

## **An Experimental Investigation of Delegation, Voting, and the Provision of Public Goods**

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Social scientists have long recognized that individuals often face strong incentives to “free ride” off of the contributions of others when public goods are provided through decentralized, voluntary institutions (Lindahl 1919, Samuelson 1954, Olson 1965, Hardin 1968, Dawes 1980). An implication of such individual incentives is that society will tend to underproduce public goods and sometimes even fail to produce them at all. One justification for government is that it solves this problem by using its coercive power—as in Hobbes’ *Leviathan*—in which citizens cede or delegate decision-making to a centralized authority. Of course, governments do in fact provide a variety of public goods ranging from security (national defense, anti-terrorism, police services), to public spaces (libraries and parks), to infrastructure (roads and highways). In contrast to Hobbes’ ideal vision of an absolute sovereign, however, decision-makers in modern democratic governments only wield their power temporarily since regular elections give citizens the opportunity to select new leaders.

We conduct laboratory experiments to investigate the effects of delegation and voting on public goods decisions. In our experimental design, a group delegates authority by electing one of its members to determine the contributions of each member to a public good. This process is repeated in every period. Our design therefore captures two essential features of modern delegated democracies.<sup>1</sup> First, once elected, a government official is not bound to take any particular action or choose any particular policy. Thus, there is the possibility that an official acts opportunistically for his or her own personal gain (or the gain of a subset of citizens) at the expense of the public at large.<sup>2</sup> Second, an official’s power is held only temporarily and continues only if the public collectively chooses to re-elect the official. Thus, repeated elections

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<sup>1</sup> We use the term “delegated democracy” to include both delegation to a single individual or executive as well as to a legislative body in order to distinguish it from “representative democracy,” which typically refers to the latter. In contrast, a “direct democracy” involves citizens proposing and voting directly on proposals and does not involve any form of delegation.

<sup>2</sup> See McGuire and Olson (1996) and Falaschetti and Miller (2001) for theoretical analyses.

may provide sufficient incentives for officials to act in the public's interest rather than in their own private interest (Barro 1973; Ferejohn 1986).

We find that such delegation almost universally yields the socially optimal level of the public good, in contrast with the no-delegation case in which the individually optimal and inefficient outcome always obtains. Groups in our experiment typically achieve the socially optimal outcome through a plurality of voters electing the person who voluntarily contributes the most to the public goods when delegation is not possible. Thus, by identifying the most “socially-oriented” individuals and granting them the power to determine collective outcomes our groups are able to solve the free-rider problem. This is in spite of the fact that the unique equilibrium of the one-period game with delegation predicts an inefficient outcome in which the elected official attempts to benefit at other players' expense – in our setting such behavior almost always yields removal from office.

We also observe instances in which officials appeal to a majority of players in the game, free ride on the contributions of the remaining players, and use this minimum-winning coalition to remain in power (though imperfectly). This outcome yields greater inequality than in the no-delegation outcome in which nobody contributes to the production of the public good, and leaves those excluded from the majority with lower earnings than they would likely obtain without delegation. Thus, while our results generally support the beneficial effects on welfare of delegation, they also highlight at least one potential pitfall.

### **Related Literature**

There is a vast experimental literature on the provision of public goods by voluntary contributions (e.g., Andreoni 1988; Dawes et al 1986; Ostrom et al 1992; Fehr and Gächter

2000)<sup>3</sup>, but there are very few public goods experiments that involve voting or delegation. Walker et al (2000) conducted an experiment in which subjects propose and vote directly on proposals to extract resources from a common pool and find that binding votes (both majority rule and unanimity) significantly increase the efficiency of resource use. Similarly, Kroll, Cherry, and Shogren (2007) find that in a linear, symmetric public goods environment like ours that binding votes and non-binding votes with punishment both increase contributions to the public good (but non-binding votes without punishment do not). Unlike our experiment, however, these two studies involve direct democracy rather than delegation—individuals propose and vote directly on contribution levels.<sup>4</sup> Although direct democracy can solve the coordination problem involved with collective action, there is no opportunity for an elected leader to unilaterally gain at the expense of other group members, as in our setting and as in many real-world environments involving delegation.

Experiments by social psychologists Messick and Samuelson are perhaps most closely related (Messick et al 1983; Samuelson et al 1984; Samuelson and Messick 1986). In their experiments, subjects play several rounds of a simulated common pool resource game – there is no actual group since opponents’ actions are actually pre-determined by the experimenter, who provides false feedback -- and then vote on whether to maintain free access to the resource (analogous to voluntary contributions in the public goods setting) or to elect a leader to make future decisions. They find that subjects are much more likely to give up free access to the resource and to delegate to an elected leader when the resource is (inefficiently) overused under a voluntary institution. This suggests that individuals will voluntarily cede control of decision-

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<sup>3</sup> See reviews, see Ledyard (1995), Fehr and Gächter (2000a), and Ostrom (1998, 2000).

