WHEN PUBLIC GOODS GO BAD:
AN INTRODUCTION TO EXPERIMENTAL RESEARCH
ON HETEROGENEOUS DEMANDS FOR PUBLIC GOODS

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PREFACE: A FABLE FOR OUR TIME (AND A TRUE STORY)

Tallahassee, Florida is in many ways a typical, progressive American university/state capital city. It voted overwhelmingly for Al Gore, John Kerry and Barack Obama. And in the recent past, it engaged in a spirited debate on a proposal to loosen city ordinances that restrict the ability of the municipal electric utility to generate electricity from coal.

During the coal debate, the possibility of so-called "alternative energy" generation was widely discussed. So, it seemed only natural that in January 2007 the local newspaper, the *Tallahassee Democrat*, praised the decision of the City Council and Florida State University to work together with a private corporation to build an alternative energy, biomass electric generation facility at an industrial park. The newspaper said that the plant "fit the bill neatly" as the type of action the community endorsed during the coal debate, with a view towards " 'green' energy" alternatives to coal. The editorial was replete with references to the Kyoto Protocol, reductions in global warming, and "thinking globally and acting locally."

In October of 2008, the state Department of Environmental Protection announced that it intended to issue a permit for the plant. It might seem surprising, therefore, that having received the approval of the city, one of the city's two universities, and the state of Florida, that only three months later, in January 2009, the private company involved in the plant, BG&E, pulled out. In shutting down the project, the company issuing an angry letter in which BG&E President S. Glenn Farris attacked Tallahassee's civic leadership, specifically calling the behavior of a County Commissioner "disgraceful"… "demagoguery, fear mongering, and race bating." The commissioner in question in turn called the demise of the facility a "victory" for Tallahassee.

If the biomass facility had passed such obvious political and legal hurdles as the city council vote, the cooperation of the university, and the DEP permitting process, what had happened? What had happened was that the biomass proposal had split the city of Tallahassee, and (most remarkably) the local environmental community, over the issue of environmental protection. On one side, represented by the *Democrat's* initial editorial, were those who saw the plant as providing environmental benefits from a carbon-emissions perspective. On the other side were neighbors of the proposed facility (and their representatives) who saw the plant as little more than an "incinerator" emitting a "toxic plume" near their homes. The story of the ultimate success of the opponents of the plant was not in winning any legislative or regulatory victories in the formal process for siting power facilities. Instead, the opponents organized for action outside these narrow channels. In addition to making their opposition well-know through local political channels, they petitioned (unsuccessfully) for the federal Environmental Protection Agency to withhold federal funds from the state DEP. They lobbied (successfully) for the empanelling of a county grand jury to investigate the agreements behind the biomass plant.

The tenor and the intensity of the debate can be seen, in part, from the headlines on editorials and opinion pieces in the *Democrat*: "Clean Deal" and "If Not Biomass, What?" on the one hand, and "Biomass Plant May Kill More Black Babies" on the other. Apparently there was one thing upon which both sides could agree. One resident in the neighborhood of the plant said, "I don't have a problem with them, I just have a problem with them being right there." And, as the executive editor of the *Democrat* said, "No, I wouldn't like a power plant of any type in my

neighborhood either. But these plants are going to have to go somewhere – and soon – to save the planet and reduce our reliance on foreign oil."[1]

I . INTRODUCTION

This research is designed to address economic issues behind the so-called NIMBY ("Not In My Backyard") problem in the provision of public goods. The issue is certainly well-known among the practitioners of public policy, and the underlying economic paradigm, heterogeneous valuations for a public good, is a standard part of the economics of public goods. However, there are two aspects of the NIMBY problem that motivate this research. First, many of the current proposals to address issues in alternative energy production are likely to be subject to NIMBY concerns. The Preface to this paper described a case study involving a biomass electric generating facility, but similar problems could be anticipated with wind power[2], solar power,[3] with electric transmission lines connecting remote wind or solar power facilities, or with small scale, locally-sited structures for "smart grid" improvements to the electric grid. Recently, even alternative-energy geothermal projects have received opposition because of a reported risk that such projects can trigger local earthquakes (Choi [2009]).

