Experimental Evidence on Voting Rationality and Decision Framing

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Abstract: Electorate sizes of 20, 40, and 70 subjects are used to test the paradox of voter turnout. Payoff schemes are designed to induce subjects to vote instrumentally. Our experimental evidence indicates that subjects do vote instrumentally, but instrumental voting may not fully explain voter turnouts in some real elections. In addition, theoretical studies associated with instrumental voting, e.g., the expected utility maximization model, the minimax regret model, and game-theoretic models cannot successfully explain the resulting voter turnouts. Our experimental evidence also shows that subjects are more willing to vote when the problem is framed as they will lose something if they make wrong decisions rather than they will gain something if they make right decisions, but only in relatively small sizes of electorates. This suggests that as the subject perceives himself to be less pivotal, the asymmetric incentive attributable to framing provides less influence on his voting decisions.

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1. INTRODUCTION

The paradox of voter turnout initiated by Downs (1957) has been considered an anomaly that cannot be explained successfully by economic theory. Downs, assuming that voters are expected utility maximizers, says that in an election a citizen votes if $pB - c > 0$, where B is the utility difference that the citizen receives from the success of his preferred candidate over the opponent, c is the cost of voting, and p is the citizen's subjective probability of casting a decisive vote. The expression above says that a citizen votes if the expected benefit from his vote being pivotal, pB, exceeds the cost of voting. This is also called the instrumental or investment theory of voter turnout, as the vote is an instrument to obtain the desired outcome. Therefore, a vote is valuable only if it can affect the direct outcome of an election, and pB is thus called the instrumental component of voting.

In a Downsian model, it is implicitly assumed that p is exogenous to the citizen's voting decision, and negatively related to the size of electorates and positively related to the closeness of elections. Therefore, according to Downs, we should observe low voter turnouts in large elections, since the probability of a vote being pivotal is so miniscule that the expected benefit from voting is unlikely to exceed any non-negligible voting cost. However, substantial voter turnouts are usually observed in major elections, e.g., U.S. presidential elections, despite p being nearly zero. This is thus called the paradox of voter turnout.

Several refinements have been developed to resolve the paradox of voter turnout. Among these, the expressive or consumption theory of voter turnout, the minimax regret model, and game-theoretic models are often discussed in the literature.[1] We start the discussion with the expressive theory of voter turnout. Riker and Ordeshook (1968) add a D-term to the basic Downsian model so that now a citizen votes if $pB - c + D > 0$. The D-term is the value from the act of voting per se and is not associated with the direct outcome of elections. Voters consume voting on this basis and D is called the expressive component of voting, as voters vote to express their support for democracy or their citizen duty. A rational voter is now much more likely to vote, even in large elections.

Instead of incorporating an additional component into the basic Downsian model, the minimax regret model and game-theoretic models go back to the instrumental component of

[1] See the discussion by Aldrich (1993) for more details.

voting and concentrate the discussion on the assumption of *p*. Ferejohn and Fiorina (1974) develop the minimax regret model in which regrets, rather than rewards, are associated with voters' acts. In the minimax regret model a voter's objective is to choose the act that minimizes the maximum regret, and therefore the probability of casting a decisive vote is irrelevant to a citizen's voting decision. They show that if $c/B < 1/4$,[2] then voting for the preferred candidate is the minimax strategy. Hence, Ferejohn and Fiorina claim that the minimax regret model explains the positive and substantial voter turnout that occurs in the real world better than the Downsian model does.

Game-theoretic models, on the other hand, treat *p* endogenously, determined simultaneously with the equilibrium voter turnout. Palfrey and Rosenthal (1983) show that turnout can be substantial even when the majority is much larger than the minority. In another article, Palfrey and Rosenthal (1985) show, however, that in the presence of uncertainty about preferences and voting costs of other voters, turnout will be low, even when including the *D*-term. Matsusaka (1995) assumes that a voter's expected benefit from casting a decisive vote increases with the certainty that he is supporting the best candidate. As a result, a voter's probability of voting goes up as he becomes more confident of voting.

The fundamental problem with the Downsian expected utility maximization model is that the theory per se fails to explain actual voter turnouts. Though the refinements above try to resolve this puzzle, they all suffer from other challenges as well. Specifically, adding the *D*-term to the basic Downsian model will, on theoretical ground, significantly raise voter turnouts, but a major criticism with it is that the *D*-term makes the instrumental theory of voter turnout useless, since whether a citizen will vote then depends crucially on the relative magnitudes of *c* and *D*. As for the minimax regret model, a major problem with it is that the assumption of no probability at all is inconsistent with much empirical evidence to the contrary. For instance, Barzel and Silberberg (1973), Denver and Hands (1974), Seidle and Miller (1976), and Chapman and Palda (1983) all obtain empirical evidence that the closeness of elections raises voter turnout, supporting the Downsian model.[3] Finally, game-theoretic models cannot successfully explain

[2] See subsection 2.2.2 for this result.

[3] Nonetheless, Ashenfelter and Kelley (1975), Fiorina (1976), and Matsusaka (1993) find no significant relationship between voter turnout and the closeness of elections. Therefore, whether *p* is negatively related to voter turnout or irrelevant to voters' decisions is empirically unresolved.

voter turnout, either. Though the basic complete information model of Palfrey and Rosenthal (1983) finds that voter turnout can be substantial, the turnout will be low after considering asymmetric information and uncertainty, even if voters also vote expressively. Given these criticisms, it seems that to date there exists no theory that can successfully resolve the riddle of voter turnout.

Two things come to the forefront from the discussion above. First, theoretical models usually assume that the motivations (e.g., expected utility maximization, maximum regret minimization, and strategic voting) behind individuals' voting behavior solve the equilibrium voter turnout. This is based on these motivations seeing whether theoretical predictions can explain actual voter turnouts. What reasons can explain voter turnout may be an empirical issue; however, findings from empirical studies are generally inconsistent. Moreover, a common problem with empirical examinations is that the sample turnout is usually upwardly biased,[4] thereby the estimators of other coefficients may be biased as well. Second, except for the minimax regret model, both the Downsian model and game-theoretic models frame the voting problem as what voters will get, rather than what they will lose, from their actions. Nonetheless, when a voter decides whether to vote or not, he may be contemplating not only how likely his preferred candidate would win if he voted (and what benefits he could get from the success of his preferred candidate), but also how likely his preferred candidate would lose (and how regretful he would feel if he abstained).

