should be in whole euros and should add up to €60. Once all members submitted their proposals, one of the group members is randomly selected according to the recognition probability. Only the recognized member's proposal and identity (shown as her color label) are revealed to the three members of the group. Then, the three members vote for or against the proposal. A proposal is accepted if two or more members vote for the proposal. Otherwise, the proposal is rejected.

If a proposal is accepted in the first proposal period, then the bargaining round is over and the proposed allocation is implemented. If a proposal is rejected in the first proposal period, then the group moves on to the second proposal period, in which each of the three members submits a proposal again. One member is newly recognized at random according to the recognition probabilities, and the group votes again. If a proposal is accepted in the second proposal period, then the bargaining round is over and the accepted proposal is implemented. If a proposal is rejected in the second proposal period, then the bargaining round is over and all three members get €0.

Once all members vote, the subjects are shown the identity of the proposer, the recognized member's proposed allocation, each member's vote, and the resulting allocation, if applicable. The same information for all past bargaining rounds is summarized on a history table, which is displayed on all screens that require the subject's decision. After each bargaining round is over, the subjects are randomly re-assigned to three-member groups for the next bargaining round. In any of the first 15 bargaining rounds, the ex-ante expected payoff according to the proposer-best subgame perfect equilibrium of the game is such that $V_1 = 14.90$, $V_2 = 19.80$, and $V_3 = 25.30$. The predicted allocations are illustrated in Table 2 below.

In the first part of the experiment, the subjects play 15 bargaining rounds. In the second part, they play another 15 bargaining rounds. The subjects are notified at the beginning of the experiment that there will be a second part with another 15 rounds of bargaining (and with a new set of instructions). No other information is given to the subjects about the second part of the experiment.

The 15 bargaining rounds in the second part are identical to those in the first, except for a short procedure added at the beginning of each round. This novel procedure is designed to elicit the direction of subjects' preference for recognition

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Table 2. Predicted allocations in baseline treatment

		Allocations		
		Player 1	Player 2	Player 3
Proposer	Player 1	41.40	0	18.60
	Player 2	0	41.40	18.60
	Player 3	0	19.80	40.20
Ex-ante expected		14.90	19.80	25.30

probability while minimizing strategic concerns. It endogenously determines the assignment of the three roles in each group. More specifically, each subject receives an endowment of €1 and is shown the recognition probability associated with each role (labeled by color). Then, the subject is asked to indicate her preferred role and the amount that she would like to pay out of the €1 endowment (in increments of €0.10) to increase the likelihood of being assigned the role that she prefers.

All three members indicate their preferred roles and the amounts they would like to pay. However, only one member is selected at random, and the selected member's indication determines the role assignments within the group. The three members are equally likely to be selected. If the selected member chooses to pay €0, all three roles are randomly assigned to the selected member with equal probabilities. Every additional €0.10 the selected member pays increases the likelihood of her preferred role being assigned to her by 1/15. If the selected member chose to pay €1, she is assigned her preferred role with certainty. In any case, the two roles not assigned to the selected member are assigned to the two remaining members with equal probability.[7] For that round, the selected member pays the amount she indicated, whereas the other two members keep the entire €1 endowment.

To clarify, the procedure described above is not an auction or a contest for recognition probability. When the member is not selected in this procedure, her choice of role and payment is irrelevant. If a member chooses to pay nothing towards role allocation and is then selected to influence the allocations, she is allocated any of the three roles with equal probability. Her expected continuation value (outside of the €1 endowment) will be exactly €20 in this case. If the selected member had chosen to pay the whole €1 towards her preferred role, she would have earned the continuation value associated with that role. Therefore, it is optimal for each member to pay the whole €1 to be allocated the role that offers the highest continuation value if that continuation value is at least €21. If no role offers a continuation value of at least €21, then it is optimal for the member to pay 0 towards role allocation. In other words, the procedure incentivizes the subjects to express

[7]The subjects indicate the amount to pay on a slider that appears only when clicked. Whenever a subject moves the slider up or down, she can see the currently chosen amount and the (updated) corresponding likelihood of each role being assigned to her. The chosen amount on the slider is submitted only when the subject clicks the next button.

