The Case for Nil Votes: Voter Behavior under Asymmetric Information in Compulsory and Voluntary Voting Systems*

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Abstract

In an informational voting environment, we study the impact of an explicit nil vote option on the ballot when some voters are uninformed and face the swing voters curse. We postulate a simple model of strategic voting in which voters entertain heterogeneous thresholds on legitimacy of different voting actions. We predict that introducing a nil vote option reduces the number of uninformed and invalid votes, increasing expected welfare in both voluntary and compulsory voting. We test our model in a pen-and-paper laboratory experiment, and find that the predictions of the model hold in the data, for both voting systems.

Keywords: information aggregation in elections, nil vote option, voluntary and compulsory voting

JEL Classification: C92, D72, D82

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I Introduction

There is considerable evidence that people's decisions whether to participate in elections depend not only on their expected gains from changing the result of the election in pivotal events, but also on direct benefits from voting, independent of whether the vote influences the outcome. Riker and Ordeshook (1968) list several possible sources of such preferences, such as the satisfaction from compliance with the ethic of voting, from affirming allegiance to the political system, or from going to the polls and being able to cast a vote. Alternatively, one can face social pressure from peers to participate, imposing a cost on someone acting against this pressure. As pointed out by many papers, in large elections the probability of a vote being pivotal is very close to zero (see for example Palfrey and Rosenthal, 1985), hence arguing that nontrivial participation rates in large elections require such psychological benefits from voting, for a significant fraction of voters.

In this paper, we show theoretically and experimentally that when some voters have psychological benefits from voting, adding an explicit nil vote option to the ballot can change the outcome of the election and improve the welfare of the voters, both when voting is voluntary, and when it is compulsory. The inclusion of a nil vote (or "None of these candidates" vote) option is subject of an active policy debate in various countries, and it is implemented in some settings: for example it is included on the voting ballot in Nevada for the president of the United States (and for state constitutional positions). A recent paper by Ujhelyi, Chatterjee and Szabo (2016) empirically investigates the effects of the introduction of such a voting option following a 2013 Supreme Court decision, in India, on election outcomes.

Our investigation is in an informational context of voting, in which all voters have the same preferences – preferring candidate 0 when the state is 0 and candidate 1 when the state is 1 – but while some voters are uninformed (only know the prior probabilities of the states, 50–50%), other voters are informed, in that they receive an imperfect but informative signal on the true state. As Feddersen and Pesendorfer (1996) have shown, uninformed voters in such an environment might face the "swing voter's curse," in that they would prefer not influencing the election to voting for either of the candidates. The intuition is that a vote for candidate 0 is more likely to be pivotal when the true state is 1, and vice versa.[1] However, for uninformed voters who receive psychological benefits from voting, these benefits might outweigh the negative expected effect of voting, causing some fraction of the uninformed voters to vote.

[1] Relatedly, Jakee and Sun (2006) point out that forcing uninformed people to vote introduces noise in the election outcome, with negative welfare consequences.

In a compulsory voting system, the only way of not influencing the election outcome for a voter (aside from paying the penalties associated with abstaining) is casting an invalid vote.[2] In line with this, there is a clear empirical pattern that in compulsory voting systems the ratio of invalid votes is much higher than in voluntary voting systems. The top three countries in a ranking of country-level shares of invalid votes in election outcomes are the South American countries Brazil, Peru, and Ecuador with invalidation rates of around 20%, each of which employs compulsory voting (Australian Electoral Commission, 2003). Australia is one of the few industrialized countries with a compulsory voting scheme. Its average share of invalid votes of about 4-5% puts it at number 46 in a ranking of countries by fraction of invalid votes, but it is very high compared to other industrialized countries. For example, the U.K. only have a share of invalid votes of about 0.2% (Australian Electoral Commission, 2003). This is consistent with the hypothesis that some uninformed voters might choose to cast an invalid vote in a compulsory system. However, there might be other uninformed voters who would suffer a psychological cost when casting an invalid vote, as it is not a vote officially legitimized by the voting system. If this psychological cost is high enough, these uninformed voters would rather cast a vote for one of the candidates. Then for some of these voters, having a nil vote option on the ballot would make a difference, as the nil vote is an officially endorsed, legitimate voting choice. Therefore, the nil vote option could decrease the number of uninformed voters voting for one of the candidates, and hence reduce some noise in the election outcome.

In a voluntary voting system, voters are free to abstain from voting. Abstaining not only saves the negative expected influence of casting a vote by an uninformed voter on the election outcome, but it can also save physical/monetary costs of showing up and casting a vote. Nevertheless, some uninformed voters might directly benefit from participating in the election, hence instead of abstaining they would rather participate and vote for one of the candidates. Having the nil vote option on the ballot can shift some of these uninformed voters to instead vote for the nil option, which is a legitimate choice on the ballot, and not influence the election outcome in an adverse manner.

We investigate these potential effects using a 2x2 experimental design, in which one dimension of experimental variation is whether voting is voluntary or compulsory, while the other dimension is whether a nil vote is explicitly provided as a choice on the ballot (besides the two candidates) or not. Those who voted incurred a small voting cost, while

[2] The Australian Electoral Commission (2009), for example, classifies invalid votes as belonging to one of ten categories: blank, number "1" only, incomplete numbering, ticks or crosses used, other symbols used, repeated or missing numbers, deliberately informal, illegible or unclear preferences, voter identified, or other.

those who abstained did not. However, in the sessions with compulsory voting, abstention was discouraged by a large penalty. Voting was conducted secretly and simultaneously, with the candidate receiving the higher number of votes winning, and random tie-breaking. We conducted a pen-and-paper experiment, in which the ballots resembled ballots from real world elections, and just like in real world elections, participants received instructions on what constitutes an invalid vote that does not get taken into account for the election result (without encouraging or discouraging the subject to vote this way).

We generate formal predictions for the experiment with a voting model in which some voters receive psychological penalties if they choose actions that they perceive as not fulfilling the civil duty of voting. Equivalently, we could assume, as in a "calculus of voting" type model (Downs, 1957; Fiorina, 1976; Riker and Ordeshook, 1968), that these voters get a psychological benefit from choosing an action that fulfills the civic duty. We enrich this well-known model framework by allowing for the possibility that different voters have a different threshold for what action is legitimate enough for fulfilling one's civil duty. There is a natural ordering of possible actions in terms of legitimately participating in voting, which is, going from the most legitimate to the least legitimate: voting for one of the two candidates, voting for the nil option (if provided), abstaining (not participating) and casting an illegitimate vote (choosing an action that is explicitly illegitimate). Motivated by this, we assume the existence of four types of voters: (1) those who are not affected by psychological penalties, whatever action they choose (standard economic agents who only care about their material payoffs); (2) those who only receive a psychological penalty if casting an invalid vote; (3) those who receive a psychological penalty if either casting an invalid vote or abstaining; and finally (4) those who receive a psychological penalty if they do not vote for one of the two candidates (so they incur the penalty even when they vote for the nil option). We assume that the distribution over these types in the population is commonly known. A limit case of the model is when the probability of type 1 is equal to 1, that is all voters are standard economic agents.

We show that in any symmetric and state-neutral equilibrium of this game (from now on, equilibrium), the action choice is uniquely pinned down for all voter types when voting is compulsory, and for all but informed type-1 voters when voting is voluntary. In particular, all informed voters who incur a psychological penalty from abstaining participate in the election and vote according to their signals. Given this, uninformed voters face the swing voter's curse, and they prefer not influencing the outcome whenever they can do so in a way that does not impose psychological costs on them. In the latter case they choose the action that achieves this in the least costly way (which depends on the type). Informed type-1 voters, when voting is voluntary, can either abstain, or vote according to their signals, or mix between the previous actions. Which one applies in equilibrium depends on the parameter specification of the model. When the voting cost is low and the signals are precise enough, corresponding to our experimental design, in equilibrium these informed voters always vote (according to their signals).