In this paper we try to use experimental methods to test the paradox of voter turnout. We will mainly investigate the effect of decision framing on subjects' voting behavior. Kahneman and Tversky (1979) and Tversky and Kahneman (1981, 1986) claim that decisions yielding the same outcome or objective may not be regarded as psychologically equivalent, since individuals' preferences or choices may be influenced by the way in which a decision is initially framed. Applying Kahneman and Tversky's idea of decision framing, the problem of voting can be framed both positively and negatively, as indeed it has been framed in both ways in the literature, though not in the same framework. In the former the problem of voting can be framed as subjects gaining something from their actions, while in the latter it can be framed as them losing something.

[4] See Ashenfelter and Kelley (1975) and Harbaugh (1996) for related discussions.

There are two purposes to this paper: First, we want to find out whether subjects vote instrumentally and whether instrumental voting is sufficient to explain voter turnout. Second, if subjects do vote instrumentally, then we would like to ask what motivations or theories can explain their voting behavior. The next section provides the framework of positive and negative framing and predictions on voter turnout in both frames under various theoretical models. Experimental design and experimental results are illustrated in Sections 3 and 4, respectively. Section 5 concludes.

2. POSITIVE AND NEGATIVE FRAMING

We first present the payoff schemes for positive and negative frames. In the positive-frame condition, voters' acts create reward, whereas in the negative-frame condition voters' acts create regret. According to these payoff schemes, we then obtain predictions on voter turnout from three theoretical models associated with instrumental voting: the expected utility maximization model, the minimax regret model, and the game-theoretic model. These models treat the subjective probability for an individual casting a decisive vote in distinct ways, which in turn affect the predictions on voter turnout. In the expected utility maximization model the probability of a vote being decisive is exogenous to the individual's voting decision and is assumed to decrease with the size of electorates; in the minimax regret model this probability is completely irrelevant to the individual's decision; and in the game-theoretic model this probability is endogenously determined by strategic interactions between voters.

2.1. The Reward and Regret from Voting and Abstention

We first list five states of nature for an individual's decision problem in Table 1, which is reproduced from Ferejohn and Fiorina (1974). In Table 1, n_i is the number of votes for candidate i excluding the individual under consideration. Let the individual's subjective probabilities for S_1 through S_5 be p_1, …, p_5, respectively, where $p_j \geq 0$, j = 1, …, 5, and $\sum_{j=1}^{5} p_j = 1$. Without loss of generality, it is assumed that the individual's preferred candidate is Candidate 1. Also following Ferejohn and Fiorina, we normalize the utility to 1 if Candidate 1 wins and to 0 if Candidate 2 wins for simplicity. Thus, the utility difference that the individual receives from the success of Candidate 1 over Candidate 2 is 1. If a tie occurs, the outcome is determined by flipping a coin, and thus the expected utility is 1/2.

Table 1: States of Nature for a Citizen's Decision Problem

States	*Definition*	*Description*
S_1	$n_1 > n_2 + 1$	Candidate 1 wins by more than one vote excluding the individual's vote
S_2	$n_1 = n_2 + 1$	Candidate 1 wins by exactly one vote excluding the individual's vote
S_3	$n_1 = n_2$	Candidates 1 and 2 tie excluding the individual's vote
S_4	$n_1 = n_2 - 1$	Candidate 1 loses by exactly one vote excluding the individual's vote
S_5	$n_1 < n_2 - 1$	Candidate 1 loses by more than one vote excluding the individual's vote

Table 2 shows payoffs from voting for Candidate 1 (V_1), voting for Candidate 2 (V_2), and abstention (A) in the positive-frame condition. Since V_1 (weakly) dominates V_2, if the individual is rational and if he votes, the he must vote for Candidate 1. Therefore, we do not consider the act V_2. Notice also that if $c > 1/2$, then no one has an incentive to vote in all states, so we restrain our analysis to the case where $c < 1/2$.[5] Among these five states, the states where the individual votes for Candidate 1 and that his vote is decisive are S_3 and S_4. That is, the individual's vote is decisive if it breaks or makes a tie.

Table 2: The REWARD from Voting and Abstention

Acts	S_1	S_2	S_3	S_4	S_5
V_1	$1-c$	$1-c$	$1-c$	$1-c$ or $-c$	$-c$
V_2	$1-c$	$1-c$ or $-c$	$-c$	$-c$	$-c$
A	1	1	1 or 0	0	0

In the negative-frame condition, we use the procedure in Ferejohn and Fiorina's (1974) minimax regret model to obtain the regret resulting from alternative actions. Table 3 presents the regrets in all states. For instance, in S_3 in which the individual's vote breaks a tie (as shown in Table 2), he gets payoff $1-c$ from voting for Candidate 1, $-c$ from voting for Candidate 2, and 1 or 0 if he abstains. If he abstained and the coin-flipping showed the success of Candidate 1, then the largest payoff he could get is 1 from abstention. Thus, he would have

[5] We ignore the case where the individual feels indifferent between voting and abstention. This assumption is innocuous to our model and results.

no regrets if he abstained, and the regret is $1-(1-c)=c$ if he voted for Candidate 1 and $1-(-c)=1+c$ if he voted for Candidate 2. If he abstained, but coin-flipping showed otherwise the success of Candidate 2, then the largest payoff he could get is $1-c$ if he had voted for Candidate 1. Thus, in this situation he would have no regrets if he did vote for Candidate 1, and the regret is $1-c-(-c)=1$ if he voted for Candidate 2 and $1-c$ if he abstained.

Table 3: The REGRET from Voting and Abstention

Acts	S_1	S_2	S_3	S_4	S_5
V_1	c	c	c or 0	0 or c	c
V_2	c	c or 1+c	1+c or 1	1 or c	c
A	0	0	0 or $1-c$	$1-c$ or 0	0

It is apparent from Table 3 that a rational voter will not vote for Candidate 2, since the regret in all states is at least as large as that if he voted for Candidate 1. Therefore, in the negative-frame condition a rational voter will certainly vote for his preferred candidate if he votes. Moreover, if $c>1/2$, then no one has an incentive to vote in all states. Hence, we restrict our analysis to the case of $c<1/2$. Notice further that the regret from voting or abstention in Table 3 is reproduced from the reward in Table 2. Therefore, "regret" and "reward" are actually generated from the same payoff scheme.

