Compulsory versus Voluntary Voting Mechanisms: An Experimental Study

Sourav Bhattacharya* John Duffy† Sun-Tak Kim‡

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Abstract

This paper reports results from a laboratory experiment designed to study the impact of voting mechanisms on the sincerity of voting decisions and on voter participation. The set-up is a Condorcet jury model in which individuals have a common interest but have noisy private information regarding the true, binary state of nature. The jury's choice is decided by majority rule. In this setting we study two different voting mechanisms: (1) compulsory voting, where all voters are required to vote, and (2) voluntary voting, where each voter may independently choose to vote or to abstain. In the latter case, we also consider whether voting is costly or not. The theoretical literature predicts that under compulsory voting, rational voters will, in certain circumstances, vote *strategically* against their private information regarding the true state of nature. By contrast, under voluntary voting, voters who choose to vote are predicted to vote sincerely, according to their private information with endogenously determined participation rates. We find strong support for these predictions in our experimental data.

Keywords: Strategic Voting, Compulsory Voting, Voluntary Voting, Condorcet Jury Model, Experimental Political Science.

*Department of Economics, University of Pittsburgh. Email: sourav@pitt.edu
†Department of Economics, University of Pittsburgh. Email: jduffy@pitt.edu
‡Department of Economics, University of Pittsburgh. Email: suk36@pitt.edu

1 Introduction

A key insight of the strategic voting literature is that rational voters may have incentives to vote strategically *against* their private information (Austen-Smith and Banks 1996; Feddersen and Pesendorfer 1996, 1997, 1998; Myerson 1998). The reason is that rational voters condition their voting decision on both their private information, i.e., their "signal", and whether their vote will be pivotal, and pivotality concerns can trump the information conveyed by their private signal in expected utility calculations.

However, Krishna and Morgan (2008) have recently shown that voting in accordance with private signals alone, that is, "sincere" voting, can be strategically optimal when voters face private costs of voting and can freely choose whether to vote or to abstain. We shall refer to the latter voting institution as "voluntary voting".[1] In Krishna and Morgan's theory the voting participation decision is described, in equilibrium, by cutoff strategies, in particular by cut-off values for the private cost of voting that are determined in such a way that sincere voting is made incentive compatible.

The goal of this study is to experimentally explore whether voluntary voting with or without voting costs does indeed suffice to induce sincere voting behavior in laboratory voting games relative to the case of compulsory voting. Specifically, we compare voting decisions and participation rates under a voluntary voting mechanism with or without voting costs with a compulsory but costless voting mechanism, where the equilibrium prediction calls for some strategic voting.

The issue of whether voting should be voluntary or compulsory has real world import as both mechanisms are observed in nature. For instance, voting may be voluntary (abstention allowed) or compulsory in small committees or in jury deliberations. In U.S. federal district courts, juror abstention from voting on a verdict in a criminal matter is not allowed while juror abstention is allowed in certain U.S. state courts, e.g., for civil cases where unanimity is not required (as in our setting). There are also differences in voting rules for larger-scale, national elections. Argentina, Australia and Belgium are among several nations where voting (more accurately, showing up to vote) in national elections is compelled by law and subject

[1] In our experiment we also allow abstention under the voluntary voting mechanism when there is no voting cost as in Feddersen and Pesendorfer (1996, 1999a) as this facilitates comparison with the compulsory but costless voting mechanism.

to sanctions for non-compliance. Voluntary voting in national elections, as in the U.S., is the more commonly observed voting mechanism.

The experimental set-up we adopt involves an abstract group decision-making task in which all group members have identical preferences, for example, a jury that wants to convict the guilty and acquit the innocent, but each group member has noisy private information regarding the unknown, binary state of the world. This is the environment of the Condorcet Jury Theorem, however that theorem concerns the efficiency of the voting mechanism in aggregating decentralized information. What is crucial for the success of the Jury Theorem is the behavioral assumption that people should vote sincerely, i.e., according to the private, but noisy signal they have about the true state. The validity of such an assumption was first questioned by Austen-Smith and Banks (1996) from the perspective of game-theoretic equilibrium. In particular, they show that, if agents are rational, the concern for pivotality can outweigh the value of the private information, thus creating an incentive to vote strategically (against one's private signal). Here we fix the voting rule – majority rule – while using the Condorcet Jury environment to study the extent of sincere versus strategic voting when voter participation is voluntary or made compulsory.

Guarnaschelli, McKelvey and Palfrey (2000) is the earliest experimental study showing evidence of strategic voting in laboratory data. They designed a group decision-making experiment in which each subject could privately observe the color of a ball drawn from a jar (which corresponds to getting a signal) prior to voting. After receiving this information, subjects were required to choose between two alternatives. The group decision was then made according to pre-announced voting rules and payoffs were determined depending on the correctness of the group decision. Under the unanimity rule, a large percentage (between 30% and 50%) of subjects were observed voting against their signals, which is largely consistent with the equilibrium predictions of Feddersen and Pesendorfer (1998). Guarnaschelli, McKelvey and Palfrey (2000) also study behavior under majority rule, as we do, but under their parameterization of the model, under majority rule, voters should always vote sincerely. By contrast, in the compulsory voting majority rule set-up we study, the equilbrium prediction calls for some insincere voting.

Importantly, Guarnaschelli, Mckelvey and Palfrey (2000) did not allow abstention– they only used a compulsory and costless voting mechanism. If instead we allow voters to make participation decisions – the voluntary voting mechanism–which can be either costless or costly– prior to making their voting decisions as in Krishna and Morgan (2008), we can change the incentive structure of strategic voting decisions in such a way that sincere voting in the Condorcet Jury model no longer contradicts rationality.

To understand why the voluntary voting mechanism leads to sincere voting behavior, consider a jury trial in which jurors have 50-50 prior beliefs as to the "guilt" of the defendant. Suppose further that the "guilty" signal is commonly known to be more accurate than the "innocent" signal.[2] If every juror is forced to participate and votes sincerely, then pivotal events (where the vote counts are roughly equal) are more likely to arise when the subject is truely innocent, and hence, a juror with a guilty signal may not find it optimal to follow her own signal, i.e., to vote sincerely to convict. However, if jurors are free to abstain and those with an innocent signal participate at a higher rate, then the bias toward the "innocent" state at pivotal events can be reduced or eliminated. In Krishna and Morgan (2008), endogenously determined participation rates completely remove such biases at pivotal events and make sincere voting incentive compatible in equilibrium.