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their preference for recognition probability without facing the strategic concerns present in bid/effort choices in auctions or contests.[8]

The proposer-best subgame perfect equilibrium predicts that the continuation values for each role (outside of the €1 endowment) are $V_1 = 14.90$, $V_2 = 19.80$, and $V_3 = 25.30$ in all treatments other than the Modified Period 2 treatment. In these treatments, paying the entire endowment of €1 for the role with the smallest recognition probability (role 3) is the dominant strategy. Conditional on being selected for paying, this strategy yields an expected continuation value of €25.30, whereas paying €0 allows the member to keep the €1 endowment but results in an expected continuation value of €20.

At the end of the experiment, one of the 30 bargaining rounds is randomly selected for all subjects, with equal probability. The subjects are paid in cash a €10 participation fee in addition to the payoff they earned in the randomly selected round: the allocation from the bargaining plus any remaining endowment from that round, if applicable.

Modified Period 2 Treatment

Modified Period 2 Treatment is identical to the baseline treatment except that the recognition probabilities in the second period differ. In particular, the three members in each group are assigned the following recognition probabilities:

- 36% in period 1 and 70% in period 2
- 33% in period 1 and 26% in period 2
- 31% in period 1 and 4% in period 2

These recognition probabilities provide stronger incentives for the proposer to form a minimal winning coalition with the player who has the lowest recognition probability.

Using the equations described in "Model," we find that the equilibrium continuation values for each role are $V_1 = 20.74$, $V_2 = 23.84$, and $V_3 = 15.42$. The predicted allocations are provided in Table 3 below. Following similar reasoning, paying the entire endowment of €1 for the role with the middle recognition probability is the dominant strategy in this treatment.[9]

Automated *Period 2 Treatment*

Automated Period 2 Treatment is identical to the baseline treatment except that the second proposal period is automated according to the equilibrium prediction. If a group moves onto the second period by rejecting the proposal in the first, one of the three members is randomly selected according to the recognition probability (36%, 33%, 31%). The selected member receives the entire €60, whereas the other two

[8]The €1 endowment is intentionally low in comparison to the budget (€60) that subjects bargain over, as this procedure is designed to elicit the direction, rather than magnitude, of subjects' preference for recognition probability.

[9]If one pays €0, the expected continuation value is €20. If one pays €1, the expected continuation value is €23.84.

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Table 3. Predicted allocations in Modified Period 2 treatment

		Allocations		
		Player 1	Player 2	Player 3
Proposer	Player 1	57.60	0	2.40
	Player 2	0	57.60	2.40
	Player 3	0	15.60	44.40
Ex-ante expected		20.74	23.84	15.42

members receive 0 for that round. Here, the continuation values are identical to those in the baseline treatment (see Table 2), and it is optimal for members to pay the full 1 to increase their likelihood of being allocated the lowest recognition probability.

Automated *Vote Treatment*

Automated Vote Treatment is identical to the baseline treatment except that rational votes are automated according to the equilibrium prediction. In the first period, a computer votes in favor of a proposal on behalf of a member only if the proposed allocation to the member is greater than or equal to the member's continuation value. Otherwise, the computer votes against the proposal. In the second period, the computer votes yes to any proposal. Again, the continuation values are identical to those in the baseline treatment, and it is optimal for members to pay the full €1 to increase their likelihood of being allocated the lowest recognition probability. Table 2 notes the predicted allocations.

The experiment instructions in Appendix E tell the subjects that a computer will vote on behalf of each member of the group in a way that maximizes the member's expected payoff, assuming that each member makes profit-maximizing proposals in any period.[10] The instructions explicitly state that the computer will vote yes to any proposal in the second period.