<sup>4</sup> Theoretical work on voting mechanisms have also focused on direct democracy rather than delegation (Ledyard 2006). Capra et al (2007) also find that voting (direct democracy) increases social efficiency relative to decentralized decision-making in a more complicated economic environment with a threshold externality.

making to a centralized authority. They also find that when subjects make decisions as the elected leader (Messick et al 1983), they tend to take advantage of their position and take more of the resource for themselves than they assign to other members of the group.

There are two critical differences between their experiments and ours. The first is that in their procedure, elected leaders never face the prospect of re-election. It is therefore not surprising that their subjects take more for themselves, although it is surprising that they don't take *all* of the resources. The second critical difference is that in order to guarantee that the resource is overused in the voluntary institution, their procedures involve false feedback. In fact, their subjects never actually interact with each other. The use of deception in economics and game theory experiments is, of course, prohibited. More importantly, it negatively affects the experimenter's control of the social situation and affects subjects' expectations and judgments, making the internal validity of such experiments questionable (Ortmann and Hertwig 2002). Finally, it also means that it is impossible to observe group outcomes under the delegation mechanism, as there are no real groups in the experiment.

Experiments based on Baron and Ferejohn's (1989) majority-rule divide-the-dollar bargaining model are also related, as they pertain to the distribution of benefits and to the way in which individuals behave when proposal power gives them a significant opportunity for personal gain at others' expense. In the Baron and Ferejohn model, the optimal proposal in a stationary subgame perfect equilibrium is for the proposer to obtain as much of the pie as possible while giving just enough to others to ensure that a majority will vote to pass the proposal.

Experimental results (Frechette, Kagel and Lehrer 2003; Diermeier and Gailmard 2006), however, show that proposers do not take advantage of their power to the full extent predicted by Baron and Ferejohn. While we are also concerned with the distributive consequences of

delegating power, our experiment differs in that we add both an efficiency dimension to the structure of payoffs as well as repeated elections.

### Theoretical Framework and Hypotheses

The setting for our experiments is a series of repeated decisions in a linear public goods environment. There are  $n$  members of a group, and interactions between members of the same group are repeated with a potentially infinite horizon.

In each period, every individual member of the group has an endowment  $w$ , which is to be divided between spending on a public good and a private good. Let  $x_i$  be the amount that individual  $i$  allocates to the public good (subject to the restriction that  $0 \leq x_i \leq w$ ), with the remainder of the endowment  $w - x_i$  allocated to the private good. Individual  $i$ 's payoff is the sum of benefits from the private and public goods, where the marginal benefit from the private good is 1 and the marginal *per capita* benefit from the public good is  $k/n$ . This is given by the expression

$$(w - x_i) + \frac{k}{n} \sum_{j=1}^n x_j .$$

We assume that  $1 < k < n$ , which ensures the presence of a collective action problem: social welfare is maximized when every individual contributes their full endowment to the public good but it is always individually rational to contribute nothing for any amount contributed by others. After every period there is some probability  $\delta \in (0,1)$  that the interaction will continue for another period. Ex ante payoffs over the course of the game are described by expected utility, which is mathematically equivalent to time preferences characterized by geometric discounting.

Alternative institutional rules determine how decisions to allocate spending between private and public goods are made in each period. The baseline institution involves *voluntary individual contributions* where every individual group member simultaneously and independently chooses his or her own contribution to the public good  $x_i$ . Previous studies of voluntary contributions involving repetition generally find that contributions start between 40-60% and converge toward the single-shot Nash equilibrium of zero contributions (e.g., Isaac, Walker, and Thomas 1984; Isaac, McCue, and Plott 1985; Andreoni 1988; Fehr and Gächter 2000a).

Our alternative collective choice institutions involve *delegation by plurality rule* in which decision-making is divided into two stages. First, group members simultaneously cast votes for any member of the group. The group member with the most votes is elected as the “allocator” for the current period (with ties broken randomly). Second, the designated allocator chooses a vector of contributions to the public good—that is, the allocator separately chooses an individual amount  $x_i$  for each of the  $n$  members of the group. In addition to the basic two-stage version of the delegation institution, we also consider *delegation with communication* in which we allow for free-form communication prior to the voting stage in every period.

Since our decision setting involves repetition between members of the same group and an infinite horizon, a folk theorem argument implies the existence of a multiplicity of equilibria in which each member receives at least the minmax payoff. Under the delegation institution, the minmax payoff for any player  $i$  is  $kw/n$ , which is obtained when all other members vote for some allocator other than  $i$  and that allocator decides that only  $i$  contributes to the public good while every other player’s endowment is allocated to the private good. Note that the minmax payoff

under delegation is worse than the minmax payoff of  $w$  under voluntary contributions, so it is possible for outcomes to be worse under delegation than under voluntary contributions.

Given the multiplicity of equilibria, we hypothesize that three kinds of outcomes will be focal. One type of outcome that we expect is that individuals will play the subgame perfect equilibrium of the single-shot game involving weakly undominated voting strategies. That is, if elected, an individual will contribute nothing to the public good while making all  $n - 1$  other members contribute their full endowment. If every group member rationally anticipates this, then the only weakly undominated strategy is to vote for himself or herself. In this equilibrium, elected allocators obtain the highest possible ex post payoffs but the election of allocators is determined randomly in every period.