2.2. Theoretical Predictions on Voter Turnout

2.2.1. The Expected Utility Maximization Model

In the positive-frame condition, if the individual votes (for Candidate 1), then the expected utility from voting, denoted RW_V (reward from voting), is

$$RW_V = p_1 + p_2 + p_3 + p_4(\tfrac{1}{2}) - c. \tag{1}$$

If the individual abstains, then the expected utility from abstention, denoted RW_A (reward from abstention), is

$$RW_A = p_1 + p_2 + p_3(\tfrac{1}{2}). \tag{2}$$

Thus, the individual votes if

$$RW_V - RW_A = \tfrac{1}{2}(p_3 + p_4) - c > 0. \tag{3}$$

In the negative-frame condition, if the individual votes, then the expected utility from voting, which is actually negative and denoted RG_V (regret from voting), is similarly

$$RG_V = p_1 c + p_2 c + p_3(\tfrac{1}{2}c) + p_4(\tfrac{1}{2}c) + p_5 c. \quad (4)$$

If he abstains, then the expected utility from abstention, which is also negative and denoted RG_A (regret from abstention), is

$$RG_A = p_3[\tfrac{1}{2}(1-c)] + p_4[\tfrac{1}{2}(1-c)]. \quad (5)$$

The individual thus abstains if RG_A is less than RG_V. That is, the individual abstains if

$$RG_A - RG_V = \tfrac{1}{2}(p_3 + p_4) - c < 0. \quad (6)$$

Comparing (3) and (6) clearly shows that if an individual votes in the positive-frame condition, then he will also vote in the negative-frame condition. Therefore, the expected utility maximization model predicts the same voter turnout regardless of the frame. In addition, if the cost of voting remains unchanged, then voter turnout should be negatively related to the size of electorates, since the probability of a vote being pivotal, $p_3 + p_4$, decreases with the size of electorates.

2.2.2. The Minimax Regret Model

In Ferejohn and Fiorina's (1974) minimax regret model, the individual chooses the act which minimizes the maximum regret. The voting decision is irrelevant to the size of electorates and the closeness of elections. Since the individual considers regrets, rather than gains, generated from his act, the minimax regret criterion applies only to the negative-frame condition. Observing from Table 3, the maximum regret from V_1 is c, that from V_2 is $(c+1+c)/2 = 1/2 + c$, and that from *A* is $(1-c)/2$. Therefore, if the maximum regret from V_1 is less than that from *A*, or equivalently $c < 1/3$, then the individual will vote for Candidate 1.[6] Because $c = 0.2$ is used in our experiments, if subjects minimize the maximum regret, then we should observe voter turnouts equal to one or at least close to one in all sizes of experiments.

[6] Our result is a little different from that in Ferejohn and Fiorina (1974), in which the individual votes if c < 1/4. The reason is that in obtaining the regret in Table 3, Ferejohn and Fiorina use the expected payoff in Table 2 whenever a tie occurs, but we keep the two possible payoffs when there is a tie, thus obtaining the corresponding regret. Because *c* = 0.2 is used in our experiments, this difference will have no influence on subjects' choices if they really minimize maximum regret.

2.2.3. The Game-Theoretic Model

We present here a simple game-theoretic model in which voters vote strategically, considering the responses by other voters.[7] The model is designed and solved completely according to Table 2 and Table 3.

Let N_i (i = 1, 2) denote the number of voters supporting candidate *i*. The pure-strategy Nash equilibrium is quite simple: If $N_1 = N_2$, then there is a unique Nash equilibrium with all voters participating in the election. If $N_1 \neq N_2$, then there is no pure-strategy Nash equilibrium.[8] We will concentrate our analysis on the mixed-strategy Nash equilibria in the following.

Consider first a voter favoring Candidate *i*. He can be in any one of the five states S_k^i (k = 1, …, 5) in Table 1 with probability p_k^i. A voter is then said to be *pivotal* if he is in state S_3^i or S_4^i, but apparently a voter has no reason to vote unless one is pivotal. Let π_i (i = 1, 2) be the equilibrium voting probability of a voter supporting Candidate *i*. We then define a function

$$G(N,n,\pi_i) \equiv \binom{N}{n} \pi_i^n (1-\pi_i)^{N-n}$$

as the probability that n out of N voters favoring Candidate i will make efforts to vote if each of them acts with probability π_i.

Now consider specifically the voting decision of a voter favoring Candidate 1. If state S_3^1 occurs, then a tie will result if he does not cast his vote. The probability of this event is:

$$p_3^1 = \sum_{s=0}^{\min\{N_1-1,N_2\}} G(N_1-1, s, \pi_1) G(N_2, s, \pi_2).$$

In state S_4^1, his favorite Candidate 1 will lose by just one vote if he abstains. The probability of

[7] The incomplete information or uncertainty of Palfrey and Rosenthal (1985) is not considered in this simple model. The reasons are: (1) We want to keep the model consistent with the other two theoretical models which both have complete information. (2) One purpose of this paper is to find out the motivations behind voting behavior. If the experimental evidence cannot be explained by the simplest complete information game-theoretic model, then it cannot be explained by a more complicated incomplete information one.

[8] Consider the following three possibilities in the case of $N_1 \neq N_2$: (1) The winner wins by two or more votes. Any single voter in either camp can then be better off by withdrawing his vote. Thus, this cannot be an equilibrium. (2) The winner wins by exactly one vote. A voter of the losing side who abstained (if there is any) will prefer to vote, whereas voters on the winning side who voted want to back out. This cannot be sustained as an equilibrium, either. (3) When we have a tie, all voters in both camps who abstained can gain from casting a vote. An equilibrium is hence impossible unless all voters have cast their votes.

this event is:

$$p_4^1 = \sum_{s=0}^{\min\{N_1-1, N_2-1\}} G(N_1-1, s, \pi_1)G(N_2, s+1, \pi_2).$$

Therefore, the probability of a voter favoring Candidate 1 being pivotal is $p_3^1 + p_4^1 \equiv \eta^1$. We can similarly write down the corresponding probabilities for a voter favoring Candidate 2, p_3^2 and p_4^2, and thus the probability that his vote is decisive, $p_3^2 + p_4^2 \equiv \eta^2$.

