POLARIZED DEMANDS FOR PUBLIC GOODS AND THE GENERALIZED VOLUNTARY CONTRIBUTIONS MECHANISM

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Abstract

We propose the Generalized Voluntary Contributions Mechanism (GVCM) where the message space includes an option to reduce the public good and the outcome space allows for its negative provision. We study the performance of the GVCM in an environment with polar heterogeneous preferences, i.e. when the public good for some players is a public bad for others. Our main treatment variables include two versions of the GVCM (censored or uncensored at positive provision) and two compositions of the polarized preferences. Uncensoring the mechanism does not impose net efficiency costs and it leads to more diversity in the provision of the public good.

Keywords: public goods, generalized voluntary contributions mechanism, experimental economics, social dilemmas

JEL classification codes: C91, C92, H41, C70, D70
I. INTRODUCTION

A number of policy environments and social issues are characterized by polar heterogeneous preferences. Such environments include gun control, abortion, gay marriage, drug legalization and choice over future energy sources (coal, nuclear, or solar). Polar preferences can be said to manifest in situations where a public good is actually a “public bad” for some subset of the population. Another example from the energy sector is the NIMBY (not-in-my-backyard) problem which has been prominent in the siting of alternative energy facilities such as biomass\(^1\), wind\(^2\), solar\(^3\), and geothermal\(^4\) power. In such cases, Coasian bargaining seems like a natural solution; but with large populations this is impractical. We carry out an experimental investigation of behavior in a public good game with polar preferences (that assumes the absence or failure of Coasian bargaining). A rivalrous public goods process emerges where individuals with positive and negative preferences contribute to two parallel activities in an attempt to secure their version of the public good.

Our experimental design extends the previous public goods literature in three main ways: 1) We allow polar heterogeneous preferences for a public good, 2) We extend the message space to include an option to reduce the public good, and 3) We extend the outcome space to allow for the negative provision of the public good.\(^5\) Nearly three decades of experimental public goods research with the traditional voluntary contributions mechanism (VCM) has censored both the message space and the outcome space at zero. We therefore call our mechanism the Generalized Voluntary

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\(^1\) During the preparation of this paper, two alternative energy biomass facilities were cancelled in the authors’ region due to NIMBY opposition (Burlew and Price [2009]).
\(^2\) The Cape Wind facility in Massachusetts is a good example. Also, wind farms are often distant from population centers and require the construction of transmission lines.
\(^3\) Woody (2009)
\(^4\) Choi (2009)
\(^5\) Negative provision of the public good can be interpreted either as negative provision of a particular public good or as the provision of an alternative public good, which part of the populations views as a public good while other participants view as a public bad. An example of the former might be the number of operating nuclear power plants. An example of the latter motivation would be polarized preferences between nuclear versus coal power plants.
Contributions Mechanism (GVCM). In our design we study groups that have individuals with two (polar) types of preferences and also investigate the effect of majority versus minority representation on behavior. We refer to the GVCM with outcomes restricted to non-negative provision (similar to prior studies) as censored and with unrestricted (positive or negative) provision as uncensored. In both cases negative messages are permitted. In the censored case the negative preference types are unable to obtain “their version” of the public good. The best outcome for the negative preference sub-group is to have zero provision of the public good. On the other hand, the uncensored mechanism allows the negative preference types to obtain their version of the public good if their contributions exceed the contributions of the positive preference types. Censored and uncensored variations may also reflect the environments with different legal constraints or beliefs about the possible range of outcomes.

Our results indicate that the level of the provision of a specific version of the public good (for example nuclear power generation) is greater in the censored treatment when an alternative is not present. The level of the provision of any public good (i.e. considering absolute value of the provision) is the same between censored and uncensored mechanisms. We do not observe significant differences in payoffs and efficiency between censored and uncensored mechanisms. This indicates that allowing an alternative does not impose net efficiency costs on the society and it leads to more diversity in the provision of the public good in the presence of polar heterogeneity in preferences.

We find differences in individual behavior between the censored and the uncensored versions of the GVCM. Subjects with negative valuations become more active in the uncensored treatments compared to the censored treatments. The effect of majority vs. minority type depends on the respective strengths in preferences. When the absolute value of preference parameters for the public good is the same, the majority type is more active. In treatments where the minority type has
stronger preferences, the “vocal” minority is significantly more active. We find evidence of sub-group optimum solution concept in subjects contribution decisions indicating that in the environment with polar preferences subjects are likely to form a sub-group identity even without priming.

Section II explains the features of GVCM with greater detail and speaks to the significance of such generalization. Section III elaborates on our experimental design and the implementation of censored and uncensored GVCM. We also apply a standard public choice treatment of concentrated benefits and diffuse costs or vice versa, a characteristic that seems common to many naturally occurring policy environments. Section IV presents aggregate and individual results. Section V offers concluding remarks and extensions.

II. POLARIZED PREFERENCES AND THE GENERALIZED VOLUNTARY CONTRIBUTIONS MECHANISM (GVCM)

This paper is part of a renewed interest in the impact of heterogeneity on public goods provision. In addition to a swell of new empirical research in this area, experimentalists have introduced heterogeneous decision-makers with respect to endowments and valuations. Generally