Like the first, the second type of outcome that we expect is based on pure self-interest but takes the nature of voting into account. It is best characterized by the phrase “tyranny of the majority.” Our expectations are based on long-standing normative concerns about majority rule (e.g., *Federalist No. 10*) and by relatively more recent theoretical results concerning minimum winning coalition sizes (Riker 1962; McKelvey, Ordeshook, and Winer 1978). In this outcome, each group member votes for himself or herself in the first period. The elected allocator then selects a simple majority of members to include in a coalition. The allocator then selects a contribution vector such that members of the coalition contribute their entire endowment to private goods and non-members are forced to contribute fully to the public good. After the initial period, members of the majority coalition will vote to re-elect the initial allocator. Even if the excluded members are able to coordinate, they will be unable to throw the initial allocator out of office and elect a replacement. If the marginal per capita return is low enough (specifically, if

$\frac{k}{n} < \frac{2}{n+1}$ ), then after the first period the same allocator will be elected in each period by

members of the majority coalition, whose payoffs are higher than they would be under the socially optimal outcome.

The third type of outcome is based on the possibility that individuals may be motivated by efficiency, equality and social welfare rather than pure self-interest (Fehr and Schmidt 1999; Charness and Rabin 2002). If so, then we expect to observe that elected allocators will implement the socially optimal outcome where the full amount of every group member's endowment goes toward the public good.

Since communication prior to voting is cheap talk, it does not change the incentive structure of the game. In principle, then, the main effect of communication in our second delegation treatment should be to increase coordination—allowing groups to quickly settle on one of the expected focal outcomes. Nevertheless, previous studies have found that pre-play communication can increase the rate of voluntary contributions (e.g., Dawes, McTavish, and Shaklee 1977; Isaac and Walker 1988). Although we do not have a good theoretical basis for expecting that groups may be more likely to settle on the socially efficient outcome, previous work suggests the possibility.

### **Experimental Design**

Our experiments were conducted at the Pittsburgh Experimental Economics Laboratory, where subjects interacted through networked computers using an application written with the software *z-tree* (Fischbacher 2007).<sup>5</sup> Subjects were primarily undergraduate and graduate students at the University of Pittsburgh and Carnegie Mellon University and were recruited through an e-mail list. Earnings in the game were denominated in “tokens,” and total earnings

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<sup>5</sup> The full text of the instructions are available from the authors.

were converted to cash at the rate of \$1 for every 200 tokens. In addition, each subject received a \$5 show-up fee. The experiment did not involve any kind of deception.

An experimental session consisted of two groups of nine subjects. Once groups were assigned, they remained fixed for the duration of the session. In every period, each individual was given an endowment of  $w = 100$  tokens. We used the parameter  $k = 1.35$  so that the marginal per capita return from the public good was  $k/n = 0.15$ . This parameterization guarantees that it is socially optimal for every member to contribute to the public good, that it is individually rational to never contribute, and that in the delegation treatments every member of a simple majority coalition is better off from “majority tyranny” than the full contribution outcome. To induce a potentially infinite horizon while ensuring that subjects interacted for a sufficiently long time, each group played a minimum of 20 periods (divided into two parts, as described below) and after the 20<sup>th</sup> and any subsequent period there was a 75 percent chance of continuing for another round. There were three conditions, and we used the same parameters for every condition.

Upon arriving in the laboratory, each subject was seated at a computer station, randomly assigned an ID number and to one of the two groups. All interactions took place through the networked computers and members of each group could only identify other group members by their ID number. In every session, subjects were first informed that they were placed in a group with nine members, that the experiment was divided into two parts, and that each part consisted of a series of “rounds.”

Part 1 of the experiment was identical across all treatment conditions and consisted of five periods of the voluntary contribution institution without communication. This allows subjects to become familiar with the structure of payoffs and to experience the free rider problem. It also allows us to obtain information on subjects' willingness to contribute to the public good under the voluntary contributions mechanism.

Subjects received instructions about the decision task, the payoffs in each period, and were informed that Part 1 would last for five rounds. The instructions did not make any reference to "public" or "private" goods but instead to "Account A" (which represented private goods) and "Account B" (which represented the public good). After every period, the results of that round were displayed, which included the individual allocations made by every group member, the total amount contributed to the public good, and their earnings from the period. In addition, subjects knew that there would be Part 2 but were not given any information about it prior to completing Part 1.

When Part 1 concluded, subjects were then given instructions for Part 2, which varied according to the institutional features of the three conditions. In every condition, subjects were informed that they would be playing at least 15 additional rounds and that after the 15<sup>th</sup> round (20<sup>th</sup> overall) and any subsequent round that there was a 75 percent chance of continuing for another round.

In the baseline control condition (*voluntary contributions*), subjects continued to play the same game as in Part 1. We conducted this treatment to ensure that the restart after the 5<sup>th</sup> round would not substantively affect the results and to serve as a comparison with the other institutions.

