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RESEARCH ARTICLE

# An experimental investigation of the calculus of consent

*Adam Hoffer, ahoffer@taxfoundation.org*
*Tax Foundation, USA*

*M. Scott Niederjohn, scott.niederjohn@cuw.edu*
*Concordia University Wisconsin, USA*

We conduct a laboratory experiment to investigate group decision-making, inspired by a model from Buchanan and Tullock's *The Calculus of Consent*. Unlike previous researchers, we move beyond simple majority and unanimity rules, allowing groups to choose voting rules endogenously. The results of our experiment are consistent with the Buchanan–Tullock model. In particular, we confirm a tendency toward less restrictive voting rules when decision-making costs are high and external costs are low. We also find that less restrictive voting rules lead to higher group profits.

**Keywords** group decision-making • voting rules • Buchanan–Tullock model • experimental economics

**JEL codes** D71 • C92 • A21

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## Introduction

Groups make decisions every day, using voting rules as simple as majority rule or as elaborate as full ranked choice. Voting rules have been the subject of scholarly inquiry for decades, inspired by Buchanan and Tullock's (1962) *The Calculus of Consent*, which established the foundations for understanding collective and constitutional decisions.

Based on the Buchanan–Tullock model, a large literature has explored the efficiency of voting rules, with a heavy emphasis on whether a simple majority or unanimity yields more efficient results (Guttman, 1998; Dougherty et al, 2014). In the lone experimental study that allowed the group to determine its own voting rule, the only offered options were simple majority and unanimity.

In this study, our experimental groups determine their own voting rules, not restricted to majority or unanimity. Instead, groups can choose any voting rule, from an individual decision by a group leader to unanimous agreement from the whole group. Our design allows us to observe how decision-making costs (DMCs) and external costs (ECs) among group members affect the choice of voting rules and resulting outcomes.

To our knowledge, this study offers the first behavioral and comparative static exploration of Buchanan and Tullock's (1962) voting rule. Specifically, we ask whether groups vary their voting rules in line with Buchanan and Tullock's model predictions as the associated costs change. We then offer results that are comparable to previous studies by summarizing the allocative outcomes that evolve from the endogenously determined voting rules.

## Background

Simple majority and unanimity are the most common formal voting rules. Yet, groups often informally adopt less common rules. Direction from the budget committee chair to "just come up with a number" resembles a sole dictator, even if a pro forma majority vote will later confirm the choice. The community pool association that waits to start a costly renovation because of one member's hesitation has implicitly set a stricter standard than majority rule. What factors affect the decision rules employed? Buchanan and Tullock's (1962: 70, emphasis added) original statement on the problem takes a cost-minimizing approach:

> For a given activity the fully rational individual, at the time of constitutional choice, will try to choose that decision-making rule which will *minimize* the present value of the expected costs that he must suffer. He will do so by minimizing the *sum* of the expected external costs and expected decision-making costs.

Their approach identifies two distinct costs:

- ECs are the costs incurred by individuals who did not agree with the group decision.
- DMCs are costs the individual expects to incur from participating in making the choice, such as the time costs of deliberation.

ECs can be expressed as:

$$EC_i = f(N_a),\ i = 1, 2 \ldots N$$
$$N_a \leq N$$
$$f\prime(N_a) \leq 0$$

ECs can be expected to decrease as the percentage of individuals required to agree with a decision increases. A dictator's decision is likely to impose costs on many who would oppose it if they could. At the other extreme, with unanimous agreement, ECs are zero because all agree with the decision.

DMCs can be expressed as:

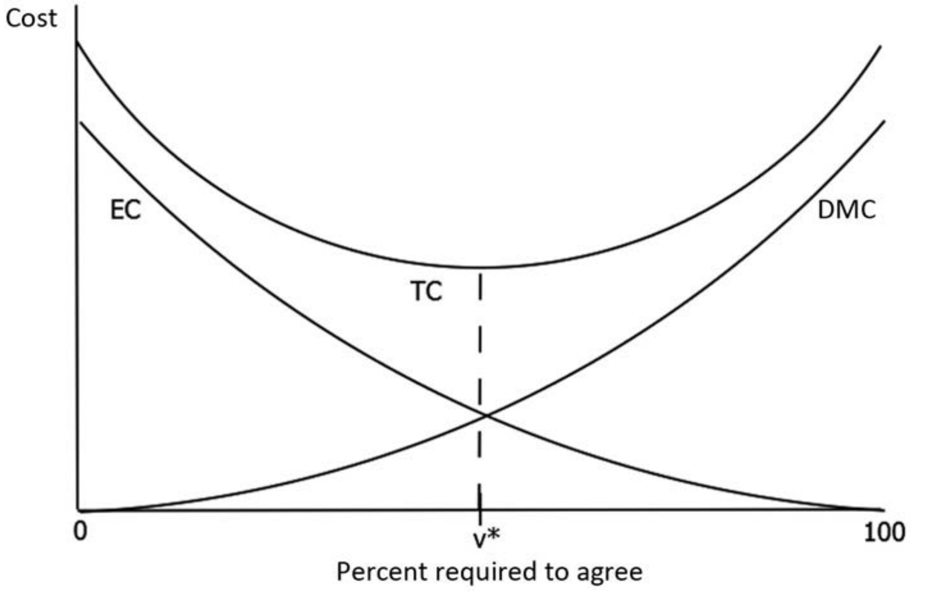
$$DMC_i = f(N_a),\ i = 1, 2 \ldots N$$
$$N_a \leq N$$
$$f'(N_a) \geq 0$$

These costs increase as the percentage of individuals required for agreement increases. A dictator's costs of making a decision would be minimal. As greater percentages are required in the decision rule, more individuals are involved, so the time and effort of negotiating and deliberating will increase. Wicksell (1958) suggests DMCs increase at an increasing rate. At the extreme, under unanimity, each voter has a monopoly of the only essential resource (their consent). Each voter can then aim to extract rents by threatening to withhold a consenting vote. As Buchanan and Tullock (1962: 69) note:

> Certainly, the rewards received by voters in any such agreement would be directly proportionate to their stubbornness and apparent unreasonableness during the bargaining stage. If we include (as we should) the opportunity costs of bargains that are never made, it seems likely that the bargaining costs might approach infinity in groups of substantial size.

Figure 1 depicts the relationship between ECs and DMCs, as well as their sum, total cost (TC). The costs of group decision-making are minimized at the lowest point on the TC curve, or $v^*$ percent of the group population. Notice the trade-off

**Figure 1:** The basic model



involved. For voting rules requiring a greater percentage, ECs are lower, as the costs of getting a less favored outcome are lowered. In return, however, much negotiation and deliberation may be required, pushing up DMCs. On the margin at $v^*$ percent, the additional DMCs just begin to outweigh the reduction in ECs.

From the base model in Figure 1, we can draw several extensions and applications. By far the most discussed and researched application involves whether $v^*$ is a simple majority, unanimity, or somewhere in between. The model reveals that at least one of two conditions would be necessary to push $v^*$ rightward to a supermajority or greater. Either the DMC curve has a shallow slope or the EC curve has a steep slope. Figure 2 illustrates the comparative statics of a marginal increase in the slope of ECs. As the EC curve becomes steeper, the cost-minimizing percentage of voters needed to agree on a decision increases from $v^*$ to $v^1$. When a decision might hurt more of those voting, a larger majority is needed to get the go-ahead.

The primary objective of this article is to study the comparative statics of the optimal voting rule model. With each shift of ECs or DMCs, $v^*$ should change. Again, for illustrative purposes, we model an additional change to the DMC curve, to DMC′, in Figure 3. The TC curve changes, now with a minimum at $v^{1\prime}$. Intuitively, a lower cost of decision-making favors a higher standard of agreement.

However, the beauty of the model is that it applies to all scenarios of group decision-making; $v^*$ is not restricted to being majority or greater. A decision to make a pot of academic department-purchased coffee should not require the majority consent of the entire department. The ECs are small, and the opportunity cost of getting majority consent from a busy department is large. Figure 4 shows the case in which $v^1$ is below a majority.