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6 This is not intended to slight earlier considerations of heterogeneity in public goods provision. Indeed, there would be no need for Samuelson’s famous critique of Lindahl pricing (1954) if common knowledge existed that all individuals held identical preferences for the public good. In such a case, individuals could calculate optimal Lindahl taxes by introspection. But, because individuals have, as private information, heterogeneous preferences Samuelson conjectures on the impossibility of obtaining enough information to calculate the optimal tax. This conjecture was eventually proven by Hurwicz (1977). The seminal research on demand-revealing mechanisms for providing public goods admitted the possibility that individuals possessed heterogeneous, and even polarized, valuations (Groves and Loeb [1979], Tideman and Tullock [1976]). In one treatment of his field experiment Tideman (1983) offered his subjects an either/or choice. Attiyeh, Franciosi, and Isaac (2000) report an experimental test of the pivot mechanism with what we call here polarized valuations. Ledyard, in his 1995 survey reports six experimental public goods papers which study heterogeneity: Bagnoli and McKee (1991), Brookshire, et al. (1989), Fisher et al, (1995), Marwell and Ames (1979, 1980) and Rapoport and Suleiman (1993). None of these papers had polarized preferences, although in Brookshire et al. demand curves were downward sloping and marginal benefit could turn negative at very high levels of provision. Palfrey and Prisbrey (1997) induced identical positive valuation of the public good for each individual, but they induced different valuations for the private good, meaning that, in their linear payoff structure, moving a token of investment from the individual exchange to the group exchange sometimes had a net negative return.

7 The literature on how diversity impacts public goods provision was ignited by Alesina, Baqir, and Easterly (1999) in their research that showed that aggregate public goods provision is inversely related to diversity. Experimental research has focused on different endowment levels with the general result that endowment heterogeneity leads to lower aggregate provision in public goods games (Rapoport and Suleiman; van Dijk et al. [2002]; Cherry et al. [2005]; Reuben and Riedl [2009]). Alternative evidence exists (Chan et al. [1999]); however, confounding treatments make it
these empirical and experimental research projects have demonstrated that heterogeneity lowers the aggregate public good provision. Mechanisms that overcome this weak provision usually involve heterogeneous actors sorting into groups with some salient homogeneous characteristic. Our experiment departs from this literature by inducing more intense heterogeneity of preferences; also, we do not investigate sorting mechanisms to overcome lower aggregate provision. Instead, we consider a setting where polarized decision-makers engage in a rivalrous provision process.

What is typically assumed in much of the existing research on public goods is that, although valuations for the public good may be heterogeneous, the public good is nevertheless a “good” for everyone (i.e. no individual receives negative marginal utility from an additional unit of provision of the public good). This restriction to positive valuations need not be the case in naturally occurring circumstances. Consider a voluntary contributions fund-raising drive for the purpose of planting more trees in a public park. There is no reason to believe that all individuals will consider the number of trees in the park to be a “good” public good. Some people may be allergic to the pollen of the proposed trees, or value the treeless open space for informal football (or futbol) games. We therefore consider polar heterogeneity.

What is clear from this example is that the typical VCM process, even though it is often modeled with quasi-linear utility and thus admits the possibility of negative valuations, is inadequate for extracting information about such negative valuations. This is because the VCM has a censored message and output space. No citizen, even if they considered trees in the park a “bad,”

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8 Consider sorting mechanisms such as the Tiebout Model. Much of the literature has focused on whether or not people move in order to match the goods and services provided by some geographical area with their preferences. In such cases, when movement occurs, does the overall level of public goods provision increase? Laboratory evidence suggests that allowing movement improves contributions in a congestible public goods game (Ehrhart and Keser [1999]) and the effect is strengthened when there are rules about restricted entry (Ahn et al. [2008]). Gunnthorsdottir et al (2010) utilize the Group-Based Meritocracy Mechanism to sort people by contribution levels. They find that even with different endowment levels overall contributions improve after sorting.
can contribute a negative amount to the fund drive. (Attempting to remove cash from the volunteer’s fund-raising basket would either not be possible or could lead to a legal action.) Instead, such a person’s messages are censored at zero. Likewise, the outcome of a typical VCM cannot result in a negative provision of trees (i.e., existing trees will not be uprooted). The best outcome an individual with negative valuations can hope for is the status quo.

Although individuals with negative valuations for the public good cannot take money out of the collection box, they are not typically helpless. As mentioned above, sorting mechanisms are a possible solution to overcome polarized differences in individual desires to provide public goods. Yet, when the domain of a policy is far-reaching, opportunities for sorting or exit are limited. We argue that, in such cases, individuals with negative valuations will contribute to a parallel VCM whose purpose is to seek other means to reduce the size of the public good. In the tree example, individuals with negative valuations would contribute to a VCM, but instead of the public good being money to plant trees, this alternate public good might be organizing for a county statute to prohibit the planting of the trees, or to support a political candidate who prefers to remove existing trees to create space for open fields.

In order to allow for a laboratory investigation of policies with the rich set of possibilities described above, we introduce the Generalized Voluntary Contributions Mechanism (GVCM), as follows:

$N$ individuals are endowed with $z$ tokens each, and can allocate them among three options:

1 ) Keep tokens in an individual account
2 ) Allocate $x \geq 0$ tokens to public account $X$, which *increases* the size $G$ of the public good
3 ) Allocate $y \geq 0$ tokens to public account $Y$, which *decreases* the size $G$ of the public good.

The payoff to each person is:
\[ \pi_i = z - x_i - y_i + a_i G \]

where \( G \) is the provision level of the public good; \( a_i > 0 \) for individuals with positive valuations for the public good and \( a_i < 0 \) for individuals with negative valuations for the public good.

In this paper, we operationalize two versions of the GVCM. In the continuous uncensored version of the GVCM,

\[
(1) \quad G = \sum_i x_i - \sum_i y_i.
\]

In the continuous censored version of the GVCM,

\[
(2) \quad G = \max \{0, \sum_i x_i - \sum_i y_i\}.
\]

As a special case we consider a binary distribution of valuations with two types, i.e. where MPCRs are \( \{a_1, a_2\} \), or even further where \( a_2 = -a_1 = a \). This can be seen to create a tension between two sub-groups not unlike the idea of group rent seeking (recently examined by Abink, et al [2009] and Ahn, Isaac, and Salmon [2011]). Theoretical predictions depend on the number of individuals with corresponding MPCRs and are presented in the next section for our experimental design. We conduct a broad baseline to examine the performance of the GVCM in the cases of both homogenous and heterogeneous valuations. We further examine what institutional and environmental modifications will exacerbate the rent-seeking tendencies in the presence of intra-group conflicts.

