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Abstract
Recent papers show that in group decisions individuals have social preferences for efficiency and equity. However, the effect of social preferences on voting, the predominant funding mechanism for public goods, has not been thoroughly examined. This study investigates whether voting decisions are affected by the distribution of net benefits associated with a proposed public program using a new Random Price Voting Mechanism (RPVM). Theoretical and econometric analysis of experimental results presented in the paper suggest that observed differences from selfish voting are caused by a concern for social efficiency, and that voting may be more efficient than previously thought.

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Majority-voting rules are used extensively in modern democracies, by representative legislative bodies and in ballot initiatives (referenda), to determine the provision of public goods. Such programs and their funding often impose unequal costs and benefits on individuals. If voters have social preferences, we should expect their decisions to be influenced by the perceived or actual impact of the voting outcome on others. For instance, a strong supporter of a school bond may be worried that voting yes on the associated tax may impose costs on the elderly that exceed their benefits. The elderly may worry that by voting no they hurt kids even though their own children are grown.

Mounting evidence from the fields of experimental and behavioral economics suggests that, indeed, at least a portion of individuals exhibits social preferences in the form of social welfare or equity concerns (see, for example, Fehr and Schmidt, 1999, Bolton and Ockenfels, 2000, Charness and Rabin, 2002, Engelmann and Strobel, 2004, and Fehr, Naef, and Schmidt, forthcoming). This study seeks to better understand the behavior of individuals in voting situations, introduces a new voting mechanism, details its theoretical properties and empirical performance, and using it, discerns which theory(ies) of social preferences best explain behavior. In the next section, we introduce the issues with a set of experiments that demonstrate that individual decisions under a majority-voting rule are inconsistent with the prediction of the rational selfish voter model. Two treatments are compared. In the first, groups of three participants vote for or against a proposal that has a uniform tax (cost) but provides one of three levels of known, different benefits (heterogeneous values) to each participant – high, medium, and low. In the second treatment, all participants pay a uniform tax and receive the same benefits (homogeneous values) if the program receives a majority vote. This experiment shows that a voter facing the prospect of a low benefit and high cost of provision is more likely to vote for the program if others stand to receive benefits that exceed the cost of the good. Similarly, high benefit voters are more likely to vote against a proposal that costs less than their value if the proposal imposes a cost above value on others. In other words, there appears to be a systematic voting anomaly borne from an individual's assessment of the impact of the program on others.

One way of exploring the origins of this observed voting behavior would be to collect a large number of yes/no (dichotomous) votes for a particular program but at varying implementation costs to trace out the demand function and estimate the tax level at which various individuals switch their vote. The sample sizes required for this approach are cost-prohibitive. As an alternative, we propose in Section 3 the Random Price Voting Mechanism (RPVM), which is best thought of as a generalization of the Becker-DeGroot-Marschak (BDM) mechanism (1964). The RPVM extends the private good BDM mechanism to public goods. A proposed public good is implemented whenever a majority of individuals indicate a maximum willingness to pay (WTP) greater than or equal to a randomly selected price. In that event, all subjects must pay the random price.[1] Thus, in contrast to the dichotomous choice format, which crudely bounds an individual's value and only yields a yes or no data point, the RPVM elicits a point estimate of the value of the good to subjects. Yet, its coercive tax feature closely parallels real ballot initiatives. Furthermore, the RPVM is less complex than incentive compatible public goods funding mechanisms, such as the Smith (1979) Auction and the Groves-Ledyard (1977) mechanism.

In Section 3, we show that the mechanism is incentive compatible in expected utility theory for selfish individuals and develop theoretical predictions of behavior for four alternative types of social preferences, and for both WTP and WTA with both gains and losses. Voting behavior and the empirical properties of the mechanism itself are explored experimentally with a design described in Section 4.

Experimental results are presented in Section 5. We report four key findings. First, the RPVM elicits preferences that are consistent with observed dichotomous (yes/no) votes. Second, we show that behavior under the new mechanism is consistent with theory, which predicts truthful demand revelation in groups of one or when a program results in equal distribution of benefits to all members of a group (regardless of the type of social preferences postulated). Third, no evidence of a WTP/WTA discrepancy is found. Finally, an econometric analysis of voting patterns leads us to conclude that voters in our experiments were motivated by the appeal of their own potential gains as well as by a concern for the overall efficiency of proposed programs (consistent with altruism as defined by Bergstrom, 2006). These findings suggest that voting may be more efficient than previously thought.

The paper contributes to the literature in several ways. It demonstrates experimentally the presence of behavioral anomalies in dichotomous voting. It introduces a new public goods mechanism and analyzes its theoretical properties. The application of the mechanism demonstrates its demand revealing properties under all four Hicksian measures of welfare change and makes it possible to identify econometrically which type of social preferences most powerfully explain observed voting behavior.

The results and their implications for public policy, future research, and the overall efficiency of voting are further discussed in conclusion.

I. Evidence of Distributional Effects on Voting Decisions

A thin empirical literature on the determinants of voting patterns in real ballots suggests the presence of non-selfish considerations in the voter's decision-making process (Mueller, 1989;

Deacon and Shapiro, 1975). In this section, we use simple dichotomous (yes/no) voting laboratory experiments to show that voting anomalies exist. These experiments, as well as the RPVM experiments discussed later, were conducted at the Cornell University's Laboratory for Experimental Economics & Decision Research using students drawn from undergraduate business and economics classes.

The first experiment employed 174 subjects to explore the effects of heterogeneous versus homogeneous values on voting (see Appendix A for experiment instructions). All subjects were placed in groups of three voters and given an initial endowment of $10. In each decision task, the subject was assigned one of three possible induced values: $2, $5, or $8, which was the amount that the individual would receive if the majority of group members vote in favor. Each participant made six voting decisions where her own value, the value of other group members, and the implementation cost varied across decisions. Exactly one participant received each of the $2, $5, and $8 values in heterogeneous value decisions. To minimize learning effects, only one voting outcome was binding and this was randomly determined after all decisions were made.

In one set of sessions participants faced heterogeneous distributions of values (Table A1 in Appendix A). In the second set of sessions participants faced homogeneous and heterogeneous distributions of values (Table A2 in Appendix A). The order of decisions was reversed in individual sessions within each set (see Appendix A for details). Variations in the level of the uniform tax were set to favor detection of non-selfish behavior. A $7.50 tax was used to examine the behavior of voters with an induced value of $8, taxes of $4.50 and $5.50 were imposed on participants with a $5 induced value, while a $2.50 tax was utilized to examine responses from those with a $2 induced value.

Figure 1 provides a comparison of voting in homogenous and heterogeneous conditions by subjects with a \$2 induced value facing a \$2.50 tax and those with an \$8 induced value facing a tax of \$7.50. When \$2 subjects were in homogenous value groups (\$2,\$2,\$2), 5.7% of subjects voted in favor of the program compared to 18.6% in the heterogeneous value case (\$2,\$5,\$8). Using a t-test, this difference is statistically significant at the 1% level. For \$8 value subjects facing a uniform tax of \$7.50, 86.4% vote in favor of the program when everyone stands to gain \$8 while only 73.3% vote yes when the distribution of benefits is (\$2,\$5,\$8). This difference is significant at the 3% level.

In contrast, the behavior of the \$5 value individuals is quite similar across homogeneous and heterogeneous settings, yielding no statistical differences at tax rates of either \$4.50 or \$5.50. In particular, for the higher cost of \$5.50, 8.2% of subjects voted yes in the homogeneous treatment, while 12.2% votes yes in the heterogeneous treatment (p=0.505). For the lower cost of \$4.50, 92.3% votes yes in the homogeneous treatment, while 84.6% votes yes in the heterogeneous treatment (p=0.288).

The detection of statistical differences in the behavior of the \$2 and \$8 subjects across value settings suggests that distributional considerations impact the utility of voters and their choices. In the heterogeneous value case, a tax of \$7.50 would impose a loss of \$2.50 on subjects with a \$5 value and a loss of \$5.50 on subjects with a \$2 value. The results suggest that subjects are concerned that they may impose losses on others (either all others, the "average" other subject or the worst of them). Such a voting pattern is consistent with the conjecture made by Johannesson et al (1996) in a study on the value of statistical life employing votes for hypothetical safety programs. They argued that pure altruism (consistent with efficiency in most studies) implies that high value voters will alter their votes in consideration of other voters who stand to gain less (or even lose). Similarly, the results for the $2 subjects would be consistent with those voters getting positive utility from the gains of others. As Bergstrom (2006) reminds us "If we are to count the sympathetic *gains* each obtains from the other's enjoyment of the shared public good, then we should not forget also to count the sympathetic *losses* each bears from the share of its costs paid by the others" (p. 399).

II. The Random Price Voting Mechanism and Behavioral Predictions

In this section, we formally introduce the Random Price Voting Mechanism and develop theoretical predictions of bidding behavior for it. For ease of exposition, we focus the presentation on the case where the game is played in the WTP for gains domain, and for the case where individuals have "social welfare" motives (Charness and Rabin, 2002). These results are readily extended to the other three Hicksian measures (WTP to avoid a loss and WTA a loss or forego a gain) and for three other forms of preferences considered in this paper. Once the results for the social welfare function have been established, we briefly discuss these extensions. Behavioral predictions for all permutations are summarized in Table 1.

The mechanism proposed here combines the incentive compatible properties (under expected utility maximization) of the private goods BDM with a majority voting rule. In the BDM, a person is asked to provide a signal of their WTP for an object. If a randomly drawn price is no greater than the individual's signal, the individual buys the good at the random price. If the price is higher, no transaction takes place.

For expected utility maximizers, the "second price" property of the BDM mechanism eliminates the incentives for strategic bidding, making truthful revelation of one's value for the object a dominant strategy. This is confirmed by experimental tests (Irwin et al. 1998). The traditional BDM mechanism, however, cannot readily be used to elicit the value of a public good. Anyone in a group of players might alter his signal (free-ride) if the object was a non-excludable good and only one buyer is required for all to enjoy full benefits. While the RVPM maintains the second price property, it is necessary to add an allocation rule that prevents strategic behavior. We do this with a majority rule. In addition to being a simple and familiar approach to collective decision-making, laboratory experiments have shown that majority voting can be incentive compatible (Plott and Levine, 1978) like more general binary choice approaches (Farquharson, 1969).

A. The RPVM

The RVPM works as follows: N individuals are asked to signal the maximum amount of money they would be prepared to pay for a program defined by a known vector $\prod = \left(\pi_1, \pi_2, ..., \pi_N\right)$. In the WTP for gains domain, π_j represents the individual benefits to be received by individual j if the program is implemented.