Heterogeneity of valuations for public goods is foundational to economic analysis. Nothing in the requirement for collective consumption of a public good requires that valuations

[1] The narrative for the story of the biomass plant is documented in a number of articles, editorials, and opinion pieces in the Tallahassee *Democrat*. In Appendix I, we provide a listing of the citations we quote and reference for this section.

[2] A well-known example is the fight over the Cape Wind project off of Cape Cod Massachusetts. Not only did the project face opposition from famous residents on Nantucket, but on November 1, 2009, the *New York Times* reported that the Wampanoag Native American tribe had files an application with the Department of Interior claiming a cultural right to an unobstructed vista across Nantucket Sound.

[3] Consider the following exchange (reported in "Desert Vistas vs. Solar Power" (Woody[2009])) regarding efforts by California Senator Diane Feinstein to limit solar facilities in California's Mojave Desert. Sen. Feinstein said, "'The Catellus lands were purchased with nearly $45 million in private funds and $18 million in federal funds and donated to the federal government for purposes of conservation, and that commitment must be upheld. Period.'" This following reply came from solar entrepreneur Robert F. Kennedy, Jr.,"' This is arguably the best solar land in the world, and Senator Feinstein shouldn't be allowed to take it off the table without a proper and scientific environmental review.'"

for the good be identical. Indeed Samuelson's famous (1954) critique of Lindahl pricing would make no sense if it were common knowledge that all of the individuals were identical in all respects affecting preferences for the public good. In such a case, introspection by any one of the individuals would be sufficient to calculate the optimal Lindahl taxes. It is precisely because individuals have, as private information, heterogeneous preferences that Samuelson conjectures on the impossibility of obtaining enough information to calculate the optimal taxes (a conjecture that was proven formally by Hurwicz [1977]).

Both theoretical, field-empirical, and laboratory experimental economics have addressed the issue of preference heterogeneity as a central concern for research on public goods. As just one example, Alesina, Baqir, and Easterly open their (1999) field empirical paper with the statement "When individuals have different preferences, they want to pull fewer resources together for public projects." Although early laboratory experimental tests of the voluntary contribution mechanism (VCM) induced identical preferences, by the time of Ledyard's 1995 survey there were already several papers that had incorporated heterogeneity either in endowment levels or in valuations for the public good.

What is typically assumed is that, while individual valuations for a public good are heterogeneous, the public good is nevertheless "good" for everyone. That is to say, no individual has $\frac{\partial u_i}{\partial G} < 0$, where u_i is agent i's utility index, and G is the level of provision of the public good.[4] (Notice, for example, that a standard Cobb-Douglas utility function can not easily accommodate valuations of the sort $u_i = AX^{\alpha}(-G)^{\beta}$.) But this restriction to positive valuations

[4] In an experimental paper, Palfrey and Prisbrey [1997] have identical positive valuation of the public good, V, for each individual, but they induced different valuations for the private good, r_i, meaning that, in their linear payoff structure, moving a token of investment from the individual exchange to the group exchange had a net negative return. One area in which it has been explicitly considered that the public good could be a public bad has been in the quasi-linear environment of "pivot" processes for demand revelation (see Tideman and Tullock [1976] and Attiyeh, Franciosi, and Isaac [2000])

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 games. This is another example of ultra-heterogeneous valuations for a public good, similar to a biomass plant, an electric power substation, or a nuclear power plant. 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 player can contribute a negative amount. (If a player were to put his hand in the volunteer's fund-raising basket and attempt to remove cash, either that would not be possible or he could face legal action.) Instead, such a player'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 being uprooted). The best outcome a player with negative valuations can hope for is the status quo.

We introduce here a generalization of the VCM that allows for the possibility of both positive and negative messages and positive and negative provision of the public good. Such a platform allows for an analysis of a broad range of questions introduced above, including forming the basis for our investigation of the NIMBY problem in facilities siting. In Section II, we introduce our Generalized Voluntary Contributions Mechanism (GVCM), and we state our research questions. In Section III, we discuss the specifics of the experimental design of the current research. Some very preliminary data (too sparse to admit of any statistical analysis) is presented in Section IV. Section V offers conclusions and our directions for future research.