### III. EXPERIMENTAL DESIGN

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9 The GVCM can admit discontinuous (provision point) production processes, which is out of the scope of this paper and we hope to investigate at a later date.

10 In a rent seeking context, individuals or group are typically modeled as seeking a unique prize, such as a government-enforced monopoly franchise. Differential “effort” affects the probability of obtaining or keeping the prize, but not the size of the prize. And although it is not required in a rent-seeking context, it is typically assumed that the utility of winning the prize is positive, while losers suffer no disutility. In this research, the payments are continuous, and the relationship between contributions and outcomes is not stochastic. And, final payoffs can be either positive or negative.

11 \( x_i^+ \) and \( x_i^- \) refer to contributions to the \( x \) account (increase) by a player with positive and negative MPCR respectively. The notations for \( y_i^+ \) and \( y_i^- \) are similar. Own profit maximization will always lead to \( x_i = y_i^+ = 0 \).
Our research is built on a 2 x 2 design, with the main treatment variables being the censorship of the mechanism and the composition of MPCR\textsuperscript{12}, as depicted in Table 1. Also denoted in this table are the number of completed sessions and the number of subjects per treatment. The levels of MPRCs determining the incentive structure across individuals, sub-groups (all those within a group that have the same preferences), and groups are also shown in the table. With a token kept in the individual account being paid at a one-to-one basis, an MPCR < 1 creates the typical free-riding incentives for individuals.

<table>
<thead>
<tr>
<th>MPRCs = {.4, -0.4}</th>
<th>MPRCs = {.4, -0.8}, {-0.4, 0.8}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Censored GVCM</td>
<td>2 Sessions (36 subjects)</td>
</tr>
<tr>
<td>Uncensored GVCM</td>
<td>2 Sessions (36 subjects)</td>
</tr>
</tbody>
</table>

Table 1: Experimental design.

Each group consisted of nine subjects, \(N=9\), that were divided into two sub-groups of six and three persons, with subjects having the same MPCR within a subgroup. Each group therefore had majority and minority sub-groups, or types. The first composition of MPRCs we consider is \{0.4, -0.4\}. Based on the assignment, half of the groups were majority negative and half of the groups were majority positive. This is the case of perfectly polar preferences with each subject having the same absolute value of MPCR but some are positive and others negative; we refer to this composition as symmetric. The second composition of MPRCs is \{+/− 0.4, −/+/ 0.8\}. Here the six majority subjects have the absolute value of MPCR equal to 0.4 and three minority subjects have

\textsuperscript{12} The definition of MPCR is somewhat more constrained compared to the classic definition of Isaac, Walker, and Thomas (1984). Here. The MPCR is the marginal change in an individual’s payoffs due to a one unit increase in the level of the public good. The difference is this definition and the historical definition is due to the fact that in the censored version of the GVCM there are cases in which a one token change in an individual’s allocation will have no effect on the size of the public good.
the absolute value of MPCR equal to 0.8. There are still positive-majority and negative-majority
groups with compositions \{0.4, -0.8\} and \{-0.4, 0.8\} respectively. We refer to this environment as
asymmetric and added it to investigate the behavior when, from a social perspective, the majority
and minority subgroups are balanced, i.e. the social benefit of extra unit of G is zero. In each period,
the initial endowment of tokens for each subject was always \( z = 500 \).

Each session included 18 subjects recruited to the XS/FS laboratory at Florida State
University using the ORSEE announcement system (Greiner [2004]). Each session consisted of
four stages of five periods each with two groups of 9 participants operating simultaneously. Stages
1 and 3 involve the main treatment mechanism as specified in one of the cells in Table 1. In Stages
2 and 4, all participants have a positive MPCR equal to 0.4. Subjects were paid based upon the
outcomes of four periods: one period was randomly drawn for payment from each Stage. We
provide below the exact implementation of the design.\(^\text{13}\)

The following rotation scheme was used to construct two groups of nine individuals with
polar preferences in each period. At the beginning of Stage 1 nine individuals are randomly
assigned to have positive MPCRs and nine are randomly assigned to have negative MPCRs. The
sign of each participant’s MPCR remains the same for all periods in a given Stage.\(^\text{14}\) At the
beginning of every period the participant is randomly assigned to one of the two groups, so in some
period the participant will be in the group where his/her sign is the majority and in some periods in
the minority. In the analysis we refer to the group with six positive MPCR participants and three
negative MPCR participants as the Majority Positive group and to the group consisting of six

\(^{13}\) The concerns that went into this complex algorithm were numerous. First, because of our need to examine individuals
with negative valuations for the public good, we needed to consider the human subjects protection requirement of no
subject net losses for the session. We did not want to rely upon a design that was likely to use the default bankruptcy
rule. Simulations of various outcomes suggested that bankruptcy across the entire session was nearly impossible (this
conjecture has proven to be correct).

\(^{14}\) The reason that we did not rotate people between positive and negative MPCR types between each period is that we
were concerned that this could induce a type of “live and let live” norm in which individuals with negative MPCRs in
any one period might behave in a passive manner, knowing that their turn as a “positive” MPCR type would come
around soon. In our rotation, individuals in one stage do not yet know the details of MPCRs in future stages.
participants with negative MPCRs and three participants with positive MPCRs as the \textit{Majority Negative Group}. In Stage 2, all participants have MPCR equal to 0.4 and, therefore, homogeneous preferences for the public good. The same random re-matching process is used between periods.