We design an experiment that compares compulsory (and costless) voting with voluntary (and costly or costless) voting. Both mechanisms differ starkly in the way they resolve the concern for pivotality, and hence in the characterization of equilibrium behavior. In the case of the compulsory mechanism, insincere voting (or mixing[3]) is the only way to counterbalance the potential bias that would result from sincere behavior. However, if voting becomes voluntary, each signal group (those members of the group receiving the same signal) will participate in voting at different rates and rational voters will be able to tackle the pivotality issue through voting participation decisions without being strategic (insincere) about their voting decisions. More precisely, the Krishna-Morgan equilibrium under voluntary voting can be characterized as follows:

(1) Given sincere behavior, the participation rate is determined endogenously for each signal group in an equilibrium, with the group whose signal is less precise participating

[2]For example, a guilty signal is known to be observed 80% of the time when the defendant is indeed guilty whereas an innocent signal is known to be observed 60% of the time when the defendant is innocent.

[3]Under the jury setup with noisy signals, we often have mixed strategy equilibrium in which people vote against their signal, with strictly positive probability (Feddersen and Pesendorfer 1998). For a large set of parameters including those used in our experiments, one signal group votes sincerely while the other mixes between the two alternatives.

at a higher rate.

(2) Given each group's (equilibrium) participation rate, the expected payoff from sincere voting is higher than the expected payoff from insincere voting.

We wish to experimentally address the key difference between the two voting mechanisms: the compulsory voting mechanism resolves the pivotality issue through the decision to vote sincerely or strategically while the voluntary voting mechanism does it through voting participation decisions, i.e. vote sincerely or abstain from voting. A laboratory experiment has several important advantages over field research for addressing this question. First, we can carefully control the noisy signal processes and we can observe the signals that subjects receive prior to their making participation or voting decisions. This allows us to accurately assess whether voters are voting sincerely, i.e., according to their signal, or insincerely voting against their signal. Second, we can carefully control and directly observe voting costs, which is more difficult to do in the field. Third, in the laboratory, we can implement the theoretical requirement that subjects have identical preferences by inducing them to hold such preferences via the payoff function that determines their monetary earnings. Outside of the controlled conditions of the laboratory, preferences might differ greatly across voters; for example, jury members might have differing "thresholds of doubt," so that each requires a varying amount of evidence before he/she could vote to convict. Such a scenario can be modeled as each voter incurring a different magnitude of utility loss from incorrect decision (as in Feddersen and Pesendorfer 1998, 1999b).[4] However, we wish to exclude any possible differences in preferences and investigate the effects of the voting mechanism in the presence of only differential private information (e.g., concerning guilt or innocence) as any potential heterogeneity in preferences would only further complicate our analysis of strategic decision-making. In our experiments, all group members will receive zero points if the group decision is incorrect, while all will receive 100 points for a correct group decision, thus eliminating potential heterogeneity in preferences. Finally, we note that all of our undergraduate subjects are voting-age adults (18 years of age or older); by contrast with many other experimental studies, our "student subjects" may be regarded as "professional subjects" in that they are all qualified to vote in elections or to serve on juries.

[4]Utility from correct decision is usually assumed to be the same across voters.

The compulsory voting mechanism involves no voting cost and, under our parameterization (discussed below) predicts that, in equilibrium, a significant fraction (15%) of one signal group will vote against their signal under majority rule (while the other group votes sincerely). We will interpret this as evidence of strategic voting, as in Guarnaschelli, Mckelvey and Palfrey (2000). Under the voluntary mechanism, subjects are expected to vote sincerely, conditional on choosing to vote (not abstaining). Under the same majority rule used in the compulsory case, the participation rate of one signal group is predicted to be 54% while that for the other group is 100% with voluntary and costless voting; the participation rates fall significantly to just 27% and 55%, respectively, with voluntary and costly voting. Thus our design enables us to test the effects of voting mechanisms on the strategic (voting and participation) decisions of subjects in laboratory voting games.

In addition to testing sincerity/insincerity of voting or predictions concerning participation rates, we can also assess the efficiency of the groups assigned to different states in making collective decisions. As discussed in further detail below, subjects will be divided into two groups every round with one group assigned to one state and the other group to the other state. The probability of receiving a correct signal (about the group's state) is higher in one state than in the other. The theory predicts that the group assigned to the state with more precise signals will have a higher chance of making a correct decision. The probability of making a correct decision can be viewed as a measure of informational welfare, hence we can say that the group with more precise signal should attain a higher level of (informational) welfare. This hypothesis can also be tested directly from the experimental data we collect on the group's choice.

The prior literature on strategic voters' participation in laboratory experiments (Schram and Sonnemans 1996; Cason and Mui 2005; Duffy and Tavits 2008) has focused on environments with symmetric information and homogeneous costs, hence they are similar to our study in informational structure, but not in cost structure. Levine and Palfrey (2007) have designed experiments based on a model with heterogeneous costs to test several comparative statics hypotheses of voter turnout. Our modeling and design of voting cost are largely the same as those of Levine and Palfrey (2007). However, the focus of our study is on individual strategic behavior which has not been well studied by the existing literature, with the notable exception of Guarnaschelli, McKelvey and Palfrey (2000).

Battaglini, Morton and Palfrey (2010) have recently reported on an experimental test of the "swing voter's curse" theory proposed by Feddersen and Pesendorfer (1996). They studied the effects of asymmetric information on voter participation under a voluntary and costless voting mechanism; the swing voters are either informed or uninformed, and some fraction of the uninformed voters participate in voting to counterbalance votes by "partisans' while the remaining fraction of swing voters abstain so as to delegate their decisions to the informed.[5] We study a common interest situation with symmetric information, where abstention under voluntary mechanism arises due to asymmetry in the precision of signals (and in part due to voting cost under costly mechanism), which has a direct impact on strategic voting behavior.

2 Model and Notation

The experiments are based on the standard Condorcet Jury setup. We will consider three different voting mechanisms: 1) compulsory and costless voting; 2) voluntary and costless voting and 3) voluntary and costly voting. In all three cases an odd number N of subjects face a choice between two alternatives, labeled R (Red) and B (Blue). The group's choice is made in an election decided by majority rule. There are two equally likely states of nature, ρ and β. Alternative R is the better choice in state ρ while alternative B is the better choice in state β. Specifically, in state ρ each group member earns a payoff of $M(>0)$ if R is chosen and 0 if B is chosen. In state β the roles of R and B are reversed.