In the mixed-strategy Nash equilibrium, a voter is indifferent between voting for his preferred candidate and abstention. Let us start with the positive-frame condition. Using Table 2, we can write down the equilibrium condition for voters favoring Candidate 1 as:

$$(p_1^1 + p_2^1 + p_3^1)(1-c) + p_4^1(\tfrac{1}{2}-c) + p_5^1(-c) = p_1^1 + p_2^1 + p_3^1(\tfrac{1}{2}). \tag{7}$$

Equivalently, the equilibrium condition of voting is determined by equating (1) and (2), or by setting (3) to be zero. Equation (7) can be simplified to $(p_3^1 + p_4^1)(\tfrac{1}{2}) - c = 0$, or, $\eta^1 = 2c$. We also have $\eta^2 = 2c$ by symmetry. Putting this together we have

$$\eta^1 = \eta^2 = 2c. \tag{8}$$

Equation (8) says that in equilibrium all voters are equally likely to vote and the probability of a vote being pivotal is 2*c*, which is independent of N_1 and N_2. Since $0 < c < 1/2$ is assumed in our model, $\eta^1 = \eta^2 = 2c$ can be any value in (0, 1). Solving p_3^1, p_4^1, p_3^2, and p_4^2 simultaneously and using (8) gives us the equilibrium voting probabilities (π_1, π_2). Notice that if $N_1 = N_2$ and (π_1^*, π_2^*) is a pair of equilibrium voting probabilities, then by symmetry $(\hat{\pi}_1, \hat{\pi}_2) = (\pi_2^*, \pi_1^*)$ must also be a pair of equilibrium voting probabilities. The expected number of votes for Candidate *i* is then simply $N_i\pi_i$,[9] and the expected number of total votes cast is $N_1\pi_1 + N_2\pi_2$, which in turn yields the (expected) equilibrium voter turnout:

$$\theta \equiv \frac{N_1\pi_1 + N_2\pi_2}{N_1 + N_2}.$$

In the negative-frame condition, the equilibrium condition of voting is similarly determined

[9] If we take (π_1, π_2) as a voter's subjective beliefs about other individuals, then $\eta^i(\pi_1, \pi_2 \mid N_1, N_2)$ is his subjective probability of being pivotal. This can be calculated easily (with N_1 and N_2) and used in the expected utility approach for comparison.

by equating (4) and (5), or by setting (6) to be zero. This will also give us the same η^1 and η^2, thereby the same equilibrium voting probabilities and equilibrium voter turnout, as those in the positive-frame condition.

We cannot derive explicitly the equilibrium voter turnout without any numerical analysis. However, since the probability for a voter being pivotal is $2c$, which is independent of the size of electorates, a non-negligible voting cost means that the voter turnout predicted by the game-theoretic model can be substantial even in large electorates. One thing for sure is that the voter turnout in both the positive-frame condition and the negative-frame condition must be identical.

3. EXPERIMENTAL DESIGN

We conduct three series of experiments with different sizes of electorate, 20, 40, and 70 subjects, respectively. Four separate sessions are conducted in the first series of experiments with 20 subjects, and two separate sessions are conducted in each series of the experiments with 40 and 70 subjects, providing a total of 300 subjects used in this study. Each session includes two conditions and every subject plays first in the positive-frame condition and then in the negative-frame condition, so that data collected from different conditions are generated by the same subjects. In sum, there are eight sessions with two conditions in each session, for a total of 16 experiments and 300 subjects used, and each subject plays in both positively and negatively-framed experiments.

There are 10 decision rounds in each experiment. At the beginning of each experiment, subjects are randomly assigned their subject numbers. We then randomly assign the subjects' group identities before each round starts by using the subject numbers. There are two group identities, one group supporting Candidate 1 and the other group supporting Candidate 2. In all experiments the numbers of subjects in both groups are identical across all rounds. All subjects are inexperienced and are recruited from intermediate economics classes at National Taiwan University and National Chengchi University. 125 are males and 175 are females, and among these subjects only 15 students do not major in economics or economics-related fields. Due to limited funds for this research, we announce at the beginning of each experiment that subjects will be paid the average, rather than the cumulative, payoff over ten rounds.

Subjects play first in the positive-frame condition and then in the negative-frame condition.

It takes about 110 minutes to finish one session of experiments. The average earnings for all experiments are NT$166 in the positive-frame condition and NT$189 in the negative-frame condition, for a total of NT$355.[10] Therefore, the average hourly earnings for a subject are about NT$194, which is a little bit higher than twice the part-time hourly wage rate for an undergraduate student in Taiwan.

3.1. Positively Framed Voter Turnout Experiments

Subjects' Instructions, Earnings Report, and the Decision Form for the first round are handed out to each subject as he/she takes the seat.[11] The rest of the Decision Forms are then passed out to subjects before each round starts. The Decision Form indicates the subject's preferred candidate. There are two decisions on each Decision Form: voting for the preferred candidate and abstention. Notice that we only allow for rational voting, that is, if subjects vote, then they must vote for their preferred candidate. The preferred candidate for each subject in each round is randomly assigned and changes across rounds. Except for the preferred candidates assigned to other subjects, all other parameters in the experiment, including available candidates (Candidate 1 and Candidate 2), the size of the electorate, the size of each group identity, the endowment, the cost of voting, and the payoff scheme for all subjects, are known to all subjects. Subjects are also informed that their earnings and decisions will remain secret over all rounds and no communication with other subjects is allowed.

Subjects are told that they are going to make 10 voting decisions. In each decision round each subject is endowed with NT$80. The benefit from the success of the preferred candidate over the opponent is NT$200, and the cost of voting is NT$40; thus, the cost to benefit ratio used in the experiment is 0.2. Subjects are also told that an additional amount of money, which represents the "REWARD" from voting or abstention, will be added to (or subtracted from) their endowments. The REWARD is designed completely according to Table 2. The subject can earn an additional NT$200 if his/her assigned candidate wins, $0 if his/her assigned candidate loses, and either $200 or $0, which is determined by coin-flipping, if a tie occurs, no matter

[10] The exchange rate between U.S. dollars and NT dollars was about 1:32.5 during the time that these experiments were conducted.