The model predicts that when types 2–4 are present with positive probability in the population, then introducing a nil vote affects the election outcome both when voting is voluntary, and when it is compulsory. With voluntary voting, some of the uninformed voters who vote for a candidate when the nil option is not provided switch to choosing the nil vote when the latter is provided. This increases the likelihood that the right candidate is selected in equilibrium, and improves the expected payoff of every voter. In the case of compulsory voting, the introduction of a nil vote option eradicates invalid votes, and decreases the number of uninformed voters who vote for a candidate. This again increases the likelihood of the right candidate winning, and increases the expected payoffs of voters.

The magnitude of the welfare effect of the introduction of a nil vote depends on the model parameters, but it can be substantial even for large electorates, if the ratio of informed voters is low relative to the ratio of uninformed voters.

Our empirical findings are in line with these theoretical predictions. As predicted by the model, basically all informed voters voted according to their signals, in all four treatments. The variation across treatments was concentrated on the behavior of uninformed voters. Furthermore, the high penalty for abstention in the case of compulsory voting induced nearly all subjects in those treatments not to abstain. Hence in the compulsory voting treatments the effect of providing a nil vote option only potentially affected what fraction of uninformed voters voted for one of the candidates versus either casting an invalid vote or a nil vote (if the latter was an option).

Again in line with the model's predictions, invalid votes from uninformed voters were only observed in the case of compulsory voting with no nil vote option, where 14% (five) of uninformed subjects handed in invalid votes (four of them blank ballots, and one "invented" a nil vote). This ratio of invalid votes differs significantly from the ratio in the case of compulsory voting and nil vote option, where no subject cast an invalid vote (p-value of 0.054 for a two-sided Fisher exact test). Correspondingly, with compulsory voting and nil vote option, a highly significant fraction of uninformed voters (39%) choose the nil vote option. Moreover, this is a significantly higher fraction of uninformed voters than the ones who cast invalid votes in the case of compulsory voting and no nil vote option. For this reason, introducing the nil vote option significantly decreased the fraction of uninformed subjects who voted for one of the two candidates and hence introduced noise in the election outcome.

In the case of voluntary voting and no nil vote option, 45% of uninformed voters abstained, and 55% voted for one of the candidates. Introducing the nil vote option did not change the fraction of uninformed voters abstaining, but in this case 21% of the uninformed voters voted for the nil option, and only 33% of them voted for a candidate. This is a smaller fraction of uninformed voters than those who voted for a candidate in the absence of nil vote (significant in a Probit model but not statistically significant with a Fisher exact test).

We also estimated the maximum likelihood population ratios of the four different types we hypothesized. Our results show that all four types have a significant presence, but only 14% are type 1, that is standard rational voters. Roughly 26% of them are type 2, 15% are type 3, and 45% of subjects are type 4, meaning that they are averse to any action other than voting for a candidate. Our model with the maximum likelihood parameter values fits the observed distribution of actions in the four different treatments fairly well, although somewhat overpredicting the fraction of uninformed voters choosing the nil vote option in the case of compulsory voting and nil vote option. This might stem from the simplifying assumption we make in the model that any nonzero psychological cost from not choosing an action is prohibitively high. If we also allow for voters with a small psychological cost in the case of not voting for a candidate, then these voters might abstain in the case of voluntary voting with nil option, in order to save the voting cost, while in the case of compulsory voting with the nil option these voters are forced to cast a vote, in which case a small aversion to casting a nil vote might push them to vote for one of the candidates.

II Related literature

Starting with the theoretical literature, our paper is on the one hand related to strategic models of voting in informational contexts (Bhattacharya, 2013; Feddersen and Pesendorfer, 1996, 1997, 1999; Krishna and Morgan, 2011).[3] Particularly relevant for our work is Feddersen and Pesendorfer (1996), pointing out that uninformed voters might strictly prefer abstaining to casting a vote, an effect present in our context, too.

[3] For a nonstrategic model of voting in an asymmetric information context, see Matsusaka (1995), while for classic papers on strategic voting in the context of no asymmetric information, see for example Ledyard (1981, 1984) and Palfrey and Rosenthal (1983, 1985). See Feddersen (2004) for a survey on various models of voting and voter turnout.

We also build on models in which voters can get psychological benefits from voting (independently of the election outcome). The classic reference here is Riker and Ordeshook (1968), who provide numerous possible psychological foundations for such preferences, some of which are possibly relevant for our stylized experimental setting (such as the satisfaction from compliance with the ethic of voting), while others are not (such as the satisfaction from affirming a partisan preference). See also Blais (2000), providing considerable evidence that voters are motivated to vote by a sense of civic duty. We extend this type of model by expanding the set of choices for the voter, adding the possibility of invalid and nil votes, and allowing different psychological costs for choosing an action other than casting a vote for a candidate. An alternative approach to model exogenously-given psychological benefits and costs for voting is provided in Feddersen and Sandroni (2006), who assume that some voter types receive a payoff from acting ethically, determined by a type-specific norm that is endogenous in equilibrium.[4]

Although it is not the main focus of our paper, our findings also relate to comparing voluntary and compulsory voting systems. Börgers (2004) shows in a model of costly voting with private values that voluntary voting strongly Pareto-dominates compulsory voting. More relatedly, Jakee and Sun (2006) show in an informational voting model that compulsory voting can introduce noise in the election outcome by forcing uninformed voters to vote (as opposed to our paper, they do not consider nil or invalid votes, or psychological costs of not voting). Krishna and Morgan (2012) show in the context of informational voting with similarly informed voters that when voting is costless, voluntary voting is welfare superior to compulsory voting.[5]

There are a number of experimental studies which have investigated the role of asymmetric information in the context of the swing voter's curse. In order to test the Feddersen and Pesendorfer (1996) model, Battaglini, Morton and Palfrey (2009) experimentally implemented their informational voting game. Holding information constant, the experimenters varied the level of partisan bias in the voter population. Consistent with the model they find that uninformed voters strategically abstained when election outcomes were equally likely, and tried to counteract partisan votes as the level of bias was increased. In a follow-up study, Morton and Tyran (2011) study the behavior of an electorate with highly informed

[4]See also Feddersen, Gailmard and Sandroni (2009) for a model of expressive preferences that are independent of the outcome of the election and influence which candidates voters vote for.

[5]Fowler (2013), however, emphasizes an opposite effect, namely that if the turnout of wealthy citizens is higher in the case of voluntary voting, then the election outcome is non-representative for all citizens. This effect is not relevant though in our setting with voters with the same preferences regarding the election outcome.

and less informed voters, and vary the level of asymmetry in information. In the experiment, uninformed voters strategically abstained when the swing voter's curse equilibrium was the efficient outcome, but many uninformed voters also abstained when the information asymmetry was close enough that full participation was the most efficient equilibrium. Bhattacharya, Duffy and Kim (2014) also find evidence for strategic voting and abstaining in a context of informational voting with symmetrically informed voters. Großer and Seebauer (2016) endogenize the asymmetry of information by letting voters buy informative signals. They find that more voters buy signals when voting is compulsory rather than voluntary, but they also find that many uninformed voters vote, even under voluntary voting. Similarly, Elbittar, Gomberg, Martinelli and Palfrey (2014) let voters acquire costly signals in a voluntary voting setting, and find that many voters who decide to stay uninformed vote nevertheless.