The public program that is submitted to a "vote" has two components: 1) the induced values $\prod$ and 2) a transfer payment (C) from individuals to the implementing authority. This cost (uniform tax) is randomly drawn from a distribution with probability density p(C) over the interval $[0, C_{\max}]$, after individuals have signaled their WTP. In what follows, we refer to individual i's signal as his "bid" and denote it by B_i.

For implementation of the program, a majority of individuals (>50%) must have expressed a WTP that exceeds a per-person cost C. If a majority of bids are greater than or equal to C, individual i receives a monetary payoff $\pi_i - C$ (the sum of which could be negative) to be added to an initial endowment Y for a utility level $U_i = u_i(Y + \pi_i - C)$. If the majority of bids are below C, the program is not implemented and subjects retain their initial endowment for utility $U_i = u_i(Y)$. We assume that U is increasing.

B. Value Revelation as a Dominant Strategy of Selfish Players

It can readily be argued that a self-interested individual has a weakly dominant strategy to choose the truthful signal $B_i^* = \pi_i$. The demonstration proceeds from a standard second price argument. As Karni and Safra (1987) and Horowitz (Forthcoming) demonstrate, the simpler BDM is not always incentive compatible outside of the expected utility framework. For this reason, we limit our analysis to expected utility.

We denote a vector of strategies chosen by the N-1 other players by B_{-i}.[2] For our purposes, however, it will be sufficient to characterize an admissible strategy profile simply by the pair of numbers (B_m, B_k). B_m is defined as the $(N+1)/2$ th largest bid in the vector. In other words, the interval $[B_m , B_k]$ defines the range over which the bid of voter i makes this individual the median voter. For N=3, this is the smallest of the two bids in B_{-i}; for N=5, it is the third largest of four, and so forth. B_k is defined as the $(N-1)/2$ th largest bid in B_{-i} (for N=3, B_k is the largest of the other two bids, for N=5 it is the second largest, and so forth.). Note that for odd N, $B_m < B_k$.

To establish that $B_i^* = \pi_i$ is a weakly dominant strategy we must establish that $EU_i(B_i = \pi_i, B_{-i}) \geq EU_i(B_i \neq \pi_i, B_{-i}) \forall B_{-i}$ in the $(N-1)*(N-1)$ strategy space of the other players. We proceed by considering different subsets of this space, and for each, demonstrating that no strategy exists for player i that provides greater utility than $B_i = \pi_i$ (π_i is fixed throughout).

Case 1: $\pi_i \le B_m$ **(**$< B_k$**), Decreasing** B_i

In the first subset of B_{-i} strategy profiles, we group all profiles for which $\pi_i \le B_m$ **(**$< B_k$**)**. First, we consider the possibility of decreasing a bid from $B_i = \pi_i$ to a smaller amount. Since $\pi_i \le B_m$, a majority of players can be found among the other players to fund any project with a random cost $C \le B_m$. Therefore, a reduction in B_i leaves the probability that the program will be implemented unchanged at $\int_0^{B_m} p(C)\, dc$. Furthermore, for any $B_i \le \pi_i$, conditional utility levels are $u_i(Y + \pi_i - C)$ if $C \le B_m$ and $u_i(Y)$ otherwise. Thus, utility levels are also unchanged by lowering B_i. The conclusion is that for all B_{-i} such that $B_m \ge \pi_i$, there are no gains (nor any losses) to be realized by reducing one's bid below π_i.

Case 2 $\pi_i \le B_m$ **(**$< B_k$**), Increasing** B_i

Continuing with the same subset of others' strategy profiles, we now analyze the desirability of increasing B_i beyond π_i. First, we note that since $\pi_i \le B_m$, increasing the bid beyond π_i has no consequences on *i*'s expected utility if the new bid $\tilde{B}_i \le B_m$. This mimics the argument developed in Case 1. A signal $B_i \le B_m$ does not affect the probability of funding and does not modify the conditional utility levels. Neither gains nor losses are therefore realized by increasing B_i up to and including B_m.

An increase beyond B_m will, however, decrease expected utility. For $B_m < \tilde{B}_i \le B_k$, B_i becomes the threshold bid in the sense that it defines the largest realization of C that leads to the implementation of the program. Pushing $\tilde{B}_i$ into this range increases the probability that the program will be implemented. However, any time a program is implemented where $C > B_m$, we know by the defining conditions of Case 2 that $\pi_i - C < 0$. Hence, $u_i(Y + \pi_i - C) < u_i(Y)$. These are programs that reduce player *i*'s utility. It follows that choosing $B_m < \tilde{B}_i \le B_k$ produces lower expected utility than the strategy $B_i = B_m$ which, we have already established, yields the same expected utility as the strategy $B_i = \pi_i$. This establishes that $B_i = \pi_i$ is strictly superior to $B_m < \tilde{B}_i \le B_k$ against profiles characterized by $\pi_i \le B_m$.

Finally, consider $\tilde{B}_i > B_k$. For all such strategies, B_k is the threshold value of *C* leading to implementation of the program. Increases of B_i beyond B_k leave the probability of implementation unchanged at $\int_0^{B_k} p(C)\, dc$. It follows that any strategy $\tilde{B}_i > B_k$ leads to the same expected utility as the strategy $B_i = B_k$, which we just established as being inferior to $B_i = \pi_i$.

By virtue of Cases 1 and 2, we have established that for any strategy profile B_{-i} such that $\pi_i \le B_m$, $EU_i(B_i = \pi_i, B_{-i}) \ge EU_i(B_i \ne \pi_i, B_{-i})$.

Case 3: $(B_m <) B_k < \pi_i$**, Increasing** B_i

We now turn to the subset of B_{-i} strategy profiles for which $(B_m <) B_k < \pi_i$. We first tackle the possibility of player *i* bidding $\tilde{B}_i \ge \pi_i$. Since $B_k < \pi_i$, it follows immediately, as above, that the probability that the program will be implemented remains unchanged for all $B_i > B_k$. Once again, since the conditional payoffs are also unaffected by increases in B_i, it follows that for the category of strategy profiles considered here, $EU_i(B_i > \pi_i, B_{-i}) = EU_i(\pi_i, B_{-i})$.

Case 4: $(B_m <) B_k < \pi_i$**, Decreasing** B_i

As Case 4, we consider the possibility of reducing *i*'s bid from $B_i = \pi_i > B_k$. Such a move has either no effect on *i*'s utility (if $\tilde{B}_i \geq B_k$) or strictly reduces it (if $\tilde{B}_i < B_k$).

By the same logic presented in Case 3, choosing $B_k \leq \tilde{B}_i < \pi_i$ has no impact on the expected utility of player *i*.

This is not the case if the bid is further reduced to $B_m \leq \tilde{B}_i < B_k$. Now, $\tilde{B}_i$ becomes the threshold that defines the lowest level of *C* leading to implementation of the program. As the bid decreases below B_k, it lowers the probability that the program will be funded. This decrease in probability is entirely associated with realizations of *C* in the interval $(\tilde{B}_i, B_k)$. Since $B_k < \pi_i$, implementation of those programs would have benefited player *i.* It follows that bidding $\tilde{B}_i \geq B_k$ (and getting the same expected utility as with $B_i = \pi_i$) dominates $B_m \leq \tilde{B}_i < B_k$ for all strategy profile characterized by $\left(B_m <\right) B_k < \pi_i$.

Further reductions of the signal below B_m do not reduce the probability of funding any further, nor does it change the conditional utility in the two states of the world. Thus the expected utility for $\tilde{B}_i < B_m$ is the same as that for $B_m \leq \tilde{B}_i < B_k$ which is in turn lower than the utility for $B_i = \pi_i$.

Collecting the results from Cases 3 and 4 establishes that $EU_i(B_i = \pi_i, B_{-i}) \geq EU_i(\pi_i, B_{-i})$ for all B_{-i} such that $\left(B_m <\right) B_k < \pi_i$.

Case 5: $B_m \leq \pi_i \leq B_k$: Increasing or Decreasing B_i

This last case includes all remaining strategy profiles B_{-i} not yet considered. As we can infer from the analysis of previous cases, these strategy profiles put player *i*'s strategy $B_i = \pi_i$ in the critical zone where it is the determinant of the probability that the program will be implemented. Increasing or decreasing B_i leads to a change in the probability of funding the public program. As B_i increases up to B_k, the increased probability of funding is associated with cases where $C > \pi_i$, necessarily lowering expected utility. As before, further increases of $\tilde{B}_i$ beyond B_k do not result in further decreases in expected utility, but do not offer any increase either. It follows that the strategy $B_i = \pi_i$ strictly dominates $\tilde{B}_i > \pi_i$ when B_{-i} is such that $B_m \leq \pi_i \leq B_k$.

By similar reasoning, $B_i = \pi_i$ also strictly dominates $\tilde{B}_i < \pi_i$. The reduction in bid into the region $\tilde{B}_i \leq B_m$ decreases the probability that beneficial programs (with $C < \pi_i$) will be implemented but offers no offsetting gain. Further decreases in $\tilde{B}_i$ have no additional effect on expected utility. For Case 5, $B_m \leq \pi_i \leq B_k$,we conclude that $EU_i(B_i = \pi_i, B_{-i}) > EU_i(B_i \neq \pi_i, B_{-i})$ for all B_{-i} such that $B_m \leq \pi_i \leq B_k$.

With cases 1 to 5, we have explored the entire strategy space of the *N*-1 other players, and considered all possible deviations from the strategy $B_i = \pi_i$. Yet, under no circumstances can departing from the strategy $B_i = \pi_i$ yield an increase in player *i*'s expected utility. $B_i = \pi_i$ is therefore a weakly dominant strategy for Player *i*. With all players postulated to be selfish and with an increasing utility function, all other players also have a dominant strategy to play $B_j = \pi_j$. This establishes that truthful revelation by all players is a Bayesian Nash Equilibrium of the RPVM game. While deviating from $B_i = \pi_i$ will, on occasion, not change the expected utility of player *i,* this is only true when B_{-i} is known and given. With any uncertainty surrounding the other player's choice of strategy, all strategies $B_i \neq \pi_i$ will necessarily have a lower level of expected utility since they will be played with some probability against a B_{-i} for which $B_i = \pi_i$ dominates. In this context, $B_i = \pi_i$ is a weakly dominant strategy of the RPVM.

C. Behavioral Predictions for Players with Social Preferences

In this section, we look more closely at the theoretical predictions emanating from more explicit models of individuals with social preferences. The corresponding utility functions will contain new arguments (the potential payoffs to others) and exhibit particulars that require a less general solution concept than shown in the previous section. We present with some detail the solution for individuals with social efficiency preferences expressing their WTP for a program conferring gains. We then summarize the predictions for four alternative models and for the remaining three welfare settings.