With this model as background, we set out to determine whether groups behave as predicted by adopting systematically different voting rules as ECs and DMCs change. In each of nine experimental rounds, we manipulated the ECs and the DMCs of

**Figure 2:** Effect of increased ECs

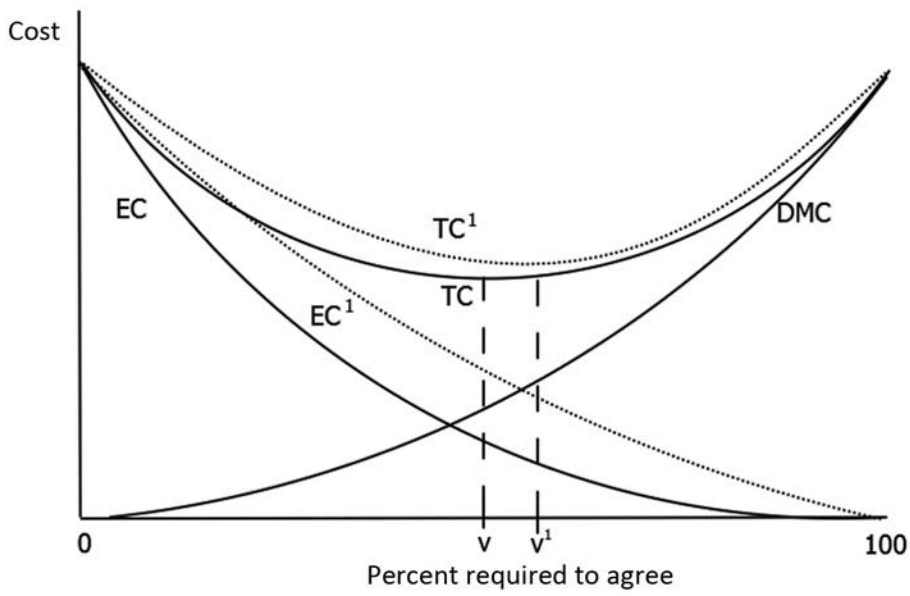
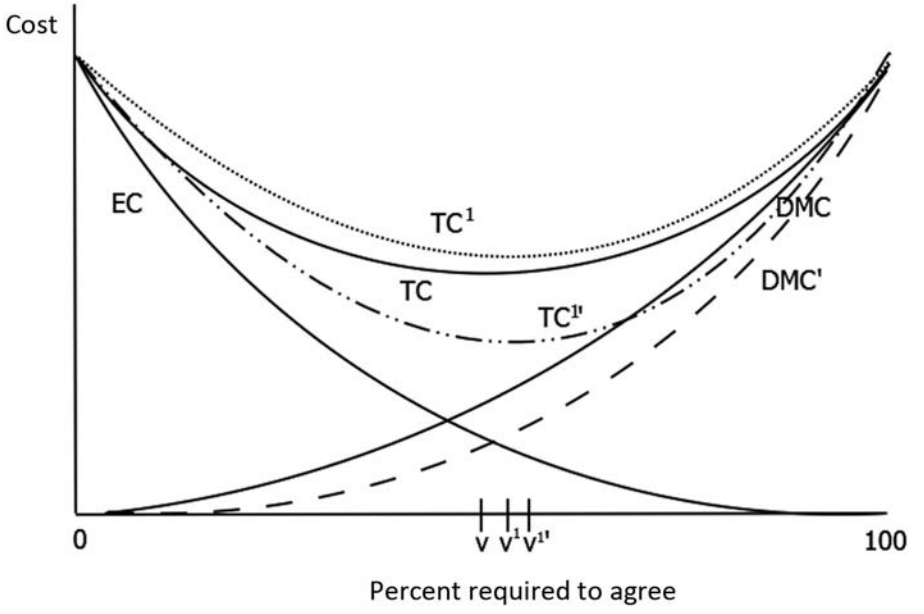


**Figure 3:** Effect of reduced DMs




group voting. We then recorded and analyzed the voting rules selected by groups. As reported in the following, the results were broadly consistent with the predictions of the Buchanan–Tullock model.

## Literature review

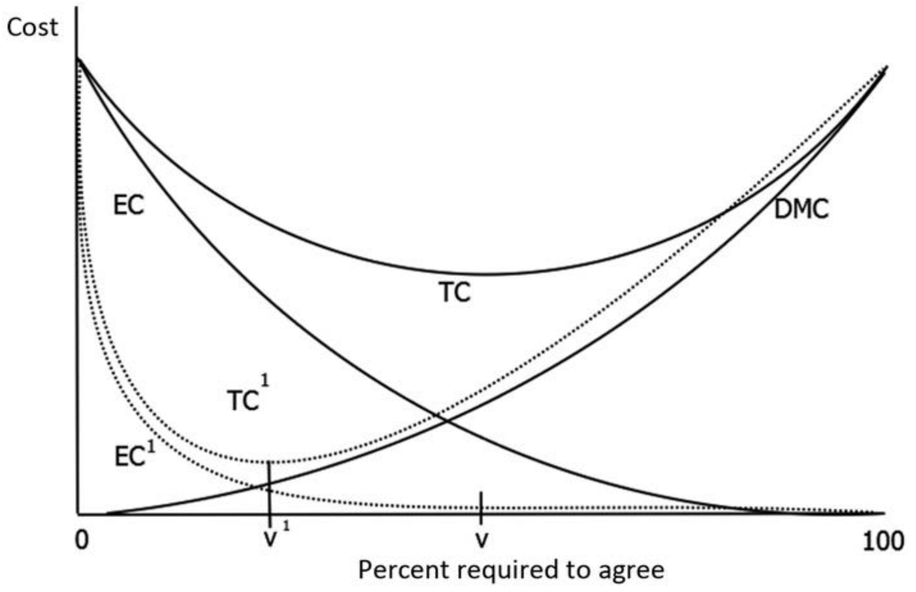
The literature built on *The Calculus of Consent* is vast. As of this writing, *The Calculus of Consent* has more than 16,500 citations according to Google Scholar. Summaries of the literature and postscripts have been published 25 years (Tullock, 1987) and 30 years (Kliemt, 1994) after its initial release. We will not attempt to summarize the entire literature in this section. Rather, we will highlight some of the most recent studies and those most applicable to our experiment and results.

Ahen and Calcagno (2019) use state-level data to examine the relationship between social capital and state constitutions. Calculus of consent (CoC) theory and models have been extended multiple times and have seen wide applicability. Sass (1991; 1992) offers extensions of the base CoC model for municipal government structure and public expenditures, as well as for constitutional choice in representative democracies. Salter (2016) extended CoC theory to political property rights and corporate polity. Piano and Rouanet (2024) developed a theory of constitutional choice for American Indian tribes and tested their extended model using data following the Indian Reorganization Act 1934.

The voluminous body of experimental research has largely focused on majority and unanimity voting rules. The efficiency of majority voting rules has been the most explored (Fiorina and Plott, 1978; McKelvey and Ordeshook, 1984a; 1984b; Bianco et al, 2006; 2008).

Fiorina and Plott (1978) find that the majority-rule core (majority of a group given the power to make decisions) is a good predictor of group behavior when majority

**Figure 4:** Less than majority consent required




rule has at least one standard equilibrium. They also find that majority-rule outcomes tend toward the center of the ideal points (the specific outcome or strategy that a player would most prefer in a given situation, representing their most desired result based on their individual preferences and priorities) when majority rule does not have a standard equilibrium.

McKelvey and Ordeshook (1984a) restrict group decisions to one issue at a time. They find that groups using majority rule are likely to select the outcome at the median of the ideal points in each separate dimension.

Bianco et al (2006; 2008) explain the centralizing behavior of majority rule (a scenario where players in a game coordinate their actions to act as a single entity, effectively making decisions as if they were a single decision-maker with access to all information rather than acting independently based on their own self-interest), attributing this finding in part to the existence of an uncovered set. Their first study surveys eight previously conducted experiments on majority rule and reports that roughly 94 percent of the experimental outcomes fall within the uncovered set (a group of options within a voting system where each option can be defeated by another option within the set, either directly or indirectly). Their second study, generating data from their own experiment, finds that the fraction of outcomes in the uncovered set ranges from 59 to 100 percent, depending on the configuration of ideal points.

Exploring a unanimity voting rule, Laing and Slotznick (1991) explore a series of single-round experiments. They find that the core outperforms the Condorcet alternative or the Nash–Harsanyi arbitration solution; however, several of their results deviate substantially when the initial status quo is not in equilibrium.