Stage 3 is equivalent to Stage 1 except that all participants are assigned an MPCR with the opposite sign of what they have in Stage 1. Finally, in Stage 4 all MPCRs revert to +.4, as in Stage 2.\footnote{Our conjecture was that in naturally occurring NIMBY problems individual interactions are somewhere between the two extremes of repeated interaction: fixed matching and a rotation in which the group is always new. Thus our design creates a type of underlying community in which different subsets of individuals interact at different points in time.}

The individual (Nash) optima, sub-group optima, and social optima\footnote{Symmetric social optimum maximizes $\sum_{i} \pi_i$ and sub-group optimum maximizes $\sum_{i \in S} \pi_i$ where S is a (majority or minority) subgroup. Subgroup optima do not necessarily represent individual Nash equilibrium behavior.} for each combination are as presented in Table 2.

<table>
<thead>
<tr>
<th>GVCML/Group</th>
<th>MPCRs {maj, min}</th>
<th>Individual Optimum (Nash)</th>
<th>Social Optimum</th>
<th>Sub-Group Optimum Dynamics (Examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Censored Majority + Asymmetric</td>
<td>{+.4, -.8}</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
<td>If $x_i^+ = 500$, $y_i^- = \min{2x, 500} = 500$ $x_i = y_i^+ = 0$</td>
</tr>
<tr>
<td>Censored Majority - Asymmetric</td>
<td>{-+.4, +.8}</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
<td>If $x_i^+ = 500$, $y_i^- = \frac{1}{2}x = 250$ $x_i = y_i^+ = 0$</td>
</tr>
<tr>
<td>Censored Majority + Symmetric</td>
<td>{+.4, -.4}</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
<td>$x_i = 500$ ( + and -)</td>
<td>If $x_i^+ = 500$, $y_i^- = 500$ $x_i = y_i^+ = 0$</td>
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<td>$x_i = y_i = 0$ ( + and -)</td>
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<td>{+.4, -.8}</td>
<td>$x_i = y_i = 0$ ( + and -)</td>
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<td>$y_i = 500$ ( + and -)</td>
<td>$x_i = y_i^- = 500$ $x_i = 500$</td>
</tr>
</tbody>
</table>

Table 2: Theoretical Predictions (N=9)
There are several things to notice about these incentive structures. First, at the individual level, the standard free riding conditions hold. Secondly, in the asymmetric cases the social optimum is for each person to keep all tokens in his/her individual exchange. In the symmetric cases the social optimum depends on the censorship treatments. In the uncensored GVCM, with symmetric MPCR, total group profits are maximized when all tokens are invested in either $x_i$ or $y_i$. Of course this depends on whether positive or negative signs are in the majority (notice that the social optima make the minority participants worse off than if they put all of their tokens in their individual accounts). This same result holds for the censored GVCM where the majority of participants have positive MPCRs. However, in the censored minority case, the social optimum also occurs when all tokens are invested in the individual accounts. Finally, the sub-group optimum allocation for the negative subgroup in the censored mechanism depends on the allocation of the positive subgroup and is equal to the amount needed to offset what has been contributed by the individuals with positive MPCRs. In this setting the hypotheses generated by sub-group optimum solution concept is that negative MPCR types are more (or less) active in their contributions towards group account as shown in Table 2. If there is subgroup identity emerging in decisions, we should observe contribution levels of negative majority types to be half of contributions of positive minority types in the censored treatment.

All experiments were conducted on the z-Tree platform (Fischbacher [2007]). Each session lasted about 60-70 minutes and subjects earned about $30 on average, including a $10 show-up payment.

IV. RESULTS

We report the results of eight sessions, comprising 144 total subjects. As noted in Table 2 above, four sessions used the Censored GVCM and the other four used the Uncensored GVCM. We
start with reporting the aggregate results on the provision of the public good and then turn to individual behavior.

A. Aggregate Data

A.1. Aggregate Results on “Net Average Size of the Public Good”

Figure 1 presents the net average size of the public good. In terms of our motivating examples, for the uncensored treatments this would measure the amount of kilowatt hours of energy produced by an alternative energy technology in excess of polluting technologies or the number of new trees planted in a park minus trees cut down elsewhere to build the parking lot. The results are obtained after the GVCM process has aggregated the x and y decisions and, where required, censored the outcomes at positive provision. For expository purposes, we have broken the data between the net average size of the public good in the censored as opposed to the uncensored version of GVCM mechanism (pooling across both majority positive/negative groups and across symmetric and asymmetric preferences). The reason for focusing upon the effect of censoring is that the choice of a censored or uncensored mechanism would presumably be a political choice of the policy process (or, alternatively, some evolving social norms). One observation is immediately apparent: on average the censored mechanism yields larger net average sizes of the group project than the uncensored mechanism in all periods of Stages 1 and 3, with the effect being more prominent in Stage 3.

In Figure 1, we present the results of all four stages, including the “control” Stages 2 and 4. The results from Stages 2 and 4 demonstrate two things: first, there were no idiosyncratic differences either in composition or in hysteresis between the censored and the uncensored groups because in Stages 2 and 4 the net average sizes of the group project are virtually indistinguishable. Secondly, the results from Stages 2 and 4 demonstrates a calibration of our experimental procedures (instructions, screen displays, etc.) in an environment in which there is robust experience with the
performance of the standard VCM. Figure 1 demonstrates that participants behave essentially as expected in a standard VCM. Therefore, unless otherwise specifically noted, we will confine our discussion of aggregate results to the treatments stages, Stages 1 and 3.

FIGURE 1 ABOUT HERE

We have a limited number of data points for statistical analysis if we assume that period observations are not independent. However, we believe that the rotation scheme we employed can be utilized, as a first approximation, to conduct simple OLS ANOVA regressions pooled across all five periods in a stage as a check upon what is visually represented in this and subsequent figures. In all cases, a full exposition of each of the regression results is contained in Appendix A.