In the *delegation without communication* treatment, rather than individually choosing how to divide their endowments between the private and public good, subjects voted for a

member of the group to be the “allocator” at the beginning of every round. When voting (in every period), subjects were informed about average individual-level voluntary contributions of each group member in Part 1 of the experiment (rounds 1 through 5). The number of votes received by each member (but not each individual vote) was then shown to all subjects, and the group member with the most votes was elected the allocator (if there was more than one member with the most number of votes, then each one was equally likely to be selected at random). The allocator then decided how many tokens each group member would allocate to the public good and was allowed to select different levels for each individual. All group members then observed the allocator’s decision prior to beginning the next period.

The *delegation with communication* treatment differed only in that, prior to voting in each round, subjects participated in up to 90 seconds of electronic written communication. The method of communication was a “chat” (i.e., “instant message”) program embedded in the software for the public goods game. Subjects were informed that they could enter any kind of text message as long as it did not allow anyone else to identify them (e.g., age, race, or appearance) and as long as they avoided using obscene, offensive, or inappropriate language.

## **Results**

We conducted 8 sessions involving 144 subjects divided into a total of 16 groups. There were two sessions of the baseline voluntary contribution condition (4 groups), three sessions of delegation without communication (6 groups), and three sessions of delegation with pre-voting communication (6 groups). Each subject participated in a single session of the experiment.

## Outcomes and Allocations

Figure 1 presents the average individual's allocation to the public good by treatment and over time. Recall that in Part 1 of the experiment (periods 1-5), every group plays the voluntary contribution game. The data show that the average contribution in each condition begins around 50 percent and steadily declines to around 15 percent in period 5.

Prior to period 6 we introduced our treatment variables. In the baseline condition, subjects continued to play the voluntary contribution game, and we see that average contributions decline even further—to about 1 percent in period 20. The declines in Part 1 for all conditions and in Part 2 for the control condition are consistent with previous findings in the literature, which gives us confidence that our parameter values provide a sufficiently strong incentive for free riding.

As the other two conditions reveal, delegation dramatically increases the amount of public good provided, but adding communication prior to voting does not appear to have any additional effect.<sup>7</sup> In both delegation treatments, the average allocation to the public good is substantially closer to the socially optimal level and never drops below 79 tokens. The three solid horizontal lines in Figure 1 indicate the average individual allocations consistent with our hypothesized delegation outcomes: social efficiency (100 tokens), the stage game equilibrium (800 total / 9 members  $\approx$  89 tokens), and majority tyranny (400 total / 9 members  $\approx$  44 tokens). While the average allocations in both delegation treatments at first bounce between the socially efficient and stage game equilibrium levels, they appear to settle down at a level consistent with the stage game equilibrium level after 6 periods of play in Part 2.

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<sup>7</sup> We also conducted two sessions of a voluntary contribution game with communication at the beginning of every period so that we would have a complete 2x2 factorial design. We found that communication is not sufficient to achieve socially efficient outcomes when contributions are voluntary, but it does slow the rate of decrease in contributions.

Although Figure 1 suggests that groups tend to play the stage game equilibrium, such a conclusion is premature because the aggregate results in Figure 1 may hide heterogeneity in allocation vectors across groups. Figure 2 presents average allocations over time for each group in the delegation treatments. The results are striking. Of the 12 groups, two (3 and 14) achieve the socially efficient (full contributions) outcome in *every* period of Part 2 of the experiment. Seven more groups achieve it in a majority of periods (7, 8, 9, 10, 18,19, and 20). Only one group (4) fails to achieve the socially efficient outcome at all.

Figure 2 also shows the dynamics of the interactions for the remaining groups, for which there does not appear to be any consistent pattern. Group 9 achieves the socially efficient outcome for most of the guaranteed periods but the average level drops somewhat when the continuation probability falls, introducing uncertainty about whether the last period is being played. This is due to the elected allocators extracting a small personal benefit, by contributing less, in every period after Period 23 – in Period 24 the outcome is the stage-game equilibrium in which every player votes for himself or herself and the elected allocator contributes nothing while making everyone else contribute the full endowment. In contrast, the average allocation for Group 17 starts at the socially efficient level, immediately drops below the stage game equilibrium average and then again reaches social efficiency in period 19, remaining there until the end of the experiment.

Interestingly, two groups demonstrate behavior consistent with majority tyranny in at least some periods. Group 13 starts at the socially efficient level but then there appears to be a shift to majority tyranny for the remainder of the session, while Group 4 appears to alternate between the stage game equilibrium outcome and allocations near the majority tyranny outcome. In Group 13, the chat transcript reveals that the elected allocator specifically proposed the

majority tyranny strategy to a coalition of four other players (“I HAVE AN IDEA . . .It would turn us against each other though . . .I have 5 ppl give 0 and 4 give 100 and screw them . . .And I would always be leader because the vote is 5-4”).

In order to obtain a clearer picture of the observed allocation vectors and heterogeneity of outcomes across groups, we classified them into five mutually exclusive categories. An allocation is coded as a full contribution vector (FULL) if the maximum amount of the public good is provided. A stage game outcome (SG) is one in which the allocator’s contribution is 0 while the eight other players’ contribution is 100. A minimum winning coalition outcome (MWC) is one where the allocator assigns five members (including him- or herself) to contribute nothing while making four members contribute 100. A symmetric (SYM) outcome is one in which the allocator makes everyone contribute the same amount (but less than 100 tokens), and the remainder are coded as non-symmetric (NON-SYM).