Walker et al (2000) conducted experiments on two-stage games where experimental groups first select either a majority or unanimity voting rule and then vote on the allocation of a resource using the voting rule selected. This experiment design closely resembled the design of our experiment in this study. Walker et al (2000) assign groups to voting rules in control conditions and allow groups to choose their voting rule in treatment conditions. They find that groups that are allowed to choose their voting rule are more likely to select an allocation that maximizes the sum of the payoffs than groups assigned a voting rule. Among the groups allowed to choose, if preferences were symmetric, the unanimity rule produced outcomes closer to the maximum sum of payoffs than did the majority rule.

Dougherty et al (2014) evaluated whether simple majority or unanimity voting rules produce more efficient outcomes. Their results suggest three primary findings: (1) groups voting with a majority rule enter the Pareto set more quickly than groups voting with a unanimity rule; (2) a majority rule groups leaves the Pareto set at the same rate as unanimity-rule groups; and (3) majority-rule groups are more likely to select a Pareto-optimal outcome than a unanimity rule at the end of the game.

Our study extends the Dougherty et al (2014) model. In our experiment, groups select their voting rules endogenously, resulting in a broader spectrum of voting rules needed, including scenarios in which groups select less than a majority to make a decision.

## Experimental design

In this article, we explore endogenous decision-making under various EC and DMC conditions and compare the results to the predictions suggested by Buchanan and Tullock's CoC model. Testing CoC predictions presents several challenges, each dealt with by specific aspects of our experimental design:

- In real-world group decisions, the costs of a non-favored outcome are hard to observe. Yet, to motivate our subjects to avoid these costs, we needed to attach a monetary reward to avoiding ECs. We did this by specifying a distance penalty based on how far a participant's ideal point differed from the point chosen by the group, further detailed later in this section.
- In real-world group decisions, the (opportunity) costs of making decisions are not easily quantified, dominated as they are by participants' time and effort. To make these costs tangible to our participants, we charged a specific dollar amount for each vote solicited in the group voting stage of our experiment.
- In real-world group decisions, simply postponing a vote is a popular decision. To get experimental results, we needed to rule out delay strategies, so we placed limits on the number of votes and overall time.

The resulting procedure, implemented through z-Tree (Fischbacher, 2007), encouraged participants to choose well as we varied ECs and DMCs. We were then able to see how groups' choices of decision rule (number of votes required to decide) responded to the changed costs. We were also able to study the efficiency of the groups' choices.

The experiment was conducted at a mid-sized public university. Subjects were recruited via campus-wide emails, flyers, and classroom announcements. The study was approved by the campus Institutional Review Board (IRB), and all IRB and recruitment materials are available upon request. Instructions as distributed to participants are included in Appendix 1.

Subjects were randomly assigned to groups of five. Each group practiced two rounds of a two-stage voting game before establishing an initial (constitutional) voting rule. Then, each subject played nine rounds of a two-stage voting game with their group.

In Stage 1 of each round, the group decided how many positive votes would be needed to make a decision in the following Stage 2: one, two, three, four, or five votes. Subjects next played a group voting game in Stage 2. Each round presented the group with a unique set of (EC and DMC) costs and called for a new decision on the number of "yes" votes required in Stage 2.

Stage 2's group voting game was adapted from Dougherty et al (2014). Similar paper-and-pencil group voting game tasks have been used by Fiorina and Plott (1978), McKelvey and Ordeshook (1984a), and Bianco et al (2008). In Stage 2, each subject was assigned an ideal point, identified as an ($x$, $y$) point, such as (55, 45) on a 100-by-100 grid. Ideal points were purely abstract and not identified with real-world counterparts (such as US$55,000 for parks and US$45,000 for libraries in a town's budget). In the groups, each individual had a different ideal point associated with getting the maximum reward for that round. Each individual was able to observe other group members' ideal points as well.

In Stage 2, each group had to select a single ($x$, $y$) group point using the voting rule they selected in Stage 1. The payoff for each individual decreased the further their ideal point was from the group point: the distance penalty. Total payment for each stage had a lower bound of zero (no one could lose money). A random member of each group was selected to be the group point proposer. Each Stage 2 began with the proposer proposing a group point on the 100-by-100 grid, identified by a yellow triangle on the participants' screens (screenshots from a sample experiment and all ideal point grids are provided in Appendix 1).

All group members then voted (yes or no) on accepting the group point. After voting, the proposer would decide which votes to solicit and reveal by clicking a box for each accepted vote. The proposer would solicit one vote at a time, essentially building out a coalition to try and reach the vote threshold determined in Stage 1. Each vote solicited cost the group a fee known as a "vote solicitation cost." If the group had enough "yes" votes to meet the Stage 1 rule, voting ended for the round, and the computer stored each person's earnings.

If the group had too few votes for its Stage 1 rule, the proposer came up with a new group point for consideration. This process continued until either two minutes had elapsed or three votes had failed. Such a failed round would result in each group member receiving zero dollars for that round. Each group participated in nine separate rounds, each round consisting of a Stage 1 and a Stage 2. Figure 5 presents a flow chart and decision tree for the experiment.

In each round, participants faced a different set of ECs and DMCs. Specifically, we varied DMCs through different vote solicitation costs: (1) US$0.50 per vote, (2) US$1.00 per vote, or (3) US$ 2.00 per vote solicited. We altered ECs by changing the distance penalty between a participant's ideal point and group point to: (1) US$0.10*distance, (2) US$0.25*distance, or (3) US$0.50*distance. The pairwise combinations of ECs and DMCs yielded nine unique experimental rounds. Participants were presented with the ECs and DMCs during Stage 1, when they were asked to select their voting rule. Participants were not yet aware of the distribution of ideal points from Stage 2 when selecting a voting rule during Stage 1.

Participants started each round with an endowment of US$30. Their payout was equal to (US$30 – vote solicitation cost – distance penalty). Participants were paid for their performance in one randomly chosen round at the end of the experiment.

## Results

Table 1 shows the summary statistics from Stage 1, sorted by the minimum number of votes the groups would choose based on the model. The minimum total cost of voting, thus the minimum number of votes predicted for a group decision rule, would occur for a relatively flat EC curve and a steep DMC curve. In such a case, ECs are minimal and decision-making is costly, so an easy rule is suitable. That scenario is represented in our experiment by a distance penalty (EC) of US$0.10*$d$ and a vote solicitation cost (DMC) of US$2.00. We label that value $v1$.

As the relative voting costs change, so do the predicted values of the minimum voting rule. We identify these predicted values as $v1$ (smallest), $v2$, $v3$, $v4$, and $v5$ (largest). The maximum number of votes in a decision rule, indicated by $v5$, would be for a relatively steep EC curve and a relatively flat DMC. In this case, there is a lot at stake and decision-making is not very costly.

Intermediate values are assigned as $v2$, $v3$, and $v4$. For example, the $v2$ value occurs in circumstances almost as favorable for an easy rule as $v1$, with medium DMCs but still with relatively flat ECs. The $v3$ cases fall in the middle, where pairwise combinations of ECs and DMCs are (Steep, Steep), (Medium, Medium), and (Flat, Flat).