Complementing our experimental investigation of the effects of introducing a nil vote option is a new paper by Ujhelyi et al. (2016), developed independently of our paper, that examines the impact of a recent introduction of a "None of the above" option in legislative elections in India. Using both reduced form analysis as well as a structural approach adopted from the Industrial Organization literature, they find that in this setting the nil vote's option main effect was increasing turnout. In particular, some voters who would have abstained in the absence of a nil vote option do show up and choose the nil vote option when it is present. They do not find evidence for the nil vote option changing the amount of votes cast for different candidates (parties), although this is difficult to identify in their non-experimental data. These are questions that definitely deserve future investigation, both experimentally and using election data.

Lastly, there is empirical literature related to our paper on investigating the importance of various factors in determining the ratio of invalid votes in elections: see McAllister and Makkai (1993); Power and Garand (2007); Power and Roberts (1995). The general finding is that socio-demographic, institutional and political factors can all play a role in determining the ratio.

III Theoretical Framework

We consider four alternative versions of an informational model of voting, that differ in two dimensions, according to our experimental design: whether voting is compulsory or voluntary, and whether or not a nil vote is an explicit choice in the ballot.

The basic features of the model are the same across all of the alternatives we consider. The set of candidates running for election is $X = \{0, 1\}$. There is an underlying uncertainty about the state of the world $z \in Z = \{0, 1\}$, with the (common) prior over Z being uniform. All voters have the same preference, in that they would like to match the candidate and the state. Formally, the policy payoff for every voter at state z when candidate x is elected is:

$$U(x, z) = \begin{cases} 0 & \text{if } x \neq z \\ 1 & \text{if } x = z. \end{cases} \quad (1)$$

The policy payoff is only part of a voter's total payoffs, as we also assume various costs associated with possible voting choices, as detailed below.

The electorate consists of $n \geq 1$ informed (I) and $k \geq 1$ uninformed (U) voters. Let $T = \{U, I\}$ denote the set of information types. Voters know their own types and the ratio of types in the electorate is common knowledge. After state z is realized, voters receive independent signals $m \in M$, where $M = \{0, 1\}$. Uninformed voters' signals take values 0 and 1 with probabilities 0.5 and 0.5, respectively, independently of z.[6] Informed voters receive a signal that matches the true state with probability $p > \frac{1}{2}$.

After observing their signals, voters simultaneously choose actions. The set of possible actions depends on whether the nil vote is offered as an explicit option in the ballot. If it is not, then the set of actions is $S = \{\phi, 0, 1, i\}$, where ϕ indicates abstention, 0 and 1 indicate voting for candidate 0 or 1, respectively, and i indicates casting an invalid vote. If a nil vote is added to the set of options for the voter, then $S = \{\phi, 0, 1, i, n\}$, where n stands for casting a nil vote.

The candidate which receives the majority of votes gets elected. Whenever there is a tie, we assume that each candidate is chosen with equal probability.

In all model variants we assume that there is a physical voting cost $0 < c < \frac{1}{4}$ that is imposed on every voter not choosing action ϕ. Furthermore, when voting is compulsory, a penalty $C \geq \frac{1}{2}$ is imposed on every voter choosing action ϕ.

On top of these material costs, we assume that a certain fraction of voters feel obliged to participate in the election, and suffer a psychological cost when not choosing an action that they consider qualifying as participation. Since a level shift in a player's payoff function does not affect the player's strategic considerations, this formulation is strategically equivalent to assuming that these players receive a psychological bonus from the act of voting, as in Riker

[6] Alternatively, we could specify that uninformed voters do not receive any signal. The current formulation is for ease of exposition of the formal analysis below.

and Ordeshook (1968), for example because of a warm glow for performing their civic duties. There are three possible actions a voter can take other than voting for one of the candidates, and they can be ordered in terms of legitimacy within the voting system: casting a nil vote (if it is provided, it is an official vote), abstaining (implicitly allowed neutral action in case of voluntary voting), and casting an invalid vote (cheating the system). Hence a voter's psychological type can be defined as a triple $c_p = (c_i, c_a, c_n)$, where c_i is the psychological cost of casting an invalid vote, c_a is the psychological cost of abstaining, and c_n is the psychological cost of casting a nil vote. For simplicity, we assume that for any psychological type, each of these costs are either 0 or equal to $\bar{c} > 1$ (a prohibitively high cost).[7] However, we allow for the existence of different types with different thresholds of what they regard as legitimate versus illegitimate actions. Motivated by the ordering of actions described above, we assume that the set of psychological types is $A = \{(0,0,0), (\bar{c},0,0), (\bar{c},\bar{c},0), (\bar{c},\bar{c},\bar{c})\}$, the elements of which we will also refer to as psychological types 1, 2, 3 and 4 (in the above order). We assume that voters' psychological types are drawn independently, with type $j \in \{1,2,3,4\}$ drawn with probability q_j. A special case we allow for is when $q_1 = 1$, when no voters face psychological costs for any possible action.

A mixed strategy is denoted by $\tau : T \times M \times A \to \Delta(S)$, where τ_s is the probability of taking action s.

In the analysis below we focus on (Bayesian) Nash equilibria of the above game in which voters' strategies are symmetric and state-neutral. Symmetry of strategies means that all voters play the same mixed strategy (note though that we formulated strategies so that they depend on the type of the player, so symmetry only requires that all players who have the same information and psychological types choose the same probability distribution over actions). State-neutrality imposes the requirement that voters of the same type (information and psychological) vote for and against the received message with the same probabilities, independently on the received message. In particular, this requirement imposes $\tau_1(t,1,c_p) = \tau_0(t,0,c_p)$ for every $t \in \{U, I\}$ and $c_p \in A$.

We introduce the notation τ_{tms} to denote the probability (given a strategy profile τ) that a voter of information type t takes action s after receiving signal m, unconditionally on psychological type. That is, $\tau_{tms} = q_1\tau_s(t,m,(0,0,0)) + q_2\tau_s(t,m,(\bar{c},0,0)) + q_3\tau_s(t,m,(\bar{c},\bar{c},0)) + (1 - q_1 - q_2 - q_3)\tau_s(t,m,(\bar{c},\bar{c},\bar{c}))$.

[7] This formulation simplifies the analysis considerably, but the qualitative conclusions of the model would be similar if we instead assumed that such psychological costs are distributed continuously between 0 and $\bar{c}$.

Similarly, let $\sigma_{tzs}(\tau)$ be the probability, unconditional on psychological type, that an agent of type t takes an action s if the state is z. Then for any $z \in Z$ and $s \in S$: $\sigma_{Uzs} = \frac{1}{2}\tau_{U0s} + \frac{1}{2}\tau_{U1s} \equiv \sigma_{Us}$.

III.A Voluntary voting without nil vote option

An easy observation to make in this version of the model is that casting an invalid vote is strictly dominated by abstaining, since the psychological cost for the former is weakly higher for any psychological type, neither of them influence the outcome of the vote, and abstaining implies saving the physical cost of voting c. Therefore below we only consider choosing actions 0, 1 or $\emptyset$.

Given this, state neutrality implies the following restrictions: $\tau_{t0\phi} = \tau_{t1\phi} \equiv \tau_{t\phi}$, $\tau_{t00} = \tau_{t11} \equiv \tau_{tm}$, and $\tau_{t01} = \tau_{t10} \equiv \tau_{ta}$. Here we defined $\tau_{t\phi}$, τ_{tm} and τ_{ta} as the probabilities that a voter with information type t (unconditional on psychological type) abstains, votes according to her message and votes against her message.