II . THE GENERALIZED VOLUNTARY CONTRIBUTIONS MECHANISM (GVCM)

Consider again the tree-planting scenario from the previous section. We argue that in such cases an individual with negative valuations for the public good cannot take money out of the collection box, but neither is he helpless. What we argue is 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, the person with the negative valuation 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 open fields in the parks to the trees. Notice that this parallels nicely the actions of the opponents of the Tallahassee biomass plant as described in the Preface. In order to capture this possibility in the laboratory, 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* tokens to public account *X*, which *increases* the size *G* of the public good

3) Allocate *y* tokens to public account *Y*, which *decreases* the size *G* of the public good.

Given the provision level of the public good, *G*, the payoff to each person is:

$$\pi_i = z - x_i - y_i + a_i G$$

where $a_i > 0$ 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 censored* version of the GVCM,[5]

$$G = max\ \{0,\ \Sigma_i x_i - \Sigma_i y_i\}.$$

In the *continuous uncensored* version of the GVCM,

$$G = \Sigma_i x_i - \Sigma_i y_i\ .$$

As a special case which can be applied to binary distributions of valuations we consider a case where MPCRs are $\{a_1\ ,\ a_2\}$ or even further where $a_2 = -a_1$. The latter environment corresponds to a NIMBY situation in which some individuals have positive valuations and some have negative valuations over *G*. 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[2009]).[6] One of our key goals is to 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 NIMBY conflicts. Such modifications will include procedural issues such as voting and group discussion.

III . INITIAL EXPERIMENTAL DESIGN

Each session consists of 18 subjects recruited to the xs/fs experimental economics laboratory at Florida State University. Each session consists of four stages of five periods each.

[5] The GVCM can admit discontinuous (provision point) production processes, which we hope to investigate at a later date.

[6] 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.

At the beginning of the session, nine of the individuals are assigned identical positive marginal per-capita returns, MPCRs, (a_i), and nine are nine are assigned identical negative MPCRs ($-a_i$).[7] In stage 2, all of the individuals are assigned identical positive MPCRs ($a_i > 0$) . In Stage 3, all individuals are assigned the opposite MPCR from Stage 1 (so subjects with $a_i > 0$ in Stage 1 have MPCR = $-a_i$ in Stage 3, and vice-versa). In Stage 4, all individuals, once again, have positive MPCRs ($a_i > 0$). As will be discussed at more length below, the MPCRs are assigned as a treatment variable across sessions, with a_i either .3 or .4. In each period, the initial endowment of tokens for each subject was $z = 500$. All experiments were conducted on the z-Tree platform (Fischbacher [2007]).

The following rotation scheme was used to construct two groups of nine individuals in each period. In Stages 1 and 3, in each period the computer randomly creates one group with six individuals with positive MPCRs and three individuals with negative MPCRs. We will refer to this as the Majority Positive group. Therefore, it follows that a second group is created consisting of six individuals with negative MPCRs and three individuals with positive MPCRs. We will refer to this as the Majority Negative Group. The rotation pattern is kept the same, but new group assignments are made each period. Also, each individual keeps the same MPCR within a stage, but Stage 3 MPCRs are the opposite of Stage 1. In Stages 2 and 4 the same remixing algorithm is used to reassign groups each period (based upon an individual's Stage 1 identity). But in Stages 2 and 4, both groups consist of nine individuals each having a positive MPCR in each period.

[7] 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 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. Subjects were paid based upon the outcomes of one randomly drawn period identity in each stage. Thus, each individual received a $3.00 initial endowment plus participation in two stages in which all individuals were assigned positive MPCRs. Simulations of various outcomes suggested that bankruptcy across the entire session was unlikely (and so far this conjecture has proven to be correct).

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.

Finally, our conjecture was that in naturally occurring NIMBY problems individual interactions are somewhere between the two extremes of repeated interaction with exactly the same individuals and a rotation in which everyone is always a stranger. Thus our design creates a type of underlying community in which different subsets of individuals interact at different points in time.

Two versions of the GVCM were constructed: the censored version in which production of G must be non-negative, and the uncensored version in which G can be either positive or negative. The next issue we had to address was the actual level of the MPCRs, because this parameter determines the incentive structure of the experiments across individuals, sub-groups

(that is, all those in the sub-group that have the same preferences), and groups. 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. With the two different versions of the GVCM and with MPCRs = +/- .3 or +/- .4, the individual, sub-group optima, and social optima are as presented in Table 1.