Hypotheses

Let V_1, V_2, and V_3 denote the expected payoffs of the members with the high, middle, and low recognition probability respectively. We test the following hypotheses:

H1 (Negative value of recognition probability)

a. In Baseline treatment: $V_1 < V_2 < V_3$
b. In Modified Period 2 treatment: $V_3 < V_1 < V_2$

[10]The part of the instructions explaining the computer's voting rule is based on the instructions used in E. Johnson et al. (2002).

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H2 (Paying for the optimal recognition probability) The subjects pay strictly positive amounts of money to increase the likelihood of being assigned the recognition probability that yields the highest expected payoff.

Results

"Value of recognition probability" and "Paying for recognition probability" respectively test H1 and H2 by examining the final allocations and the elicited preference for recognition probability. "Coalition formation" further examines the pattern of coalition formation to show why, counter to the theoretical prediction, the chance of inclusion in the winning coalition does not decrease in recognition probability. Other various aspects of bargaining behavior are examined in the Appendix. The analysis will focus on the experienced subjects' behavior when appropriate. In that case, the last five rounds with and without the procedure to elicit preference (rounds 11–15 and 26–30, respectively) will be examined. To avoid confusion, we refer to players 1, 2, and 3 as the high-, mid-, and low-powered member, respectively.

Value of recognition probability

Result 1: Contrary to the BF prediction, recognition probability does not have a negative value in the baseline, Modified Period 2, and Automated Vote treatments. In the Automated Period 2 treatment, we observe a negative value of recognition probability.

Figure 1 shows the mean allocation to the three members of the groups, separately for all rounds, rounds 11–15, and rounds 26–30. The figure shows that in treatments other than Automated Period 2, the mean allocation weakly increases in recognition probability: $V_1 \geq V_2 \geq V_3$.[11] In the Automated Period 2 treatment, we observe $V_1 < V_2$, that is, the high-powered member on average earns a smaller payoff compared to the mid-powered member in all rounds (€20.20 vs. 2€2.33, $p = 0.0405$; 1-sided paired-sample t-test), and in rounds 11–15 (€18.11 vs.€25.03, $p = 0.0201$). However, the difference becomes smaller and statistically insignificant in rounds 26–30.

One might be concerned that the mid-powered member's advantage in Automated Period 2 might have been driven by the treatment design that automatically allocates the entire budget to one group member if a group rejects a proposal in period 1. However, the data suggest that the automatic allocation is in fact disadvantageous to the mid-powered member relative to the high-powered member. For example, conditional on rejection, mid-powered members earn a slightly higher mean allocation than high-powered members in the baseline treatment (€19.18 vs. €20.02). In Automated Period 2, the opposite should hold by

[11]The result that is seemingly consistent with Gamson's law (a conjecture that the members receive allocations proportional to the size of their power) might be due to the relatively even distribution of recognition probability assumed in our study. Diermeier and Morton (2005) and Fréchette et al. (2005a, 2005c) show that such conjecture does not hold well under uneven distribution of recognition probability. The almost identical result in our Modified Period 2 treatment also contradicts the proportionality idea.