Prior to voting, everyone receives a private signal regarding the true state of nature. The signal can take one of two values, r or b. The probability of receiving a particular signal depends on the true state of nature. Specifically, each voter receives a conditionally independent signal where

$$\Pr[r|\rho] = x \quad \text{and} \quad \Pr[b|\beta] = y.$$

We suppose that both x and y are greater than $\frac{1}{2}$ but less than 1 so that the signals are informative, but noisy. Thus, the signal r is associated with state ρ while the signal b is

[5] The presence of partisans (whose preference doesn't depend on states) introduces a conflict of interests. By contrast, we study a common interest setup where there is no conflict of interest after the state is realized.

associated with state β (we may say r is the correct signal in state ρ while b, is the correct signal in state β). The posterior probabilities of the states after receiving signals are

$$q(\rho|r) = \frac{x}{x + (1 - y)} \quad \text{and} \quad q(\beta|b) = \frac{y}{y + (1 - x)}$$

We assume, without loss of generality, that $x > y$ so that $q(\rho|r) < q(\beta|b)$.

We consider both compulsory and voluntary voting mechanisms without costs, however we also consider the voluntary voting case with private costs of voting. One may think that it suffices to study the change in voting behavior by comparing the former two mechanisms without consideration of voting cost. However, it is in general regarded as more realistic to assume that individuals incur voting costs when going to the polls. Reflecting on this, the previous literature on the theory of voter participation, either decision-theoretic (Liker and Ordeshook 1968) or game-theoretic (Ledyard 1984; Palfrey and Rosenthal 1983, 1985), often includes voting costs as an important element of the model. Krishna and Morgan (2008) also concentrate on the voluntary and costly mechanism. The voluntary and costless mechanism can be viewed as an intermediate case, facilitating the important comparison between the compulsory (and costless) mechanism and the voluntary (and costly) mechanism.

In the voluntary mechanism with costs, individuals privately learn their own cost of voting which is determined by an independent realization from a known probability distribution F. After observing their private cost, they can decide whether or not to participate in voting. We also assume that voting cost is independent of the signal as to which choice, R or B, is the better alternative.

A strategy for a voter is a mapping from a type space to an action space. The type space is given by the set of signals $\{r, b\}$ in compulsory mechanism and voluntary mechanism without costs, and by the product of signals and cost $\{r, b\} \times C$ in the voluntary mechanism with costs, where C denotes the set of possible voting costs, i.e., the support of F. The action space is $\{R, B\}$ in the case of compulsory voting and $\{R, B, \phi\}$ in voluntary voting (with or without costs), where ϕ denotes abstention.

Under the compulsory mechanism, we look for a symmetric "informative" equilibrium in which voters with the same signal play the same (mixed) strategy and don't ignore their signals. For a large set of parameter values (x, y), $x > y$, including those to be used in our experiments, the group with signal b votes according to their signal while the group with signal r votes against their signal with a strictly positive probability (that is, one group plays a pure strategy while the other, a mixed strategy) in equilibrium. Under our parameter setup, there exists a unique symmetric informative equilibrium, which facilitates the testing of the compulsory voting equilibrium.

Under the voluntary mechanism, we look for a sincere voting equilibrium with endogenously determined participation rates. The equilibrium we focus on is again a symmetric one in which voters of the same type adopt the same strategies. Krishna and Morgan (2008) show that all equilibria of voluntary voting games entail sincere voting behavior. Under our parameter setups, there exists a unique equilibrium participation rate for each signal group under both costless and costly mechanism of voluntary voting. Hence, we again have a unique equilibrium for our laboratory voting games with voluntary participation. If voting is costless, then the group with signal b votes with probability one while the group with signal r mixes between voting and abstaining. If voting is costly, then there exists a positive threshold cost c_i, $i = r, b$, for each signal group such that an agent whose signal is i votes only if her realized cost is below the threshold. In both cases, all those who vote, vote sincerely.

In particular, under costless (and voluntary) mechanism, the equilibrium participation rate p_r of type r voters is obtained from the following condition:

$$U_r(p_r) \equiv q(\rho|r)\Pr[Piv_R|\rho] - q(\beta|r)\Pr[Piv_R|\beta] \quad = \quad 0. \tag{1}$$

where $\Pr[Piv_R|\rho]$ denotes, for example, the probability that a vote for R is pivotal in state ρ and these pivot probabilities are functions of p_r. The term on the left side represents utility difference between (sincere) voting and abstaining, hence (1) requires that type r voters should be indifferent between the two choices, given that each voter participates with probability p_r and all those who participate, vote sincerely. On the other hand, under costly (and voluntary) mechanism, the equilibrium participation rates $p_i = F(c_i)$ are determined by the following two conditions:

$$U_r(p_r, p_b) \equiv q(\rho|r)\Pr[Piv_R|\rho] - q(\beta|r)\Pr[Piv_R|\beta] \quad = \quad c_r, \tag{2}$$

$$U_b(p_r, p_b) \equiv q(\beta|b)\Pr[Piv_B|\beta] - q(\rho|b)\Pr[Piv_B|\rho] \quad = \quad c_b. \tag{3}$$

(2)-(3) are individual rationality conditions for the voters whose realized cost is given by the cutoff c_i since it requires that the expected benefit from (sincere) voting should be the same as their costs, given that all the other voters with signal j participate only when their cost is below c_j, $j = r, b$, and that those who participate, vote sincerely. Hence, a voter with type (i, c_i) is indifferent between going to the polls and abstaining. Here, the pivot probabilities depend on the participation rates p_j, hence on the cutoff costs c_j.