[11] The Appendix provides Subjects' Instructions. Chinese translations are used in experiments. Earnings Report, Decision Form, and data from the experiments are available upon requests.

whether he/she votes. If the subject votes, then he/she has to pay $40 no matter whether his/her assigned candidate wins or loses. Therefore, subjects' earnings are completely instrumental, depending on the direct outcome of election and their own voting decisions. Several examples are provided after the description of the payoff scheme.

After subjects make their decisions in each round, the assistants collect the Decision Forms and give them to the experimenter. The experimenter counts the votes supporting Candidate 1, Candidate 2, and the votes abstained, and then announces the voting results. At the same time, the voting results are recorded on the chalkboard. The assistants also mark down each subject's assigned candidate, decision, and the results of voting, and compute each subject's earnings on the Earnings Report and then return it to the subjects.

3.2. Negatively Framed Voter Turnout Experiments

With the payoff scheme designed completely according to Table 3, the same procedures in the positively-framed experiment are run in the negatively-framed experiment. Subjects are endowed with $210 at the beginning of each round. This magnitude is chosen such that the average earnings in the negatively-framed experiment are about the same as those in the positively-framed experiment. Subjects are told that an extra amount of money, which represents the "REGRET" from voting or abstention, will be subtracted from their endowments. The benefit from the success of the preferred candidate over the opponent is still $200, and the cost of voting is $40. Subjects are informed that these two numbers are simply used to compute REGRET and will not necessarily be added to or subtracted from their endowments. Specifically, the voting problem is phrased as ". . . if you vote, but your vote does not change the outcome without counting your vote, then you regret to vote. On the contrary, if you abstain, but your vote could have reverted the outcome of voting, then you were regretful for your abstention as well." According to Table 3, we divide each case of voting and abstention into three examples to compute subjects' REGRET.

These instructions have no effect on subjects' incentives to vote. The size of the electorate in the negative-frame condition remains the same as in the positive-frame condition. If subjects perceive that the probability of casting a decisive vote is inversely related to the size of electorate, as assumed in the Downsian expected utility maximization model, then this decisive probability does not change with frames. In addition, we use the same cost-to-benefit ratio in these two conditions so that the probability of a subject being pivotal as determined by the game-theoretic model, 2*c*, also remains unchanged. Therefore, if the subject is in his/her self-interest to free-ride in the positive-frame condition, then he/she should also free-ride in the negative-frame condition. If instead, the subject minimizes the maximum regret, then he/she should vote all the time in the negative-frame condition, since the cost-to-benefit ratio, 0.2, used in our experiments, does not exceed the threshold, 1/3, for subjects to abstain.

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

Tables 4 through 6 illustrate the voter turnout per round for the different sizes of electorates. Notice first that the overall average turnouts are at least as high as 36 percent, and in some experiments the average turnouts are higher than 80 or even 90 percent. This shows that subjects do vote instrumentally. Notice also that except in the negative-frame condition of electorate size 20, the average turnout in most experiments is generally lower than 50 percent. As compared to voter turnout in some real elections, e.g., above 50 percent in the U.S. presidential elections and even above 75 percent in the Taiwanese presidential elections, these figures suggest that instrumental voting may only partially contribute to voter turnouts in some real elections and other motivations may also induce voting.

Table 4: The Voter Turnout per Round of the Electorate Size 20

	Round										
	1	2	3	4	5	6	7	8	9	10	All
Positive 20-1	0.45	0.30	0.35	0.30	0.40	0.35	0.35	0.40	0.35	0.45	0.37
Positive 20-2	0.60	0.50	0.40	0.40	0.30	0.40	0.60	0.45	0.35	0.25	0.43
Positive 20-3	0.30	0.30	0.30	0.30	0.25	0.40	0.20	0.20	0.25	0.25	0.28
Positive 20-4	0.40	0.55	0.35	0.45	0.35	0.45	0.25	0.35	0.40	0.25	0.38
Average	0.44	0.41	0.35	0.36	0.33	0.40	0.35	0.35	0.34	0.30	0.36
Negative 20-1	0.85	0.80	0.70	0.70	0.85	0.70	0.65	0.90	0.70	0.55	0.74
Negative 20-2	0.90	0.80	0.90	0.95	1.00	0.75	0.90	0.85	0.95	0.95	0.90
Negative 20-3	0.80	0.80	0.80	0.90	0.85	0.80	0.90	0.80	0.95	0.95	0.86
Negative 20-4	0.80	1.00	0.90	0.75	0.60	0.55	0.85	0.75	0.90	0.80	0.79
Average	0.84	0.85	0.83	0.83	0.83	0.70	0.83	0.83	0.88	0.81	0.82
Difference	-0.40	-0.44	-0.48	-0.47	-0.50	-0.30	-0.48	-0.48	-0.54	-0.51	-0.46

Table 5: The Voter Turnout per Round of the Electorate Size 40

	Round										
	1	2	3	4	5	6	7	8	9	10	All
Positive 40-1	0.40	0.48	0.40	0.45	0.48	0.43	0.38	0.30	0.33	0.23	0.39
Positive 40-2	0.48	0.45	0.48	0.38	0.30	0.38	0.38	0.25	0.50	0.35	0.39
Average	0.44	0.46	0.44	0.41	0.39	0.40	0.38	0.28	0.41	0.29	0.39
Negative 40-1	0.85	0.88	0.83	0.90	0.93	0.95	0.93	0.95	0.98	0.93	0.91
Negative 40-2	0.75	0.65	0.60	0.53	0.43	0.30	0.53	0.38	0.25	0.18	0.46
Average	0.80	0.76	0.71	0.71	0.68	0.63	0.73	0.66	0.61	0.55	0.68
Difference	-0.36	-0.30	-0.27	-0.30	-0.29	-0.23	-0.35	-0.38	-0.20	-0.26	-0.29

Table 6: The Voter Turnout per Round of the Electorate Size 70

	Round										
	1	2	3	4	5	6	7	8	9	10	All
Positive 70-1	0.64	0.63	0.50	0.47	0.49	0.40	0.44	0.34	0.26	0.37	0.45
Positive 70-2	0.39	0.40	0.26	0.34	0.29	0.30	0.27	0.23	0.19	0.24	0.29
Average	0.51	0.51	0.38	0.41	0.39	0.35	0.36	0.29	0.22	0.31	0.37
Negative 70-1	0.70	0.84	0.59	0.43	0.26	0.31	0.50	0.56	0.67	0.29	0.51
Negative 70-2	0.51	0.44	0.37	0.26	0.20	0.29	0.29	0.19	0.27	0.21	0.30
Average	0.61	0.64	0.48	0.34	0.23	0.30	0.39	0.37	0.47	0.25	0.41
Difference	-0.10	-0.13	-0.10	+0.07	+0.16	+0.05	-0.03	-0.08	-0.25	+0.06	-0.04