**Figure 5:** Flow chart and decision tree of the experiment

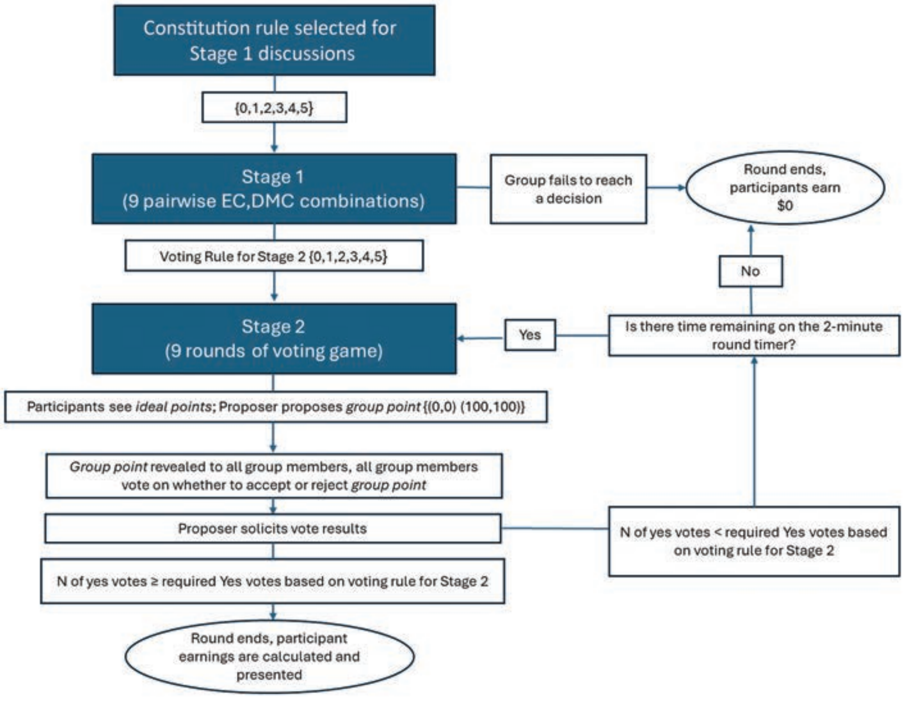


**Table 1:** Stage 1 results and predictions

| Distance penalty (EC) | Vote solicitation fee (DMC) | Minimum TC predicted | *N* | Mean participant vote value in Stage 1 | SD | 95% CI low | 95% CI high |
|---|---|---|---|---|---|---|---|
| US$0.10*$d$ (Flat) | US$2.00 (steep) | $v1$ | 85 | 2.18 | 0.09 | 2.01 | 2.35 |
| US$0.10*$d$ (Flat) | US$1.00 (medium) | $v2$ | 99 | 2.49 | 0.06 | 2.37 | 2.62 |
| US$0.25*$d$ (Medium) | US$2.00 (steep) | $v2$ | 97 | 2.16 | 0.07 | 2.02 | 2.31 |
| US$0.25*$d$ (Medium) | US$1.00 (medium) | $v3$ | 101 | 2.53 | 0.08 | 2.38 | 2.69 |
| US$0.10*$d$ (Flat) | US$0.50 (flat) | $v3$ | 100 | 2.78 | 0.07 | 2.64 | 2.92 |
| US$0.50*$d$ (Steep) | US$2.00 (steep) | $v3$ | 105 | 2.31 | 0.08 | 2.15 | 2.48 |
| US$0.25*$d$ (Medium) | US$0.50 (flat) | $v4$ | 101 | 3.06 | 0.07 | 2.91 | 3.21 |
| US$0.50*$d$ (Steep) | US$1.00 (medium) | $v4$ | 109 | 2.66 | 0.08 | 2.51 | 2.81 |
| US$0.50*$d$ (Steep) | US$0.50 (flat) | $v5$ | 104 | 3.66 | 0.08 | 3.51 | 3.81 |

*Note*: CI = confidence interval.

Each $v3$ round is predicted to have a greater minimum vote than its $v2$ counterpart. Similarly, we expect $v3$ rounds to have a smaller minimum vote chosen than rounds with a predicted $v4$ or $v5$.

Possible votes for the Stage 1 choice ranged from one (individual choice by the proposer) to five (group unanimity). We collected a total of 901 individual votes across 17 groups of five participants playing nine rounds. Individuals occasionally needed to revote, and a failed vote in Stage 1 necessitated a revote for all five group participants, increasing the baseline number of votes beyond a minimum of 765.

The mean individual participant vote ranged from 2.18 ($v1$) to 3.66 ($v5$). This is the pattern predicted by the Buchanan–Tullock model.

The results from Stage 2 are presented in Table 2. In every case, groups rejected a unanimity voting rule of five out of five, going instead for two, three, or four.

Groups achieved the best average results with easy voting rules. As the average number of votes required increased, average group payments were strictly decreasing. Part of this came from the effects of higher voting solicitation costs, as additional rounds were necessary to meet higher voting thresholds. Although it was possible that proposers' profit-increasing efforts could have offset those voting solicitation costs, among these groups, the solicitation costs dominated.

In the moment of a real-world committee decision, inefficient outcomes are possible. Members could later realize that there was an outcome that could have made someone better off and no one else worse off (a Pareto improvement). For our groups, every point proposed in the entire experiment was within the Pareto-optimal set. Even if the proposer selected a group point equal to their ideal point, the group could not Pareto-improve on that outcome.

In seven of the 153 group rounds, the group failed to achieve its chosen Stage 1 vote total, resulting in no payment for the participants. Each failure to select a group point occurred when a group selected a voting rule of three or four. The only

**Table 2:** Stage 2 results

| Round and voting rule selected | Average selected *x* | Average selected *y* | Average total vote solicitation cost | Average of total group profit |
|---|---|---|---|---|
| **1** | **53.4** | **48.0** | **2.2** | **112.0** |
| 2 | 54.1 | 44.9 | 1.1 | 117.3 |
| 3 | 54.1 | 50.4 | 2.3 | 111.4 |
| 4 | 41.0 | 51.0 | 9.0 | 74.4 |
| **2** | **47.8** | **68.2** | **1.3** | **81.5** |
| 2 | 55.0 | 58.5 | 0.5 | 90.9 |
| 3 | 46.0 | 68.6 | 1.2 | 87.1 |
| 4 | 50.7 | 73.0 | 2.3 | 51.3 |
| **3** | **67.1** | **76.1** | **1.6** | **70.9** |
| 2 | 70.0 | 75.0 | 1.0 | 78.2 |
| 3 | 64.2 | 77.1 | 2.2 | 63.7 |
| **4** | **65.1** | **71.5** | **1.6** | **134.1** |
| 1 | 76.0 | 72.0 | 0.0 | 318.0 |
| 2 | 63.6 | 71.5 | 1.9 | 109.5 |
| **5** | **29.4** | **80.9** | **2.1** | **25.7** |
| 2 | 29.4 | 87.1 | 1.1 | 37.5 |
| 3 | 30.3 | 77.0 | 2.9 | 18.1 |
| 4 | 21.0 | 66.0 | 2.0 | 0.0 |
| **6** | **52.5** | **18.1** | **2.2** | **57.5** |
| 2 | 50.4 | 18.2 | 1.2 | 60.6 |
| 3 | 53.2 | 18.3 | 2.5 | 56.2 |
| 4 | 55.0 | 16.0 | 3.0 | 57.5 |
| **7** | **39.4** | **78.9** | **2.9** | **83.0** |
| 1 | 33.0 | 90.0 | 0.0 | 178.5 |
| 2 | 39.6 | 76.8 | 2.9 | 72.8 |
| 3 | 44.5 | 82.5 | 6.0 | 59.5 |
| **8** | **58.0** | **40.4** | **1.0** | **120.5** |
| 2 | 70.0 | 37.7 | 0.5 | 122.3 |
| 3 | 58.9 | 41.0 | 1.0 | 120.4 |
| 4 | 34.0 | 40.5 | 1.5 | 118.4 |
| **9** | **52.0** | **32.6** | **2.9** | **42.5** |
| 1 | 62.0 | 27.5 | 0.0 | 87.0 |
| 2 | 57.9 | 33.8 | 2.9 | 43.7 |
| 3 | 35.0 | 32.0 | 4.0 | 22.1 |
| **Total** | **51.5** | **57.1** | **2.0** | **80.5** |

*Note*: Bold entries represent Level averages.

instance across all rounds of a voting rule failing to achieve a successful outcome in Stage 2 involved a rule of four out of five votes to agree in Round 5 (*v*4 predicted).

## Conclusions

In this article, we have explored group decision-making by testing a model proposed by Buchanan and Tullock (1962) in *The Calculus of Consent*. Our results were broadly consistent with the model's predictions. Groups chose easier voting rules under experimentally imposed conditions of high DMCs and low ECs. Easier voting rules also resulted in higher group profits. In our experimental rounds, all proposed outcomes remained within the Pareto-optimal set. Although there are always questions in applying experimental results outside their tightly controlled setting, we believe the general principles confirmed provide useful guidance for understanding real-world group decisions.

**ORCiD ID**
Scott Niederjohn https://orcid.org/0000-0002-2292-8585

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**Conflict of interest**
The authors declare that there is no conflict of interest.