		Individual Optimum (Nash)	Sub-Group Optimum	Group Optimum
Censored GVCM Majority +	MPCRs = + .3 and - .3	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = 0$ (min.)	$x_i = y_i = 0$
Censored GVCM Majority -	MPCRs = +.3 and - .3	$x_i = y_i = 0$	$x_i = 0$ (maj.) $y_i = 0$ (min.)	$x_i = y_i = 0$
Censored GVCM Majority +	MPCRs = + .4 and - .4	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = ?$	$x_i = 100$ $y_i = 0$
Censored GVCM Majority -	MPCRs = + .4 and - .4	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = ?$	$x_i = 0$ $y_i = 0$
Uncensored GVCM Majority +	MPCRs = + .3 and - .3	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = 0$ (min.)	$x_i = y_i = 0$
Uncensored GVCM Majority -	MPCRs = + .3 and -.3	$x_i = y_i = 0$	$x_i = 0$(maj.) $y_i = 100$ (min.)	$x_i = y_i = 0$
Uncensored GVCM Majority +	MPCRs = +.4 and - .4	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = 100$ (min.)	$x_i = 100$ $y_i = 0$
Uncensored GVCM Majority -	MPCRs = + .4 and - .4	$x_i = y_i = 0$	$x_i = 100$(maj.) $y_i = 100$ (min.)	$x_i = 0$ $y_i = 100$

Table 1: Incentive structure

Notice that the sub-group optimum is not well-defined for the negative MPCR participants in the censored mechanism with their MPCRs = -.4. This is because the outcome that

is optimal for the negative sub-group is contingent: it equals the amount needed to exactly offset whatever amount has been contributed by the individuals with positive valuations.

Our current research program involves a 2 x 2 design, over mechanism and MPCR, as depicted in Figure 2. Also denoted in this figure are the sessions we have currently conducted.

	MPCRs = + and - .3	MPCRs = + and - .4
Censored GVCM	1 Session Completed (18 subjects)	
Uncensored GVCM	1 Session Completed (18 subjects)	

Table 2: Roadmap of the experimental program.

As we accumulate data in the intended cells, we will initially address five research questions.

First and Second, we will compare the results in Stages 2 and 4 to the historically typical pattern of a standard VCM where individuals all have positive preferences. The results from the sessions with MPCRs equal to + and - .3, will interesting because, unlike in most existing experiments, the social optimum is for none of the public good to be provided. Likewise, the uncensored GVCM sessions allow us to look at whether individuals with positive MPCRs and whose message space is not truncated at zero will ever choose to submit a negative message. The issue of truncation of the message space has long been of concern in linear VCM games.

Furthermore, there are several dimensions of cross-treatment comparison that will be of interest, including: a) decisions in the censored versus the uncensored mechanism; b) decisions

by individuals who are in the majority versus those who are in the minority; and c) behavior of individuals with positive versus negative evaluations.

IV . PRELIMINARY RESULTS

We report the results of two sessions completed to date, comprising 36 total subjects. As noted in Table 2 above, one session used the Censored GVCM and the other used the Uncensored GVCM. Both sessions employed MPCRs equal to + and - .3 . The results are displayed in Figures 1-4, with the data presentation organized as follows. Each of the figures represents, in order, one of the four stages. Each figure contains two panels. The left panel displays the results from the censored GVCM session, the right panel displays the results from the uncensored GVCM session. Each data point is the *per-capita* contribution (on both the positive and negative sides) to the two group accounts. The code for the data key is as follows: In Stages 1 and 3, "PGR_Npc", for example, means that the data point is from a **P**ositive MPCR Majority **Gr**oup, looking at the individuals with a **N**egative MPCR, on a **p**er **c**apita average basis. In Stages 2 and 4, the lines are simply the net per-capita average contributions.[8]

With this limited number of completed sessions, analysis of these data is neither feasible nor instructive. What is demonstrated here is that our GVCM can be successfully operationalized, forming the testbed for a research program into issues of heterogeneous demand for public goods and the NIMBY problem.