An individual *i* with social efficiency preferences is postulated to have utility that is increasing (decreasing) in the gains (losses) of others and of the form $U_i = u\left(Y + \pi_i - C + \sum_{j \neq i} \left(\alpha_i \cdot (\pi_j - C) \right) \right)$, where $\alpha_i \geq 0$ parameterizes the intensity of individual *i* altruism (for pure selfishness, $\alpha_i = 0$). This is a purely altruistic individual who weights equally the gains and losses to others. It can be considered a special case of Charness and Rabin's (2002) social welfare function.

To compute the Bayesian Nash Equilibrium we once again rely on the critical values B_m and B_k, the interval defining the range over which the bid of voter *i* makes this individual the median voter. Thus, *i*'s expected utility can be expressed as

$$EU_i\left(B_i,B_{-i}\right)=\int_0^{B_m} p(C)U\left(Y+\pi_i-C+\alpha_i\sum_{j\neq i}(\pi_j-C)\right)dC$$

(1)
$$+\int_{B_m}^{B_i} p(C)U\left(Y+\pi_i-C+\alpha_i\sum_{j\neq i}(\pi_j-C)\right)dC\ .$$

$$+\int_{B_i}^{B_k} p(C)U\left(Y\right)dC+\int_{B_k}^{C_{\max}} p(C)U\left(Y\right)dC$$

The first term is the expected utility conditional on the randomly drawn cost being below B_m. Here, i's bid is irrelevant since there is already a majority of voters willing to pay more than the cost of implementing the program. The second and third terms cover the interval over which the bid of individual i will have a marginal effect on the probability that the program is implemented. Conditional on C falling in that range, B_i is effectively the median bid. The last term is the interval over which i has no effect on the outcome since no matter how large B_i is, too few individuals have bid high enough to implement the program.

In searching for an equilibrium, we focus on affine bidding strategies. Let individual i conjecture that individuals m and k choose bids of the form

(2)
$$B_m=\gamma_m\left(\pi_m+\sum_{j\neq m}\alpha_m\,\pi_j\right)$$

and

(3)
$$B_k=\gamma_k\left(\pi_k+\sum_{j\neq k}\alpha_k\,\pi_j\right).$$

where γ_k and γ_m are positive (still unknown) constants. Substituting these expressions in Equation 1 and maximizing with respect to B_i yields the first order condition:

(4)
$$p(B_i)U\left(Y+\pi_i-B_i+\sum_{j\neq i}\left(\alpha_i\cdot(\pi_j-B_i)\right)\right)=p(B_i)U(Y)\,.$$

This equation has a degenerate solution at $p(B_i) = 0$ that can safely be ignored. The interior solution equates expected utility under the two states of the world (the program is funded or not). Solving for B_i, the optimal bid is given by:

(5) $$B_i^* = \frac{\pi_i + \sum_{j \neq i} \alpha_i \, \pi_j}{1 + (N-1)\alpha_i}.$$

The optimal strategy has a form that matches the priors of individual *i* regarding the bidding strategies of *m* (Equation 2) and *k* (Equation 3) for $\gamma_i = 1/\left(1 + (N-1)\alpha_i\right)$. Thus, if all *N* players adopt the linear conjecture and bid their optimum, all conjectures are simultaneously proven correct. No one has any incentive to deviate, establishing that (Equation 5) is a Bayesian Nash Equilibrium.[3] It is useful to note that the private BDM is nestled in the RPVM. Setting *N*=1 yields the familiar BDM result: $B_i^* = \pi_i$.

A number of testable behavioral predictions emerge from this solution.

1) If $\pi_j = \pi_i \ \forall j$, $B_i^* = \pi_i$. Truthful revelation is optimal with equal payoffs because bidding above induced value increases the probability that the program will be funded in the range where costs exceed everyone's benefits. Bidding below value is also sub-optimal since it reduces the probability that the program will be implemented, in the range where everyone could benefit.

2) The optimal bid is increasing in one's induced value since

(6) $$\frac{\partial B_i^*}{\partial \pi_i} = \frac{1}{1 + (N-1)\alpha_i} > 0.$$

3) For social welfare preferences, an increase (decrease) in the sum of gains of others increases (decreases) *i*'s optimal bid:

(7) $$\frac{\partial B_i^*}{\partial \pi_j} = \frac{\alpha_i}{1 + (N-1)\alpha_i} > 0.$$

4) By direct extension of Equation 7, individual *i* will increase (decrease) his bid when moving from a homogenous distribution where $\pi_i = \pi_j = \pi \; \forall j$, to a heterogeneous distribution where all payoffs other than his own are increased (decreased). For example, while everyone in a ($2,$2,$2) distribution is predicted to bid $2, the $2 individual in a ($2,$5,$8) distribution would set $B_i^* > \$2$. The individual values the higher benefits to others and is thus prepared to incur (in expectation) a personal cost to increase the probability that the program will be implemented. On the other hand, an $8 type would bid less in the ($2,$5,$8) distribution than for a ($8,$8,$8) program regardless of the scenario presented. These results are summarized in the first row of Table 1.

WTA and Losses for A

The theory can be reinterpreted to describe the optimal bidding strategy for an individual expressing his minimum WTA compensation to forego gains. In this case, *C* represents the randomly determined compensation to be paid in exchange for not receiving a payoff defined by $\prod$. B_i then denotes the smallest amount that individual *i* would accept. If a majority of bids are less than or equal to *C,* compensation *C* is paid but the gains $\prod$ are not, for a utility level $U\left(Y + C + \alpha_i \sum_{j \neq i} C \right)$. Otherwise, $\prod$ is paid and utility is $U\left(Y + \pi_i + \alpha_i \sum_{j \neq i} \pi_j \right)$.

Re-deriving the optimal bidding strategy yields exactly Equation 5 and the same theoretical predictions, although the vector $\prod$ now represents individual opportunity costs of implementing the compensation program. An increase in the opportunity cost of any player implies a decrease in the social value of the compensation offer, and therefore increases the minimum acceptable level of compensation required by voters. In Table 1, the "smallest π" is therefore the smallest absolute induced value, be it a gain or a loss.[4]

The optimal strategies for the WTA compensation for a program that imposes a loss and for the WTP for a program that eliminates a loss also replicate Equation 5.

Alternative Forms of Other-Regarding Preferences for B

Similar approaches can be followed to analyze the optimal bidding strategy of voters who have different forms of social preferences. Of interest are three other utility specifications that can be identified by the experimental data we collected. They are the Maximin utility (Charness and Rabin, 2002) (MM), a version of Bolton and Ockenfels (2000) (ERC) theory of equity, and Fehr and Schmidt (1999) (FS) inequity aversion preferences. For empirical reasons discussed later, we also produce behavioral predictions for a model where players care simultaneously about social efficiency of the program and the welfare of the poorest player (i.e. Maximin preferences).

Perhaps the most intuitive approach to understanding the results of Table 1 is to focus immediately on the predictions in the last column of Column 4. First, no matter what type of preferences, gains or losses, WTA or WTP, the predicted bid when all payoffs are equal (homogenous distribution) is $B_i^* = \pi_i$ for all players. In contrast, heterogeneous distributions will have varied effects under alternative preferences. To review these effects, consider the vector Π=(2, 5, 8) as an example.

B.1 Maximin

With Maximin preferences, utility depends on one's own payoff as well as on the potential gains (losses) of the individual who stands to gain the least (lose the most) from implementing the program. Denoting the payoff for this "worst off" player by π_w,we write this social component into the utility function by adding the term $+\alpha_i\left(\pi_w - C\right)$ to player *i*'s own earnings. However, it is now necessary to identify the worst off player. In WTP cases, the person who potentially gains the least (loses the most), is the one with the smallest induced value ($\pi_w = \$2$ in our example). This is true regardless of whether the WTP is for a gain or to avoid a loss. The prediction is that this person will bid exactly \$2, while others will bid less than induced value in order to reduce the probability that a net loss will be imposed on the \$2 individual.

In WTA scenarios, the individual with a high absolute induced value is the worst off and the prediction is that those with lower absolute induced values will set $B_i^* > \pi_i$ to reduce the probability of imposing costs on the \$8 individual.

B.2 ERC Preferences

With ERC preferences, individual inequity aversion manifests itself as disutility when the individual's payoff differs from the mean group payoff. The social component of utility assumed here is $-\alpha_i \left| (\pi_i - C) - \frac{1}{N} \sum_{j=1}^{N} (\pi_j - C) \right|$ (written for a WTP gains context). Those with a payoff exactly equal to the mean will continue to optimally bid $B_i^* = \pi_i$. However, others will behave differently. In the gains domain, individuals will be willing to pay less than their private value for a program that provides additional income, and will require a smaller amount of compensation to forego such gains. This happens because the program creates inequities that offset part of the individual's own payoff. The opposite behavior should be observed in the losses domain. Individuals will require more than their private value in compensation to accept a loss and be willing to pay more to avoid a loss.

B.3 FS Preferences

FS preferences differ from ERC preferences in two aspects. First, the aversion to inequity comes from a direct comparison of one's payoff with that of other individuals (rather than with the mean). Second, FS preferences allow for different valuations of positive and negative differences between individual payoffs. The function we employ is $-\frac{\alpha_i}{N-1}\sum_{j\neq i} Max\left[(\pi_j - C)-(\pi_i - C),0\right]-\frac{\beta_i}{N-1}\sum_{j\neq i} Max\left[(\pi_i - C)-(\pi_j - C),0\right]$. Fehr and Schmidt postulate that individuals are less affected by differences in their favor than by situations where they are the poor party in the comparison (a situation that would be characterized by $\alpha_i \geq \beta_i$). Practically, this implies that all individuals (even one with a payoff equal to the mean) get disutility from a heterogeneous distribution. It follows that all individuals in any game with heterogeneous distributions will be willing to pay less than their induced value for gains and willing to accept less than induced value to forego a gain. By the same logic, all individuals will be willing to pay more than induced value to avoid unequal group losses and require greater compensation to accept them.

B.4 Combining Social Efficiency (Pure Altruism) and Maximin Preferences

As Charness and Rabin (2002) postulated in their work, it is actually possible that individuals may have preferences that simultaneously reflect a concern for both social efficiency and care for those who stand to gain least or lose most from the implementation of a program. Because we will be estimating this model in the empirical section of the paper, we introduce it here and in Table 1. The combined components of social concerns are given by $+\alpha_i\sum_{j\neq i}(\pi_j - C)+\beta_i\left(\pi_w - C\right)$. While we still obtain that individuals in groups of one or facing homogeneous distributions optimally bid their induced values, combining these two types of preferences modifies the behavioral predictions in interesting ways.