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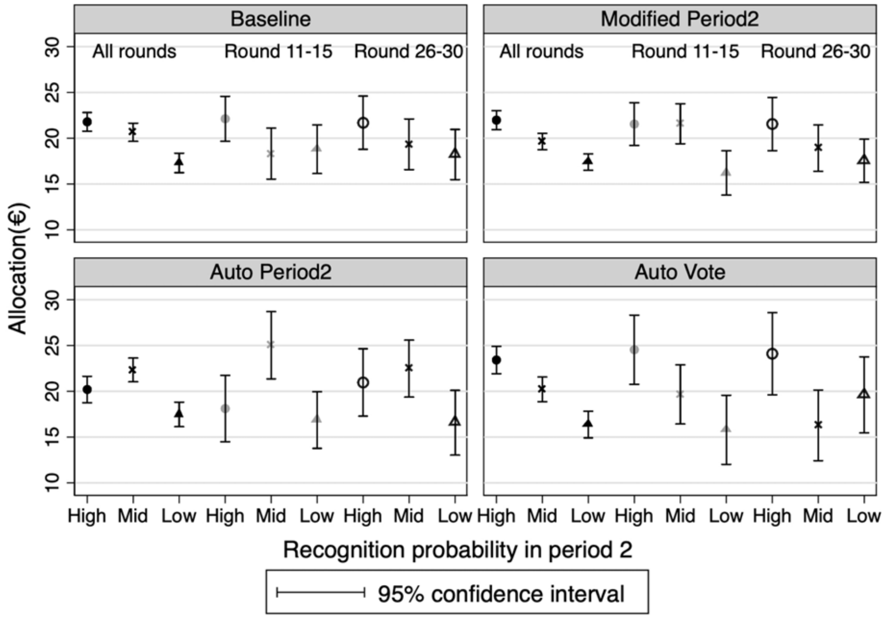

Figure 1. Mean allocation.

design, which the data confirm (€22.73 vs. €21.82). Accordingly, the adverse effect of high recognition probability becomes more prominent once we rule out the design effect by focusing on proposals that are accepted in the first period. The difference between the high- and the mid-powered member in the Automated Period 2 treatment is greater and statistically significant (€19.79 vs. €22.42, $p = 0.004$; 1-sided paired-sample t-test).

Paying for recognition probability

Result 2: In all treatments, a majority of subjects choose to pay a strictly positive amount of money to increase the likelihood of being assigned the highest recognition probability. They are no less likely to pay for this role in the Automated Period 2 treatment, despite the empirical suboptimality of such behavior.

Figure 2 shows the distribution of the amounts the subjects chose to pay in rounds 26–30.[12] The recognition probability that the subjects indicated as their preferred role is indicated by the color of the bar. The upper-right corner of each panel also shows the distribution of preferred roles conditional on choosing to pay a non-zero amount.

The figure shows that, in all treatments, about 30–40% of subjects pay nothing, whereas a majority are willing to pay a strictly positive amount. A substantial fraction is willing to pay the entire endowment of €1. Furthermore, in all treatments, over 70% of the subjects who choose to pay a non-zero amount pay for the highest recognition probability. Compared to the baseline treatment, the subjects in the

[12]Figure 6 in the Appendix shows the distribution for all rounds.

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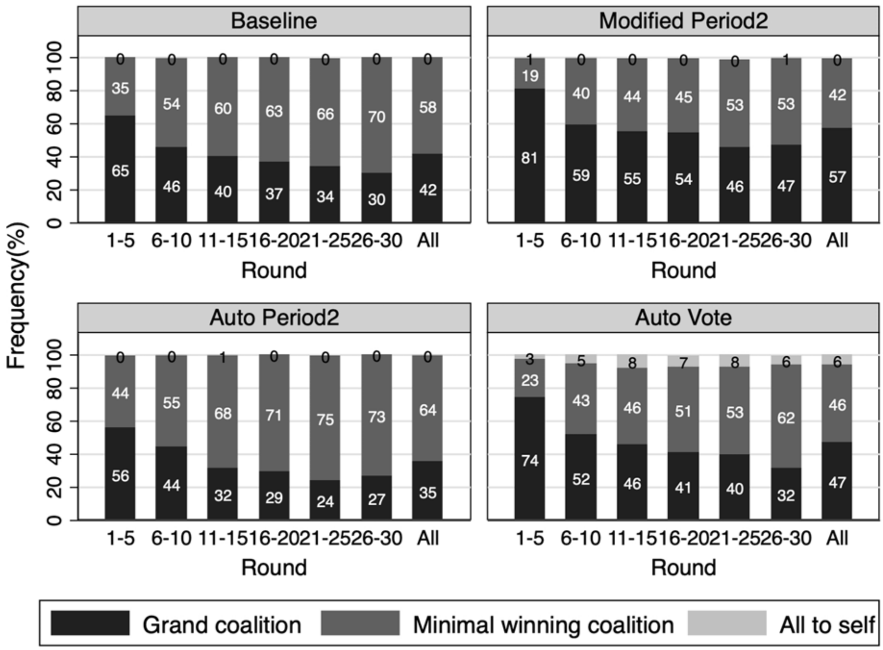

Figure 2. Distribution of chosen amount to pay: round 26–30.