Define

$$\begin{aligned}
\sigma_{Uv} \equiv& \sigma_{U0} = \sigma_{U1} = \frac{1}{2}\tau_{Um} + \frac{1}{2}\tau_{Ua}, \\
\sigma_{U\phi} \equiv& \tau_{U\phi}, \\
\sigma_{I\phi} \equiv& \sigma_{I0\phi} = \sigma_{I1\phi} = \tau_{I\phi}, \\
\sigma_{Im} \equiv& \sigma_{I00} = \sigma_{I11} = p\tau_{Im} + (1-p)\tau_{Ia}, \text{ and} \\
\sigma_{Ia} \equiv& \sigma_{I01} = \sigma_{I10} = p\tau_{Ia} + (1-p)\tau_{Im}.
\end{aligned}$$

Voters trade off their physical and psychological costs of choosing various possible actions and the expected effect of their vote (in the case where they vote for a candidate) on the policy outcome. There are three situations in which a voter may be pivotal (her vote making a difference to the political outcome):

1. An equal number of other agents vote for each candidate.

2. Candidate 1 receives one more vote than candidate 0.

3. Candidate 0 receives one more vote than candidate 1.

Let the probabilities of the above pivotal events, from the point of view of a voter with information type t, given state z, be $\pi_t^*(z)$, $\pi_t^0(z)$ and $\pi_t^1(z)$. Further, let $Eu_{tmc_a}(s)$ be the expected payoff of a voter of type t who receives a signal m, has a psychological cost of abstaining c_a, and takes action s when all other players play according to τ. Then for any $m \in M$ and $c_a \in A$, the expected utility differentials of an *uninformed* voter are given by:

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^*(1) - \pi_U^*(0) + \pi_U^1(1) - \pi_U^1(0)\right] - c + c_a \tag{2}$$

$$Eu_{Umc_a}(0) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^*(0) - \pi_U^*(1) + \pi_U^0(0) - \pi_U^0(1)\right] - c + c_a \tag{3}$$

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(0) = \frac{1}{4}\left[2(\pi_U^*(1) - \pi_U^*(0)) + \pi_U^1(1) - \pi_U^1(0) + \pi_U^0(1) - \pi_U^0(0)\right]. \tag{4}$$

The expected utility differentials of an *informed* voter are given by:

$$Eu_{Imc_a}(m) - Eu_{Imc_a}(\phi) = \frac{1}{2}\left[p(\pi_I^*(m) + \pi_I^m(m)) - (1-p)(\pi_I^*(1-m) + \pi_I^m(1-m))\right] - c + c_a \tag{5}$$

$$Eu_{Imc_a}(1-m) - Eu_{Imc_a}(\phi) = \frac{1}{2}\left[(1-p)(\pi_I^*(1-m) + \pi_I^{1-m}(1-m)) - p(\pi_I^*(m) + \pi_I^{1-m}(m))\right] - c + c_a \tag{6}$$

$$\begin{aligned} Eu_{Imc_a}(m) - Eu_{Imc_a}(1-m) = &\frac{1}{2}p[2\pi_I^*(m) + \pi_I^m(m) + \pi_I^{1-m}(m)] \\ &- \frac{1}{2}(1-p)[2\pi_I^*(1-m) + \pi_I^m(1-m) + \pi_I^{1-m}(1-m)] \end{aligned} \tag{7}$$

Here in the main text we restrict attention to analyzing the case when $n = k = 3$, which corresponds to our experimental design. In the Supplementary Appendix we show that the main qualitative conclusions of the model are the same for general n and k.

First we show that informed voters never vote against their signal. All formal proofs are in the Appendix.

Claim 1 *In any symmetric and state-neutral equilibrium* $\tau_0(I,1,c_p) = \tau_1(I,0,c_p) = 0$ *for any* $c_p \in A$.

Note that the claim implies that $\sigma_{I00} = \sigma_{I11} = p(1-\tau_{I\phi})$, $\sigma_{I01} = \sigma_{I10} = (1-p)(1-\tau_{I\phi})$. The result also pins down the equilibrium strategy for informed voters with a high psychological abstention cost (psychological types 3 and 4): they always vote according to their signals ($\tau_0(I,0,c_p) = \tau_1(I,1,c_p) = 1$ if $c_a = \bar{c}$).

Now consider uninformed voters' strategies. The next claim establishes that uninformed voters with zero abstention cost always abstain, while those with high abstention cost vote for each candidate with equal probability in a symmetric state-neutral equilibrium. The intuition for this is the same as in Feddersen and Pesendorfer (1996), despite some technical differences between the models: uninformed voters, when voting for a candidate, are more likely to influence the policy outcome in a negative way than in a positive way (taking into account that the vote only influences the outcome at pivotal events). Hence, whenever the psychological costs of not casting a vote do not affect them, they would rather leave the decision to informed voters.

Claim 2 *In any symmetric and state-neutral equilibrium* $\tau_{\phi}(U, m, (0,0,0)) = \tau_{\phi}(U, m, (\bar{c}, 0, 0)) = 1$ *for any* $m \in M$, *and* $\sigma_{U0} = \sigma_{U1} = \frac{1}{2}(q_3 + q_4)$.

The above results pin down the equilibrium strategies of all voters except for informed types with zero psychological abstention cost. These voters can either abstain, or vote according to their messages, or mix between the previous two actions. Below we show that all these possibilities can happen in equilibrium, depending on the parameters of the model (the cost of voting, the informativeness of the signal of the i types, and the probability of high abstention cost). For a fixed value of the other parameters, for a low enough cost of voting there is a unique symmetric state-neutral equilibrium, in which informed voters with zero psychological abstention cost always vote (according to their signals). Correspondingly, for a high enough cost of voting there is a unique symmetric state-neutral equilibrium, in which informed voters with zero psychological abstention cost always abstain.
To simplify notation, let $q = q_1 + q_2$. This is the probability of $c_a = 0$.

Theorem 1 *For any* $p > \frac{1}{2}$ *and* $q \in (0, 1]$ *there exist critical cost thresholds* $0 < c_0 \leq c_1 < c_2$ *such that:*

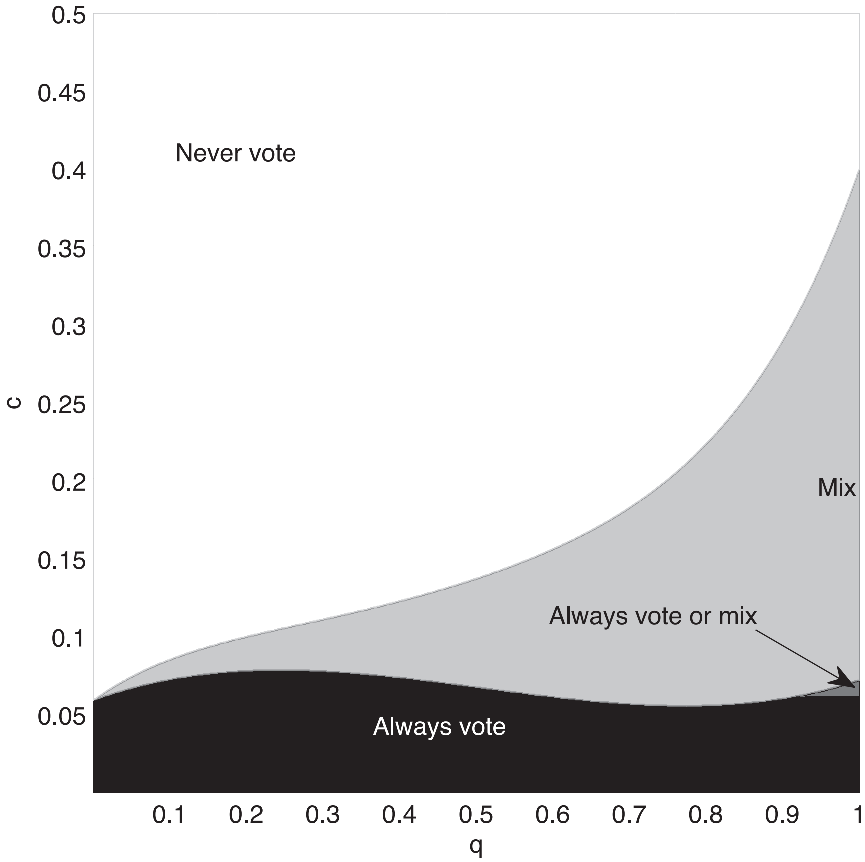
1. *A symmetric state-neutral equilibrium with* $\tau_0(I, 0, c_p) = \tau_1(I, 1, c_p) = 1$ *whenever* $c_a = 0$ *exists iff* $c \leq c_1$;