In terms of the net average size of the public good, the statistical tests are consistent with the visual impression in Figure 1. The simple (or “main”) effect of censoring is positive in both cases, but statistically insignificant in Stage 1 ($p = 0.60$) and statistically significant in Stage 3 ($p = 0.00$). The simple effect of “negative majority group” was negative and statistically significant in Stage 1 (coefficient = -1298.20, $p = 0.00$) and in Stage 2 (coefficient = 471.8, $p = 0.06$) in Stage 3. No other effects were significant.

A.2. Aggregate Results on “Absolute Level of Public Goods Provision”

It is important to emphasize that Figure 1 reflects two statistical realities. First, each observation reflects contributions to the two accounts (“increase” and “decrease”) that are netted according to the rules for the production of the public good in that session to produce the final size of the public good for that group for that period and then averaged to produce the graph. Secondly, in the censored treatments, by definition, the censoring rule is in force, while in the uncensored series the positive and negative provisions are symmetrically netted. We investigate the level of provision further by comparing what we call “the absolute level of public goods provision”. We separate the total public good provision decisions of the majority positive and majority negative
groups and then multiply the latter by negative one. This transformation maps the (often) “negative” provision of the majority negative groups in the uncensored treatment into the positive domain thus presenting the level of public good that is desired by majority sub-group. We present data on the absolute provision level in Figure 2 by treatment and group type (pooling across asymmetric/symmetric payoff structures). This recalibration is useful if one wishes to consider the idea that the GVCM represents groups providing alternate public goods. As mentioned, we restrict here our attention to Stages 1 and 3 with polar preferences.

FIGURE 2 ABOUT HERE

As can be seen in Figure 2, the visual pattern is relatively stable for the two types of groups in the censored condition with majority positive groups providing significantly higher level of the public good except in the end of the experiment. In the censored setting the majority positive groups have a provision level typically in the range of 1000 – 1500 tokens in both stages (with slight negative trend in stage 1 and provision of about 500 in period 5), while the majority negative groups in the censored treatment are stable in providing a much lower level: (-50) – (-400) tokens. The pattern is different for the uncensored condition. Initially, in periods 1- 4, the provision level of the majority positive groups is substantially above that of the majority negative groups. The gap narrows by period 5 of Stage 1, and disappears and reverses in Stage 3. The average provision level of the negative majority groups in uncensored treatment consistently increases, eventually surpassing the average of the positive majority groups. Thus, the observation in Figure 1 that the net average provision of the public good in the uncensored treatment wanders around zero does not represent overall non-provision of the public goods. Instead, it represents, especially in Stage 3, the

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17 For expositional purposes, we say that an observation in Figure 2 is an “Average Provision Level” for each of the two types of groups in each of the two treatments.
18 Majority positive groups are depicted with lighter grey-scale line colors while majority negative groups with black lines.
19 Negative provision level on the graph reflects provision of the public good that is opposed by the majority (and preferred by the minority) subgroup.
relatively equal provision of the public good (in offsetting directions) by the majority positive and majority negative groups. It is evident from Figure 2 that the average absolute provision of public good remains around 750 and is the same for both types of mechanism, censored and uncensored. Thus, it appears to be the act of censoring \textit{per se} and not the underlying behavior of the participants, that drives the differences in the censored versus the uncensored mechanism in Figure 1.

A.3. Aggregate Results on “Total Tokens Moved”

The previous two results suggest a related datum that should interest policy-makers, namely, the total amount of resources committed to the two parallel group accounts. Under some, but not all, interpretations of this process, this measure could be analogous to the amount of rent-seeking activity. Low provision of the public good may indicate low contributions or high contributions by each subgroup and cancel each other out. We measure the magnitude of contributions by reporting absolute values of the” increase” and the “decrease” decisions and obtain a sum of total resources moved from the private account to either of the two public accounts. These results are displayed in Figure 3 for stages with polar preferences.

\textbf{FIGURE 3 ABOUT HERE}

Figure 3 shows that in all but one period more total resources are allocated to the public accounts in the uncensored mechanism. The difference is not statistically significant in Stage 1 (ANOVA) but holds in Stage 3 where the effect is driven by a statistically significant drop in total tokens moved only when a negative majority group operates in a censored environment. These results suggest a possible policy tradeoff in terms of mechanism choice in situations of polarized valuations for public goods. The censored mechanism may incite less “rent-seeking” activity in
some circumstances; however, censorship will, by definition, limit efficient social outcomes for negative majority groups.\(^\text{20}\)

A.4. Aggregate Results on “Efficiency”

We also investigate the performance of each mechanism relative to the efficiency of its outcome under free riding. We present this relative (to free riding) efficiency of the uncensored mechanism in Figure 4. The data presented in Figure 4 is calibrated so that “0 Percent” is the free riding outcome and “100 Percent” is the maximum the group could earn, ignoring the effects of the censoring\(^\text{21}\). Figure 4 obviously contains data only from the symmetric treatments.