Automated Period 2 treatment are no less likely to pay for the high recognition probability ($p = 0.100$, probit regression with clustering at the individual subject level), and no more likely to pay for the middle recognition probability ($p = 0.211$), although the middle recognition probability yields the highest expected allocation that is also above €21 in that treatment.[13]

Coalition formation

Result 3: Most experienced subjects propose minimal winning coalitions (MWCs) as predicted. However, counter to the prediction, they often choose a coalition partner who has the higher recognition probability. As a result, the low-powered member is not more likely to be included in the winning coalition. In the Automated Period 2 treatment, the mid-powered member is the most likely to be included, which explains her high mean allocation in the treatment.

Coalition types[14]

In line with the general findings from BF bargaining experiments Baranski and Morton, 2022), we find that the most experienced subjects propose a minimal

[13]See section 4.1 for the relevant argument.

[14]The original BF model's narrow definition of MWC and the broad definition of grand coalitions have a drawback. Specifically, under these definitions, allocations that are extremely close to MWC (e.g., (30, 29,1)) are categorized as grand coalitions. Appendix B replicates Figs. 3 and 4 in this section under alternative definitions to show qualitatively similar findings.

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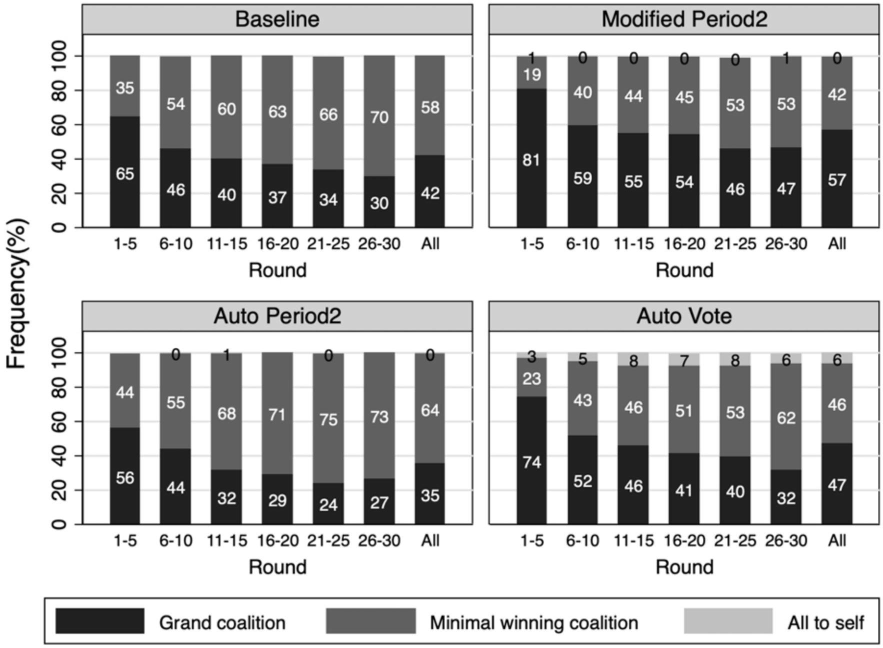

Figure 3. Distribution of coalition types proposed in period 1.

winning coalition (exactly one member receives a zero offer). Figure 3 shows how the distribution of coalition types proposed in the first period evolves over time. On the horizontal axis, the 30 bargaining rounds are divided into six 5-round bins. The right-most bar in each panel shows the distribution from all rounds. A grand coalition refers to proposals that allocate strictly positive amounts to all three members. The figure shows that MWC proposals become more prevalent over time in all treatments, an observation that is confirmed by probit regressions of MWC indicator on the round number with clustering at the individual subject level (coefficient = 0.03, p = 0.000 in each treatment). Furthermore, in the last five rounds of all treatments, a majority of subjects propose MWCs, although a substantial share of subjects in the Modified Period 2 treatment propose grand coalitions.