2. *A symmetric state-neutral equilibrium with* $\tau_{\phi}(I, 0, c_p) = \tau_{\phi}(I, 1, c_p) = 1$ *whenever* $c_a = 0$ *exists iff* $c \geq c_2$;

3. *A symmetric state-neutral equilibrium with* $\tau_0(I, 0, c_p) = \tau_1(I, 1, c_p) = x \in (0, 1)$ *whenever* $c_a = 0$ *(and* $\tau_{\emptyset}(I, 0, c_p) = \tau_{\emptyset}(I, 1, c_p) = 1 - x$*) exists iff* $c \in (c_0, c_2)$.

Figure 1 depicts the regions for different types of equilibria for $p = 0.9$, which we used in the experiments (in (q, c) coordinates). While for a low enough and a high enough c there is always a unique symmetric and state-neutral equilibrium, there are some combinations of q

FIGURE 1: Regions for different types of equilibria for $p = 0.9$



and c for which there exist both an equilibrium in which informed voters with zero psychological costs always vote, and an equilibrium in which they mix between abstaining and voting according to their signal. For example, this is the case when $q = 1$ and $c \in [0.062, 0.072]$. The intuition behind this multiplicity is the following. Despite the fact that in the mixed equilibrium informed voters abstain more often than in the pure equilibrium, the probability of a draw (in particular the probability that exactly 1 other voter votes for each of the two candidates) can decrease, reducing the incentive to vote.

We can also verify that for $p = 0.9$, if $c = 0.02$, as in our experimental design, the unique equilibrium for any $q \in (0, 1]$ is the one in which informed voters with zero psychological abstention cost always vote (as it is in general when the informed voters' signal is precise enough and the cost of voting is low enough). Hence our model gives the following predictions when voting is voluntary and there is no nil vote on the ballot: all informed voters vote according to their signals, while among uninformed voters some abstain and some split their vote evenly between the two candidates. No voter casts an invalid vote.

Before switching to analyze the other versions of the model, it is useful to state the following comparative statics results.

Claim 3 *Consider the symmetric state-neutral equilibrium in which informed voters with zero psychological abstention cost always vote, in the region where such equilibrium exists. The probability of electing the right candidate, the expected payoff of both informed and uninformed voters, and total social surplus are all strictly increasing in both p and q.*

III.B Voluntary voting with nil vote option

Recall that in this case $S = \{\phi, 0, 1, i, n\}$ and $A = \{(0,0,0), (\bar{c},0,0), (\bar{c},\bar{c},0), (\bar{c},\bar{c},\bar{c})\}$. For any $t \in T$, $m \in M$ and $s \in S$:

$$\begin{aligned}\tau_{tms} =& q_1\tau_s(t,m,(0,0,0)) + q_2\tau_s(t,m,(\bar{c},0,0)) \\ &+ q_3\tau_s(t,m,(\bar{c},\bar{c},0)) + (1-q_1-q_2-q_3)\tau_s(t,m,(\bar{c},\bar{c},\bar{c}))\end{aligned}$$

In this model version it is still true that abstention strictly dominates casting an invalid vote, hence no voter chooses the latter action in any equilibrium. Similarly, abstaining or choosing a nil vote is strictly dominated by voting for either of the candidates for voters of type 4 (psychological type $(\bar{c},\bar{c},\bar{c})$). For voters of type 3 (psychological type $(\bar{c},\bar{c},0)$) abstaining is strictly dominated by any of the other actions. Below we only consider actions that are not strictly dominated, for any given voter type.

The requirement of symmetry and state-neutrality implies $\tau_{t0n} = \tau_{t1n} \equiv \tau_{tn}$ and $\sigma_{Un} = \tau_{Un}$. Let $\sigma_{tz} = \sigma_{t\phi} + \sigma_{tn}$ (the probability that information type t does not influence the election result).

As in the model with no nil vote option, it can be established that in a symmetric state-neutral equilibrium, voting according to the signal always yields a higher payoff than voting against the signal, hence informed voters never choose the latter action (implying $\tau^*_{I\phi} = \tau^*_{In} = 0$). Since the proof is completely analogous to the proof of Claim 1, we omit it from here.

Consider now uninformed voters. The next claim shows that in any symmetric state-neutral equilibrium those of types 1 and 2 (with zero psychological abstention costs) abstain, those of type 3 (with psychological costs $(\bar{c},\bar{c},0)$) cast a nil vote, while those of type 4 (with psychological costs $(\bar{c},\bar{c},\bar{c})$) vote for each candidate with equal probability. The intuition is the same as before: uninformed types in equilibrium can only influence the policy outcome negatively, therefore if there is a way to avoid it without incurring a psychological cost, they prefer not voting for either candidate. Voters of type 3 achieve this by utilizing the provided nil vote option.

Claim 4 *In any symmetric and state-neutral equilibrium* $\tau_\phi(U, m, (0, 0, 0)) = \tau_\phi(U, m, (\bar{c}, 0, 0)) = 1$ *and* $\tau_n(U, m, (\bar{c}, \bar{c}, 0)) = 1$ *for any* $m \in M$*, and* $\sigma_{U0} = \sigma_{U1} = \frac{1}{2}q_4$.

The above implies that the probability of not influencing election results for an uninformed voter is $\sigma_{Uz} = \sigma_{U\phi} + \sigma_{Un} = q_1 + q_2 + q_3 = 1 - q_4$.

The above characterization of uninformed voters' action choices in equilibrium can be used to narrow down possible equilibrium action choices of the informed voters. If we denote $1 - q_4$ by q', then we get that for any c_a, $Eu_{I1c_a}(1) - Eu_{I1c_a}(n) \geq Eu_{I10}(1) - Eu_{I10}(n) = \Delta(\tau_{Iz}, p, q') > 0$. Hence, informed voters never vote for nil. As before, this implies that informed voters of types 3 and 4 (with $c_a = \bar{c}$) always vote according to their signals.

All that remains to be determined is the equilibrium action choices of informed voters of types 1 and 2 (with $c_a = 0$). But our results above imply that the analysis of these voters' possible equilibrium strategies is exactly analogous to that in the previous model, with a change from q to q'. In particular, depending on the parameters, there can be equilibria in which informed voters with zero psychological costs of abstaining always abstain, always vote according to their signals, or mix between the previous two actions. However, for low enough c, the unique symmetric state-neutral equilibrium is one in which such voters always vote according to their signal. In particular this is the case when $p = 0.9$ and $c = 0.02$, as in our experiments, for any specification of q and r.

This implies that the model's prediction in the case of voluntary voting and a nil vote option present on the ballot is that all informed voters vote according to their signals, some uninformed voters abstain, some of them choose the nil vote, and the remaining uninformed voters vote with equal probability for either candidate.