V . CONCLUSIONS AND EXTENSIONS

[8] Of the 360 observations in Stages 2 and 4 so far, only 5 involved an individual submitting a "negative" contribution (two of those were for 1 token). The graphs simply display the net per-capita contributions (positive in all cases).

The Not In My Backyard phenomenon is a reality in industrial facilities siting, and as such it can be expected to be important in the siting of so called "green energy" facilities. Indeed, this paper has documented that this has already been the case. Approaching the NIMBY problem requires analyzing instances in which a public good has extremely heterogeneous values, to the point that the good is a "good" for some individuals and a "bad" for others. This is an economic environment with only a limited amount of exploration in experimental economics.

We present here a new mechanism, the Generalized Voluntary Contributions Mechanism, to model collective action in the presence of greatly heterogeneous valuations for public goods. This paper derives the incentives properties for several parameterizations of that mechanism, and demonstrates that laboratory experimental research with the mechanism is not only possible but useful through the results from two initial sessions.

The first stage of our research program, reported here, will focus upon benchmark and calibration analysis of the GVCM in a standard environment. In the next phase of our research, we intend to examine how various political contexts to the environment can affect the provision of the competition for countervailing collective activity.

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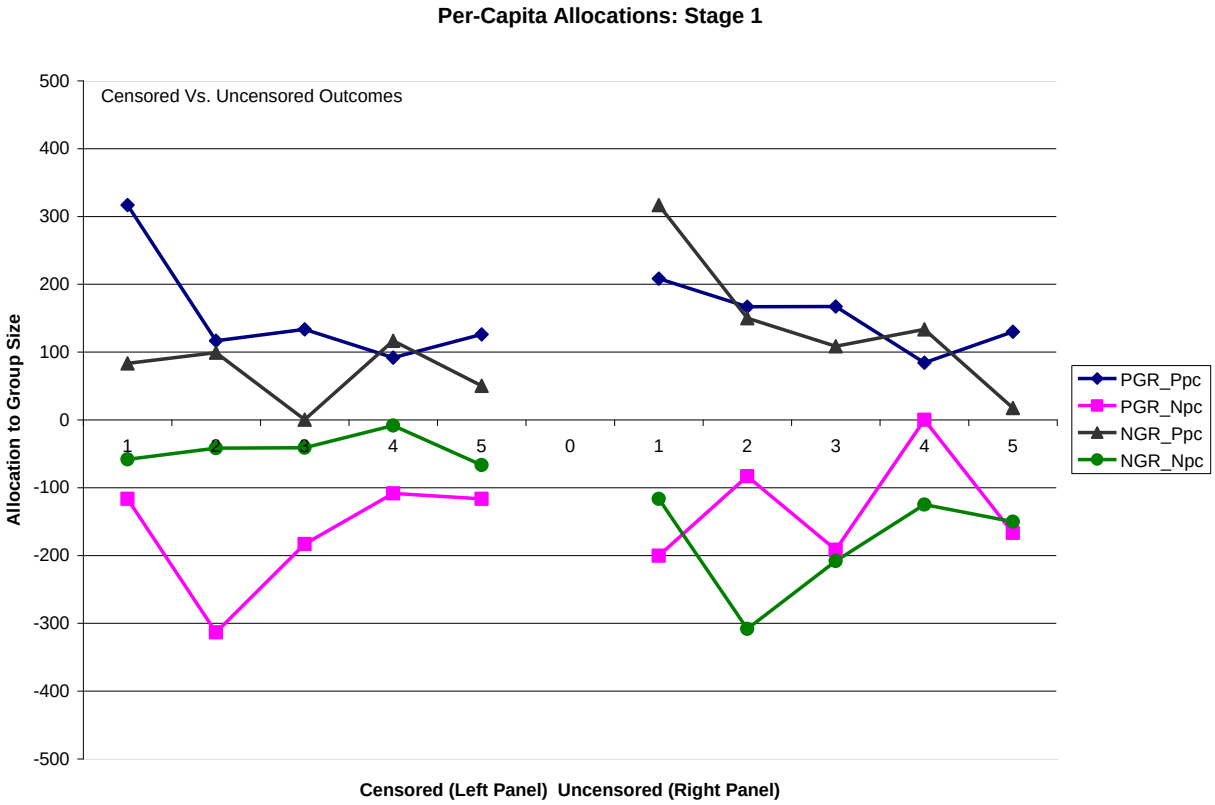
Per-Capita Allocations: Stage 1
Censored Vs. Uncensored Outcomes
Allocation to Group Size
500
400
300
200
100
0
-100
-200
-300
-400
-500
1
4
5
0
1
2
3
4
5
PGR_Ppc
PGR_Npc
NGR_Ppc
NGR_Npc
Censored (Left Panel) Uncensored (Right Panel)