Furthermore, sincere voting is incentive compatible under the equilibrium participation rates [that solves (1) or (2), (3)] if the following conditions hold:

$$\begin{aligned} U(R|r) &\equiv q(\rho|r)\Pr[Piv_R|\rho] - q(\beta|r)\Pr[Piv_R|\beta] \\ &\geq q(\beta|r)\Pr[Piv_B|\beta] - q(\rho|r)\Pr[Piv_B|\rho] \equiv U(B|r) \qquad (4) \\ U(B|b) &\equiv q(\beta|b)\Pr[Piv_B|\beta] - q(\rho|b)\Pr[Piv_B|\rho] \\ &\geq q(\rho|b)\Pr[Piv_R|\rho] - q(\beta|b)\Pr[Piv_R|\beta] \equiv U(B|r) \qquad (5) \end{aligned}$$

Here, $U(A|i)$ denotes the payoff from the alternative $A \in \{R, B\}$ when the signal is $i \in \{r, b\}$, hence the first inequality (4), for example, requires that the expected benefit from voting for R (sincere voting) is at least as large as that from voting for B (insincere voting) when a voter has signal r in hand, given sincere voting by others and the equilibrium participation rates (all the pivot probabilities are evaluated at the corresponding equilibrium participation rates).

3 Experimental Design

The experiment is conducted using neutral language and involves an abstract group decision-making task that avoids any direct reference to voting, elections, jury deliberation, etc. so as not to trigger other (non-theoretical) motivations for voting (e.g., civic duty, the sanction of peers, etc.). Specifically we use the experimental design of Guarnaschelli, McKelvey and Palfrey (2000) for the benchmark case of the compulsory but costless voting mechanism. Each session consists of a group of 18 subjects and 20 rounds. At the start of each round, the 18 subjects are randomly assigned to one of two groups of $N = 9$ subjects. One group is assigned to the red jar (state ρ) and the other group is assigned to the blue jar (state β)

with equal probability, thus fixing the true state of nature for each group. No subject knows which group they have been assigned to and group assignments are determined randomly at the start of each new round so as to avoid repeated game dynamics.

The red jar contains fraction x red balls (signal r) and fraction $1 - x$ blue (signal b) balls while the blue jar contains fraction y blue balls and fraction $1 - y$ red balls. These distributions are made public knowledge in the written instructions, which were read aloud at the start of each session. Before any voting decision occurs, each subject blindly and simultaneously draws a ball (with replacement) from her group's (randomly assigned) jar. This is done virtually in our computerized experiment. The subject then observes the color of the ball that she has drawn, but not the color of the other subjects' selections or the jar itself from which she has drawn a ball. The group's common and known objective is to correctly determine the jar, "red" or "blue" that has been assigned to their group.

In the two treatments without voting costs, after subjects have drawn a ball (signal) and observed its color, they then proceed to make a voting decision. In the compulsory voting treatment, they must make a "choice" (i.e. vote) between "red" or "blue", with the understanding that the group's decision, either red or blue, will correspond to that of the majority of the 9 group members' choices and that the group aim is to correctly assess the jar (red or blue) that was assigned to the group. In the event of a tie, the group's decision is labeled "indeterminate", otherwise it is labeled "red" or "blue" according to the majority choice. In the voluntary but costless voting treatment, the only difference from the compulsory treatment is that subjects must make a "choice" between "red", "blue" or "no choice" (abstention). The group's decision in this case, "red" or "blue," will correspond to that of the majority of the group members who made a choice between "red" or "blue" i.e., the majority choice of those who did not choose "no choice" (abstain). Again, if there is a tie, the group's decision is labeled "indeterminate," otherwise it is labeled "red" or "blue".

In the voluntary but costly voting treatment, after each subject has drawn a ball, each subject n gets a private draw of their cost of voting for that round, c_n, that is revealed before they face a voting decision. After observing both the color of the ball drawn and the cost of voting, each group member then privately votes for either a red jar or a blue jar or chooses to abstain ("no choice") as in the case where voting is voluntary and costless. The group decision is again made by majority rule among all group members who do not abstain and the color chosen by the majority is the group's decision. A tie is again regarded as an "indeterminate" outcome.

Payoffs each round are determined as follows. If the group's decision via majority rule is correct, i.e., the group's decision is red (blue) and the jar assigned to that group was in fact red (blue), then all members of the 9 member group, (even those who abstained in the voluntary treatment) earn 100 points ($M = 100$). If the group's decision is incorrect, then all members of the 9 member group receive 0 points. If the group's decision is "indeterminate" i.e., there is a tied vote for "red" or "blue", then all members of the 9 member group receive 50 points. This payoff function is the same for both the compulsory and voluntary and costless voting treatments.

In the voluntary and costly treatment, the cost of voting is implemented as an NC-bonus (NC for "no choice") so that subject n gets $100 + c_n$ points if she abstains and her group decision is correct while she gets c_n points if she abstains but the group's decision is incorrect and $50 + c_n$ points if she abstains and the group's decision is indeterminate. A decision by subject n to vote in a round of this costly voting treatment means that she foregoes the NC-bonus for that round, receiving a payoff of either 100, 0 or 50 depending on the group's decision. Subjects are informed that the NC-bonus for each round (c_n) is an iid uniform random draw from the set $\{0, 1, ..., 10\}$[6] for each subject n and applies only to that round.[7]

We consider two treatment variables: 1) the voting mechanism, compulsory and voluntary, and within the voluntary treatment we consider 2) whether voting is costly or costless. We adopt a between subjects design so that in each session subjects only make decisions under a single set of treatment conditions either 1) compulsory and costless voting, 2) voluntary and costless voting or 3) voluntary and costly voting. Across these three treatments all parameters of the voting model are held constant.

Specifically each session involves 18 subjects. We fix the probabilities, x and y, at 0.9 and 0.6, respectively, for the duration of each session. The magnitude of signal precision impacts on participation rates. If the signal is less precise, players have a greater incentive to participate in voting to compensate for their imprecise signals. For instance, in our case

[6]The upper bound for c_n could have been, say, 100 rather than 10. For the present experiment, the bound is set at 10 to boost voter participation rates so that we have enough data for voting decisions.

[7]Our implementation of voting cost follows that of Levine and Palfrey (2007) and has the nature of an opportunity cost.

where signal r is more precise than signal b ($x > y$), if subjects vote sincerely, then the probability that a vote for B is pivotal (Piv_B) is higher than the probability that a vote for R is pivotal (Piv_R).[8] But this means that the benefit from voting for B is higher, hence those with signal b will rationally choose to participate at a higher rate than those with signal r.