Coalition partner selection

The selection of coalition partner conditional on proposing a MWC also becomes more consistent with the BF prediction over time, in line with other experimental findings (Baranski and Morton, 2022). Figure 4 shows the upward trends in the fraction of MWC offers made to the non-proposing member with the smaller recognition probability, as predicted by the BF model. These trends are confirmed by probit regressions with clustering at the individual subject level in the baseline treatment (coefficient = 0.06, p = 0.000), Modified Period2 treatment (coefficient = 0.04, p = 0.000), and Automated Period2 treatment (coefficient = 0.02, p = 0.031).

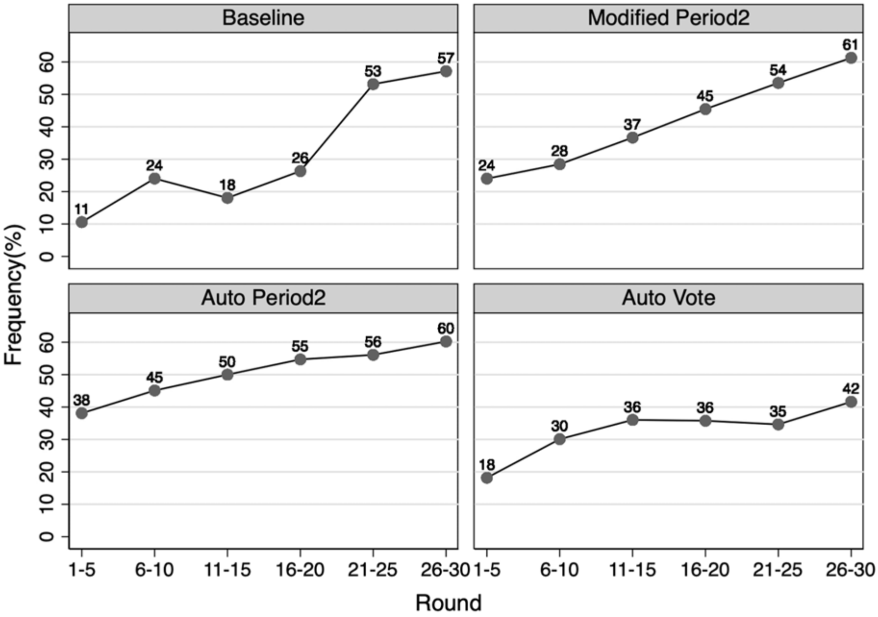

Figure 4. Fraction of MWC partner selections consistent with Baron and Ferejohn (1989).

However, even after sufficient opportunities for learning, a non-trivial share of subjects select a MWC partner inconsistent with the BF prediction. In all treatments other than Automated Vote, about 40% of MWCs proposed in the last five rounds are inconsistent with the BF prediction. In Automated Vote treatment, a majority of MWC proposals made in the last five rounds are inconsistent.

The relatively low rate of consistency with the BF prediction in MWC partner selection is also found in Diermeier and Morton (2005). In a treatment with similar recognition probabilities (34%, 33%, 32%) and five bargaining periods, the authors find that 49% of MWC partner selections are inconsistent with the BF prediction. They find no evidence that subjects learn towards the theoretically predicted partner selection, whereas we find clear evidence of learning.[15]

Likelihood of inclusion in winning coalition

Baron and Ferejohn (1989) predict that the high recognition probability might have a lower value because it is associated with a lower probability of inclusion in the winning coalition. For the remainder of this section, we examine how the previously observed patterns of proposed coalition types and coalition partner selections affect the likelihood of inclusion for each member, and how this likelihood translates to the mean allocation previously observed in 6.1.