Figure 1

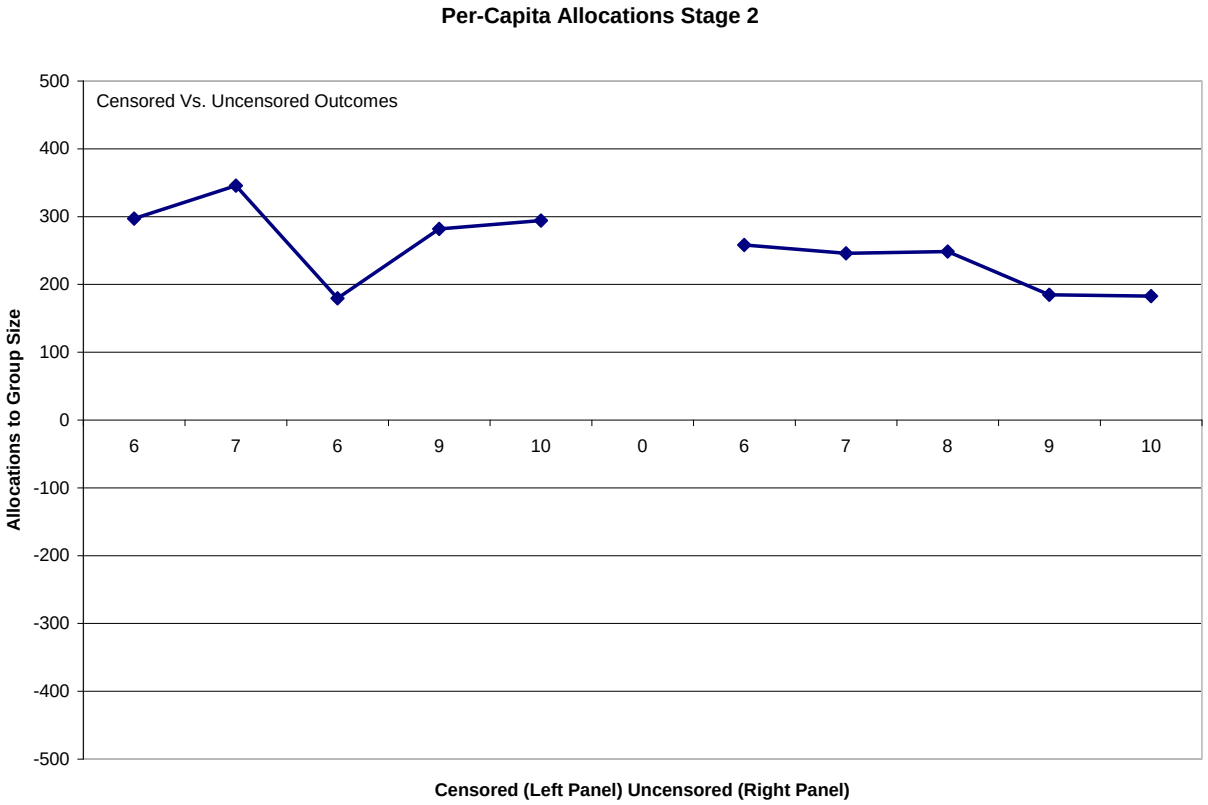
Per-Capita Allocations Stage 2
Censored Vs. Uncensored Outcomes
500
400
300
200
100
0
-100
-200
-300
-400
-500
Allocations to Group Size
6
7
6
9
10
0
6
7
8
9
10
Censored (Left Panel) Uncensored (Right Panel)