The worst off player in heterogeneous distributions (the lowest absolute induced value in WTP and largest in WTA) (qualitatively) abandon their Maximin because they now care about the fate of others whose welfare could be improved (more) by the program. Thus, the worst off player in WTP games increase their bid above π_w while those in WTA games decrease their bid.

A player with a payoff equal to the mean of the distribution on the other hand, would now definitely behave like a Maximin. The pure altruism model left this player ambivalent between favoring the best off or worst off individuals in under the social welfare function assumption. This ambivalence is shattered in favor of the worst off individual who now has greater weight on the average player's utility. For individuals at or above average payoff, the concerns for efficiency and the worst off individual both push the bid in the direction of π_w. However, for individuals with induced values between π_w and the average payoff of the distribution, the two sources of utility are actually in conflict and weight in opposite direction. On the one hand, concern for the worst off pulls the optimal bid toward π_w to minimize potential losses for that player. Efficiency, on the other hand, calls for moving one's bid away from own payoff and in the direction of the average payoff. This implies a fixed point between π_w and the average payoff defining a value where bid is equal to induced value.

III. Experimental Design

To test the theories outlined above, an additional 276 participants were recruited from a variety of undergraduate business and economics courses. Each session consisted of either two WTP experiments: WTP-Gains and WTP-Losses (*n*=138) or two WTA experiments: WTA-Gains and WTP-Losses (*n*=138), representing all four welfare settings. All sessions consisted of four parts; an example session is as follows:

Part A: WTP-Losses, low-incentive practice rounds using the RPVM in a private setting where the cost and payoffs were determined for each round.

Part B: WTP-Losses, high-incentive private and public RPVM treatments where the treatment and cost which resulted in earnings were determined for one randomly selected treatment at the end of the experiment.

Part C: WTP-Gains, low-incentive practice rounds using the RPVM in a private setting where the cost and payoffs were determined for each round.

Part D: WTP-Gains, high-incentive private and public RPVM treatments where the treatment and cost which resulted in earnings were determined for one randomly selected treatment at the end of the experiment.

To control for potential order effects, the order of parts was varied across sessions switching between ABCD and CDAB as described above. Further, Part B and Part D varied the order of the treatments with respect to the amount of the induced values, voting group size, and the distribution of values among group members. In public RPVM treatments, subjects were provided complete information about the payoff amounts of the other subjects. To prevent order effects from potentially deteriorating social preference behavior as is common in repeated voluntary contribution games (Davis and Holt, 1993), subjects submitted bids for the treatments in Part B and Part D without feedback. At the end of the experiment one of the nine RPVM programs was implemented from both Part B and Part D by having the subjects draw from a bag of marked poker chips. The exchange rate for Part A and Part C was fifteen experimental dollars for one US dollar, while the exchange rate for Part B and Part D was one experimental dollar for one US dollar. The experiment lasted approximately one and one-half hours and the average payoff was $35.

Subjects received written instructions (see the example for WTP-Gains in Appendix B) and were permitted to ask questions at the beginning of each part of the experiment. The instructions used language parallel to that found in public referenda. The WTP instructions directed each subject to *vote* whether to *fund* a *program* by submitting a *bid* that represented the "highest amount that you would pay and still vote for the program." The WTA instructions directed each subject to *vote* whether to *implement* a program by submitting an *offer* that represents the "lowest amount of compensation that you would accept and still vote against the program." Each subject was seated at an individual computer equipped with a privacy shield. Subjects were assigned into voting groups of varying size of either one or three. For the groups of three, the administrators announced the groups and asked each group member to raise their hand so that they could be identified by other members of their group. This ensured that subjects were aware of who was in their voting group for all treatments. No communication was allowed.

For simplicity, consider the WTP-Gains experiment. In each treatment, subjects started with an initial balance of $10 and were assigned an induced value ($1, $2, $4, $5, $6, $8 or $9). Subjects then decided how much to bid ranging from zero to the entire initial balance. After the subjects submitted their bids, the cost for the program was determined by using a random numbers table with values from zero to nine. The first random number from the table represented the dollars amount, the second number the dimes amount, and the third number the pennies amount. For example, if the first random number was a four, the second was a nine, and the third was a four, the determined cost would have been $4.94. Consequently, the cost was uniformly distributed between $0.00 and $9.99 with discrete intervals of $0.01.

Treatments consisted of groups of three or one participant where treatments with group size of one were identical to the private good BDM as each subject's bid constitutes a majority. In WTP-Gain treatments, if the majority of the bids were *greater than or equal to* the randomly determined cost, then the program was funded. In this case, all of the subjects in the voting group received their personal payoff amount in addition to the initial balance, but also had to pay the determined cost. If the majority of bids were *less than* the randomly determined cost, then the program was not funded. In this case, all of the subjects in the voting group neither received their personal payoff amount nor paid the cost, and thus, the subjects received only their initial balance.

For all welfare settings, the majority of the public good treatments with heterogeneous values were conducted with a symmetric distribution, i.e. ($2,$5,$8) (93 subjects for WTP; 93 for WTA). In addition, to help identify the parameters of the alternative social welfare bid functions, sessions were conducted that had heterogeneous values with asymmetric distributions, i.e. ($4,$5,$9) and ($1,$5,$6) (45 subjects for WTP; 45 subjects for WTA).[5] For the WTP experiments, in the private good treatments, a subject's optimal strategy was to either submit a bid equal to her induced value or one penny less, due to discrete costs. For the voting groups of three, the majority rule introduced a coercive tax element, because if a majority of the group submitted bids *greater than or equal to* the randomly determined price, then everyone had to pay the price regardless of their individual bids.

For the WTP-Losses experiments if a majority of the bids was *less than* the random cost, the program was *not funded*. Consequently, all group members have their personal loss amount deducted from their initial balance of $10. If the majority of bids were *greater than or equal to* the determined cost, the program was funded and all voting group members had to pay the determined cost from their initial balance of $10 but did not have the personal loss amount deduced. For WTP-Losses, the same logic holds as the majority rule could force a low value subject to pay a higher cost then their induced value and the high value subject may be denied the opportunity of paying a cost lower than their induced value. The logic of how the vote creates a coercive tax element for both the induced gains and induced losses treatments is identical in the WTA-Gains and WTA-Losses experiments.

For the WTA experiments, subjects submitted *offers* that represented the lowest amount of compensation they would accept where the optimal offers were either the induced value or one penny above it. The induced gains and losses were the same as the WTP setting and the possible compensation again ranged from $0.00 to $9.99. To avoid income effects, the initial balance was $5 which made the expected earnings in the WTA setting equivalent to the WTP setting. In WTA-Gains, an offer was the lowest amount a subject would accept to vote *against* the program which otherwise would provided the subject a gain. If the majority of the offers were *less than or equal to* the random compensation, then the program was not implemented and all voting group members received the compensation in addition to their initial balance. If the majority of the offers were *greater than* the random compensation, the program was implemented and the group members received their personal payoff amount in addition to their initial balance.

In contrast, in WTA-Losses, an offer represented the lowest amount a subject would accept to vote *in favor* of the program, which forced the subject to pay the induced loss if funded. Therefore, if the majority of offers were *less than or equal to* the random compensation, the program was implemented and all group members received the compensation and the initial balance but had to pay their induced losses. If the majority of the offers were *greater than* the random compensation, the program was not implemented and all group members kept their initial balance.

IV. Results

Similar to other studies using the BDM mechanism (Boyce et al. 1992; Irwin et al. 1998), the goal of the initial low-incentive practice rounds was to give subjects an opportunity to gain experience with the mechanism before introducing additional complexities to the decision environment. Repeated low incentive private rounds provided subjects an opportunity to receive feedback on how their bids and offers affected their payoff. Over ten practice rounds, subjects' bids/offers converged towards induced value, starting at $0.69 above induced value in the first round and declining by 70% to only $0.21 above induced value in the tenth round. By the last practice round subjects' offers/bids were statistically indistinguishable from their induced values in all four welfare settings (One Sample T-test).

A. Comparing RPVM with Dichotomous Choice Voting

Direct comparisons can be made between the dichotomous choice data presented earlier in Section 2 and selected treatments from the RPVM experiment, in particular, the ($2,$2,$2), ($5,$5,$5), ($8,$8,$8) and ($2,$5,$8) value distributions for the WTP-Gains setting. First, we find a close correspondence between dichotomous choice voting at a particular cost and the number of RPVM subjects who bid at or above that same cost (and are thus indicating they would vote "yes" at this cost). For example, 23.7% of RPVM subjects with a $2 value indicated that they would pay at least $2.50 for a program that had benefits that were distributed heterogeneously ($2,$5,$8). This percentage is statistically indistinguishable from the 18.6% of subjects who voted yes in the similar dichotomous choice voting setting (p = 0.410). As shown in Table 2, in fact, none of the dichotomous choice voting treatments yielded results that were statistically different than the results of the RPVM.

Second, the differences between RPVM homogeneous and heterogeneous treatments mirror that found for dichotomous choice voting. For \$2 value subjects, a statistically different and higher percentage of subjects in heterogeneous value treatments bid at or above \$2.50 (p = 0.004). This difference across treatments, -11.9%, is quite similar to the -12.9% difference in the dichotomous choice experiment. For \$8 value subjects, a statistically different and lower percentage of subjects in heterogeneous value treatments bid at or above \$7.50 (p = 0.003). This difference across RPVM treatments, 10.8%, is quite similar to 13.1% difference in the dichotomous choice experiment. Similar to dichotomous choice, no difference across RPVM treatments is found for \$5 subjects at costs of \$4.50 (3.2% difference, similar to 4.0% in dichotomous choice) (p = 0.320) or \$5.50 (-4.3% difference, similar to -7.7% in dichotomous choice) (p = 0.320). Overall, there is a very close correspondence between dichotomous choice voting and RPVM bidding both in levels and in terms of homogeneous versus heterogeneous treatment differences.

B. RPVM Bidding Behavior and the Nature of Social Preferences

The RPVM experiments yield 76 unique (high incentive) treatments, where a treatment is defined by a specific welfare setting (e.g. WTP-gains), the subject's induced value, and the distribution of other players' values (if any). To facilitate comparisons between bidding behavior and induced values, we pool the data from all treatments and regress individual bids on 76 indicator variables to produce estimates of the average bid in each treatment. As each individual produces multiple observations, we estimate robust standard errors adjusted for clustering at the individual level. Given all decisions from the individual are made without feedback, there are no controls for learning behavior. Tables 3 and 4 present the treatment-specific mean bids for the gains and loss settings, respectively, for both WTP and WTA. Estimates that are statistically different than induced value at the 5% level are italicized. Inspection of these results suggests that behavior does not appear to exhibit WTP/WTA discrepancies.