[15]The greater number of bargaining rounds (30 in this study, 18 in Diermeier and Morton, 2005) and the smaller number of proposal periods in each round (2 in this study, 5 in Diermeier and Morton, 2005) might have facilitated learning in our experiment.

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Table 4. Probabilities of inclusion in coalitions proposed in Period 1

		Recognition probability		
		High (%)	Middle (%)	Low (%)
Theoretical prediction		36	64	100
(All treatments)				
Empirical probabilities				
Treatment	Rounds			
Baseline	All rounds	86	84	70
	Round 11–15	94	73	69
	Round 26–30	80	79	70
Modified Period 2	All rounds	86	87	84
	Round 11–15	87	90	80
	Round 26–30	79	83	89
Automated Period 2	All rounds	76	87	74
	Round 11–15	74	85	75
	Round 26–30	73	88	71
Automated Vote	All rounds	88	85	70
	Round 11–15	91	83	66
	Round 26–30	84	78	69

Table 4 shows the observed probability of each member being included in the coalition (that is, receiving a non-zero offer) proposed in the first period. The theoretically predicted probabilities of inclusion for the high-, mid-, and low-powered members are 36, 64, and 100%, respectively, as summarized at the top of the table.

The experimental data deviate from the prediction in a few ways. First, due to the frequent offers of grand coalitions, the overall probability of inclusion is higher than predicted (i.e., the sum of three members' probabilities of inclusion exceeds 200%). Second, the probabilities of inclusion are more similar across recognition probabilities than predicted. Lastly, counter to the prediction, the likelihood of inclusion does not decrease in recognition probability, which explains the non-negative value of recognition probability observed in most treatments in 6.1. On the other hand, the mid-powered member in the Automated Period 2 treatment is more likely to be included than the high-powered member,[16] which contributes to the mid-powered member's higher mean allocation.

To further understand how these likelihoods of inclusion emerge, we again examine the fraction of MWC partner selections consistent with the BF prediction – but this time the fractions are disaggregated by the proposer's recognition probability. Table 5 shows that the subjects exhibit low rates of consistency, that is,

[16]The Automated Period 2 treatment is the only treatment in which the difference between the high- and the mid-powered member is statistically significant at the 10% level (signrank test, $z = -3.769, p = 0.0002$).

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Table 5. Fraction of MWC partner selection consistent with the BF model conditional on recognition probability

		Recognition probability		
Treatment		High (%)	Middle (%)	Low (%)
Baseline	All rounds	26	33	45
	Round 11–15	14	23	17
	Round 26–30	53	39	79
Modified Period 2	All rounds	37	43	53
	Round 11–15	23	29	58
	Round 26–30	59	65	59
Automated Period 2	All rounds	39	51	68
	Round 11–15	36	53	65
	Round 26–30	53	53	76
Automated Vote	All rounds	26	32	49
	Round 11–15	22	35	58
	Round 26–30	44	38	42

they are more likely to select a coalition partner with the higher recognition probability, when they themselves face higher recognition probabilities. For example, the rates for high- and mid-powered members in the all-round data are mostly below 50%. The difference between the high/mid-powered members and the low-powered member seems to disappear in the last five rounds of Modified Period 2 and Automated Vote treatments.

Compared to the case in which subjects show the same rate of consistency regardless of their own recognition probability, the observed pattern of coalition partner selection would further lower the rate of inclusion for the low-powered member. The observed pattern in the Automated Period 2 treatment also explains the relatively high rate of inclusion of the mid-powered member in that treatment.

Appendix C presents individual-level analyses of coalition formation behavior. We show that the subjects who frequently propose MWCs are also more likely to select a coalition partner consistent with the BF prediction. Most subjects' rates of consistency in coalition partner selection vary depending on their own recognition probability, and a non-negligible share of subjects make mostly inconsistent coalition partner selections regardless of their own recognition probability.