Figure 2

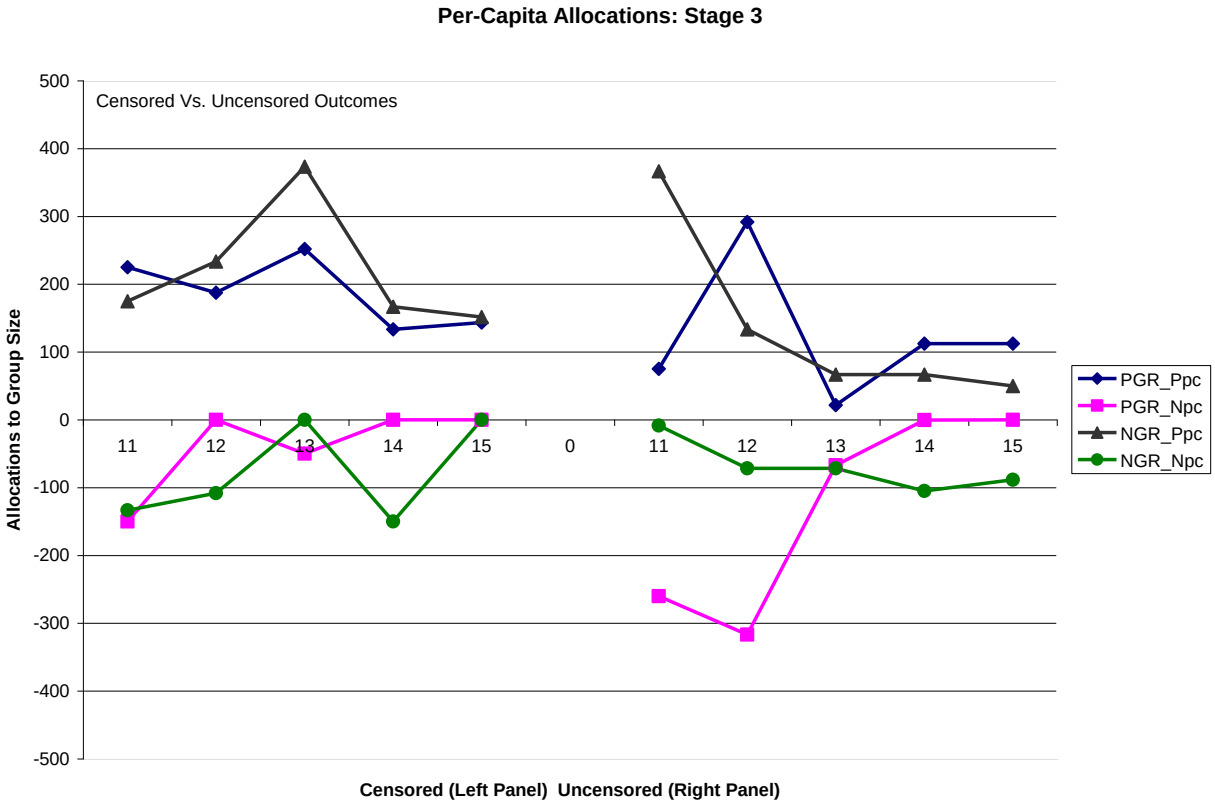
Per-Capita Allocations: Stage 3
Censored Vs. Uncensored Outcomes
Allocations to Group Size
500
400
300
200
100
0
-100
-200
-300
-400
-500
11
12
13
14
15
0
11
12
13
14
15
Censored (Left Panel) Uncensored (Right Panel)
PGR_Ppc
PGR_Npc
NGR_Ppc
NGR_Npc