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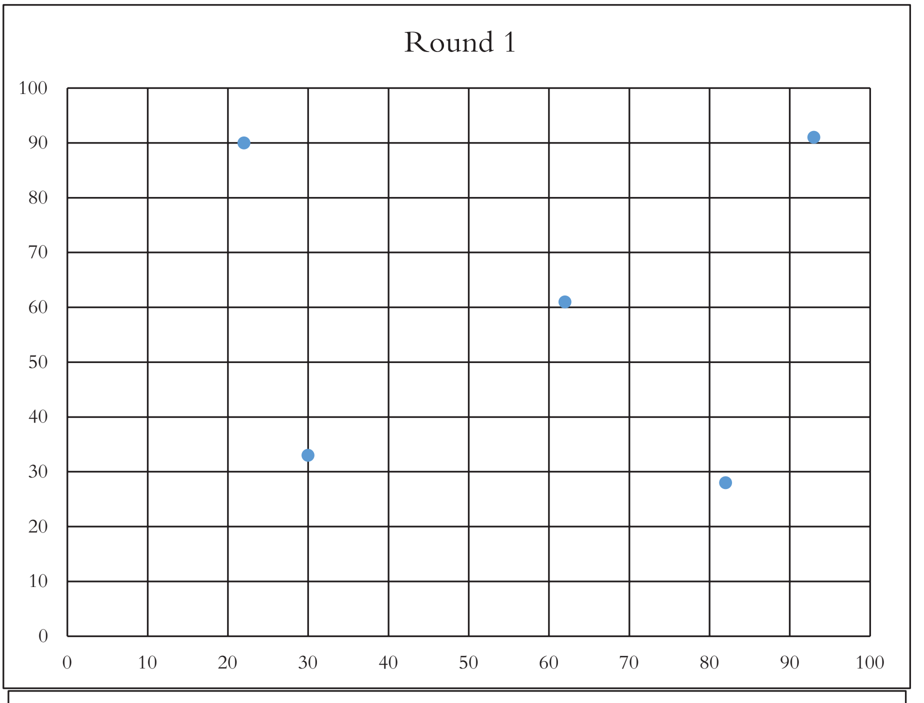
## Appendix 1


Round 1
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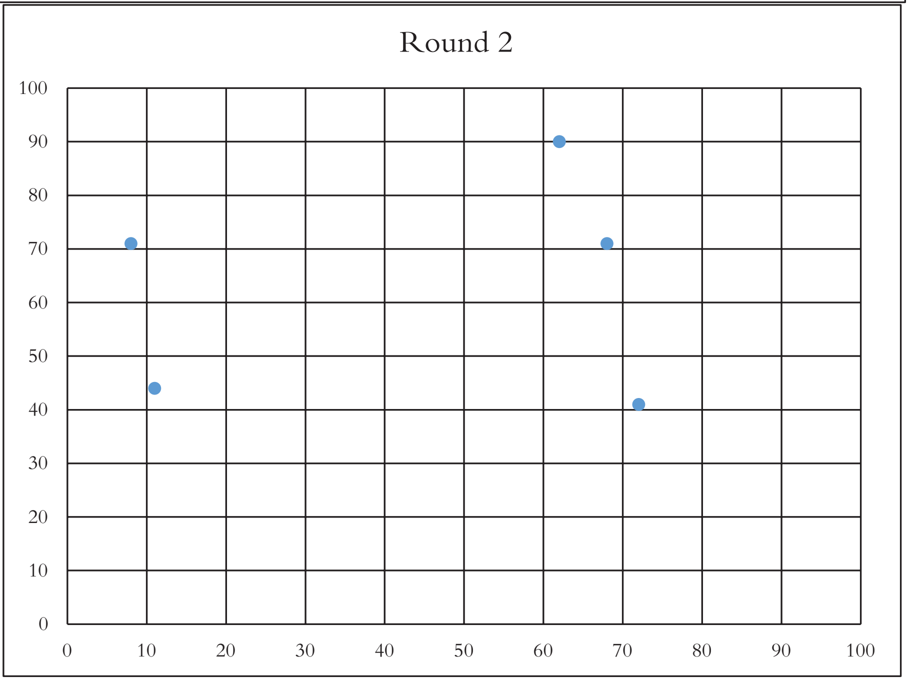
90
100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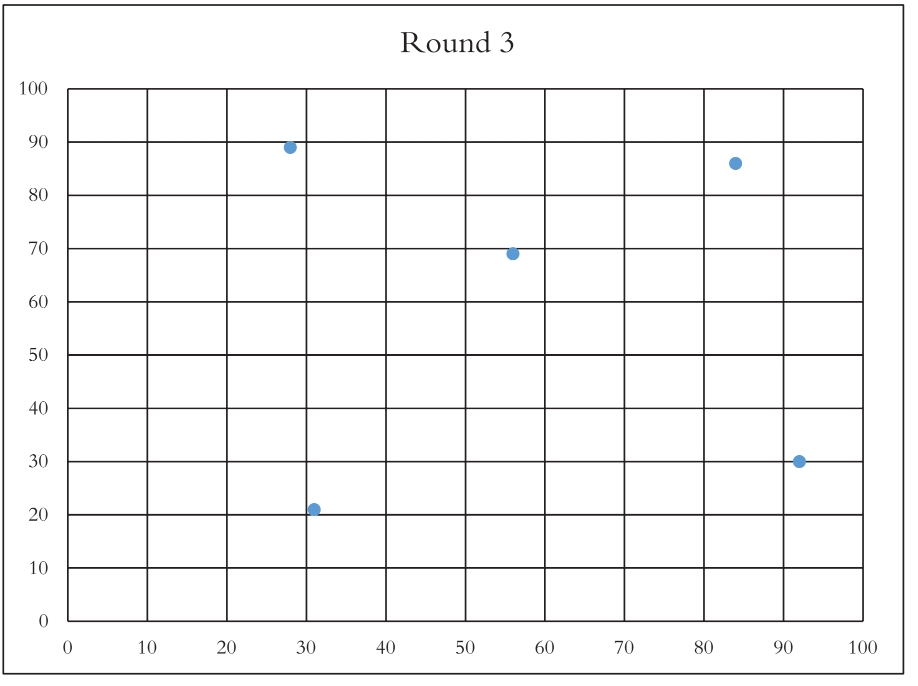
80
90
100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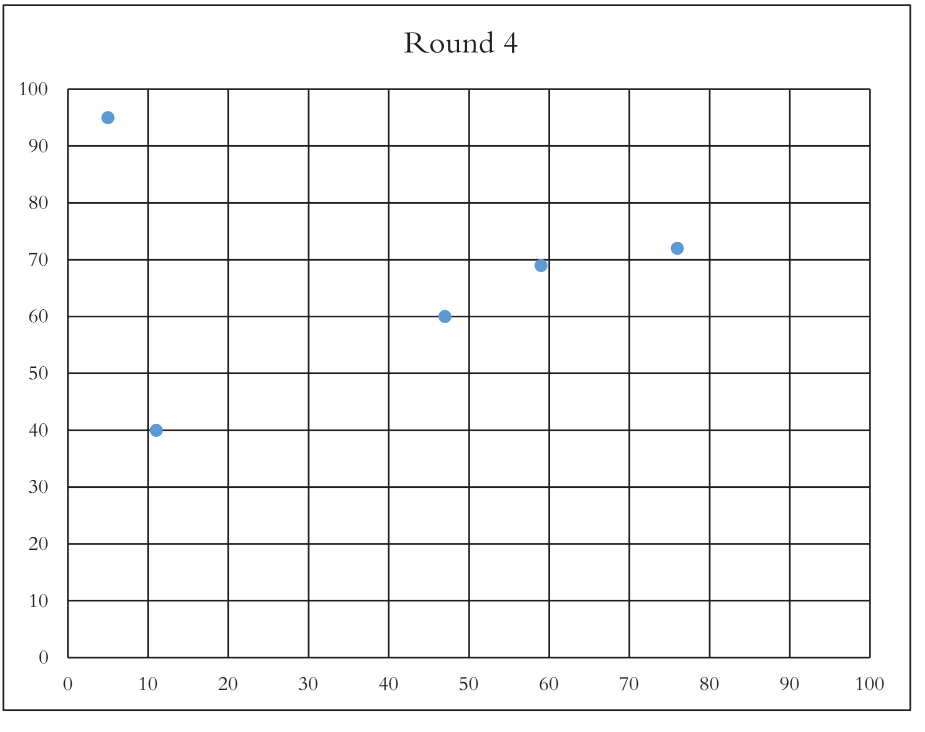
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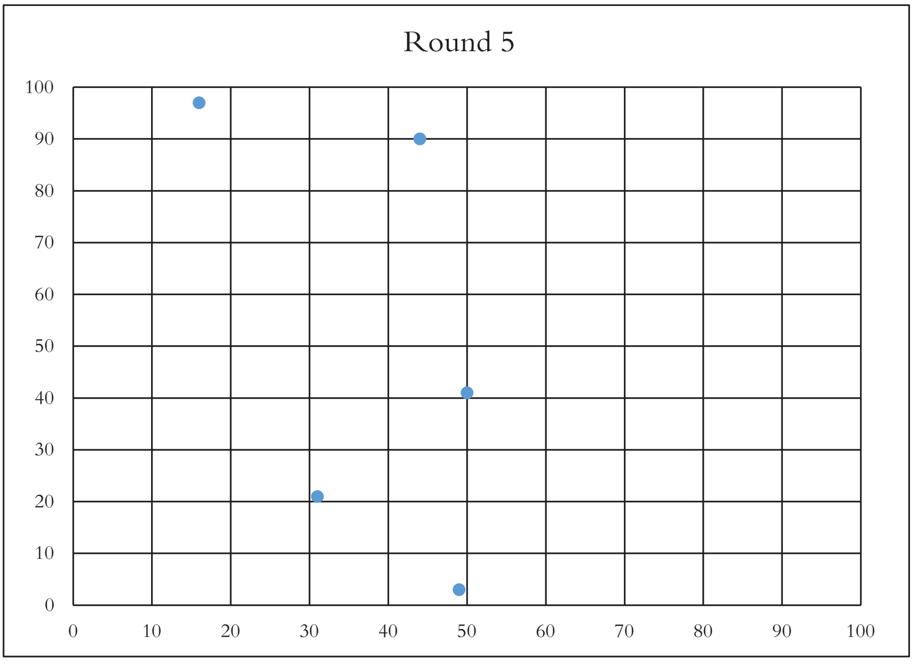
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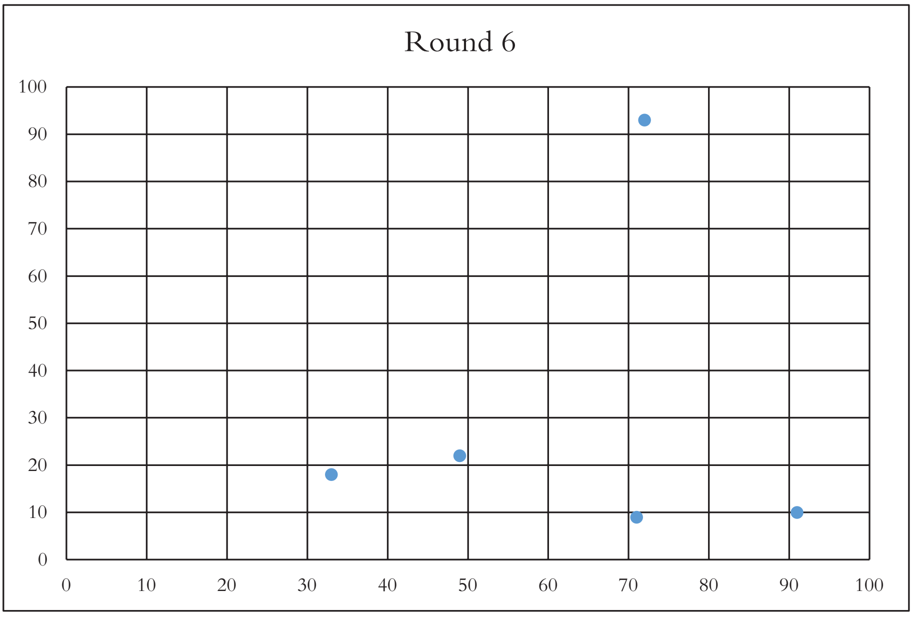
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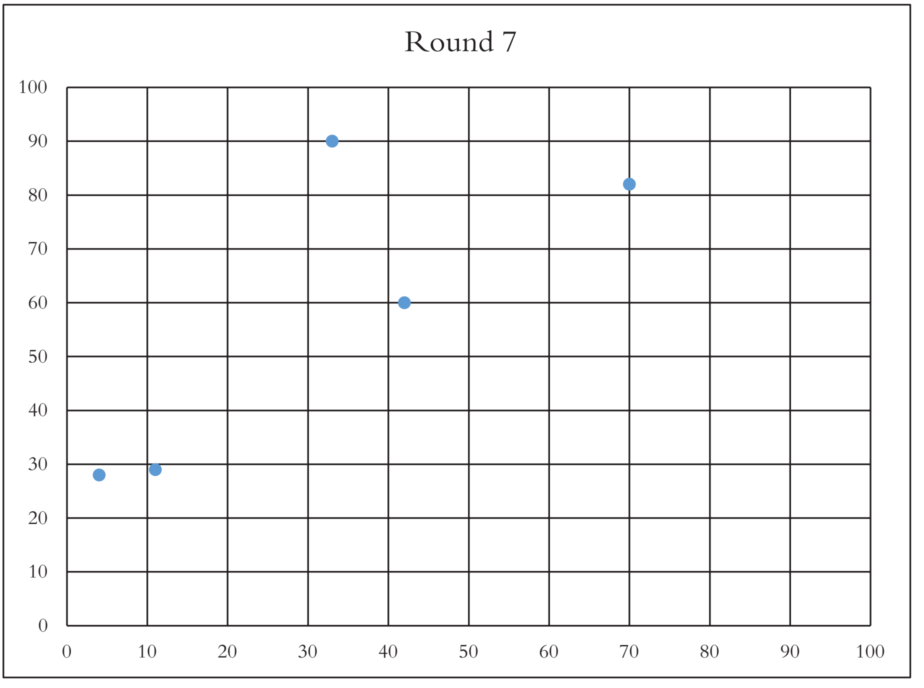
0 10 20 30 40 50 60 70 80 90 100