Several reasons may cause high voter turnouts in our experiments. First, each side contains an equal supporting population in our experiments. As mentioned in the Introduction, some empirical evidence shows a positive relation between voter turnout and the closeness of elections, though this issue remains unresolved. Equal competition in our experiments may thus generate high voter turnouts. Second, as compared with real election campaigns, electorate sizes used in our experiments are relatively small, thereby voter turnouts may be high. The limitation of sizes is a common problem for most experimental studies. In Schram and Sonnemans's (1996) experiments on voter turnout, the largest electorate size is 28 subjects. In related literature of voluntary contributions to public goods experiments, the largest size used, to our knowledge, is 100 subjects in Issac, Walker, and Williams (1994), with group sizes used in other studies usually around 5 to 10 subjects. Despite the limitation of sizes, our experimental evidence, as will be presented later, shows no definite relation between voter turnout and electorate size. Third, it has been shown in some voluntary contributions to public goods experiments that a provision point may significantly raise contributions. Since in voting experiments there is an unavoidable provision point, which is the number of votes cast by the opponent group, the resulting turnout (contributions) may be high.

Observing from Table 4 through Table 6, voter turnouts are generally higher in the negative-frame condition than in the positive-frame condition. More precisely, in the experiments of 20 subjects, voter turnouts in the negative-frame condition are all much higher than those in the positive-frame condition. The overall turnout in the negative-frame condition is 82 percent, which is 46 percent higher than that in the positive-frame condition. As the electorate size increases to 40 (except for rounds 6, 9, and 10 in Experiment 40-2), turnout per round is still significantly higher in the negative-frame condition than in the positive-frame condition. The overall turnout in the negative-frame condition is 68 percent, which is 29 percent higher than that in the positive-frame condition. Turnouts in these two conditions become very close when the electorate size increases further to 70. The difference between the overall turnouts in these two conditions is only 4 percent.

We can examine the significance of the difference between frames, but within the same electorate size, by using a Wilcoxon matched-pairs signed-ranks test. For electorate sizes 20 and 40, the test statistic has a value of $T = 0$ which is significant beyond the significance level $\alpha \leq 0.01$. For electorate size 70, the test statistic has a value of $T = 18$ which is insignificant even if the level of significance is selected at 15%. These results show that negative frame significantly raises voter turnout when the electorate size is small.

To examine the significance of the difference across various electorate sizes, but within the same frame, a Kruskal-Wallis one-way analysis of variance by ranks test can be used. Within the positive frame, the Kruskal-Wallis test statistic has a value of $H = 1.785$. The critical value of chi-square with 2 degrees of freedom is 4.605 for $\alpha = 0.1$. Therefore, we conclude that there exists no electorate size effect in the positive-frame condition.

We now look at the negative frame. The Kruskal-Wallis test statistic has a value of $H = 23.538$ which is significant beyond the significance level $\alpha \leq 0.005$. Therefore, we conclude that turnouts are not the same in all three electorate sizes. We then ask which sizes are different from which others and use multiple comparisons to find out the difference between sizes. Let

$\overline{R}_i$, i = 20, 40, and 70, be the mean of the ranks of electorate size i. The value of the inequality is $\left|\overline{R}_{20} - \overline{R}_{40}\right| = 9.4$ which does not exceed the critical value 9.409 for the error rate α = 0.05, but does exceed the critical value 8.386 for the error rate α = 0.1. Hence, the electorate size effect exists between group sizes 20 and 40 at the error rate 0.1. Between electorate sizes 40 and 70 and between electorate sizes 20 and 70, the values of the inequality are $\left|\overline{R}_{40} - \overline{R}_{70}\right| = 9.7$ and $\left|\overline{R}_{20} - \overline{R}_{70}\right| = 19.1$, respectively. Thus, the electorate size effect under these two pairs of sizes exists at the error rate 0.05.

Summing up our experiments, the results suggest that subjects do vote instrumentally, but instrumental voting may not fully explain the voter turnout in some real elections. In addition, voter turnouts are significantly higher in the negative-frame condition than in the positive-frame condition in electorate sizes 20 and 40, but this difference diminishes when the electorate size increases to 70. Moreover, voter turnouts do not vary between different electorate sizes in the positive-frame condition, while the differences are significant in the negative-frame condition, especially between electorate sizes 20 and 70 and between 40 and 70.

The findings above suggest that subjects in small electorate sizes are more willing to vote when the problem of voting is framed as they will lose something if they make wrong decisions rather than as they will gain something if they make right decisions. However, this difference diminishes in larger electorate sizes, for instance, when 70 subjects are used in our experiments. If subjects perceive themselves to be more pivotal in small groups than in large groups, then these findings indicate that the asymmetric incentives attributable to framing provide less influence on subjects' voting decisions when they are in large groups. Furthermore, our experimental evidence suggests that if gaining something is the motivation inducing subjects to vote, then whether they perceive their own votes are pivotal has no effect on this motivation. On the contrary, if they vote to prevent from losing something, then the perception of being pivotal is influential.

We now compare our experimental evidence with the predictions from theoretical models discussed in Section 2. We claim that neither theoretical model can successfully explain subjects' voting behavior and our arguments are as follows. The expected utility maximization theory only predicts correctly in the negative-frame condition that voter turnouts decrease with electorate sizes. Though high voter turnouts observed in some experiments are consistent with the predictions from the game-theoretic model, the game-theoretic model still fails to explain the difference of voter turnouts between frames when electorate sizes are small. Finally, the minimax regret model cannot successfully explain the voter turnouts in the negative-frame condition, either. In all of our experiments the cost-to-benefit ratio, 0.2, does not exceed the threshold, 1/3, for subjects to abstain. Therefore, if subjects act to minimize the maximum regret, then we should observe turnouts equal to 1 or at least close to 1 in all experiments. However, this can be observed only in experiments of electorate size 20 and one experiment of electorate size 40. Voter turnouts decrease significantly when electorate size increases to 70, as subjects may perceive that the probability of their vote being pivotal becomes small and therefore they are less likely to be punished for not voting.