As we showed in Claim 4, the probability of the right candidate elected $\mathbb{P}^{right}(p, q)$ is increasing in the second argument, and since $q' = q_1 + q_2 + q_3 > q_1 + q_2 = q$, hence $\mathbb{P}^{right}(p, q') > \mathbb{P}^{right}(p, q)$. The same holds for total net social surplus in equilibrium. Thus, our model predicts that introducing the nil vote option, given voluntary voting, increases the probability of electing the right candidate and total social surplus. It provides uninformed voters that have psychological abstention costs with the opportunity to cast a vote without the risk of altering the election result in the wrong direction.

III.C Compulsory voting

Consider first the case of no nil vote option. First note that $C > \bar{c}+c$ implies that abstaining is strictly dominated by casting an invalid vote, for all types of voters. Hence we can restrict attention to strategies $\{0, 1, i\}$.

It is completely analogous to the previous model versions to show, and therefore omitted from here, that informed voters are always better off voting according to their signals than voting against it, and so $\tau^*_{Ia} = 0$.

Note now that for uninformed voters, $Eu_{Umc_a}(1) - Eu_{Umc_a}(0)$ and $Eu_{Umc_a}(1) - Eu_{Umc_a}(i)$ in the current game for type 1 are the same as $Eu_{Umc_a}(1) - Eu_{Umc_a}(0)$ and $Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi)$ for type 1 without compulsory voting and the nil vote option. For all other types, $Eu_{Umc_a}(1) - Eu_{Umc_a}(0)$ stays the same, and casting an invalid vote implies prohibitively high cost $\bar{c}$. Hence the analysis of the previous subsection applies analogously, implying that in any symmetric state-neutral equilibrium of the current game, uninformed voters of type 1 cast invalid votes, while other uninformed voters vote for each candidate with equal probability.

Given this, the same argument as we used in the previous subsection, to show that informed voters in equilibrium always prefer voting according to their signals to casting a nil vote, can be used to establish that in this version of the model informed voters in equilibrium always prefer voting according to their signals to casting an invalid vote. Given that in this version of the model informed voters never abstain, this implies there is a unique symmetric state-neutral equilibrium for any parameter specifications, in which informed voters always vote according to their signals. To summarize, for compulsory voting and no nil vote option our model predicts that all informed voters vote according to their signals, voters of type 1 cast invalid votes, while the rest of them vote for each candidate with equal probability.

Consider next the case of compulsory voting with the nil vote option. It is still the case that abstaining is strictly dominated for all players (by both casting a nil vote and casting an invalid vote). Moreover, in this model version casting an invalid vote is strictly dominated by casting a nil vote for voters of types 2 and 3 (with $c_i > c_n$). The analysis of the previous model version carries through here, with the only difference in the predictions being that uninformed voters of type 1 (with $c_i = c_n = 0$) are indifferent between casting an invalid versus a nil vote, hence they can mix between those two actions in equilibrium, while uninformed voters of types 2 and 3 always choose the nil vote in any symmetric state-neutral equilibrium. Introducing a miniscule preference for a nil vote versus an invalid vote (for example, a voter may need to figure out *how* to invalidate a ballot) would imply that uninformed voters of type 1 also always choose the nil vote in any symmetric state-neutral equilibrium. Therefore, in this case, only type 4 votes for each candidate with equal probability, while all other types cast the nil vote.

III.D Comparisons

Comparing the cases of nil vote option versus not, we find that it does not affect the equilibrium behavior of informed voters when voting is compulsory. However, if $q_2+q_3 > 0$ then less uninformed voters vote for one of the candidates, since psychological types 2 and 3 switch to choosing the nil vote. In the case of voluntary voting, the introduction of a nil vote still does not change the equilibrium behavior of the informed voters, provided that the voting cost is low enough and the precision of their signal is high enough (as for the parameters chosen in our experiment). However, if $q_3 > 0$ then again less uninformed voters vote for one of the candidates, since psychological types 2 and 3 switch to choosing the nil vote.

Therefore, if all psychological types are present with nonzero probability then the model predicts that both the probability of choosing the right candidate and total social surplus increase when introducing nil vote. The effect is more pronounced in the case of compulsory voting.

The magnitude of the welfare effect of the introduction of a nil vote depends on the model parameters, including the relative ratio of informed and uninformed voters, and the distribution of psychological types. We note though that even with a large electorate, the welfare effects can be substantial. This is despite the fact that the law of large numbers implies that the ratio of uninformed voters voting for one candidate versus the other converges to fifty-fifty in equilibrium as the number of uninformed voters goes to infinity. This might suggest that if all psychological types are present with positive probability, then for a large electorate the noise that uninformed voters create in the election outcome is negligible. However, this is only true if the ratio of informed voters is relatively high in the electorate. Even for a large electorate, the expected absolute difference between the numbers of uninformed voters voting for candidate A versus candidate B is large. Therefore if there are many more uninformed voters in the electorate than informed, for typical realizations of the equilibrium mixing strategies the informed voters are unable cancel out a vote margin created by uninformed voters, and the wrong candidate is selected with close to probability $1/2$ in the absence of the nil vote option. Introducing the nil vote option in this case can have a large effect on election outcomes if the likelihoods of psychological types 2 and 3 are high relative to type 4.

Introducing the nil vote option also (weakly) decreases the number of invalid votes when voting is compulsory, while it does not affect invalid votes in the case of voluntary voting (as our model predicts no invalid votes when voting is voluntary).

In the special case when $q_1 = 1$, hence voters do not face psychological costs, our model predicts that introducing a nil vote option does not affect efficiency. However, even in this case it can decrease the number of invalid votes.

IV Experimental Design and Procedures

Our experiment directly implemented the theoretical framework discussed above as a one-shot voting game. There were six potential voters in an electorate such that $n = k = 3$. Voting choices, signals, and state of the world were framed as "A" and "B". Informed voters received signals $m \in \{A, B\}$, where $p = Pr(m = z) = 0.9$. Uninformed voters do not receive a signal (but they are told that the prior probability of each state is 50-50%). Each of the six voters earned \$15.00 if the elected candidate equalled the state of the world, $x = z$, and \$5.00 if $x \neq z$. Voting costs c were defined as c = \$0.20. The abstention penalty in compulsory voting was set to $C = \$5$. These parameters were chosen to ensure that voting costs were sufficiently low but positive such that in equilibrium informed voters vote according to their signal in all conditions, and that abstention costs are prohibitively high under compulsory voting.

We implemented a 2 x 2 factorial design, with the voting system being either voluntary (no penalty on abstention ϕ) or compulsory (choosing ϕ incurs a penalty of C), and the ballot including an nil vote option ($S = \{\phi, 0, 1, i, n\}$), or not ($S = \{\phi, 0, 1, i\}$). Henceforth, we will refer to these 4 treatments as treatment V, V:NIL, C, and C:NIL, respectively. The upper part of Table 4 in Section V summarizes type definitions and equilibrium actions, given our chosen parameters, for the four theoretical voting types in our four treatments.

The experimental sessions took place between June and October 2010 in the UNSW Business School Experimental Research Laboratory at the University of New South Wales. A total of 292 subjects were recruited through the online recruitment system ORSEE (Greiner, 2015). About an equal amount of males and females took part in the experiment, with an average age of 22.3. The subject pool was approximately equally split in regards to whether or not participants had voted in real-life elections before. Each session lasted approximately 45 minutes. Participants received a show-up payment of \$5.00, plus their earnings from the experiment which were on average \$14.

The experiment was entirely pen-and-paper-based, all materials were printed, and participants made their decisions by marking physical ballot papers. Participants each received private information, were not allowed to communicate with one another, and made all their decisions under a randomly assigned identification (ID) number. To create anonymity we employed a double blind procedure with a monitor (see, for example, Büchner, Coricelli and Greiner, 2007). In each session a "monitor" was first randomly selected from the subjects, who would then distribute and collect all materials associated with the ID numbers. In addition to the monitor, a third party (a laboratory administrator not involved in the study) administered the payment receipts as they contained personal information and a participant's monetary payoffs were potentially choice-revealing.[8] This design ensured that no single person involved in the experiment had enough information to connect a subject with their personal information or their choices in the experiment. Neither experimenter nor other participants could observe whether or for what a person voted (unless, of course, all participants in a session would do the same, which never happened). In this sense, voting choices were anonymous.