Figure 3

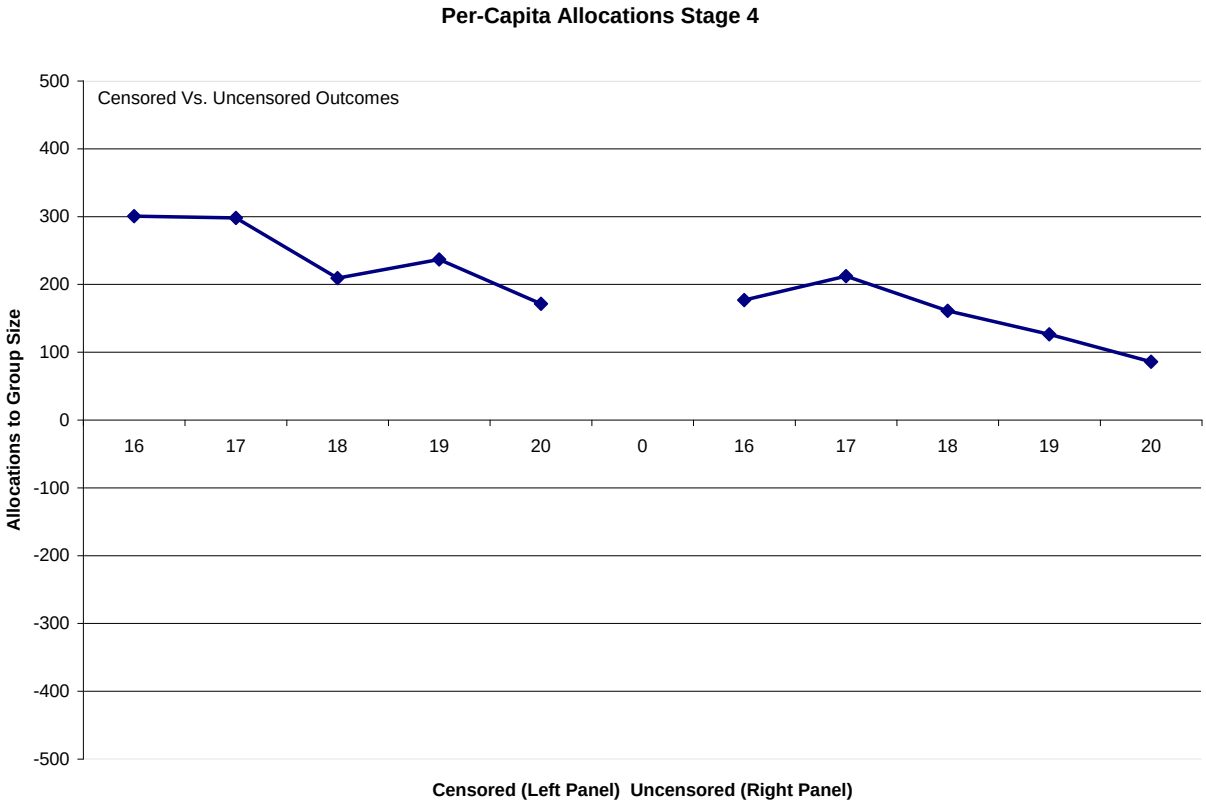
Per-Capita Allocations Stage 4
Censored Vs. Uncensored Outcomes
Allocations to Group Size
500
400
300
200
100
0
-100
-200
-300
-400
-500
16
17
18
19
20
0
16
17
18
19
20
Censored (Left Panel) Uncensored (Right Panel)

Figure 4

APPENDIX

The sources for the events in the preface are stories, editorials, and opinion pieces from the Tallahassee *Democrat*, and were accessed from the *Democrat's* archive at www.tdo.com (payment and registration required). The following sources were quoted or cited in the Preface.

1) "Clean Deal" , unsigned editorial, January 26, 2007: details on the City Council and Florida State University agreements, "…fit the bill…", "Kyoto," "…thinking globally and acting locally…", etc.

2) "DEP to Permit Biomass," Bruce Ritchie, October 28, 2008.

3) "Biomass Debate Coming to a Boil," Bruce Ritchie, November 19, 2008. "Incinerators." "Plume of toxins."

4) "Biomass Plant May Kill More Black Babies," opinion piece, Edward Holifield, November 20, 2008.

5) "If Not Biomass, What?" signed editorial, Bob Gabordi (Executive Editor), December 2, 2008. "I wouldn't want a power plant of any type in my neighborhood, either. But…"

6) "NAACP Challenges Biomass Site," Bill Cotterell, December 6, 2008. Request for EPA to withhold funds from Florida DEP.

7) "Biomass Plant Pulls Out," Jeff Burlew and Stephen D. Price, January 24, 2009. Letter from BG&E President. " 'Victory' for Tallahassee." "I don't have a problem with them…." Information to be presented to grand jurors.