Bidding behavior for the heterogeneous value treatments suggests that social preferences do play a role. Whereas mean bids are statistically equal to value in 39 of the 40 treatments involving private good or homogeneous value settings, there are many instances in heterogeneous treatments where mean bids are statistically different than induced value. Overall, as illustrated in Figure 2, low-value subjects tend to bid above value and high-value subjects to bid below value. As can be seen in the cumulative distributions in Figure 3, subjects' bids/offers in the heterogeneous value treatments systemically deviated from their bids/offers in either the private treatments or the public homogeneous value treatments.

As can be seen by inspecting Tables 3 and 4, in seven out of the eight treatments where the lowest-value subject has an induced value more than a dollar less than the middle-value subject (subjects with induced gains and losses of $1 and $2), subjects significantly raise their WTP/WTA relative to the induced value. Likewise, when the highest-value subjects had an induced value that was more than a dollar higher than the middle-value subject ($8 and $9 values), subjects significantly lowered their WTP/WTA in seven of the eight treatments. When the low-value (high-value) subject has a value close to the middle-value subject, statistical differences between bids and induced values are not generally observed.

There is not a systematic divergence from induced values for middle-value ($5) subjects. Symmetric distributions produce bids that are roughly equal with value, although in one of four cases there is a statistical difference. In asymmetric distribution treatments, there is a weak tendency for middle-value subjects to bid below value when their value is above average (i.e. the

\$1, \$5, \$6 distribution) and a weak tendency to bid average value when their value is below average (i.e. the \$4, \$5, \$9 distribution).

Finally, we investigate the extent to which the social welfare theories discussed in Section 3 are consistent with observed bidding behavior using data from public good treatments. In particular, we estimate the unknown parameters (i.e. α and β) of the theory-specific optimal bid functions. Estimated parameters that are statistically different than zero, with the correct sign, provide evidence that a particular theory has the ability to organize the data. Further, estimated parameters shed light on the relative importance of social versus selfish preferences on bidding behavior.

Consistent with our previous framework, we use a linear regression approach to estimate unknown parameters; to allow for heteroscedasticity and the correlation of individual-level responses, we estimate robust standard errors adjusted for clustering at the subject level. The bid function parameters for the two equity models are directly estimable (imposing the constraint that the coefficient on π_i equals one). However, the bid functions for the Social Efficiency, Maximin, and the combined Efficiency-Maximin theory are nonlinear in the unknown parameter(s). This does not preclude linear regression as the bid functions can be re-written as linear in unknown parameters and our estimates of interest recovered from these in a straightforward fashion. For example, we can express the Maximin bid function as:

$$B_i = \delta_1 \pi_i + \delta_2 \pi_w \tag{8}$$

where $\delta_1 = 1/(1+\alpha_i)$ and $\delta_2 = \alpha_i/(1+\alpha_i)$. The parameter α_i is overidentified. It can be easily shown that $\delta_2 = 1 - \delta_1$, and we can impose this restriction directly into the model to resolve the identification issue. The restricted model is:

$$B_i - \pi_w = \delta_1(\pi_i - \pi_w) \tag{9}$$

With an estimate of δ_1 in hand, an estimate of α_i and its standard error can be obtained using the delta-method. In a similar vein, exactly identified specifications that correspond to the Efficiency and Efficiency-Maximin theories can be constructed.

Unfortunately, it is not possible to estimate individual-specific coefficients from our design. We instead constrain the unknown parameters to be equal across individuals, and what we estimate are best thought of as bid functions for the representative individual in the sample. Further, for estimation purposes we include an error term and an overall model constant. Although the theoretical bid functions do not imply a constant term, whether or not one should be included is essentially an empirical question. If the mean of the error term is not zero, for instance, omitting the constant term would serve to distort coefficient estimates.

Table 5 presents bid functions, estimated by pooling the entire sample as well as estimated separately for the WTP and WTA treatments. Pooling WTP (WTA) gains and loss data is justified by statistical tests, and data from all welfare settings can be justifiably pooled for all but the Maximin specification. The two equity-based specifications are not supported by the data. The parameter of the ERC model is not statistically different than zero and has the incorrect sign. The two parameters of the FS model are statistically different than zero. However, the result $\alpha < 0$ is inconsistent with the theory. In particular, it suggests that individuals bid to *increase* disadvantageous inequality (i.e. reduce equality).

Consistent with the respective theories, the estimated parameter for both the Social Efficiency and Maximin model is positive and statistically different from zero at the 1% level. The estimate of $\alpha = 0.057$ in the WTP Efficiency model implies that the weights on self-interest, $1/(1+2\alpha)$, and efficiency, $\alpha/(1+2\alpha)$, are equal to 0.90 and 0.05, respectively. This suggests that if own payoff from a program increases by $1, ceteris paribus, the average individual increases his bid by $0.90. If the program payoff to another group member increases by $1, ceteris paribus, an individual increases his bid by $0.05. This suggests an individual is willing to give up $0.05 in order to give a $1 to someone else. In a similar vein, the WTP Maximin model implies that an individual, ceteris paribus, increases his bid by $0.92 for a $1 increase in own payoff and by $0.08 for a $1 increase in the payoff to the worst-off group member.

The empirical support of both the Social Efficiency and Maximin theories motivated an examination of whether a model that accounts for both motives (along with self-interest) would be a better depiction of observed behavior, and is the reason we considered such a theory in Section 3. However, the estimated parameters of this Efficiency-Maximin model lend support for a Social Efficiency-only model. In particular, we find that $\alpha > 0$ and $\beta = 0$. This suggests that efficiency is a statistically significant motive and, once efficiency preferences are controlled for, Maximin preferences explain little about bidding behavior. Thus, the combined theory model essentially breaks down to a pure social efficiency model and, if anything, the inclusion of Maximin preferences simply serves to add noise to the relationship between efficiency and bidding behavior.

A casual comparison between theoretical predictions and simple tests of mean bid against induced value provides further evidence that Maximin preferences, if present, are not the main driving force. For instance, in the heterogeneous treatments with a symmetric distribution one would expect that both middle- and high-value respondents would bid below value to help the worst-off individual. However, middle-value respondents tended to bid equal to value. Further, we should see worst-off individuals bidding at value, but it is clear that these individuals have concerns for the persons who are better off. In sum, while some evidence exists that Maximin considerations may drive observed bidding behavior, preferences for efficiency seem most consistent with the data and explain a wider range of observed bidding patterns.

V. Conclusion

The evidence presented in this paper suggests that the public good version of the BDM mechanism, which involves submitting a bid/offer as a vote in a coercive tax setting, is demand revealing both for induced values and for social preferences. In addition, no WTP/WTA discrepancies are evident for the induced values used in these experiments or for revealed social preferences. However, the result that participants with high induced gains (low induced gains) tend to understate (overstate) their WTP and WTA relative to the induced value (this pattern is mirrored in the induced loss treatments) is most succinctly explained by social concerns for efficiency (or, similarly, pure altruism).

Equity or relative rank concerns do not seem to add much explanatory power in this setting utilizing induced values and undergraduate business/economics majors. These results are consistent with evidence presented by Charness and Rabin (2002) for efficiency preferences but not with the evidence they provide for equity preferences. The results presented here are entirely consistent with those of Engelmann and Strobel (2004). Both of these studies use student subjects. It also should be noted that our findings are consistent with a conjecture made by Johannesson *et al*. (1996) based on hypothetical voting among randomly chosen survey participants. These results are somewhat surprising, in that several studies (Engelmann and Strobel, 2006, Fehr, Naef, and Schmidt, forthcoming) have shown that non-business/economics students or adult participants are more likely to show concerns for equity than undergraduate business/economics majors. It is possible that the context of voting itself favors efficiency preferences over equity preferences. In contrast, other contextual settings, such as dictator games, may make equity much more salient both to business/economics student participants and others.

The experiments presented in this paper represent a first step from which a number of issues can be examined further. Extensions of the RPVM include changes in voting group size when values are heterogeneously distributed, changes in the distributions of the heterogeneous treatments, multiple-round voting using heterogeneous distributions, the use of a variety of actual public goods, field application of the mechanism in situations where costs are unknown and the application of the mechanism to examine how various behavioral anomalies respond to different public good settings. Of particular importance is the impact of increasing both stakes and group size. It is trivial to show that efficiency preferences will decrease the probability of inefficient programs being funded. Consider a referendum on a program which has negative total net benefits but, because of heterogeneous benefits, the median voter has her own selfish benefit slightly greater than cost. If she has efficiency concerns similar to those found in a number of studies she will take into account that the sum of the net benefits to others is negative and weight those in her decision along with her own selfish net benefit. With a sufficiently large number of other voters, the effect of negative net benefits could easily outweigh her own positive net benefit and result in a vote against the program. Thus, the presence of preferences for efficiency raises the possibility that voting may be more efficient than is commonly supposed.

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[1] In a willingness to accept (WTA) setting, subjects indicate their minimum WTA and if the majority of offers are less than or equal to the randomly selected compensation, all subjects must accept this amount.
[2] To simplify exposition, we restrict the presentation to the situations where *N* is an odd number. Minor modifications are required to prove the claim when *N* is even, but the same conclusion is reached.
[3] Note that an individual's optimal bid does not require knowledge of the α_j of other individuals.
[4] In evaluating the results of Table 1, note that the basic formulation (Column 2) is given for WTP for Gains where $\pi > 0$ and $C > 0$. Thus, the optimal bid (Column 3) is a positive amount and the behavioral prediction (Column 4) is readily interpreted. For the other cases, the optimal bid formula and the behavioral predictions are written for the absolute values of π_i, π_j and *C* and therefore positive values for B_i^*.
[5] Similar to Section 3, for ease of exposition we refer to induced values in absolute terms for the remainder of the paper.
[6] Similar patterns exist for the other three welfare treatments and are available upon request from the authors.

APPENDIX A: DICHOTOMOUS CHOICE DESIGN AND INSTRUCTIONS

Design

Two sets of sessions were employed, one where all decision tasks involved heterogeneous distributions (Table A1) and the other which involved heterogeneous and homogenous tasks (Table A2). As shown in Table A1, the order of the first two induced values, $2 and $8, are reversed in the two sessions. In Session A, the 1st vote for each subject ($2 induced value) is combined with the 3rd vote ($5 induced value) from one other subject and the 4th vote ($8 induced value) of a third subject to determine the outcome of the group vote. The design for votes on programs with equal values of $2 or $8 is constructed similarly (Table A2). The extra four votes are not needed to complete the voting triplets. These additional votes are used to explore heterogeneous values for the $5 individuals.