We conducted 16 sessions, 14 sessions with 19 subjects each (three groups of six plus monitor), and, due to no-shows, two sessions with only 13 subjects each (two groups of six plus monitor). As a result, we collected 66, 66, 72, and 72 observations in treatments V, V:NIL, C, and C:NIL, respectively.

The information and forms given to participants differed minimally between treatments, only in the presence of abstention costs and the nil vote option. In each session participants were given *Participant Instructions*, an *ID number*, a *Hint Sheet*, a *Ballot Paper*, a *Return Envelope*, and *Voting Instructions*.[9]

Subjects received the *Participant Instructions* first, which detailed how the session would proceed. The role of the monitor in ensuring anonymity was described, as well as how the groups would be randomly formed, the set-up and rules of the voting game, the information distribution across the group, how the election result would be determined and announced, and the payoffs associated with group decisions.

Following reading time, participants selected an envelope at random from a box circulated by the monitor. The envelope contained the remaining experimental documents. Subjects were assigned to groups of six voters according to their ID number, but did not know the other five participants in their group. The *Hint Sheet* was unique to each participant. Three

[8]Payoffs are a function of the group's choice and the individual's voting costs. So an individual's payment may reveal whether they voted or not, but not what they voted for.

[9]Materials as well as a detailed procedures description are included in Supplementary Appendix C.

voters in each group were "informed" in that their hint sheet (which displayed either A or B) was correct with 90% probability. For the other three, "uninformed" voters the sheet read *No Hint*.[10]

All potential decisions were presented as "choices" in as neutral a way as possible. The *Ballot Paper* was only altered between treatments to include the nil vote option. Voters were instructed to submit the *Ballot Paper* in the *Return Envelope* should they wish to be considered as having voted. Submitting an empty *Return Envelope* indicated abstention. The *Voting Instructions* stated the costs associated with voting, and were altered between treatments to indicate the availability of the nil vote option, and whether an abstention fine existed. These instructions also re-iterated the payoffs and detailed how to complete the *Ballot Paper* in order for it to be counted as a valid vote. The full anonymity of decisions was emphasized as it was important to create an atmosphere in which participants felt they could make choices without unexpected consequences.

Invalid votes were framed neutrally, so as not to directly encourage or discourage voters from this behavior. Statements about valid and invalid votes appeared several times throughout the instructions, and they were described as being "not counted towards the election result". However, our pen-and-paper design allowed subjects to invalidate their vote in any number of ways. The *Voting Instructions* contained a full section on invalid votes which stated that votes would be considered invalid if they were "Ballots which are left blank", "Ballots with a tick, numbering, or any other kind of mark apart from the cross X", and "Ballots with any writing on them other than the cross X selection." Thus, as in real-life voting, invalid votes were not presented as an explicit voter choice. The instructions on invalid votes were exactly the same across all experimental conditions.

After reading the voting materials, participants were then allowed make their voting decision. All participants were required to submit the *Return Envelope* to the monitor, if the envelope contained a ballot paper they would be considered as having voted and incur the \$0.20 cost. If the envelope was empty then they would be considered as having abstained, incurring no costs under voluntary voting and a \$5.00 cost under compulsory voting.

After making their decisions, and once all choice-related material had been collected, participants were asked to complete a post-experimental questionnaire. The questionnaire was intended to collect information about demographics, participants' beliefs, and some

[10]In preparation of the experimental sessions, for each group the state A or B had first been randomly pre-assigned as their state of the world. The state of the world was made known to the participants after the announcement of the election result. For the three informed voters, hints were drawn independently with a 90% probability of receiving the correct hint.

indication of their prior voting experiences. During this time the results were tallied and the payoffs were determined. The monitor was then asked to read aloud the results for each group. This included the number of votes submitted, the number of valid votes, the number of votes for each option, the winner selected by the group, and the randomly pre-determined HIGH payoff option for the group.[11] The cash and receipts were placed in envelopes marked with their associated ID numbers, which the monitor then distributed to the participants. Participants signed their receipt which was collected by a third party.

V Results

V.A Aggregate results and treatment effects

In our experiment we gathered a total of 276 independent voting decisions, half from informed and half from uninformed voters. Table 1 shows the voting choices by voter information type and treatment. In all treatments, nearly all of the informed voted as expected according to their signal.[12] The main focus of this paper is the behavior of uninformed voters, and we therefore concentrate on them in our analysis below.[13]

The observed behavior of uninformed voters differs consistently from predictions of a model that only includes Type 1 voters who have no psychological costs for not voting. When voting is voluntary and a standard ballot is used, 55% of the uninformed voters chose to vote for a candidate, A or B, rather than abstain, despite having no reliable information. The other voters abstained, and we did not observe any invalid votes.

When voting was compulsory (but still using the standard ballot), there was no abstention at all. However, we observed an invalidation rate of 14% (or five out of thirty-six voters), and it is the only condition in which we observe any invalidation among uninformed voters. Most of the invalid ballot papers observed in this treatment were completely blank; in one the voter added a nil vote to the ballot paper by herself. This provides evidence of strategic invalidation as opposed to voter errors.

When introducing a nil vote ballot paper under voluntary voting, still more than half of the uninformed voters (55%) decided to vote. However, 39% of these did not cast a vote for one of the candidates, but for the nil vote, therefore not affecting the election outcome.

[11]The announcement did not associate individual ID numbers with their decisions.

[12]Five informed voters deviated from this behavior. One submitted an invalid vote which was marked with a tick instead of a cross, and we can reasonably assume that this was a genuine voter error rather than strategic invalidation. Of the remaining four, two abstained and two voted against their signal.

[13]An inclusion of informed voters' choices into the hypothesis tests reported below does neither impact test results and significance levels nor conclusions.

TABLE 1: VOTER CHOICES BY VOTER TYPE AND TREATMENT

	V	V:NIL	C	C:NIL
Informed voters				
For Signal m	97%	97%	100%	91%
Against Signal m	0%	0%	0%	6%
Abstain (ϕ)	3%	0%	0%	3%
Nil Vote (n)	-	0%	-	0%
Invalid (i)	0%	3%	0%	0%
N	33	33	36	36
Uninformed voters				
For candidate	55%	33%	86%	58%
Abstain (ϕ)	45%	45%	0%	3%
Nil Vote (n)	-	21%	-	39%
Invalid (i)	0%	0%	14%	0%
N	33	33	36	36

Under compulsory voting, offering a nil vote ballot paper reduced the share of uninformed voters from 91% to 58%, as many pick up the nil vote. (We also observed one abstention in this treatment.)

We employ a series of Fisher Exact hypothesis tests to corroborate our descriptive analysis. We examine the effect of changes in a single treatment variable on the proportion of uninformed voters making a particular choice. We construct hypothesis tests for these different categories based on the benchmark model with only Type 1 voters, and discuss the full model that also allows for other voter types (with positive psychological costs) in the next subsection. Table 2 reports hypotheses in terms of comparative statics across our four treatments, the two-sided Fisher Exact p-values, the corresponding conclusions with respect to H_0, and whether these conclusions are in line with a Type-1-only model.[14]

We begin by drawing a comparison between voluntary and compulsory voting before focusing on the effect of nil votes. When ballot papers did not include (did include) a nil vote option, making voting compulsory by introducing a high penalty for abstention leads to a significant (weakly significant) decrease in abstention votes, a significant (significant) increase in votes for candidates, and a weakly significant increase (no change) in invalid votes. In other words, compulsory voting leads to basically no abstention, but when no nil vote option is available it also leads to invalid votes.