Round 7
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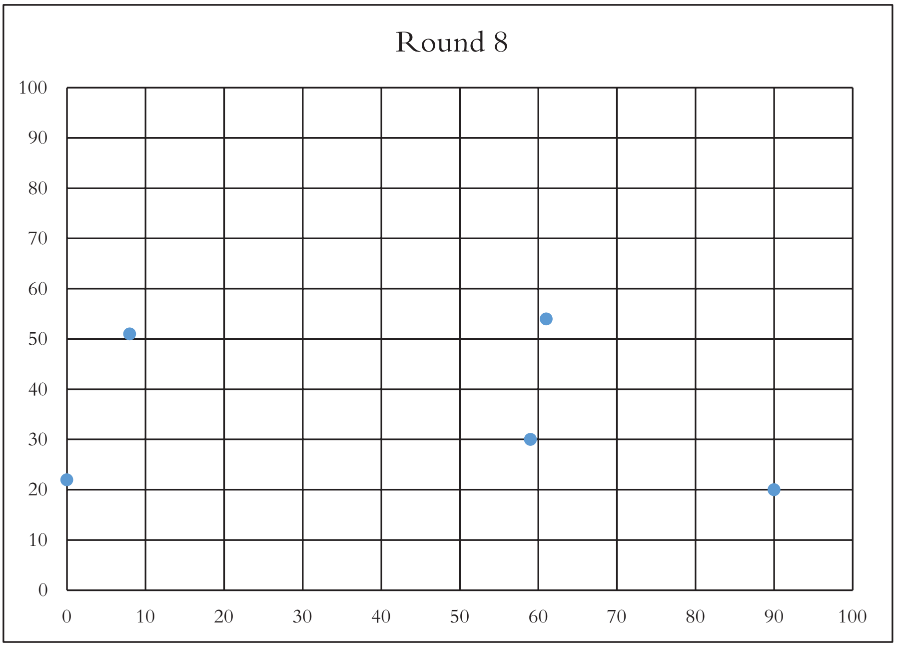
Round 8
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90
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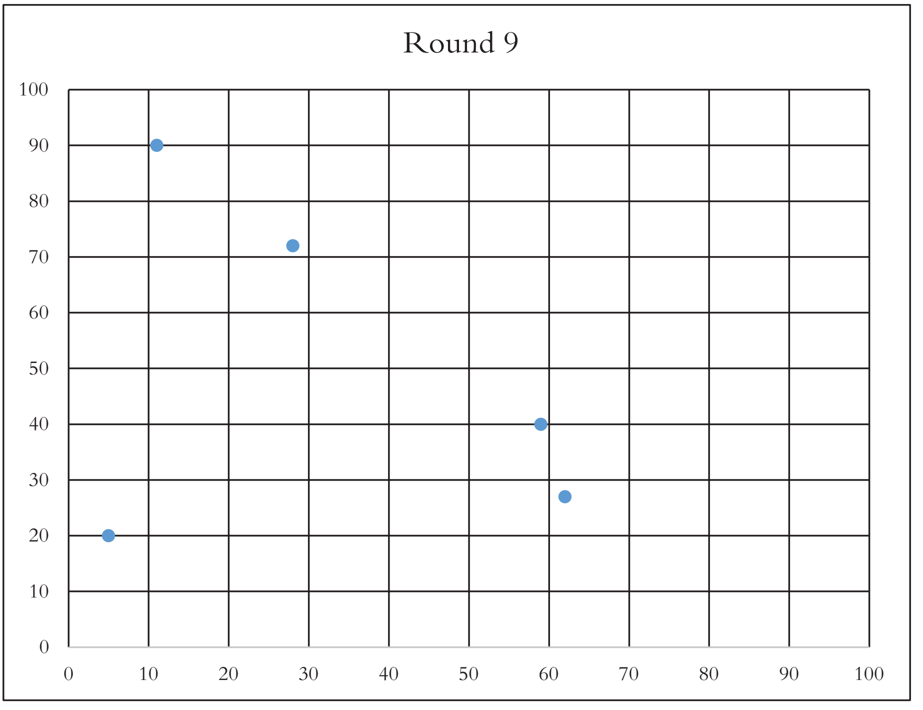