There are two indications from this data. First, most of the polarized groups are earning less than if they all agreed to do \(x_i=y_i=0\). In VCM mechanisms with homogeneous positive MPCRs contributing subjects may earn less than free riders however this would not apply to the whole group. Second, there is no clear pattern as to which effect dominates in the mechanism choice: the greater “rent seeking” type activity in the uncensored groups or the inability of the censored groups to produce optimal negative response to the positive allocation to the public good. The regression results are quite mixed. In Stage 1, as suggested on Figure 4, being in the negative majority group is associated with a statistically significant decrease in efficiency (\(p = 0.09\)). In Stage 3, on the other hand, negative majority is no longer significant. Note that the series in Figure 4 which appears to have the highest efficiencies is that of majority positive groups in the censored condition. Indeed there are complicated interactive effects pointing in that direction (the simple censored coefficient is

\(^{20}\)With the asymmetric MPCR assignments, as seen in Table 1, the social optimum is for all tokens to be invested in the private exchange. How do the groups behave relative to a simple behavioral rule like “Maximize the amount of money that all subjects combined earn from the experimenter (in this case, the social optimum)?” In Figure C.1 in Appendix C we present data on total tokens moved (for only the asymmetric MPCR sessions) for Stage 3 (with polar preferences and free-riding as the group optimum) and Stage 4 (where all MPCRs revert to +.4 and the group optimum is full contribution. We find that the average decisions are about the same. In this analysis, we restrict our attention to Stages 3 and 4 because, as we show below, there were fewer unexpected decisions in these stages.

\(^{21}\)That is, the efficiency calculations do take account of the loss in efficiency from the inability of the censored mechanism to obtain the socially optimum outcome in cases with a negative valuation majority.
18.08, \( p = 0.01 \), while the interactive effect of being in a censored group with a negative majority is 23.90, \( p = 0.01 \).

**FIGURE 4 ABOUT HERE**

A.5. Aggregate Results on “Earnings”

With the efficiency results, we excluded the asymmetric MPCR observations because of their distinct social optimum. We can include them in an examination of total earnings\(^{22}\) (Figure 5). There is no effect of the censored or uncensored version of GVCM on average earnings. Both treatments with asymmetric composition of MPCRs result in slightly lower earnings than symmetric composition treatments, however the difference is very small. Indeed the main effect of asymmetry is a highly significant decrease in per-capita earnings of about 114 (\( p = 0.00 \)) when there are asymmetric, polarized MPCRS, but there are also numerous significant interactive effects that makes it difficult to tell a simple narrative.

**FIGURE 5 ABOUT HERE**

A.6. Further Consideration of Negative Majority Group Behavior

We have already noted the following pattern reflected in Figures 1 and 2: in the uncensored mechanism decisions begin with a bias towards positive outcomes and this bias decreases and then disappears across Stages 1 and 3. By the beginning of Stage 3 the outcomes are almost perfectly balanced between positive and negative groups, with the negative majority groups showing an actual advantage near the end. This dynamic comes in part from a greater initial difficulty by some subjects in understanding the GVCM mechanism, particularly the effect of negative MPCRs. Figure 6 tracks the incidence of “unexpected decisions,” namely, positive tokens from negative MPCR

\(^{22}\) The units of per-capita earnings are in “experimental dollars” across all ten periods, the actual dollar earnings were from the two randomly drawn periods from Stages 1 and 3.
subjects and vice-versa. Notice that the number of these unexpected decisions is much greater for individuals with a negative MPCR in the early rounds, although both decline across time.

There is another interesting result that can be gleaned from Figure 6. One long-standing question in the experimental public goods literature has been how much of the so-called “cooperative” behavior is merely an artifact of the censored message space. There have been several investigations that have looked at this question, such as designs that admit of interior Nash and/or dominant strategy equilibrium. Using the GVCM in situations where all MPCRs are positive (Stages 2 and 4) we get a direct look at that question (because negative messages are allowed). As can be seen, there are simply not many negative messages. By Stage 4 negative messages constitute only around 1 – 1.5 % of all decisions, and the data from Figure 1 shows that the standard “cooperative” outcomes still obtain.

FIGURE 6 ABOUT HERE

B. Individual Decisions

In this section we investigate the effect of the mechanism and the majority/minority role on individual behavior. Table B.1 in Appendix B reports average individual decisions (tokens moved to either group account) for each treatment.23 Note that all decisions to affect the public good, x (increase) and y (decrease), are reported in the positive domain for this comparison. For censored mechanisms the contributions of participants with positive MPCRs are significantly greater than for participants with negative MPCRs ({p<}0.01). Positive MPCR majority participants are more active than positive MPCR minority participants, although there is no effect for subjects with negative MPCR. When an alternative public good is not available, subjects opposing the provision are less active. In the uncensored mechanism there is no difference between the behavior of positive and negative majority. Therefore, in the censored treatments, for both compositions of MPCRs, there

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23 We pool data from Stages 1 and 3.
are significant effects of majority/minority and positive/negative roles, while the effect (of both) is not significant in the uncensored treatments. We find asymmetry in the effect of the type and the composition of MPCRs. In the symmetric uncensored treatment, the negative majority group is significantly more active than negative minority, while there is no significant difference for the positives. In the asymmetric uncensored treatment there is no significant effect of the majority/minority role.

These findings are further confirmed by the OLS regression results presented in Table 3. The dummy variables reflect the mechanism (censored=1) and MPCR (positive=1) types and well as majority subgroup.

<table>
<thead>
<tr>
<th></th>
<th>MPCRs = {.4,−.4}</th>
<th>MPCRs = {.4,−.8}, {−.4,.8}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Censored</td>
<td>-14.81 (30.55)</td>
<td>-5.12 (31.17)</td>
</tr>
<tr>
<td>Positive</td>
<td>-74.51** (32.02)</td>
<td>-29.06 (35.99)</td>
</tr>
<tr>
<td>Majority</td>
<td>-36.05 (32.99)</td>
<td>-51.70 (43.55)</td>
</tr>
<tr>
<td>Cen*positive</td>
<td>-5.40 (47.11)</td>
<td>-42.05 (45.28)</td>
</tr>
<tr>
<td>Cen*majority</td>
<td>-97.00* (47.34)</td>
<td>-91.29** (40.69)</td>
</tr>
<tr>
<td>Pos*majority</td>
<td>71.32 (50.43)</td>
<td>77.90 (58.78)</td>
</tr>
<tr>
<td>Cen<em>pos</em>majority</td>
<td>181.48** (68.92)</td>
<td>139.31** (72.85)</td>
</tr>
<tr>
<td>Constant</td>
<td>197.86 (26.91)</td>
<td>228.03 (20.27)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1440</td>
<td>1440</td>
</tr>
<tr>
<td>(R^2)</td>
<td>.04</td>
<td>.04</td>
</tr>
</tbody>
</table>

Standard errors (in parentheses) are clustered on individual level.