Instructions

This is an experiment in the economics of decision making. In the course of the experiment, you will have opportunities to earn money. Any money earned during this experiment is yours to keep. It is therefore important that you read these instructions carefully. Please do not communicate with other participants during the experiment.

In today's experiment, you will be asked to vote for or against six different programs. In this experiment, a program is simply a distribution of money. As you will see, your vote will help determine whether or not the program is funded. The procedures that will be followed are the same for all programs. However, each program and vote is independent from the other. Therefore, your vote in one program will not affect the results for other programs.

Only one of the six programs will actually be implemented and result in cash earnings. At the conclusion of the experiment, we will randomly determine which of the programs will generate cash earnings by drawing from a bag containing six chips lettered A through F which correspond to each program.

For each program, the experiment proceeds as follows:

For each of the programs, you will be part of a group of three voters. First, you and every other member of your group will receive an initial balance of $10.00.

You will then be informed of your personal payoff amount for this program. Your personal payoff amount is the amount of money that you will receive if the program is funded. Your personal payoff amount will vary during the course of the experiment. The possible amounts are $2.00, $5.00, and $8.00. The payoff amounts that the other voters in your group would receive if the program is funded are indicated on your computer spreadsheet. Your spreadsheet also will inform you of the **per person cost** of the program. This is the cost that you and everyone else in your group would have to pay if the program is funded.

You will then be asked to vote for ("Yes") or against ("No") this program. You will submit your vote by clicking the "Submit" button. For each program, there are two possible outcomes:

<u>The program is NOT FUNDED:</u> The program is not funded if a majority of votes from your group are "No." In this case, neither you nor any other member of your group will receive a personal payoff amount and no one will pay the cost. Therefore, your cash earnings for this part of the experiment would simply be your initial balance of $10.00.

<u>The program is FUNDED:</u> The program is funded if a majority of votes from your group are "Yes." In this case, you will receive your personal payoff amount in addition to your initial balance. However, you will also have to pay the per person cost. Every other member of your group will also receive their personal payoff amount and they will also have to pay the same per person cost. Therefore, your cash earnings would be your initial balance ($10.00), plus your personal payoff amount, minus the per person cost.

At the conclusion of the experiment, a volunteer subject will draw which of the six programs will be implemented to determine your cash payoff. Upon notification by the administrator, please click the "Update Results" button.

APPENDIX B – RANDOM PRICE VOTING MECHANISM INSTRUCTIONS (WPT-GAINS)

Part A – Low-Incentive Private Practice Rounds

This is an experiment in the economics of decision making. In the course of the experiment, you will have opportunities to earn money. Any money earned during this experiment is yours to keep. It is therefore important that you read these instructions carefully. Please do not communicate with other participants during the experiment.

In today's experiment, you will be asked to indicate the highest amount of money you would pay and still vote for different programs. In this experiment, a *program* is simply a distribution of money. As you will see, the amount that you indicate as the highest amount that you would pay for the program will become a vote in favor or against the program, and will determine whether or not the program is funded. It is therefore important that you consider all of the information given to you about the different programs and that you make judicious decisions. The procedures that will be followed are the same for all programs. However, each program and vote is independent from the other. Therefore, the decisions you make and the result of a vote for one program will not affect the results for other programs.

For each program, the experiment proceeds as follows:

First, you will receive an initial balance of $10.00.

You will then be informed of your "personal payoff amount" for this program. Your personal payoff amount is the amount of money that you will receive if the program is funded. Your personal payoff amount will vary during the course of the course of the experiment. The possible amounts are $2.00, $5.00, and $8.00.

You will then be asked to write down the highest amount that you would pay and still vote for this program; we will call this your "bid". For each program, you can bid any amount between $0.00 and your initial balance of $10.00. Once you have decided your bid, you will write it on a Voting Sheet and enter it into the computer spreadsheet. We will then collect the Voting Sheets and determine the cost of the program.

The cost of the program will be determined by reading off three numbers from a random number table. The starting number will be determined by dropping a pen onto the random number table. (If more than one mark occurs from the drop, then the one closest to the upper-left corner will be used.) The numbers will be read from left to right on the table. The first number will represent the dollar amount. The second number will represent the dime amount. The third number will represent the penny amount. Together, the three numbers will form a cost between $0.00 and $9.99. Note: since these numbers have been generated by a random number table each cost between $0.00 and $9.99 is equally likely. Once the cost has been determined, you will be asked to enter it into the spreadsheet on your computer.

Whether or not the program is funded depends on the amount of your bid and the cost of the program. There two possible outcomes:

The program is NOT FUNDED: The program is not funded if your bid is *less than* the cost determined from the random number table. In this case, you will not receive your personal payoff amount and you will not have to pay the cost. Therefore, your earnings for this portion of the experiment would simply be your initial balance of $10.00.

The program is FUNDED: The program is funded if your bid is *equal to or greater than* the cost determined from the random number table. In this case, you will receive your personal payoff amount in addition to your initial balance. However, you will also have to pay the determined cost. Therefore, your cash earnings for this portion of the experiment would be your initial balance ($10.00), plus your personal payoff amount, minus the cost.

Note how your bid is like a vote for or against funding the program. With your bid, you are writing down the highest amount you would pay and still vote for the program. Therefore, your bid is like a vote in favor of the program if you are prepared to pay an amount equal to or greater than the randomly determined cost. On the other hand, your bid is like a vote against the program if your bid turns out to be less than the cost. Since you are the only voter, your bid will determine whether the program is funded or not.

While your bid helps determine whether the program is funded or not, your earnings for a particular program are based on your initial balance, your personal payoff amount and the determined cost. For example, if a program was *not funded* and your personal payoff was $5.00 and the determined cost was $9.00, your earnings would be $10.00. However, if the program was *funded* with the same personal payoff and cost, your earnings would be only $6.00 ($10 + $5 - $9). Consider another example where your personal payoff was $5.00 and the determined cost was $2.00. In this example if the program was *funded* your earnings would be $13.00 ($10 + $5 - $2), while if the program was *not funded*, your earnings would be only $10.00.

Calculation of Your Earnings

Once you enter the cost of the program determined from the random number table, the computer will automatically determine whether the program was funded and calculate your earnings. At the end of the experiment, the computer will add your experimental earnings for all of the programs, and convert this amount to US dollars by applying an exchange rate of one US dollar for twenty experimental dollars. For example, if you earn $232.45 experimental dollars, your monetary payoff from this part of the experiment would be $11.62. At the end of the experiment, we will audit all of the spreadsheets to ensure accuracy.

It is important that you clearly understand these instructions.
Please raise your hand if you have any questions.
Please do not talk with other participants in the experiment.

<u>*Part II – High Incentive Private and Public Treatments*</u>
For the second part of this experiment, you will now be asked to indicate how much you would pay for each of 12 separate programs. The procedures are similar to the ones used in the first part of the experiment, except for four important differences.

1) For each of the programs, you may be the only voter (as in the first part of the experiment), but you may also be part of a group of 3 or 15 voters. For programs where the group size is 3 or 15, the payoff amounts that the other voters in your group would receive if the program is funded are indicated on your Voting Sheet.

2) Only one of the 12 programs will actually be implemented and result in cash earnings. Therefore, all votes will be made prior to determination of any costs. After the Voting Sheets are collected, we will randomly determine which of the programs will generate cash earnings by drawing from a bag containing 12 chips lettered A through L. Each letter corresponds to one of the 12 programs.

3) For the program that generates cash earnings, the exchange rate will be one US dollar for one experimental dollar. For example, if you earn $12.25 experimental dollars in the second part of the experiment, your monetary payoff would be $12.25.

4) Again, you must decide the highest amount that you would pay and still vote for the program. However, now you will be part of a group. Therefore, in determining your bid you may want to consider how your bid will impact others in your group.

<u>For each program, the experiment proceeds as follows:</u>
You and every other member of your group will receive an initial balance of $10.00.

For each program, your personal payoff amount may be $2.00, $5.00, or $8.00. Other participants will also receive one of these three payoff amounts.

For each program, you will be asked to write your bid on the Voting Sheet provided and enter the same amount into the second spreadsheet on the computer. Consider all of the information for the program before writing down your bid. For each program, you can bid any amount between $0.00 and your initial balance of $10.00.

Once everyone has written down his/her bid and entered the bid into the computer, we will collect the Voting Sheets and distribute the new Voting Sheets for the next program. After bids for all the programs have been entered and Voting Sheets collected, we will determine which of the programs will be implemented and produce cash earnings.

Next, we will determine the cost of the program to be implemented and whether or not it will be funded by your group. The cost of the program will be determined in exactly the same manner as before, except that a new random number table will be used. However, this cost will now be a cost that each person in your group will have to pay if the program is funded. Each person will have to pay the same amount.

Whether or not the program is funded depends on the bids by members of your group and the cost of the program. Once again, there are two possible outcomes:

The program is NOT FUNDED: The program is not funded if a majority of bids from your group are *less than* the cost determined from the random number table. In this case, neither you nor any other member of your group will receive a personal payoff amount and no one will pay the cost. Therefore, your cash earnings for this part of the experiment would simply be your initial balance of $10.00.

The program is FUNDED: The program is funded if a majority of bids from your group are *equal to or greater than* the cost determined from the random number table. In this case, you will receive your personal payoff amount in addition to your initial balance. However, you will also have to pay the randomly determined cost. Every other member of your group will also receive their personal payoff amount and they will also have to pay the determined cost. Therefore, your cash earnings would be your initial balance ($10.00), plus your personal payoff amount, minus the cost.

The programs, in which you are a group of one, are identical to the programs you experienced in the first part of the experiment. Therefore, the program is not funded if your bid is *less* than the cost determined from the random number table, and program is funded if your bid is *equal to or greater* than the determined cost.

Note once again how your bid is like a vote for or against funding the program. With your bid, you are writing down the highest amount you would pay and still vote for the program. Therefore, your bid is like a vote in favor of the program if you are prepared to pay an amount equal or greater than the randomly determined cost. On the other hand, your bid is like a vote against the program if it turns out to be less than the cost. When a majority of bids are equal to or greater than the determined cost, this translates into a majority vote in favor of the program. Similarly, a majority of bids below the cost translates into a majority vote against the program at that cost.

Calculation of Final Earnings

To calculate your earnings from Part B, you will be asked to enter into the spreadsheet the cost for the implemented program and whether this program was funded. Your computer will then calculate your earnings for Part B, add them to your earnings from Part A, and award you an additional $5 show up fee. We will audit the spreadsheets to ensure accuracy.

It is important that you clearly understand these instructions.
Please raise your hand if you have any questions.
Please do not talk with other participants in the experiment.