The first three categories represent our hypothesized outcomes, and Table 1 shows that they account for 82.2 percent of all allocation vectors in both delegation treatments with FULL allocations accounting for 70.3 percent overall. As noted above, there are two groups (3 and 14) which *always* implement the full contribution outcome. SG outcomes are observed in two-thirds of the groups (8 groups), accounting for 7.4 percent of all allocations. Interestingly, 100 percent of allocations for two additional groups (10 and 19) are either FULL or SG; in both groups the elected allocator implemented the SG outcome in one period and was never again elected. We observe MWC allocations in two groups, and in Group 13 it is the modal outcome. However, MWC allocations account for only 4.6 percent of all allocations. SYM allocations only account for 1.6 percent.

The remaining 16.1 percent of outcomes are classified as NON-SYM. To better describe these outcomes, we determine the proportions of NON-SYM outcomes that satisfy either of two properties. First, we consider a NON-SYM allocation to reflect majority tyranny (MAJ TYR) if 4 or fewer members pay the highest amount toward the public good – though we do not include in this category MWC outcomes, which are a more precise prediction. This includes allocations where the highest amount may not be the full endowment or where the majority contributions to the public good are non-zero. Second, if the allocator uses his or her power for personal gain by contributing less to the public good than any other member – but not so extreme to classify as the SG outcome – we consider the allocator to be skimming (SKIM). Note that these properties are not mutually exclusive and that allocations with these properties are qualitatively similar to the MWC and SG allocations, respectively. The percentage of NON-SYM allocations satisfying MAJ TYR and SKIM are also presented in Table 1, which helps to describe the nature of the observed proposals. With the exception of Group 17, one or both attributes describe most of the NON-SYM allocations.

From Table 1 we obtain a better sense of the kinds of allocations implemented in the groups least able to achieve the socially efficient outcome (groups 4, 13, and 17), all of which achieved it in less than 50 percent of the periods they played. Groups 4 and 13 appear to exhibit a high degree of selfish behavior. For Group 13, this selfishness manifests itself clearly in terms of a majority benefitting at the expense of a minority: the modal category is MWC (42.1%) and when MAJ TYR allocations are considered (10.5%), these two categories account for a 52.6 percent of this group's outcomes. In contrast, Group 4's allocations are more volatile (as we noticed from Figure 2). Although only 47.8 percent of Group 4's allocations fall into either the SG or MWC categories, when we consider the NON-SYM allocations that satisfy either MAJ

TYR and SKIM, we see that a substantial portion of allocations can be categorized as some version of majority tyranny (13% MWC + 47.8% MAJ TYR = 60.8%) or as benefitting the elected allocator the most (34.8% SG + 34.8% SKIM = 69.6%).

Finally, most of Group 17's allocations do not fit into these categories. Of these three groups, they are best able to achieve social efficiency (42.9% FULL). However, they otherwise seem to be rather confused, as 47.6 percent of their allocations are neither socially optimal nor exhibit any form of the two types of selfish behavior we expected (SG and its close counterpart SKIM or MWC and its close counterpart MAJ TYR). The chat transcripts reveal what occurred in this group. Subjects repeatedly elected the same allocator and this allocator attempted to generate higher total payoffs by implementing asymmetric allocations in which some players contributed fully and others did not, and promised to rotate who benefited from this asymmetry. Despite the fact that other participants repeatedly pointed out that the symmetric full contributions outcome was socially optimal – including typing in the payoff formula in the chat screen – it took the group several periods to converge on this outcome. Note that once they reached this outcome, they remained there for the remainder of the experiment.

### **Achieving Social Efficiency: Voting and Allocator Behavior**

To better understand how groups achieved the socially efficient outcome, in this section we first present our analysis of voting to select the initial allocator, then we examine the decisions of the elected allocators in later periods and the collective choices regarding the retention of previously elected allocators.

At the beginning of Part 2, we expected that purely self-interested subjects would vote for themselves. Otherwise, they have only two other pieces of information upon which to base their

votes: members' average contributions in Part 1 and members' identification numbers. Table 2 summarizes individual voting behavior in the first period of Part 2. The upper portion presents percentages of subjects who voted for themselves, the high and low contributors from Part 1, and the member with the lowest subject ID number (we included the latter because we conjectured that there may have been ballot-order effects). The results suggest that overall, subjects mainly vote for themselves (43%) or for the high contributor (35%). Comparing the two types of delegation treatments, more subjects vote for themselves than for the high contributor in the no-communication than in the communication treatment (52% vs 33%). There are some votes for the low contributors or the subjects with the lowest ID number, although since the categories are not exclusive this may simply be the result of subjects voting for themselves.