Conclusion

This study has experimentally investigated the potentially negative value of recognition probability in legislative bargaining. Contrary to the theoretical prediction of the finite-horizon majoritarian multilateral bargaining model (Baron and Ferejohn, 1989), we do not find a negative value of recognition probability in most treatments. One exception was the Automated Period 2 treatment, in which we found a lower mean allocation to the high-powered member compared to the mid-powered member. When given the opportunity, a majority of subjects pay a positive sum of money to secure the high recognition probability in all treatments, despite the suboptimality of such behavior in the Automated Period 2 treatment.

In addition to testing these main hypotheses, we confirm that subjects learn to form minimal winning coalitions with the member with the smaller recognition probability, as predicted by the Baron-Ferejohn model and as found in its experimental implementations. However, even after many opportunities for learning, a substantial share of subjects still choose a coalition partner with the greater recognition probability. This tendency is greater when the subject has a high recognition probability. Because of these deviations from the theoretical prediction, the higher-powered members are not more likely to be excluded from the winning coalition compared to the lower-powered members, and, as a result, they earn high average allocations in most treatments.

We consider some possible explanations for the deviation by subjects from the predicted pattern of coalition partner selection. First, some subjects might have homophilous preferences, that is, they prefer to form a coalition with a member with a similar recognition probability. This conjecture is supported by the fact that homophily in legislatures is a widely documented phenomenon,[17] and the fact that the similarity between the agents facilitates agreements on within-group allocations in other contexts.[18] Second, even if the subjects do not have any preference over coalition partners, the recognition probability might provide a focal point for partner selection, given that the environment is otherwise sparse in information. Lastly, the sense of legitimacy or entitlement, which might derive from greater recognition probabilities in subjects' perceptions, might explain the behavior of the minority of subjects who consistently choose the coalition partner with the greater recognition probability regardless of their own recognition probability.

There are a few conjectures that help explain the suboptimal investment in high recognition probability in the Automated Period 2 treatment. For example, subjects might hold empirically incorrect beliefs about the value of recognition probability. Alternatively, they might have an intrinsic preference for decision right/power (Bartling et al., 2014; Pikulina and Tergiman, 2020). A further examination of our experimental data shows that the subjects are generally responsive to the (individually) observed profitability of different recognition probabilities. However, a substantial fraction persistently pays for the high recognition probability despite accumulating empirical evidence against such behavior.[19]

[17]For example, previous studies have documented homophily based on political party, geographic location, gender, race, ethnicity, language, committee, and interest groups. See McPherson et al. (2001) and Neal et al. (2022) for an overview.

[18]For example, Ivaldi et al. (2007)'s review of studies on tacit collusion concludes that symmetry between firms, for example, in production cost, capacity, and product quality, facilitates agreement on collusion prices.

[19]For example, subjects who more often observed the high-powered member receiving a strictly greater allocation than the mid-powered member are more likely to pay for the high recognition probability ($p = 0.031$, probit regression on pooled data from all treatments) and less likely to pay for the middle recognition probability ($p = 0.025$). At the same time, at least 47% of the subjects pay for the high recognition probability in the treatments where the mid-powered member earns a greater allocation than the high-powered member.

Admittedly, the current experimental design, which focuses on documenting bargaining behavior and outcome, does not allow us to directly test for these various interesting conjectures. Identifying the detailed reasons and mechanisms underlying the non-equilibrium behavior could be a fruitful direction for future research.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/XPS.2023.26

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Competing interests. The authors have no conflicts of interest to declare.

Ethics statement. This study was approved by IRB (IRB 00126347) and Economics & Business Ethics Committee at the University of Amsterdam (EC 20190924030933). This study adheres to APSA's Principles and Guidance for Human Subjects Research. Please see Appendix G for the details.

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