Table A1: Dichotomous Choice Experiment – Heterogeneous Value Design (n=86)**.**

Session A

Treatment	Initial Endowment	Own Benefit	Others Benefits	Uniform Cost	Expected Earnings
1st	$10	$2	$5, $8	$2.50	$9.50
2nd	$10	$8	$2, $5	$7.50	$10
3rd	$10	$5	$2, $8	$2.50	$12.50
4th	$10	$8	$2, $5	$2.50	$15.50
5th	$10	$2	$5, $8	$7.50	$10
6th	$10	$5	$2, $8	$7.50	$10

Session B

Treatment	Initial Endowment	Own Benefit	Others Benefits	Uniform Cost	Expected Earnings
1st	$10	$8	$2, $5	$7.50	$10
2nd	$10	$2	$5, $8	$2.50	$9.50
3rd	$10	$5	$2, $8	$7.50	$10
4th	$10	$2	$5, $8	$7.50	$10
5th	$10	$8	$2, $5	$2.50	$15.50
6th	$10	$5	$2, $8	$2.50	$12.50

Table A2: Dichotomous Choice Experiment – Homogeneous Value Design (n=88)

Session A

Treatment	Initial Endowment	Own Benefit	Others Benefits	Uniform Cost	Expected Earnings
1st	$10	$2	$2, $2	$2.50	$10
2nd	$10	$8	$8, $8	$7.50	$10.50
3rd	$10	$2	$5, $8	$4.50	$7.50
4th	$10	$5	$2, $8	$4.50	$10
5th	$10	$8	$2, $5	$4.50	$13.50
6th	$10	$5	$5, $5	$4.50	$10

Session B

Treatment	Initial Endowment	Own Benefit	Others Benefits	Uniform Cost	Expected Earnings
1st	$10	$8	$8, $8	$7.50	$10.50
2nd	$10	$2	$2, $2	$2.50	$10
3rd	$10	$8	$2, $5	$5.50	$10
4th	$10	$5	$2, $8	$5.50	$10
5th	$10	$2	$5, $8	$5.50	$10
6th	$10	$5	$5, $5	$5.50	$10

Table 1. Optimal Bidding Strategy and Behavioral Predictions for Alternative Social Preferences Illustrated for a ($2,$5,$8) Distribution

	Optimal Bid				Summary of Predictions
	WTP GAINS	WTP LOSSES	WTA LOSSES	WTA GAINS	
Social Efficiency (Pure Altruism)	$\frac{\pi_i + \sum_{j\neq i}\alpha_i\ \pi_j}{1+(N-1)\alpha_i}$ 2:>2; 5:=5 8:<8	$\frac{\pi_i + \sum_{j\neq i}\alpha_i\ \pi_j}{1+(N-1)\alpha_i}$ 2:>2; 5:=5 8:<8	$\frac{\pi_i + \sum_{j\neq i}\alpha_i\ \pi_j}{1+(N-1)\alpha_i}$ 2:>2; 5:=5 8:<8	$\frac{\pi_i + \sum_{j\neq i}\alpha_i\ \pi_j}{1+(N-1)\alpha_i}$ 2:>2; 5:=5 8:<8	N=1 or Homo $\Rightarrow B_i^* = \pi_i$ Heterogeneous Mean $\pi: B_i^* = \pi_i$ Lower $\pi: B_i^* > \pi_i$ Higher $\pi: B_i^* < \pi_i$
Maximin	$\pi_w = \$2$ $\frac{\pi_i + \alpha_i\pi_w}{1+\alpha_i}$ 2:=2; 5:<5 8:<8	$\pi_w = \$2$ $\frac{\pi_i + \alpha_i\pi_w}{1+\alpha_i}$ 2:=2; 5:<5 8:<8	$\pi_w = \$8$ $\frac{\pi_i + \alpha_i\pi_w}{1+\alpha_i}$ 2:>2; 5:>5 8:=8	$\pi_w = \$8$ $\frac{\pi_i + \alpha_i\pi_w}{1+\alpha_i}$ 2:>2;5:>5 8:=8	N=1 or Homo $\Rightarrow B_i^* = \pi_i$ Heterogeneous $\pi_w \Rightarrow B_i^* = \pi_i$ If $\pi_i > \pi_w \Rightarrow B_i^* < \pi_i$ (WTP) If $\pi_i < \pi_w \Rightarrow B_i^* > \pi_i$ (WTA)
ERC Equity	$\pi_i - \alpha_i \left\lvert \pi_i - \sum_{j=1}^{N}\frac{\pi_j}{N} \right\rvert$ 2:<2; 5:=5 8:<8	$\pi_i + \alpha_i \left\lvert \pi_i - \sum_{j=1}^{N}\frac{\pi_j}{N} \right\rvert$ 2:>2; 5:=5 8:>8	$\pi_i + \alpha_i \left\lvert \pi_i - \sum_{j=1}^{N}\frac{\pi_j}{N} \right\rvert$ 2:>2; 5:=5 8:>8	$\pi_i - \alpha_i \left\lvert \pi_i - \sum_{j=1}^{N}\frac{\pi_j}{N} \right\rvert$ 2:<2; 5:=5 8:<8	N=1 or Homo $\Rightarrow B_i^* = \pi_i$ Heterogeneous Mean $\pi: B_i^* = \pi_i$ Others: $B_i^* < \pi_i$ (Gains) $B_i^* > \pi_i$ (Losses)
FS Equity	$\pi_i - \frac{\alpha_i}{N-1}\sum_{j\neq i} Max[(\pi_j - \pi_i, 0]$ $-\frac{\beta_i}{N-1}\sum_{j\neq i} Max[(\pi_i - \pi_j, 0]$ 2:<2; 5:<5 8:<8	$\pi_i + \frac{\alpha_i}{N-1}\sum_{j\neq i} Max[\pi_i - \pi_j, 0]$ $+\frac{\beta_i}{N-1}\sum_{j\neq i} Max[\pi_j - \pi_i, 0]$ 2:>2; 5:>5 8:>8	$\pi_i + \frac{\alpha_i}{N-1}\sum_{j\neq i} Max[\pi_i - \pi_j, 0]$ $+\frac{\beta_i}{N-1}\sum_{j\neq i} Max[\pi_j - \pi_i, 0]$ 2:>2; 5:>5 8:>8	$\pi_i - \frac{\alpha_i}{N-1}\sum_{j\neq i} Max[(\pi_j - \pi_i, 0]$ $-\frac{\beta_i}{N-1}\sum_{j\neq i} Max[(\pi_i - \pi_j, 0]$ 2:<2; 5:<5 8:<8	N=1 or Homo $\Rightarrow B_i^* = \pi_i$ Heterogeneous $B_i^* < \pi_i$ (Gains) $B_i^* > \pi_i$ (Losses)
Efficiency and Maximin	$\frac{\pi_i + \alpha_i \sum_{j\neq i}\ \pi_j + \beta_i\ \pi_W}{1+(N-1)\alpha_i + \beta_i}$ 2:>2; 5:<5 8:<8	$\frac{\pi_i + \alpha_i \sum_{j\neq i}\ \pi_j + \beta_i\ \pi_W}{1+(N-1)\alpha_i + \beta_i}$ 2:>2; 5:<5 8:<8	$\frac{\pi_i + \alpha_i \sum_{j\neq i}\ \pi_j + \beta_i\ \pi_W}{1+(N-1)\alpha_i + \beta_i}$ 2:>2; 5:>5 8:<8	$\frac{\pi_i + \alpha_i \sum_{j\neq i}\ \pi_j + \beta_i\ \pi_W}{1+(N-1)\alpha_i + \beta_i}$ 2:>2; 5:>5 8:<8	N=1 or Homo $\Rightarrow B_i^* = \pi_i$ Hetero: WTP WTA π_w $B_i^* > \pi_w$ $B_i^* < \pi_w$ Mean π : $B_i^* < \pi_i$ $B_i^* > \pi_i$ Better off π : $B_i^* < \pi_i$ $B_i^* > \pi_i$

Table 2. Selected Comparisons between Dichotomous Choice and RPVM in a WTP-Gains Setting and Symmetric Value Distributions[a]

Mechanism	Value	Cost	Distribution of Values	Percent "Yes"	t-stat	p-value
DC Voting	$2	$2.50	Heterogeneous	18.6%	0.825	0.4102
RPVM	$2	$2.50	Heterogeneous	23.7%		
DC Voting	$2	$2.50	Homogeneous	5.7%	1.469	0.1436
RPVM	$2	$2.50	Homogeneous	11.8%		
DC Voting	$8	$7.50	Heterogeneous	73.3%	1.350	0.1787
RPVM	$8	$7.50	Heterogeneous	81.7%		
DC Voting	$8	$7.50	Homogeneous	86.4%	1.330	0.1854
RPVM	$8	$7.50	Homogeneous	92.5%		

[a] Sample size is 93 for RPVM, 88 for Homogeneous DC Voting, and 86 for Heterogeneous DC Voting.

Table 3. Random Price Voting Mechanism Experiment Results, Induced Gains.

	Private[a]			***Homogeneous***[b]			***Heterogeneous***[c]	
Value	**WTP**	**WTA**	**Others**	**WTP**	**WTA**	**Others**	**WTP**	**WTA**
$1			**$1, $1**	$1.25	$1.28	**$5, $6**	*$1.40*	*$1.91*
$2	$2.10	$1.96	**$2, $2**	$2.06	$2.06	**$5, $8**	*$2.64*	*$2.47*
$4			**$4, $4**	$4.06	$3.90	**$5, $9**	$4.26	*$4.77*
						$1, $6	$4.95	$4.74
$5	$5.09	$5.12	**$5, $5**	$5.10	$5.03	**$2, $8**	$5.19	$5.06
						$4, $9	$5.31	$5.35
$6			**$6, $6**	$6.08	$6.14	**$1, $5**	$5.90	$5.64
$8	$8.11	$8.15	**$8, $8**	$8.14	$8.18	**$2, $5**	$7.78	*$7.75*
$9			**$9, $9**	$8.75	$8.84	**$4, $5**	*$8.24*	*$8.41*

Note: estimates that are statistically different than induced value at 5% level are italicized.

[a] For both WTP and WTA, n=93.

[b] For both WTP and WTA, n = 138 for the homogeneous distribution of values of $5; n = 93 for the homogeneous distribution of values of $2 and $8; and n = 45 for the homogeneous distribution of values value of $1, $4, $6, and $9.

[c] For both WTP and WTA, n = 93 for the heterogeneous distribution of values of $2, $5, $8 and n = 45 for the heterogeneous distribution of values of $1, $5, $6 and $4, $5, $9.

Table 4. Random Price Voting Mechanism Experiment Results, Induced Losses.