**\(p<0.05\), *\(p<0.10\)

**Table 3: Regression Results: allocation towards group account.**

The dependent variable is the number of tokens allocated to affect the size of the group project. We report separate regressions for the symmetric and the asymmetric compositions of MPCR.
For both compositions of MPCRs, a positive majority is significantly more active in the censored treatment ($p<0.05$). This effect of positive MPCR types allocating more ($p<0.05$) is only present in the majority role in the censored treatment indicating further that when an alternative public good provision is possible those who prefer it are just as active. The minority is relatively more active in the censored treatment ($p<0.05$). In the $\{+/-0.4, +/-0.8\}$ treatments the effect of minority being more active in the censored treatment is significant at a higher level.

Significantly lower contributions by majority negative types in censored treatment is consistent with one of the three solution concepts we considered: sub-group optimum. Subjects considered themselves part of majority or minority type even without priming. Because the majority/minority distinction could be viewed as a source of group identity, the formation of identity through institutions such as communication and voting and how those exacerbate or mitigate inter-group competitions in public good provision are central treatments for future research. Results indicate that when an alternative is present, people become more active in expressing their preferences against the provision of the public good and allocate more resources to the provision of an alternative public good.

V. CONCLUSIONS AND EXTENSIONS

Despite numerous applications to policy environments “polar heterogeneous” preferences for public goods have received limited exploration. This paper contributes to the emerging theoretical, empirical and experimental research on public goods with heterogeneous preferences by allowing the public good to be a “good” for some individuals but “bad” for others.

We introduce the Generalized Voluntary Contributions Mechanism which, compared to the standard VCM, extends the message space to include an option to reduce the public good and extends the outcome space to allow for the negative provision of the public good. We obtain the
incentive properties of the mechanism in the presence of polar preferences, and investigate its performance using laboratory experiments.

Our main treatment variables are 1) the censored or uncensored variations of GVCM, which allow for negative provision of the public good or censor the provision at zero respectively, and 2) the composition of MPCRs. We also investigate the effect of majority vs. minority representation in the group. We find that in the presence of polar heterogeneous preferences the level of provision of any public good is the same for censored and uncensored treatments. In the uncensored mechanism (which can be envisioned either as a process for negative provision of a single public good or as a case in which provision of an alternative is available) opponents of the default public good become more active.

The overall efficiency levels of the censored versus the uncensored mechanism are similar. We believe this lack of difference between the censored and uncensored treatments suggest two countervailing effects. In the uncensored treatment there is more competitiveness between groups seeking to provide their version of the public good. Thus, there are more resources burned in this process. However, if the environment is characterized by a censored outcome space and there are a majority of people with “negative preferences” they are never able to obtain their version of the public good. More resources burned versus disallowing certain beneficial outcomes represents an interesting tradeoff between the censored and uncensored rules of play. We find evidence of subgroup optimum solution concepts in subjects decisions in the censored treatment. The result suggests that in the presence of polar preferences subjects of each type are more likely to consider the benefits for their whole group (even without priming). We expect the effect of sub-group identity to be stronger in natural environments that involve specific identity encouragement.

Extensions to current work include examining how adding various political and social contexts to this environment exacerbate or attenuate contributions decisions in the GVCM.
Specifically, we hope to utilize the GVCM mechanism to further study the NIMBY problem as a conflict between people with polar heterogeneous preferences. In the past hierarchical approaches to siting unwanted facilities resolved this conflict; but, more participatory approaches require different rules to handle these conflicts. Communication and voting are two commonly proposed rules thought to attenuate conflict by building consensus and trust (Kunreuther et al, 1991; Magat and Schroeder 1984). But, it is possible that communication and voting may exacerbate conflict by enhancing identification with the in-group. Further extensions include adding the spatial component of NIMBY and inducing heterogeneous endowments; both of these features seem to be critical to the literature on siting unwanted facilities. These treatments aim to push the institutional environment of the laboratory closer to the naturally-occurring context while maintaining the control which is the hallmark of laboratory experiments.

ACKNOWLEDGMENTS

This research was supported by the Florida State University Institute for Energy Systems, Economics, and Sustainability (IESES) and by the John and Hallie Quinn Eminent Scholar Chair. We thank Sean Collins for invaluable programming assistance. Many helpful comments have been provided by participants in presentations at the FSU xs/fs weekly seminar, the Southern Economics Association, the 2010 ASSA Convention, and the 2010 ESA World Meetings in Copenhagen.

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24 The Chen and Li (2009) procedure for generating identity within the laboratory involves voting followed by communication.
REFERENCES


Figure 1: Average net size of the public good by period: censored versus uncensored treatments (pooled across positive/negative majority and symmetric/asymmetric payoff structures).
Figure 2: Average provision level by group type and treatment in periods with polarized preferences (pooled across symmetric/asymmetric compositions of MPCR).
Figure 3: Average total tokens moved in periods with polarized preferences: censored versus uncensored treatments (pooled across positive/negative majority and symmetric/asymmetric payoff structures).
Figure 4: Efficiency relative to free riding in periods with polarized preferences (pooled across positive/negative majority but excluding groups with asymmetric preferences). The efficiency measures are normalized so that the efficiency at the free riding outcome is 0.
Figure 5: Average earnings by treatment (pooling across positive/negative majority). In this figure, the data are pooled across equivalent periods in Stages 1 and 3.
Figure 6: Unexpected decisions by period (pooled across symmetric/asymmetric payoff structures).