We also can compare our findings with other experiments on the paradox of voter turnout and decision framing. Our experimental evidence of no electorate size effect in the positive frame condition is similar to that in Schram and Sonnemans (1996). Schram and Sonnemans vary the group size supporting each candidate from 6 by 6 to 8 by 6 and further to 14 by 14 and find no significant difference in voter turnout. There are two major differences between Schram and Sonnemans's experiments and ours. First, Schram and Sonnemans do not frame the voting problem negatively. As shown previously, the electorate size effect exists in the negative-frame condition. Second, they use rather small sizes and small variations in electorate sizes, and thus may easily find no group size effect.[12]

As compared with other framing settings, public goods/common pools experiments are somewhat in common with the voter turnout experiments. Subjects in both types of experiments make decisions on contributing (voting) or not, and the outcome depends on whether a threshold is reached. The threshold in public goods/common pools experiments is exogenously given, while in voter turnout it is endogenously determined by the votes cast by the opponent group. Results from public goods experiments are inconclusive. Sonnemans, Schram, and Offerman (1998) find that subjects contribute more in the public goods experiments than in the common pools experiments, while Brewer and Kramer (1986) find the opposite result. Aquino, Steisel, and Kay (1992), Fleishman (1988), and Rutte, Wilke, and Messick (1987), however, find no

[12] Another difference is that they fix the group composition over all decision rounds when they examine the group size effect, but in our experiments the group composition changes over decision rounds. In the same paper they find that changing the group composition raises voter turnout, contradicting the results in Andreoni (1988).

difference between frames.[13] Notice that because there is a threshold in these experiments, any subject may easily become pivotal when group sizes are small. Unfortunately, except for the two group sizes of 8 and 32 used in Brewer and Kramer (1986), group sizes are only 5 or 6 in all other public goods/common pools experiments. Though theoretically the subjective probability of a subject being pivotal is the same regardless of frame, psychologically framing may still provide subjects with different incentives in small groups than in large groups. Our experimental evidence of a salient framing effect in electorate sizes 20 and 40 and no framing effect in electorate size 70 may verify this conjecture.

5. CONCLUSIONS

In this paper we design experiments in which subjects' payoffs depend completely on their act of voting or abstaining and the direct outcome of elections. This design induces subjects to vote instrumentally. There are indeed some interesting findings in this paper. First, our experimental evidence suggests that subjects do vote instrumentally, but instrumental voting may not fully explain the voter turnouts in some real elections. Second, voting patterns observed in our experiments are not consistent with expected utility maximization, maximum regret minimization, nor with strategic play in voting games. This suggests that subjects' voting behavior, even though induced solely by instrumental voting, cannot be explained by any of these theories alone. Third, our experimental evidence shows that voter turnouts are higher in the negative-frame condition than in the positive-frame condition when electorate sizes are small, and framing has no effect on turnouts in large electorates. This indicates that as the subject perceives himself/herself to be less pivotal, the asymmetric incentives attributable to framing provide less influence on his/her voting decisions. Finally, we find no electorate size effect in the positive-frame condition, but turnouts do decrease with electorate size in the negative-frame condition. This implies that if subjects vote to prevent themselves from losing something rather than in an attempt to gain something, the perception of being pivotal is influential.

[13] In a different setting, Andreoni (1995) assumes no threshold and frames voluntary contributions to public goods as an externality problem, in which contributing creates a positive externality and not contributing creates a negative externality to other group members. He finds that subjects are more willing to contribute when the externality is positive.

APPENDIX: SUBJECTS' INSTRUCTIONS (for 20 subjects)

A1. Positive Frame: The Reward Condition

Subjects' Instructions

Welcome

This experiment is a study of voting behavior. You may earn a lot of money if you follow the instructions and make your decisions carefully. National Science Council provides the funds for this experiment.

The Voting Environment and Your Voting Decisions

In this experiment you will make a series of 10 voting decisions. Each voting decision you make will result in a *cash return* which depends on the voting decisions that you and all other subjects make. *Notice that you will be paid the average cash returns over the 10 decision rounds.*

There are two candidates, Candidate 1 and Candidate 2, in this voting experiment and there are totally 20 subjects (voters) participating this experiment. Subjects are split into two groups randomly: 10 subjects are assigned Candidate 1 as their preferred candidate and the other 10 subjects are assigned Candidate 2 as their preferred candidate. The preferred candidate assigned to every subject will be changing in ***every*** decision round.

For each voting decision, you and all other subjects decide to vote or to abstain. At the beginning of each round you will be given a Decision Form with your assigned candidate on it. If you decide to vote, then please mark "√" on the top of your assigned candidate on the Decision Form and hand it to the assistant. Your assigned candidate will then get one vote. If you decide not to vote, then put "√" on the top of abstention and also give it to the assistant. Neither candidate will get your vote in this case. The assistant will record your assigned candidate and your voting decision on your Earnings Report.

In each round, the experimenter will count the votes supporting each candidate and announce the result after all subjects give Decision Forms to assistants. The outcome of voting is determined by simple majority voting rule, that is, the candidate who gets more votes wins.

In the case of a tie, the outcome is determined by flipping a coin: *Head* shows the success of Candidate 1 and *Tail* shows the success of Candidate 2. The assistant will then put the voting result and your payoff on your Earnings Report.

The above procedure will be repeated for all ten rounds. **NOTICE THAT YOUR VOTING DECISIONS AND EARNINGS WILL REMAIN SECRET. NO COMMUNICATION WITH OTHER PARTICIPANTS IS ALLOWED.**

Your Earnings

You are endowed with $80 at the beginning of each round. In addition, you can earn an additional amount of money, depending on your voting decisions and the outcome of voting. In this experiment the benefit from the success of your assigned candidate over the opponent is $200 and the cost of voting is $40.

If your assigned candidate wins, then you receive another $200 no matter whether you vote. If the opponent wins, then you receive $0. If a tie occurs, then your earnings are determined by flipping a coin: Candidate 1 wins if *Head* shows up and Candidate 2 wins if *Tail* shows up. If you cast your vote, then your earnings are subtracted by $40, the cost of voting, no matter whether your assigned candidate wins or loses. Any subjects who vote have to pay $40 as well.