	Private[d]			***Homogeneous***[e]			***Heterogeneous***[f]	
Value	**WTP**	**WTA**	**Others**	**WTP**	**WTA**	**Others**	**WTP**	**WTA**
$1			**$1, $1**	$1.04	$1.07	**$5, $6**	$1.24	*$1.77*
$2	$2.23	$2.06	**$2, $2**	$2.14	$2.11	**$5, $8**	*$2.67*	*$2.54*
$4			**$4, $4**	$3.93	$3.98	**$5, $9**	$4.18	$4.47
						$1, $6	$4.74	*$4.36*
$5	$5.19	*$4.68*	**$5, $5**	$4.98	$4.92	**$2, $8**	*$5.38*	$4.82
						$4, $9	$5.05	$5.67
$6			**$6, $6**	$6.01	$6.26	**$1, $5**	$5.73	*$5.42*
$8	$7.99	$7.91	**$8, $8**	$7.80	$7.94	**$2, $5**	*$7.68*	*$7.29*
$9			**$9, $9**	$8.91	$8.87	**$4, $5**	*$8.30*	*$8.35*

Note: estimates that are statistically different than induced value at 5% level are italicized.

[d] For both WTP and WTA, n=93.

[e] For both WTP and WTA, n = 138 for the homogeneous distribution of values of -$5; n = 93 for the homogeneous distribution of values of $2 and $8; and n = 45 for the homogeneous distribution of values value of $1, $4, $6, and $9.

[f] For both WTP and WTA, n = 93 for the heterogeneous distribution of values of $2, $5, $8 and n = 45 for the heterogeneous distribution of values of $1, $5, $6 and $4, $5, $9.

Table 5. Estimated Bid Functions†

	Efficiency	Maximin	ERC	FS	Efficiency and Maximin
			WTP Data, n = 2106		
α	0.057** (0.013)	0.082** (0.023)	-0.013 (0.019)	-0.108** (0.025)	0.069** (0.016)
β	–	–	–	0.097** (0.023)	-0.037 (0.023)
			WTA Data, n = 2106		
α	0.084** (0.017)	0.140** (0.032)	-0.023 (0.021)	-0.164** (0.029)	0.087** (0.019)
β	–	–	–	0.125** (0.028)	-0.009 (0.030)
			WTP & WTA Data, n = 4212		
α	0.070** (0.011)	0.070** (0.018)	-0.018 (0.014)	-0.136** (0.019)	0.076** (0.014)
β	–	–	–	0.111** (0.018)	-0.019 (0.024)

Notes: *, ** denote estimate is statistically different than zero at 5% and 1% level, respectively.
† Pooling the WTP & WTA data is not supported statistically for the Maximin model.
Standard errors in parentheses.

Figure 1. Voting Bias in Dichotomous Choice Voting (WTP-Gains)

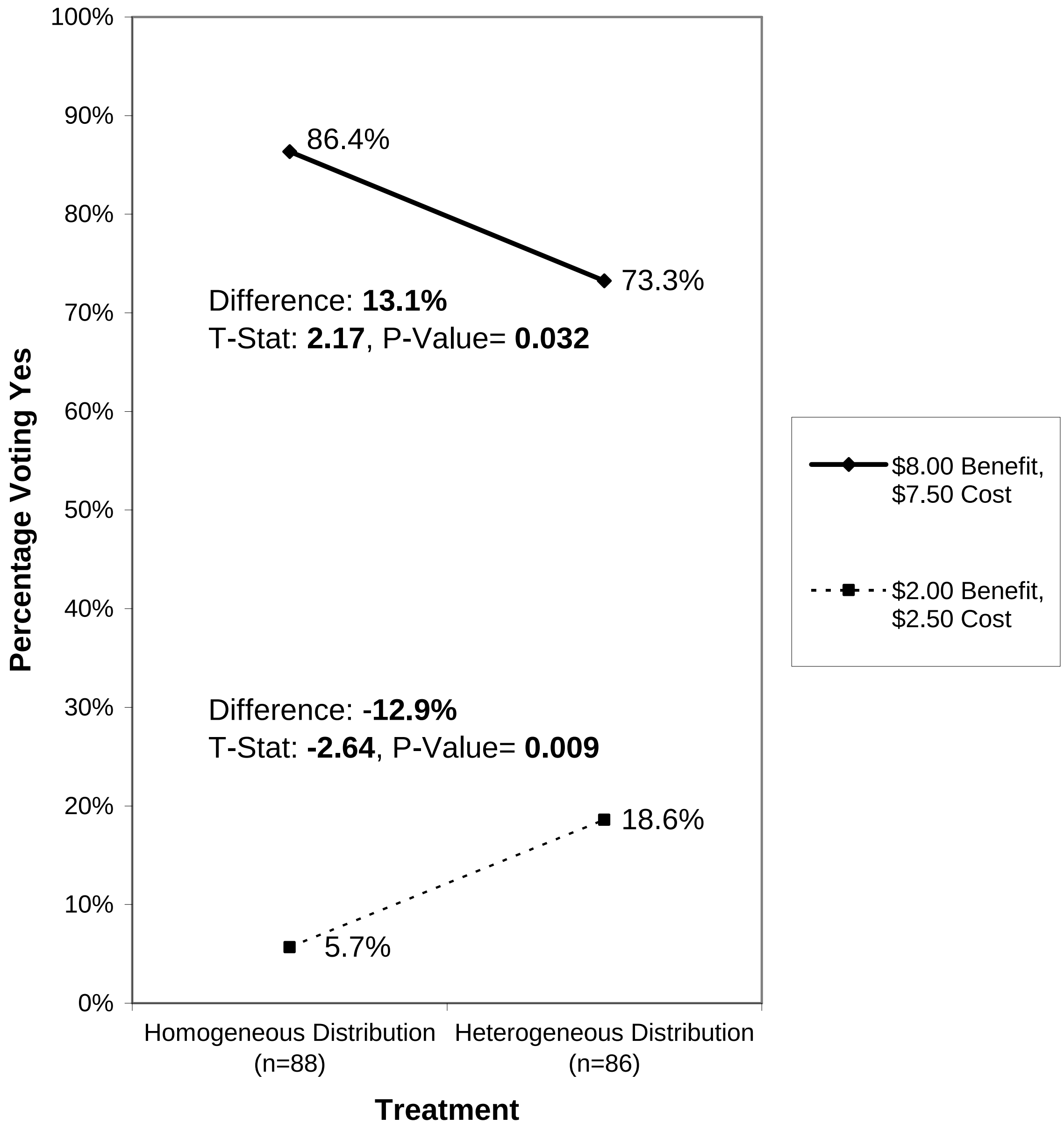

Figure 2. Bids and Offers in Private, Public Homogeneous, and Public Heterogeneously Value Treatments

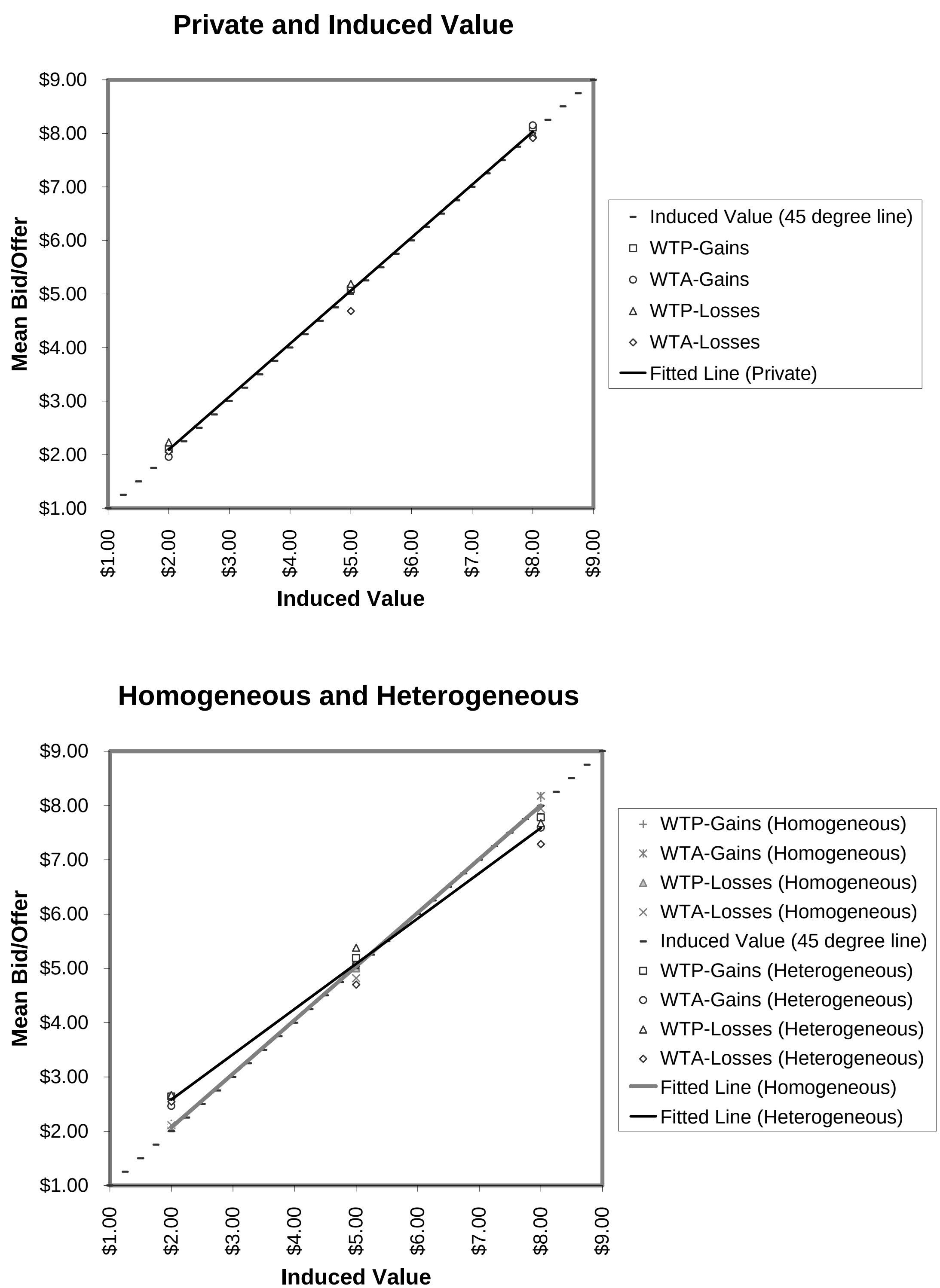

Figure 3. Cumulative Distributions of WTP-Bids for Private, Public Homogeneous, and Public Heterogeneous, Symmetric Values[6]