Session Numbers	No. of subjects per session	No. of rounds per session	Voting Mechanism	Voting Costly?
C1-3	18	20	compulsory	no
VN1-3	18	20	voluntary	no
VC1-3	18	20	voluntary	yes

Table 1: The Experimental Design

Table 1 outlines our experimental design involving 3 sessions of each of the 3 treatments. Each session involves a single voting mechanism (compulsory, voluntary and costless and voluntary and costly). We thus have results from a total of $3 \times 3 \times 18 = 162$ subjects. In each session, the 18 subjects will be further divided randomly each round into two groups of 9 subjects with one group assigned to the red jar and the other to the blue jar. In this way, the two states of nature are equally represented in any single session. Finally, each session consists of 20 rounds of the compulsory or the voluntary voting (with or without voting cost) games.

4 Research Hypotheses

We first consider the equilibrium predictions for the compulsory voting mechanism. For our parameter values, there exists a unique symmetric informative equilibrium in which subjects with signal b always vote for B (sincere voting) and those with signal r vote against their signal with strictly positive probability (strategic voting).[9] If $x = 0.9$ and $y = 0.6$ as in our experimental design, then 15.6% of voters receiving the red signal are predicted to vote against their signal, i.e. vote blue (or, equivalently, each individual in the latter group is

[8] Precisely, it must be the case that $\frac{\Pr[Piv_B|\rho]}{\Pr[Piv_B|\beta]} > \frac{\Pr[Piv_R|\rho]}{\Pr[Piv_R|\beta]}$.

[9] There always exists an uninformative equilibrium in which everyone ignores the signal.

predicted to vote insincerely with the above mentioned frequency, thus playing a mixed strategy).

The equilibrium predictions for the voluntary mechanism without voting costs are first that all those who choose to vote should vote sincerely, but participation rates should vary according to the signal received. Specifically the equilibrium is characterized by a pair of participation rates p_r^*, p_b^*. The same type of behavior is predicted for the voluntary but costly voting mechanism, but we have alternative equilibrium predictions regarding the cut-off levels for the cost of voting c_r^*, c_b^*. Specifically, subjects whose realized voting costs are below these cut-off levels are expected to participate in voting and those whose costs lie above these cut-off levels are expected to abstain from voting. Table 2 reports the predicted values of these variables for the two voluntary voting treatments.[10]

Voluntary Voting	c_r^*	c_b^*	p_r^*	p_b^*	$p_b^* - p_r^*$
with costs	2.70	5.50	0.2700	0.5497	0.2797
costless	n/a	n/a	0.5387	1.000	0.4603

Table 2: Voluntary Voting Equilibrium

Table 2 also contains other interesting aspects of voluntary voting that can be tested by laboratory data. We can divide the subjects into two groups according to the signals they receive (i.e. the color of the balls that they have drawn). As mentioned in the previous section, the theory then predicts that the participation rate for each signal group will be different; that is, those whose signal is less precise will participate at a higher rate ($p_r^* < p_b^*$). Thus, the group with signal b has an incentive to participate more to compensate for their imprecise signals.

We next consider the incentive for sincere voting under the two voluntary mechanisms. Table 3 shows the expected payoffs $u(A|i)$ that a subject is predicted to gain from voting for $A(= R, B)$ when the signal received is $i = r$,b.

As is evident from Table 3, subjects always get negative payoffs from voting against their signals; in view of equations (4) and (5) in the second section, the utility difference

[10]Under our parameterization, we have a unique equilibrium in terms of participation rates and cut-off cost levels which implies the existence of unique equilibrium for the voluntary voting games.

Voluntary Voting	$U(R\|r)$	$U(B\|r)$	$U(B\|b)$	$U(R\|b)$
with costs	2.70	-11.88	5.50	-12.77
costless	0	-4.02	3.42	-6.93

Table 3: Expected Payoffs under the Voluntary Mechanisms

from voting and abstaining is negative, given others' sincere voting and participation behavior. Therefore, Table 3 suggests that subjects should follow their signals (vote sincerely) conditional on deciding to vote (rather than abstain).[11]

Voting Mechanism	$W(\rho)$	$W(\beta)$
compulsory & costless	0.9582	0.8485
voluntary & costless	0.9513	0.9106
voluntary & costly	0.8572	0.8501

Table 4: Welfare Comparison

A final issue is the efficiency of group decisions. Let us denote by $W(\rho)$ and $W(\beta)$ the probabilities of making a correct decision by the group assigned to the red and the blue jar, respectively (recall that the red jar corresponds to state ρ while the blue jar, to state β). The theory predicts that $W(\rho)$ is greater than $W(\beta)$ under all three mechanisms (compulsory and costless, voluntary and costless, and voluntary and costly) even if the difference is negligible under voluntary and costly mechanism. $W(\rho)$ and $W(\beta)$ are measures for informational welfare, hence the group assigned to the red jar (which entails more precise correct signals) is predicted to attain a higher level of welfare. Table 4 given above shows the predicted values for $W(\rho)$ and $W(\beta)$.

Based on the equilibrium predictions, we can now formally state our research hypotheses:

[11]We have confirmed through calculations that sincere voting is incentive compatible for our parameter values. However, it is in general hard to show incentive compatibility of sincere voting for an *arbitrary* fixed number of voters. If the number of voters is made to be uncertain (and to follow a Poisson distribution), the task becomes more tractable; this is the approach taken in Krishna and Morgan (2008). However, the latter approach is more difficult to implement in the laboratory and hence we choose to work with a fixed number of voters.

H1. The fraction of those who vote *against* their signals (insincerely) is significantly greater than zero (and equal to the predicted values) when voting is compulsory while it is zero when voting is voluntary.

H2. A subject with signal $i = r,b$ participates at a rate p_i^* under the voluntary voting mechanisms (with and without voting costs); or chooses to vote only when her realized cost (NC-bonus) is below the cut-off c_i^* under the voluntary and costly mechanism. (Here, the values for p_i^*, c_i^* are as in Table 2.)

H3. Under the voluntary voting mechanisms, subjects with b signals participate at a higher rate than subjects with r signals ($p_r^* < p_b^*$). Furthermore, the participation rate is higher under the voluntary and costless mechanism than under the voluntary and costly mechanism for each type.

H4. Under all voting mechanisms, the probability of making a correct decision is strictly higher for the group assigned to the red jar than for the group assigned to the blue jar.

5 Results

We report results from nine experimental sessions (three sessions for each of the compulsory, voluntary and costless, and voluntary and costly treatments) with 18 subjects playing 20 rounds in each session. The computerized experiment was run at the Pittsburgh Experimental Economics Laboratory (PEEL) of the University of Pittsburgh. Subjects were recruited from the university's student population via email announcements and in-class recruitment.