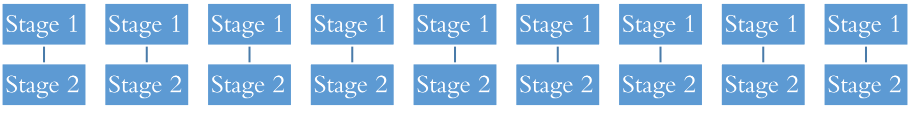

## Instructions

Thank you for agreeing to participate in today's experiment. You are about to participate in a study of group decision-making, and at the end of the session, you will be paid in cash for your participation. The amount of money you earn will vary based on your decisions.

You will be randomly assigned to a group of five individuals. You will complete the entire experiment with this group.

Today's experiment will consist of nine experiment rounds. Each round comprises two stages. Figure A1 outlines the experimental process. We will begin with one practice round consisting of all three stages before moving on to the experiment.

**Figure A1:** Experimental procedure




To begin, each group will play two practice rounds. The practice rounds are designed to give each person a chance to familiarize themselves with the procedure and the computer interface. The practice rounds will have extra time, and no part of the practice rounds will count toward final compensation in any way.

In the following, we describe the experiment stages in reverse order.

## Stage 2

Each individual is assigned an ideal point, identified as an $(x, y)$ point on a 100-by-100 grid. Each group will consist of five individuals with five different ideal points. Each ideal point represents the maximum amount of money an individual can earn during any round. Each individual can observe the distribution of ideal points for their group in each round.

Each group will have to select a single $(x, y)$ group point that will count for the entire group. The payoff for each individual will decrease the further their ideal point is from their group's selected $(x, y)$ point. We refer to this as a "distance penalty." The distance penalty may change from round to round.

Only a single member of the group can propose group points in each round. The group-point proposer is randomly selected each round.

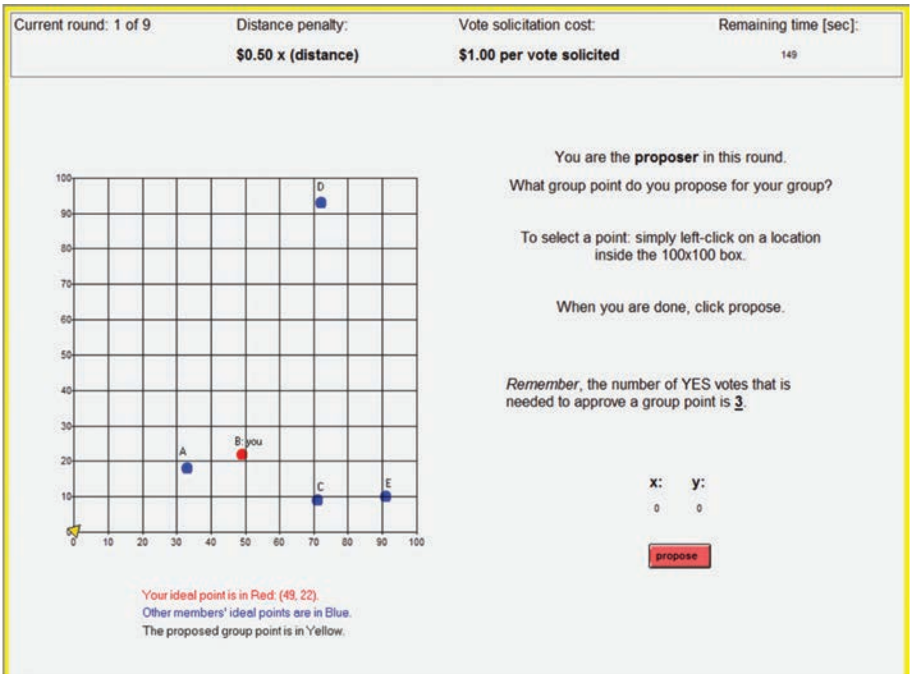
Each Stage 2 begins with the proposer proposing a group point on the 100-by-100 grid. This point will be identified by a yellow triangle.

After the proposer proposes a group point, each group member can vote (yes or no) to accept the group point. Once each group member votes, the group proposer will decide which votes to solicit from the group by clicking on the corresponding box next to the group member's letter on the proposer's screen. Each vote solicited costs the group a fee, US$0.50, for example. This fee may change from round to round.

If, after soliciting votes, the group has enough "yes" votes, based on the group's rule established in Stage 1 (described later), voting ends for the round, and the computer stores each person's earnings from that round.

If the group fails to collect "yes" votes, based on the group's rule established in Stage 1, the voting process repeats itself with the proposer proposing a new group point. This process continues until either two minutes pass or three votes fail. If the group has not successfully selected a group point after two minutes or there are three failed votes, the round ends, and each group member earns zero dollars for that round.

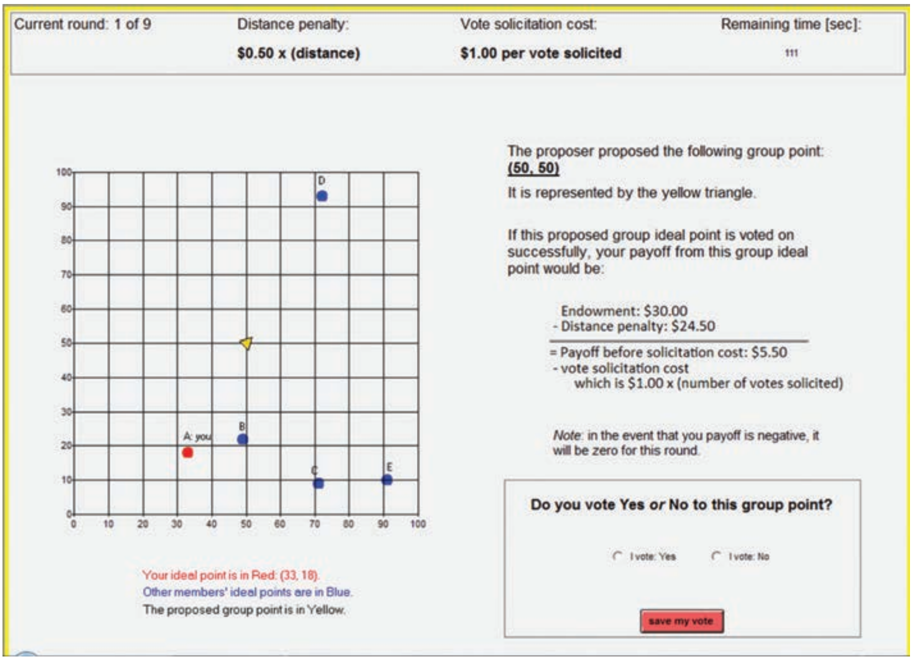
Let us walk through an example with screenshots. In the following, you can see a sample screen. Each group member's ideal point is represented by a dot. Person B's screen is shown in the following screenshot. Each person's ideal point has the label "you." As the round begins, Person B is the proposer, so the instructions on the screen instruct Person B to propose a group point anywhere on the 100-by-100 grid by left-clicking. The screen also informs Person B of the number of "yes" votes needed to select the group point, and on the header of each screen, the distance penalty, the vote solicitation cost, and the remaining time for the round are displayed.