NG_N – negative MPCR player in Negative Majority group

PG_N – negative MPCR player in Positive Majority group

NG_P – positive MPCR player in Negative Majority group

PG_P – positive MPCR player in Positive Majority group

(note: group type in Stages 2 and 4 is redundant since all subjects have MPCR=0.4; it is carried over from identity in immediately preceding stage merely for reference).
APPENDIX A: OLS ANOVA regression results for aggregate decisions.

The ANOVA regressions for Figures 1-5 take the following general form:

\[ y = f(CONSTANT, CEN, NM, AS, CEN*AS, AS*NM, CEN*NM, CEN*AS*NM) \]

where \( y \) is the dependent variable of interest in the figure, \( CEN \) is a dummy variable which takes the value “1” for the censored institution, \( NM \) is a dummy variable which takes the value “1” for a group with a majority of individuals have negative MPCR5S, and \( AS \) is a dummy variable which takes the value “1” for the asymmetric MPCR condition. The interactive variables are defined likewise. The condition of a positive-majority group with symmetric MPCR5S in an uncensored session have “0s” all across and thus can be considered the reference condition.

There are two further explanations required. Table 4 excludes the asymmetric sessions, so there are no \( AS \) values. And, the regressions in Table 5 were conducted on aggregate earnings, whereas for expositional purposes Table 5 in the text is notated in per-capita earnings. For brevity, the adjusted R-squares are in brackets below the Figure name and the coefficients of the constants are in brackets below the dependent variable. P-values are in parentheses. Coefficients with a P-value < 0.10 are denoted with bold.

<table>
<thead>
<tr>
<th>Figure</th>
<th>Depend. Var.</th>
<th>( CEN )</th>
<th>( NM )</th>
<th>( AS )</th>
<th>( CEN*NM )</th>
<th>( CEN*AS )</th>
<th>( NM*AS )</th>
<th>( CEN<em>NM</em>AS )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-St 1</td>
<td>Net Size [1002.1]</td>
<td>131.1 (0.60)</td>
<td>-1318.7 (0.00)</td>
<td>31.6 (0.90)</td>
<td>307.7 (0.40)</td>
<td>-131.9 (0.71)</td>
<td>132.5 (0.71)</td>
<td>181.1 (0.72)</td>
</tr>
<tr>
<td>1-St 3</td>
<td>Net Size [413.2]</td>
<td>921.7 (0.00)</td>
<td>-1298.2 (0.00)</td>
<td>292.7 (0.24)</td>
<td>140.4 (0.69)</td>
<td>-390.3 (0.27)</td>
<td>-177.4 (0.62)</td>
<td>294.9 (0.55)</td>
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<td>2-St 1</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
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<tr>
<td>2-St 3</td>
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<td>N.A.</td>
<td>N.A.</td>
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<td>N.A.</td>
<td>N.A.</td>
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</tr>
<tr>
<td>3-St 1</td>
<td>Moved [1986.9]</td>
<td>40.3 (0.89)</td>
<td>-69.5 (0.80)</td>
<td>-21.2 (0.94)</td>
<td>-614.9 (0.12)</td>
<td>-139.1 (0.73)</td>
<td>341.3 (0.39)</td>
<td>-71.2 (0.90)</td>
</tr>
<tr>
<td>3-St 3</td>
<td>Moved [1613.6]</td>
<td>129.5 (0.66)</td>
<td>211.4 (0.47)</td>
<td>387.5 (0.19)</td>
<td>-1089.7 (0.01)</td>
<td>-270.3 (0.51)</td>
<td>-302.2 (0.47)</td>
<td>683.7 (0.25)</td>
</tr>
<tr>
<td>4-St 1</td>
<td>Efficiency [-14.5]</td>
<td>2.2 (0.78)</td>
<td>-13.9 (0.09)</td>
<td>NA</td>
<td>-0.2 (0.99)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>4-St 3</td>
<td>Efficiency [-20.7]</td>
<td>18.1 (0.01)</td>
<td>6.6 (0.27)</td>
<td>NA</td>
<td>-23.9 (0.01)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>5-Pooled</td>
<td>Earnings [3528.9]</td>
<td>521.79 (0.02)</td>
<td>-199.16 (0.38)</td>
<td>-1032.3 (0.00)</td>
<td>-654.9 (0.04)</td>
<td>-401.9 (0.21)</td>
<td>108.66 (0.73)</td>
<td>1200.98 (0.01)</td>
</tr>
</tbody>
</table>
Appendix B. Individual decisions.

Table B.1. Average allocations towards group account.

<table>
<thead>
<tr>
<th></th>
<th>Censored .4/.4</th>
<th>Uncensored .4/.4</th>
<th>Censored .4/.8</th>
<th>Uncensored .4/.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>negative minority</td>
<td>34.43 (26.77)</td>
<td>81.37 (35.10)</td>
<td>79.5 (26.80)</td>
<td>160.41 (28.76)</td>
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<tr>
<td>positive minority</td>
<td>103.13 (23.69)</td>
<td>123.35 (23.14)</td>
<td>151.8 (26.64)</td>
<td>198.97 (33.14)</td>
</tr>
<tr>
<td>negative majority</td>
<td>50 (16.54)</td>
<td>161.81 (23.16)</td>
<td>79.93 (16.8)</td>
<td>176.33 (20.41)</td>
</tr>
<tr>
<td>positive majority</td>
<td>228.89 (17.45)</td>
<td>158.63 (19.32)</td>
<td>226.02 (17.66)</td>
<td>225.17 (16.96)</td>
</tr>
</tbody>
</table>
Figure C.1: Total resources moved in stages with different social optimum.