Aggregate findings from all 9 sessions are presented in Table 5.

This table reveals that Nash equilibrium performs rather well in predicting the qualitative results for our voting games of compulsory or voluntary participation. The frequency of sincere voting was relatively high (95-97%) under the voluntary voting mechanisms. Decomposition of sincere behavior by types (the signals or the color of the balls drawn) indicate that subjects behaved sincerely regardless of the signal drawn under both voluntary voting

Treatment/ Session[a]	Red/type-r	Blue/tybe-b
C1	0.8956 (249)[b]	0.9910 (111)
C2	0.8730 (244)	0.9914 (116)
C3	0.8970 (233)	0.9921 (127)
C Overall	0.8884 (726)	0.9915 (354)
C Predicted	0.8440	1.0000
VN1	0.8871 (186)	0.9914 (116)
VN2	1.0000 (154)	0.9848 (132)
VN3	0.9752 (161)	0.9048 (105)
VN Overall	0.9501 (501)	0.9632 (353)
VN Predicted	1.0000	1.0000
VC1	0.9794 (97)	0.9600 (75)
VC2	0.9706 (102)	1.0000 (86)
VC3	0.9444 (108)	0.9574 (94)
VC Overall	0.9642 (307)	0.9725 (255)
VC Predicted	1.0000	1.0000

[a] C=Compulsory, VN=Voluntary with No Cost, VC=Voluntary with Cost.
[b] Number of Observations is in parentheses.

Table 5: Proportion of Sincere Voting by Signal

mechanisms. On the other hand, we find evidence for strategic (or insincere) voting under the compulsory mechanism among subjects drawing a red ball; slightly more than 11% of these "type-r" voters (who drew a red ball) voted insincerely which is close to, though slightly lower than the equilibrium prediction of 15.6%. It is also interesting to note that the behavior of subjects under the compulsory mechanism was remarkably consistent across sessions in terms of aggregate sincerity. Therefore, the data seem to suggest that the voting mechanism (compulsory vs. voluntary) do indeed change the incentives for subjects to vote sincerely or strategically. voting decisions.

Are the differences in voting behavior between mechanisms statistically significant? To answer this question, we have conducted a Wilcoxon-Mann-Whitney (WMW) rank-sum test using the session-level observations reported in Table 5. The null hypothesis is that the proportions of sincere voting (3 session-level observations per treatment) from the two mechanisms under consideration come from the same distribution. Table 6 reports the rank sums as well as p-values for each pairwise treatment comparison.

	C vs. VN[a]	C vs. VC	VN vs. VC
Red	$W_C = 8$, $W_{VN} = 13$	$W_C = 6$, $W_{VC} = 15$	$W_{VN} = 11$, $W_{VC} = 10$
	0.2752[b]	0.0495	0.8273
Blue	$W_C = 13.5$, $W_{VN} = 7.5$	$W_C = 12$, $W_{VC} = 9$	$W_{VN} = 10$, $W_{VC} = 11$
	0.1840	0.5127	0.8273

[a] C=Compulsory, VN=Voluntary with No Cost, VC=Voluntary with Cost.
[b] The decimal numbers are p-values for the corresponding comparison.

Table 6: Wilcoxon-Mann-Whitney Test of Difference in Voting Behavior

First, consider the voting behavior of type-r subjects (who have drawn a red ball). The comparison between compulsory (C) and voluntary with cost (VC) treatments reveals a clear difference in voting behavior. Given the high frequency of sincere voting under the VC mechanism, we can say that subjects indeed behaved strategically under the C mechanism. Second, we cannot reject the null of the same proportions of (sincere) behavior under both voluntary mechanisms for type-r subjects.

Somewhat puzzling is the comparison between the C and the VN treatments. We only find weak evidence for a difference in voting behavior under the two mechanisms. This suggests that subjects under voluntary with no cost (VN) treatment have voted "less sincerely." According to the theory, the existence (or absence) of voting cost affects only participation decisions, and not voting decisions; hence, subjects should have voted sincerely regardless of cost under voluntary mechanisms. Empirically, individuals may not think seriously about participation (or abstention) decisions in the absence of voting cost because participation is "free," and given that participation rates by type-r subjects are higher than the predicted rates (as will be shown below), they can do no better than voting insincerely to raise the probability of reaching a correct decision in case their group is assigned to the blue jar.

When it comes to the voting behavior of type-b subjects, we cannot reject the null hypothesis of sincere voting for any of the three pairwise comparisons. This leads to the conclusion that type-b subjects have voted sincerely under all three treatments, as is predicted by Nash equilibrium. The test statistics also suggest that type-b subjects have voted slightly "more sincerely" under the C treatment even if the difference is not statistically significant at the conventional levels.

Treatment/ Session[a]	Red/type-r	Blue/type-b
VN1	0.7815 (238)[b]	0.9508 (122)
VN2	0.6906 (223)	0.9635 (137)
VN3	0.6545 (246)	0.9211 (114)
VN Overall ($\hat{p}_j$)	0.7086 (707)	0.9464 (373)
VN Predicted (p_j^*)	0.5397	1.0000
VC1	0.4128 (235)	0.6000 (125)
VC2	0.4250 (240)	0.7167 (120)
VC3	0.4519 (239)	0.7769 (121)
VC Overall ($\hat{p}_j$)	0.4300 (714)	0.6967 (366)
VC Predicted (p_j^*)	0.2700	0.5497

[a] C=Compulsory, VN=Voluntary with No Cost, VC=Voluntary with Cost.
[b] Number of Observations is in parentheses.

Table 7: Participation Rates by Signal

Next, we examine participation decisions under the voluntary voting mechanisms. As is evident from Table 7, the participation rate of type-b voters was substantially higher than that by type-r voters throughout all sessions of voluntary treatments. Since blue balls were rare, relative to red balls, the type-b voters had more incentive to participate in voting decisions (and of course to vote sincerely). A Wilcoxon signed-rank test (on the session level data show in Table 7 leads us to reject the null hypothesis of no difference in participation rates at the best possible significance level with three observations ($p = .11$) since the differences between observed participation rates ($\hat{p}_b - \hat{p}_r$) were all positive.