To determine the independent effects of each variable, the lower portion of Table 2 presents the results from estimating a conditional logit choice model (McFadden 1974).<sup>8</sup> The model also controls for the average amount contributed in Part 1. The statistical analysis suggests that the effects of subjects voting for themselves and of voting for the high contributor are independent and statistically significant. We cannot reject the hypothesis that the coefficients are equal so we cannot order the two effects. Interestingly, we also find that there is a statistically significant ballot-order effect—subjects tend to vote for the group member with the lowest ID number. This effect is smaller than that of voting for self or for the high contributor (we can reject the joint hypothesis that the low ID number coefficient is equal to either the self or high contributor coefficients).

When this voting behavior is aggregated, what are the results? Table 3 presents data on the number of votes received. The upper portion displays the average number of votes received

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<sup>8</sup> The conditional logit model is similar to the multinomial logit model except that the independent variables are attributes of the choices rather than the individuals. In this model, each observation represents a potential choice and subject pair.

by certain types of group members, and it shows that the members who contributed the most in Part 1 tend to receive the most votes overall. This is not surprising given the results on individual behavior from Table 2 but this nevertheless helps us to see that the pattern is fairly typical across groups. The lower portion presents the results from a Poisson regression (for count data) that estimates the effects of contribution levels and ballot-order effects on the number of votes received by each subject. The results reinforce the conclusion that the highest contributor receives the most votes but that there is also a statistically significant ballot-order effect. (The effect of subject ID number is lower and significantly different from the effect of high contributions.)

All in all, in Period 6 seven out of twelve groups elected the high contributor while four groups elected the member with the lowest ID number—one of these was also the high contributor while two others happened to be the low contributors. Next, we turn to an analysis of the contribution decisions made by the elected allocators and whether socially efficient outcomes corresponded with the selection of the highest contributors in the voluntary rounds of the experiment.

The data presented in Table 4 clearly suggests that if groups seek to implement the socially efficient outcome, it is worthwhile for them to avoid selecting the members who voluntarily contribute the least. The upper portion of Table 4 presents the mean and standard deviation for the number of total tokens allocated to the public good (across all rounds) by one of three types of Part 1 contributors: the highest ranked, lowest ranked, and everyone else (the “middle” category). The highest ranked contributors allocated the most to the public good—very close to the socially efficient level—while middle-ranked contributors also allocated a high amount to the public good. The difference between high and middle-contributors is not

statistically significant. In contrast, low contributors allocate at least 200 tokens less to the public good than middle or high contributors and this difference is statistically significant.

The lower portion of Table 4 presents the distribution of allocation characteristics by type of contributor using the same categories as in Table 1. Again, the types of allocations chosen by high and middle contributors appear to be very similar: full contribution vectors account for 79.6 and 83.2 percent of decisions made by high and middle contributors, respectively. It is very clear that the lowest contributors are the least likely to implement the socially efficient allocation: only 12.8 percent of their allocations fall in full contribution category while 43.6 percent are characterized by some form of majority tyranny (18% MWC and 25.6% MAJ TYR) and low contributors gain at the group's expense in 53.9 percent (23.1% SG and 30.8% SKIM).

The data suggests that voting for the highest contributor helps not so much because the high contributor is the most likely to implement the socially efficient outcome but because it helps to coordinate votes in order to *avoid* selecting the lowest contributor. Our results also suggest that ballot-order can have negative side effects: two of the groups who selected their initial allocator on the basis of ballot order happened to select the lowest contributor.

But even if a group that seeks to achieve the socially efficient outcome is “unlucky” enough to select the lowest contributor in their first vote, the repeated nature of elections should in principle mitigate against less efficient outcomes in one of two ways. First, once elected, an allocator may wish to retain control of allocation decisions in future periods even though there is no intrinsic value of holding office because it prevents worse outcomes for the allocator in which he or she is excluded from future majority coalitions. The prospect of losing power in future elections should therefore decrease the likelihood that allocators select the single-shot equilibrium contribution vector. It may not, however, necessarily lead to the socially efficient

allocation if the allocator seeks re-election by implementing the best allocation for a minimum winning coalition.<sup>9</sup> The data already presented, however, suggest the prospect of future elections is insufficient to deter stage-game equilibrium outcomes or skimming, and it remains to be seen whether minimum winning coalitions guarantee an allocator's re-election.

Second, if a plurality of members wants to achieve the socially efficient outcome but the low contributor fails to implement it, they could select a new allocator in the next period. In other words, repeated elections provide a natural mechanism for correcting any previous mistakes by “throwing the bums out.”

Table 5 presents data on whether or not allocators are re-elected after each type of allocation decision. The first row shows that across all groups, allocators who implement the full contribution outcome are nearly always re-elected (96%). Consistent with the use of future elections as a corrective device, allocators who implement the stage game equilibrium outcome are least likely to be re-elected (35%). Although the re-election prospects after implementing a minimum winning coalition are better than for implementing the stage game outcome, it nevertheless falls short of guaranteeing re-election (60%). Surprisingly, the re-election rates for outcomes in the MAJ TYR and SKIM categories are relatively high (82% and 79%).