Examples

Example. If you vote and your assigned candidate wins, then you receive $\$80 + \$200 - \$40$. $= \$240$

Example. If you abstain and your assigned candidate wins, then you receive $80 + $200 = $280.

Example. If you vote and your assigned candidate loses, then you receive $\$80 - \$40 = \$40$.

Example. If you abstain your assigned candidate loses, then you receive $80.

Example. If you vote and a tie occurs, then you receive either $\$80 + \$200 - \$40 = \$240$ (the coin shows the success of your assigned candidate) or $\$80 - \$40 = \$40$ (the coin shows the failure of your assigned candidate).

Example. If you abstain and a tie occurs, then you receive either $80 + $200 = $280 (the coin shows the success of your assigned candidate) or $80 (the coin shows the failure of your assigned candidate).

We now start the first round.

A2. Negative Frame: The Regret Condition

Instructions in the negatively-framed experiment are identical to those in the positively-framed experiment, expect for the computation of subjects' earnings. We therefore provide only the information associated with subjects' earnings below.

Your Earnings

You are endowed with $210 at the beginning of each round. An extra amount of money, which represents your REGRET from your voting decision, will be subtracted from your endowment. Whether REGRET occurs depends on your voting decisions and the outcome of voting, and the degree of your REGRET is associated with the cost of voting and the benefit from the success of your assigned candidate over the opponent. The cost of voting is $40 and the benefit from the success of your assigned candidate over the opponent is $200. **NOTICE THAT WE WILL NOT ADD ADDITIONAL $200 TO YOUR ACCOUNT IF YOUR ASSIGNED CANDIDATE WINS, AND WE WILL NOT NECESSARILY SUBTRACT $40 FROM YOUR ACCOUNT IF YOU VOTE. THESE NUMBERS ARE SIMPLY USED TO COMPUTE THE DEGREE OF YOUR REGRET.**

As you may find out in some voting events, sometimes you regretted casting or not casting your vote afterwards. For instance, if you voted and your preferred candidate won by a lot of votes, then you regretted voting, because your preferred candidate would still win even if you abstained. In contrast, if you abstained and it turned out that your preferred candidate lost by just one vote, then you regretted not voting, because your vote could have reverted the outcome.

Be specific, if you vote but your vote does not change the outcome without counting your vote, then you regret voting. On the contrary, if you abstain, but your vote could have reverted the outcome of voting, then you were regretful for your abstention as well.

In the following page, we illustrate the computation of your REGRET with several examples. These examples comprehend all possible outcomes.

The Case That You Vote:

Example. If you vote, but your assigned candidate still loses or your assigned candidate wins by more than one vote, then your REGRET is $40, the cost of voting that you spend. In this case your vote does not change the outcome without counting your vote, but you waste $40 to vote. Therefore, your earnings are $210－$40 = $170.

Example. If you vote and your assigned candidate wins by exactly one vote, then your REGRET can be either $40 or $0. The tie would remain if you did not vote, and the outcome would be determined by flipping a coin. In other words, your assigned candidate could still win even if you abstained. In this case we will flip a coin. If the coin shows the success of your assigned candidate, then your REGRET is $40 (the voting cost you wasted), since your assigned candidate would still win even if you abstained. Therefore, your earnings are $210－$40 = $170. If the coin shows otherwise the failure of your assigned candidate, then you have no regret, since your vote breaks the tie to prevent this from happening. In this case your earnings are $210.

Example. If you vote and a tie occurs, then your REGRET can be either $0 or $40, depending on coin-flipping. If the coin shows the success of your assigned candidate, then your REGRET is $0 and your earnings are $210. Otherwise, your REGRET is $40, and your earnings are $210 －$40 = $170.

The Case That You Abstain:

Example. If you abstain, but your assigned candidate still wins, or your assigned candidate loses by more than one vote, then you have no regret from abstention, since your vote would not change this outcome even if you voted. Therefore, your earnings are $210.

Example. If you abstain and a tie occurs, then in this case you could break the tie but you did not. In this case the outcome is determined by coin-flipping. If the coin shows the success of your preferred candidate, then you have no regret from abstention, since your assigned candidate wins no matter whether you vote or not. Therefore, your earnings are $210. However, if the coin shows the failure of your assigned candidate, then your vote could have prevented this from happening. In this case, your REGRET is $(\$200-\$40)=\$160$ (the lost benefit from the success of your assigned candidate minus the cost of voting saved), and your earnings are

$\$210-(\$200-\$40)=\$50$.

Example. If you abstain and your assigned candidate loses by exactly one vote, then your vote could have made a tie if you voted, and the outcome of voting would be determined by flipping a coin. In this case we will flip a coin to determine the degree of your regret. If the coin shows the success of your assigned candidate, then your REGRET is $(\$200-\$40)=\$160$, since your assigned candidate would have won simply counting your vote, and therefore you would not lose the benefit from his success, but meanwhile you saved $40 from not voting. Your earnings are then $\$210-(\$200-\$40)=\$50$. If the coin shows otherwise the failure of your assigned candidate, then you have no regret from abstention, since your assigned candidate could still lose even if you voted. Therefore, your earnings are $210.

The six examples above are summarized in the following tables.

<table>
<tr><td>Vote</td><td>your assigned candidate wins by more than one vote
or
your assigned candidate loses</td><td>your assigned candidate wins by exactly one vote</td><td>tie</td></tr>
<tr><td>Your Earnings</td><td>$210－$40 = $170</td><td>$210－$40 = $170
(the coin shows the success of your assigned candidate)
or
$210
(the coin shows the failure of your assigned candidate)</td><td>$210
(the coin shows the success of your assigned candidate)
or
$210－$40 = $170
(the coin shows the failure of your assigned candidate)</td></tr>
<tr><td>Abstain</td><td>your assigned candidate wins
or
your assigned candidate loses by more than one vote</td><td>tie</td><td>your assigned candidate loses by exactly one vote</td></tr>
<tr><td>Your Earnings</td><td>$210</td><td>$210
(the coin shows the success of your assigned candidate)
or
$210－($200－$40) = $50
(the coin shows the failure of your assigned candidate)</td><td>$210－($200－$40) = $50
(the coin shows the success of your assigned candidate)
or
$210
(the coin shows the failure of your assigned candidate)</td></tr>
</table>

We now start the first round.

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