Furthermore, each type participated at a higher rate under the VN treatment than under the VC treatment, which is consistent with the theoretical prediction that the introduction of voting costs will reduce participation incentives for all types. Again, a Wilcoxon-Mann-Whitney test applied to the session level data reported in Table 7 allows us to reject the null hypothesis of no difference in participation rates under both voluntary treatments at the level less than 5% since all three participation observations in the VN treatment rank higher than those in the VC treatment for both types. Therefore, the participation behavior observed in our data strongly supports the qualitative prediction of Nash equilibrium.

However, we also observed that subjects tended to participate at a higher rate than the equilibrium prediction, with the lone exception of type-b subjects under the VN treatment. This tendency of over-participation was also observed by Levine and Palfrey (2007), (when the electorate was sufficiently large as in our case) with the rate of over-participation increasing with the group size. They explain such systematic tendency of over-participation with Quantal Response Equilibrium (QRE), an equilibrium concept that formalizes noisy best responses. It will be interesting to explain our data with QRE estimates of both voting behavior and participation rates (we haven't yet obtained QRE estimates for our data). In particular, the participation by type-r voters was high under the VN mechanism to the point of changing their incentive with regard to voting decisions. Given such high participation rates, type-r can do no better than voting insincerely with strictly positive probability. According to the theory, those insincere type-r voters should have abstained, rather than participating and voting insincerely. We speculate that, despite our neutral framing of the problem (e.g. avoidance of references to voting), subjects may nevertheless have had a negative feeling about selecting a "No Choice" option and thus avoided choosing it when they should have. Offering a proper incentive to select No Choice, as in our costly voting treatment with its NC bonus, appears to have worked to reduce any stigma that might have been attached to choosing "No choice".

Finally, we observed a significant difference in the frequencies of making a *correct* decision between group R and B (Table 8), which are our (informational) welfare measures. Type-r subjects made mistakes more often (by voting insincerely or participating at a higher rate), and their mistakes always worked in favor of group R (that is assigned to the red jar). This resulted in group R performing better than group B (that is assigned to the blue jar) in terms of the correctness of majority-rule group decision throughout all sessions of all treatments. In general, the frequencies of correct decision by group R tended to be higher than the equilibrium predictions, while those for group B were found to be well below the predicted values, with some exceptions among the compulsory voting sessions.

The success probabilities are closely tied to participation decisions and voting behavior. The observed discrepancy follows from the relatively high rates of participation under

Treatment/ Session[a]	Red	Blue
C1	0.9500	0.6000
C2	1.0000	0.8500
C3	1.0000	0.7500
C Overall	0.9833	0.7333
C Predicted	0.9582	0.8485
VN1	1.0000	0.8000
VN2	1.0000	0.9250
VN3	1.0000	0.6000
VN Overall	1.0000	0.7750
VN Predicted	0.9513	0.9106
VC1	0.8750	0.7250
VC2	0.9000	0.7750
VC3	0.9250	0.9000
VC Overall	0.9000	0.8000
VC Predicted	0.8572	0.8501

[a] C=Compulsory, VN=Voluntary with No Cost, VC=Voluntary with Cost.

Table 8: Observed Welfare by Group

the voluntary mechanisms and from the relatively low rates of insincere voting under the compulsory mechanism by type-r voters who drove up the success rates while they were in group R, but the error rates while they were in group B. The frequency of insincere voting by type-r voters under the compulsory treatment was lower and the participation rates by them under voluntary treatments were higher than the predicted values, which explain the low success rates of group B. This was even true for the voluntary voting treatments under which a small proportion of type-r voters voted insincerely.

In analyzing the data we propose to develop an econometric model of voter participation behavior. We also plan to explore whether a Quantal Response Equilibrium (QRE) model or the non-equilibrium, level-k theory might help in explaining voting behavior in our experiment.

6 Conclusion

The rational choice approach to voting predicts that players adopt mixed strategies that manifest themselves in different ways depending on whether voting is compulsory or voluntary. In the compulsory, majority rule voting environment we study, voters should play a mixed strategy with respect to whether they vote sincerely when they receive a r signal. In the voluntary, majority rule voting environment we study, voters should always vote sincerely but should play a mixed strategy with respect to their decision to vote or to abstain. We have designed the first ever experiment aimed at comparing these two different voting mechanisms and testing this hypothesis and found strong evidence that voters do indeed change their fundamental behavior in the manner consistent with equilibrium predictions, voting insincerely with some probability under the compulsory mechanism and participating in voting decisiosn with some probability under the voluntary voting mechanisms.

Appendix

The following are experimental instructions for the voluntary and costly voting treatment. The instructions for the other treatments are similar, with the omission of the voting cost part for the voluntary and costless treatment and further omission of the participation decision part for the compulsory and costless treatment.

6.1 Overview

Welcome to this experiment in the economics of decision-making. Funding for this experiment has been provided by the University of Pittsburgh. We ask that you not talk with one another for the duration of the experiment.

For your participation in today's session you will be paid in cash, at the end of the experiment. Different participants may earn different amounts. The amount you earn depends partly on your decisions, partly on the decisions of others, and partly on chance. Thus it is important that you listen carefully and fully understand the instructions before we begin. There will be a short comprehension quiz following the reading of these instructions which you will all need to complete before we can begin the experimental session.

The experiment will make use of the computer workstations, and all interaction among you will take place through these computers. You will interact anonymously with one another and your data records will be stored only by your ID number; your name or the names of other participants will not be revealed in the session today or in any write-up of the findings from this experiment.

Today's session will involve 18 subjects and 20 rounds of a decision-making task. In each round you will view some information and make a decision. Your decision together with the decisions of others determine the amount of points you earn each round. Your dollar earnings are determined by multiplying your total points from all 20 rounds by a conversion rate. In this experiment, each point is worth 1 cent, so 100 points = $1.00. Following completion of the 20th round, you will be paid your total dollar earnings plus a show-up fee of $5.00. Everyone will be paid in private, and you are under no obligation to tell others how much you earned.

6.2 Specific details

At the start of each and every round, you will be randomly assigned to one of two groups, the R (Red) group or the B (Blue) group. Each group will consist of 9 members. All assignments of the 18 subjects to the two groups of size 9 at the start of each round are equally likely. Neither you nor any other member of your group or the other group will be informed of whether they are assigned to the R or B groups until the end of the round.