In the remaining rows of Table 5, we separate the outlier groups discussed above (Groups 4, 13, and 17) and find that the re-election patterns for these groups are quite different from the groups that achieve the socially efficient outcomes. The latter groups tend not to re-elect allocators whose decisions depart from the socially efficient outcome—9 out of 12 groups do in

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<sup>9</sup> Note that in our linear public goods environment no such minimum winning coalition would be stable (i.e., a Condorcet winner) if group members voted directly on contributions. For example, when only four members fully contribute, their payoff is 60 while the majority's individual payoff is 160. If the contributions of one of the majority's members goes from 0 to 100, then minority payoffs increase from 60 to 75 while the remaining majority members' payoffs increase from 160 to 175. Everyone except the member whose contribution increases would therefore prefer the new allocation.

fact use future elections to “throw the bums out.” In contrast, the other three (“outlier”) groups typically fail to do so. Group 17 elected the same allocator in *every* period despite failing to settle on the socially efficient outcome until the end of the guaranteed periods (as we discussed previously, this group appeared to mistakenly search for something better than the social optimum). Group 4 appears to have experienced the greatest amount of electoral insecurity as allocators were re-elected in 68% of rounds compared to the overall average of 86%. Contrary to our intuition, allocators in Group 4 were re-elected more frequently when they chose the stage-game outcome (57%) than when they chose a minimum winning coalition outcome (33%) and were re-elected even more frequently when they chose other forms of majority tyranny (91%) or when they skimmed (100%). Group 13 comes closest to our expectations of tyranny of the majority: although they always re-elected allocators who implemented the socially efficient contribution vector, they also re-elected allocators who implemented the minimum winning coalition outcome 71% of the time. This finding for Group 13 is consistent with the evidence from the chat transcript indicating that they explicitly agreed to pursue the minimum winning coalition strategy.

### **Conclusion**

We find that a version of the Hobbesian solution to the free rider problem – that is, delegation to a central decision-maker – works to achieve socially efficient outcomes. In theory, delegation might be inefficient if leads to a serious principal-agent problem, but when it is combined with frequent elections, as it is in modern real-world institutions, the problem is mitigated. Efficiency is typically achieved when voters select an initial allocator who has previously been willing to contribute to the public good.

However, we also observe a form of majority tyranny – when a majority free rides off of the contributions of a minority of group members. The outcome is clearly inequitable but a majority is better off than it would be under the socially efficient level. Groups experienced majority tyranny when they both happened to select a low contributor (sometimes due to ballot-order effects) and when they subsequently failed to replace a low contributor with a higher contributor.

Two avenues for future research seem fruitful to us. First, subsequent experiments should investigate alternative institutional arrangements and their effects on the frequency of observing social efficiency versus majority tyranny. The institutional environment that we investigated was relatively simple: a single allocator is elected by plurality rule. What outcomes would we observe in a representative democracy, where the group is divided into subgroups (i.e., districts) that elect representatives to a central committee (i.e., a legislature)? Would voting by plurality rule with a run-off increase the likelihood of achieving the socially efficient outcome? What if communication was more limited but focused on proposed allocations? Second, we should investigate whether a more heterogeneous society will lead to a greater likelihood that inequitable outcomes will be chosen – for example, where endowments or marginal benefits from the public good are distributed unequally. Our experiment has shown that delegation is quite beneficial, and we expect that future research will clarify more precisely the conditions under which social efficiency is most likely to be achieved.

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Table 1. Percentage of observed allocations in delegation conditions

Group	Chat	Hypothesized Allocations				Other Allocations					Number of Periods
		FULL	SG	MWC	Total Hypothesized	SYM	NON-SYM	MAJ TYR	SKIM	Total Other	
3	N	100	0	0	100	0	0	--	--	0	23
4	N	0	34.8	13.0	47.8	4.4	47.8	47.8	34.8	52.2	23
7	N	66.7	11.1	0	77.8	0	22.2	0	22.2	22.2	18
8	N	88.9	5.6	0	94.5	0	5.6	5.6	0	5.6	18
9	N	60.9	8.7	0	69.6	4.4	26.1	4.3	17.4	30.4	23
10	N	95.7	4.4	0	100	0	0	--	--	0	23
13	Y	26.3	0	42.1	68.4	0	31.6	10.5	0	31.6	19
14	Y	100	0	0	100	0	0	--	--	0	19
17	Y	42.9	4.8	0	47.6	4.8	47.6	4.8	0	52.4	21
18	Y	95.2	0	0	95.2	0	4.8	4.8	0	4.8	21
19	Y	94.1	5.9	0	100	0	0	--	--	0	17
20	Y	82.4	11.8	0	94.1	5.9	0	--	--	5.9	17
Subtotal	No Chat	68.0	10.9	2.3	81.3	1.6	17.2	7.0	10.2	18.8	128
Subtotal	Chat	72.8	3.5	7.0	83.3	1.8	14.9	11.4	3.5	16.7	114
Total		70.3	7.4	4.6	82.2	1.7	16.1	7.0	6.6	17.8	242

Table 2. Voting behavior in first period of delegation treatments

	Percentage of Votes		
	No Chat	Chat	Total
Self	52%	33%	43%
High contributor	41%	30%	35%
Low contributor	11%	19%	15%
Subject low ID number	13%	26%	19%
N	54	54	108