*Note*: This figure is printed in black and white, but the image on your screen will be in color.

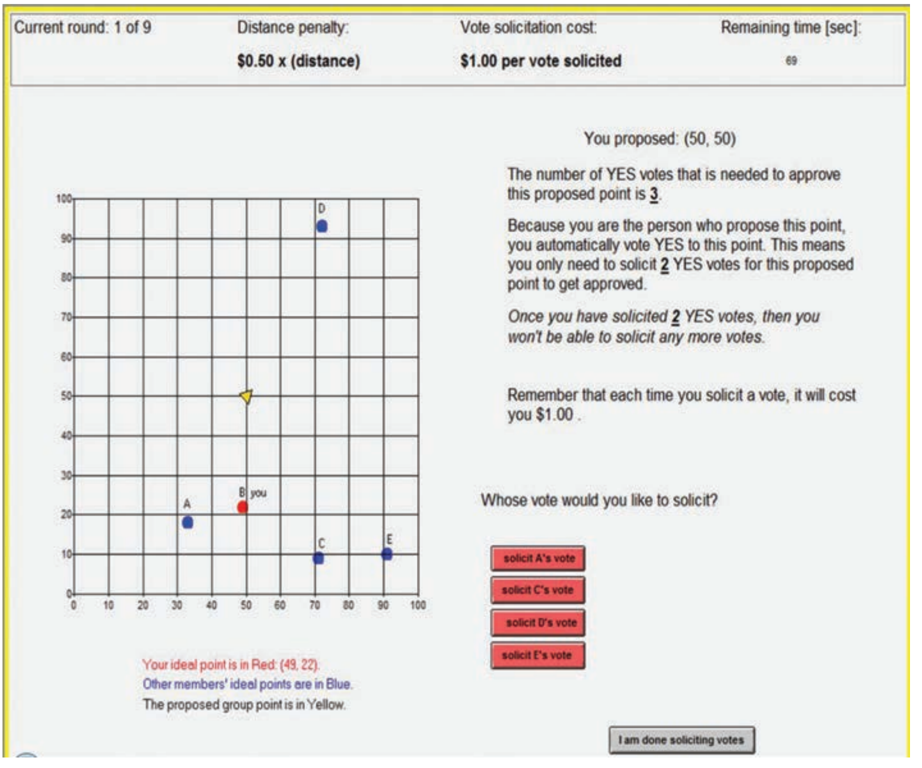
By clicking anywhere on the 100-by-100 grid, Person B will place the yellow triangle on a proposed group point. Once Person B is satisfied with the point selection, they can click propose, and each other member of the group (Persons A, C, D, and E) will have a chance to vote on whether or not to accept the proposed point as the group's group point.

Suppose Person B proposes the point (50, 50). Each member of the group will now vote "yes" or "no" to accept (50, 50) as the group's group point. Each person has 20 seconds to make a "yes"/"no" selection and click the "save my vote" button. Person A's screen is shown in the following. The computer calculates your potential payoff for you.




*Note*: This figure is printed in black and white, but the image on your screen will be in color.

After each group member votes, the proposer can now solicit (or reveal) any of the group members' votes they would like. Person B's screen is shown in the following. Each solicited box on which Person B clicks costs the group the vote solicitation cost, US$1.00 in this example. The voting process continues until either the group receives enough "yes" votes to accept a group point (three votes needed in the screenshot example provided), the clock runs out, or three votes fail. If the clock runs out or three votes fail, each group member earns zero dollars for the round.

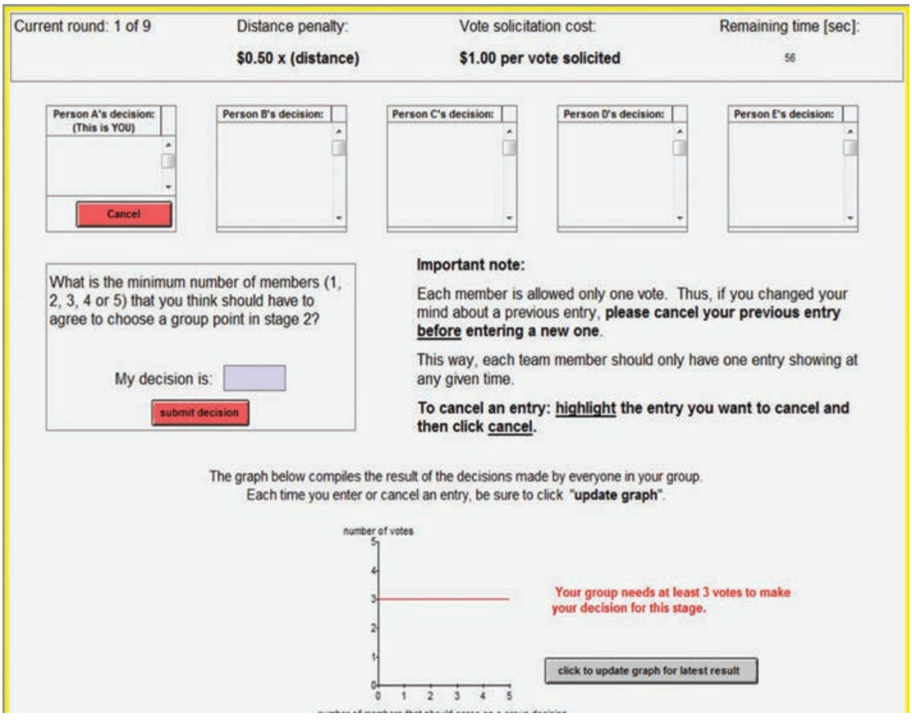



*Note*: This figure is printed in black and white, but the image on your screen will be in color.

## Stage 1

In Stage 1, each group will decide how many of the group members (that is, one, two, three, four, or all five members) need to agree on the group's group point decision in Stage 2, or, in other words, how many "yes" votes the proposer needs in Stage 2. Groups will have one minute to complete Stage 1.

As the game progresses to future rounds, the distance penalty and vote solicitation costs may change, and groups will reconvene and participate in a new Stage 1, again deciding how many group members need to agree on the group's decision in the new Stage 2. Stage 1 decisions are in place only for the Stage 2 that immediately follows. A screenshot of Stage 1 is presented next.




*Note*: This figure is printed in black and white, but the image on your screen will be in color.

Each group member can cast their vote to determine the minimum number of "yes" votes (that is, one, two, three, four, or all five members) the group will need to select a group point in the following Stage 2. The votes from all group members will be displayed onscreen. The group will need to achieve a minimum consensus illustrated by the graph at the bottom of the screen. In this example, at least three group members need to agree on the minimum number of "yes" votes needed in Stage 2. The graph can be updated to current vote totals by clicking on the update graph button at any point.

Each group member is allowed only one final vote. Any member can change their vote within the 60 seconds of Stage 1 by first clicking on their vote, then clicking cancel, typing a new number in the "My Decision" box, and submitting a new vote. For example, if you first vote for four group members who need to agree, you can change your mind and vote for five group members who need to agree, but please *do not* vote for both four and five group members. You should have only one vote submitted at a time.

The round will run for 60 seconds, even if the group reaches this consensus more quickly. If the group fails to reach the needed consensus in this round, the group will default to a predetermined number of votes.

## Rounds

The lab operator will direct groups through a total of nine separate rounds. The individual and group ideal points in Stage 2 will likely change during each round. Please carefully read the instructions for each round.

## General lab rules

We ask that you:

- DO NOT TALK TO ANY OTHER PARTICIPANTS DURING THE EXPERIMENT;
- PLEASE SILENCE YOUR PHONE AND DO NOT CHECK IT DURING THE EXPERIMENT; and
- USE THE COMPUTER ONLY FOR THE EXPERIMENT.

## Payment

You will be paid in US dollars based on the amount you earn from one of the rounds of today's experiment. Following the conclusion of the final round, the lab operator will invite individuals to draw a card from a deck that has been limited to only the numbers 1–9. The card you draw corresponds to the round for which you will be paid. If you drew the five of diamonds, for example, you would be paid based on the payment you earned in Round 5.

Please ask any questions you have at this time. Thank you.