Imagine that there are two "jars", which we call the red jar and the blue jar. Each jar contains 10 balls; the red jar contains 9 red balls and 1 blue ball while the blue jar contains 6 blue balls and 4 red balls. The red jar is always assigned to the R (Red) group and the blue jar is always assigned to the B (Blue) group. However, recall that you do not know which group (Red or Blue) you have been assigned to; that is, you don't know the true color of your group's jar. Furthermore, your assignment to the R or B group is randomly determined at the start of every round.

To help you determine which jar is assigned to your group, each member of your group will be allowed to independently select one ball, at random, from your group's jar. You do this on the first stage screen on your computer by clicking on your choice of the ball to examine: the balls are numbered 1 to 10. Once you click on the number of a ball, you will be privately informed of the color of that ball. You will not be told the color of the balls drawn by the other members of your group, nor will they learn the color of the ball you chose, and it is possible for members of your group to draw the same ball as you do or any of the other 9 balls as well. Each member in your group selects one ball on their own, and only sees the color of their own ball. However, all members of your group (Red or Blue) will choose a ball from the *same* jar that contains the same number of red and blue balls. Recall again that if you are choosing a ball from the red jar, that jar contains 9 red balls and 1 blue ball while if you are choosing a ball from the blue jar, that jar contains 6 blue balls and 4 red balls.

After each individual has drawn a ball and observed the color of their chosen ball, each individual is asked to decide (1) whether they want to join in the group decision process and make a choice between "RED" or "BLUE" or (2) whether they do not want to join in the group decision process, corresponding to the option "NO CHOICE".

Your group's decision depends on both individual decisions.

Your 9-member group's decision will be the color chosen by the majority of those who decided to join the group decision process. Suppose for example that 6 of your group members decided to join the group decision process (i.e., 3 members selected NO CHOICE). If 4 or more of the 6 who decided to make a choice choose RED, then the group decision is RED by the majority rule. Similarly, the group's decision is BLUE if a majority of those who decided to make a choice chose BLUE. That is, your group's decision will be whichever color receives more individual choices among the members of your group who decided make a choice. In the case of a tie, where each color receives the same number of individual choices by members of your group (for example, 3 members chose RED and the other 3 chose BLUE), the group decision is INDETERMINATE. If the number of those who decided to make a choice is odd (for example, 5 members decided to make a choice while 4 members selected NO CHOICE), then your group's decision can be either CORRECT or INCORRECT, as discussed below, but it cannot be INDETERMINATE.

If you decided not to join the group decision process, that is, you selected NO CHOICE, then you will get additional points, which we refer to as the NC BONUS. The amount of your NC BONUS is assigned randomly by the computer. In any given round, your NC bonus points for the round will be a number drawn randomly from the set $\{0, 1, 2, ..10\}$, with all numbers in that set being equally likely. Your NC BONUS in each round does not depend on your prior round NC BONUS or your decisions in any previous rounds, or on the NC BONUSes or decisions of other members. While you are told your own NC BONUS before you make any decision, you are never told the NC BONUSes of other participants. You only know that each of the other members has an NC BONUS that is some number between 0 and 10, inclusive.

The points you earn in any given round are determined as follows. Suppose you decided to join the group decision process and you then chose RED or BLUE. If your group's decision (via majority rule) is the same as the true color of the jar that is assigned to your group, then the group decision is CORRECT, and you will earn 100 points from the group's correct decision. If your group's decision is different from the true color of your group's jar, then the group decision is INCORRECT, and you will earn 0 points from the group's incorrect decision. If the group decision is INDETERMINATE, then you will earn 50 points from the group's indeterminate decision. Suppose instead that you selected NO CHOICE. In that case, if your group's decision is the same as the true color of the jar that is assigned to your group, then the group decision is CORRECT, and you will earn 100 points plus the NC BONUS assigned to you for that round. If your group's decision is different from the true color of your group's jar, then the group decision is INCORRECT, and you will earn the NC BONUS. If your group's decision is INDETERMINATE, then you will earn 50 points plus the NC BONUS. In other words, if you decide not to join the group decision-you select NO CHOICE-then your earnings will increase by the amount of the NC BONUS that is assigned to you in each round. Notice that both decisions, your decision to make a choice or not (NO CHOICE) and, if you decide to make a choice, your decision between RED or BLUE can affect whether the overall decision of your group is CORRECT, INCORRECT or INDETERMINATE.

If the final (20th) round has not yet been played, then at the start of each new round you and all of the other participants will be randomly assigned to a new 9-person group, R or B. You will not know which group, R or B you have been assigned to but you will have the opportunity to draw a new ball from your group's jar, to decide whether to make a choice or not (NO CHOICE) and if you have decided to make a choice to choose between RED or BLUE. In other words, the group you are in will change from round to round.

Following completion of the final round, your points earned from all rounds played will be converted into cash at the rate of 1 point = 1 cent. You will be paid these total earnings together with your $5 show-up payment in cash and in private.

6.3 Questions?

Now is the time for questions. If you have a question about any aspect of these instructions, please raise your hand and an experimenter will answer your question in private.

Quiz

Before we start today's experiment we ask you to answer the following quiz questions that are intended to check your comprehension of the instructions. The numbers in these quiz questions are illustrative; the actual numbers in the experiment may be quite different. Before starting the experiment we will review each participant's answers. If there are any incorrect answers we will go over the relevant part of the instructions again.

1. I will be assigned to the same group, R or B in every round. Circle one: True False.

2. I will get a different NC Bonus in every round. Circle one: True False.

3. If I decide to make a choice I give up the NC Bonus Circle one: True False.

4. The red jar contains ______ red balls and ______ blue balls. The blue jar contains ______ red balls and _______ blue balls.

5. Consider the following scenario in a round. 5 members of your group decide to make a choice and 3 of these members choose RED.

   a. How many members of your group made NO CHOICE? _________

   b. What is your group's decision? _________

   c. If the jar of balls your group was drawing from was in fact the RED jar, how many points are earned by those who made a choice? _________

   d. If the jar of balls your group was drawing from was in fact the BLUE jar, how many points are earned by those who made a choice? _________

6. Consider the following scenario in a round. 4 members of your group decide to make a choice and 2 of these members choose RED.

a. How many members of your group made NO CHOICE? _________

b. What is your group's decision? _________

c. If the jar of balls your group was drawing from was in fact the RED jar, how many points are earned by those who made a choice? _________

d. If the jar of balls your group was drawing from was in fact the BLUE jar, how many points are earned by those who made a choice? _________

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