	Conditional Logit Model		
	Odds Ratio	Standard Error	p-value
Self	7.86	1.77	0.00
High contributor	4.54	1.71	0.00
Low contributor	1.84	0.71	0.12
Subject low ID number	1.95	0.59	0.03
Average Part 1 contributions	1.01	0.01	0.35
Log likelihood	-175.00		
$\chi^2$	124.59		
N	972		

Table 3. Votes received in the first period of delegation treatments

	Average Number of Votes Received		
	Total	No Chat	Chat
High contributor	2.9	3.1	2.7
Middle contributors	0.8	0.7	0.9
Low contributor	1.1	0.9	1.4
Low subject ID number	1.8	1.2	2.3
Not low subject ID number	0.9	1.0	0.8

	Poisson Regression		
	Coefficient	Standard Error	p-value
High contributor	1.31	0.28	0.00
Low contributor	0.47	0.33	0.15
Low subject ID number	0.48	0.26	0.07
Average Part 1 contributions	0.00	0.01	0.51
Constant	-0.56	0.23	0.02
Log likelihood	-140.27		
$\chi^2$	45.34		
N	108		

Table 4. Elected allocator decisions

	Allocator Part 1 Contribution Rank		
	High	Middle	Low
Tokens allocated to public good			
Mean	867.8	839.3	610.1
S.D.	103.4	167.4	242.1
Percentage of allocation types			
FULL	79.6	83.2	12.8
SG	1.9	7.4	23.1
MWC	0.0	4.2	18.0
SYM	2.8	1.1	0.0
NON-SYM	15.7	4.2	46.2
MAJ TYR	2.8	4.2	25.6
SKIM	3.7	0.0	30.8
N	108	95	39

Table 5. Allocations and re-election

Group	FULL	SG	MWC	OTHER	MAJ TYR	SKIM	Total
All Groups	96% (155/162)	35% (6/17)	60% (6/10)	76% (31/41)	82% (14/17)	79% (11/14)	86% (198/230)
4		57% (4/7)	33% (1/3)	83% (10/12)	91% (10/11)	100% (8/8)	68% (15/22)
13	100% (5/5)		71% (5/7)	100% (6/6)	100% (2/2)		89% (16/18)
17	100% (8/8)	100% (1/1)		100% (11/11)	100% (1/1)		100% (20/20)
Other Groups	95% (142/149)	11% (1/9)		33% (4/12)	33% (1/3)	50% (3/6)	86% (147/170)

Figure 1. Average individual allocations to the public good

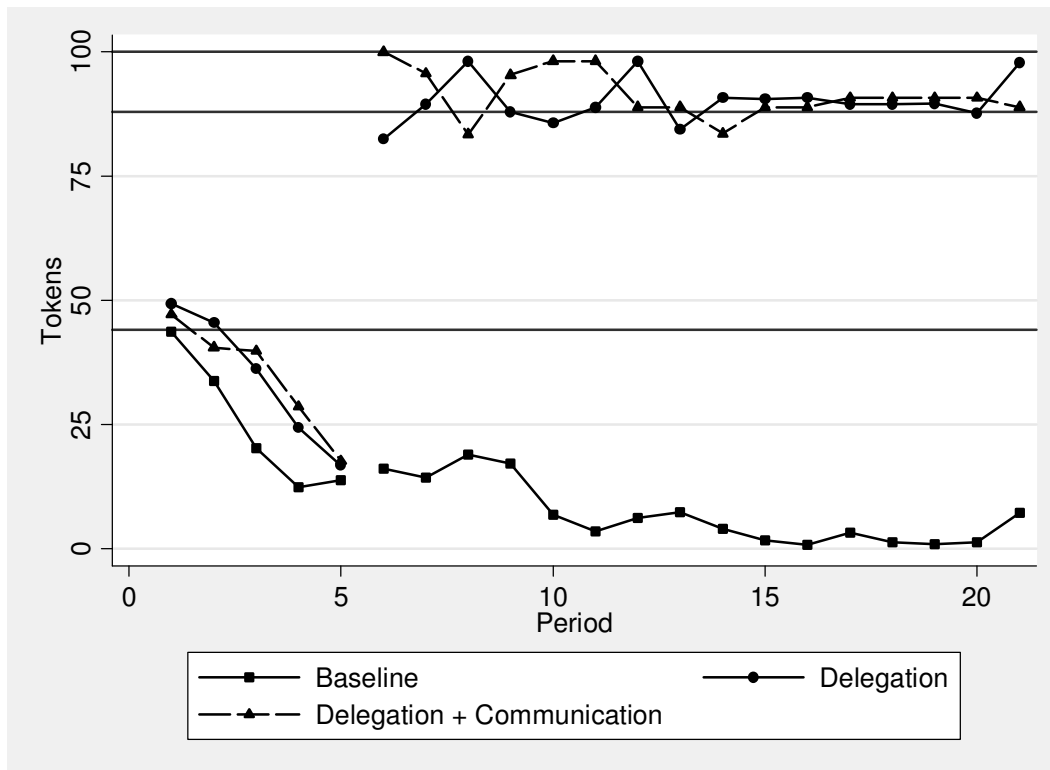


Figure 2. Public good allocations in delegation treatments by group