[14]All tests were replicated including the informed voters' choices, and the significance levels were not affected. That is, our test results on treatment differences are entirely driven by differences in the choices of uninformed voters.

TABLE 2: Results from hypothesis tests on choice distributions

Category	Rest	Fisher Ex p-value	Conclusion	In line with Type-1-only model
V vs. C				
0, 1	ϕ, i	0.007	H_0 rejected	no
ϕ	0, 1, i	0.000	H_0 rejected	yes
i	0, 1, ϕ	0.055	H_0 rejected	yes
V:NIL vs. C:NIL				
0, 1	ϕ, n, i	0.054	H_0 rejected	no
ϕ	0, 1, n, i	0.000	H_0 rejected	yes
n, i	0, 1, ϕ	0.126	H_0 not rejected	no
V vs. V:NIL				
0, 1	ϕ, n, i	0.136	H_0 not rejected	yes
ϕ	0, 1, n, i	1.000	H_0 not rejected	yes
i	0, 1, n, ϕ	-[1]	H_0 not rejected	yes
C vs. C:NIL				
0, 1	ϕ, n, i	0.017	H_0 rejected	no
ϕ	0, 1, n, i	1.000	H_0 not rejected	yes
i	0, 1, n, ϕ	0.054	H_0 rejected	no pred
n, i	0, 1, ϕ	0.031	H_0 rejected	no

Notes: Throughout we apply two-sided Fisher Exact tests comparing the distribution over "Category" and "Rest" between treatments. The Null hypothesis H_0 is always that the distributions do not differ, while H_1 postulates that they differ. [1]There were zero invalid votes in both of these treatments.

Introducing a nil vote option in a voluntary voting system does not affect the proportion of different voting categories in a statistically significant way. The share of abstention votes is not affected, being 45% both without and with nil vote option. Even though we observe a share of 21% nil votes in treatment V:NIL, the respective decline in votes for a candidate, from 55% to 33%, is statistically not significant in a Fisher exact test (but see below for the Probit model results where this effect is (weakly) significantly).

The nil vote option has a statistically more prominent effect in a voting system with compulsory voting. Abstention votes are basically non-existent and therefore not affected, but we observe a significant decline in votes for a candidate as well as in invalid votes (here weakly significant).

Table 2 also shows that many treatment effects are not in line with a model that only assumes Type-1-voters. In order to better explain voter behavior and treatment effects we will need to consider the general model that allows for psychological costs of not voting.

We complement this analysis of aggregate voting choice distributions with probit regression models run on the individual choices made by the uninformed. In the models, our dependent variables isolate a single choice, either voting for a candidate or abstention.[15] The following two probit models were estimated:

$$0or1 = \beta_0 + \beta_1 \, comp + \beta_2 \, nilvote + \beta_3 \, comp \times nilvote + \varepsilon \text{ (M.1a)}$$
$$Abstain = \beta_0 + \beta_1 \, comp + \beta_2 \, nilvote + \varepsilon \text{ (M.2a)}$$

The dependent variable in model M.1a is $0or1$, which is equal to 1 if a subject voted for a candidate and 0 otherwise. Similarly, in model M.2a the dependent *Abstain* is equal to 1 if a subject abstained and 0 otherwise. Our independent variables are all dummies, which are defined as follows: *comp* is 1 for compulsory voting and 0 for voluntary voting, *nilvote* is 1 for nil vote treatments and 0 for standard ballot treatments. The variable $comp \times nilvote$ interacts the two. This interaction variable cannot be used in the *Abstain* model because of perfect prediction (no abstention) in treatment C; however, inspection of our results indicates that the interaction effect would be very small anyway.

We estimated two additional models controlling for voter demographics as follows:

$$\begin{aligned} 0or1 = {} & \beta_0 + \beta_1 \, comp + \beta_2 \, nilvote + \beta_3 \, comp \times nilvote + \beta_4 \, male + \beta_5 \, age \\ & + \beta_6 \, english + \beta_7 \, business + \beta_8 \, undergrad + \beta_9 \, votedbefore + \varepsilon \text{ (M.1b)} \end{aligned}$$

$$\begin{aligned} Abstain = {} & \beta_0 + \beta_1 \, comp + \beta_2 \, nilvote + \beta_4 \, male + \beta_5 \, age \\ & + \beta_6 \, english + \beta_7 \, business + \beta_8 \, undergrad + \beta_9 \, votedbefore + \varepsilon \text{ (M.2b)} \end{aligned}$$

The demographic variables added in models M.1b and M.2b were defined as follows: *male* is 1 for male and 0 for female, *age* is a continuous variable ranging from 18 to 47, *english* is 1 if the subject spoke in English in their household and 0 otherwise, *business* is 1 for those who studied in a business-related discipline and 0 otherwise, *undergrad* is 1 for those studying at the undergraduate level and 0 otherwise, and *votedbefore* is 1 if the subject stated that they had voted in real life before and 0 if they had not. Six individuals who did not have a response to one of these variables were treated as missing and their observations were dropped.

[15] We do not estimate a model isolating the nil vote as the choice was not present across all treatments. Also, we do not isolate invalid votes, as compulsory voting with standard ballot paper was the only condition

TABLE 3: Probit model estimation on uninformed voter choices

		0or1		Abstain	
		Model (M.1a)	Model (M.1b)	Model (M.2a)	Model (M.2b)
comp		0.971***	1.051***	-2.095***	-2.286***
		(0.340)	(0.372)	(0.422)	(0.454)
nilvote		-0.545*	-0.673**	0.107	0.289
		(0.314)	(0.341)	(0.289)	(0.330)
$comp \times nilvote$		-0.329	-0.363		
		(0.459)	(0.504)		
male			-0.438*		0.311
			(0.257)		(0.358)
age			-0.046		-0.055
			(0.052)		(0.075)
english			-0.431		0.600*
			(0.270)		(0.338)
business			-0.300		0.072
			(0.266)		(0.362)
undergrad			-0.320		1.032*
			(0.381)		(0.563)
votedbefore			0.223		0.446
			(0.240)		(0.321)
constant		0.114	1.834	-0.168	-0.563
		(0.219)	(1.460)	(0.212)	(2.025)
Observations		138	132	138	132
Log Likelihood		-82.70	-74.77	-50.67	-40.09
Pseudo R^2		0.117	0.169	0.311	0.443
Average marginal effects on the predicted *Pr*					
comp	when $nilvote = 0$	0.316***	0.317***	-0.428***	-0.387***
	when $nilvote = 1$	0.250**	0.249**	-0.442***	-0.413***
nilvote	when $comp = 0$	-0.212*	-0.243**	0.043	0.090
	when $comp = 1$	-0.278***	-0.311***	0.004	0.012

Notes: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively. Standard errors are given in parentheses. Models M.2a and M2.b do not contain $comp \times nilvote$ interaction effect because of perfect prediction (no abstention) in treatment C.

The results of our probit estimations are shown in Table 3. Compulsory voting significantly increases the likelihood of voting for a candidate and reduces the likelihood of abstaining. The option of a nil vote, on the other hand, (weakly) significantly decreases the likelihood of voting for a candidate, but not of abstaining. This indicates a two-step process,

with a non-zero number of invalid votes, and hence perfectly predicts the outcome.

with an uninformed voter first deciding to vote or not to vote (a process strongly influenced by the abstention penalty), and then deciding which option to choose on the ballot paper. Note also that consistent with this finding, for all four behavioral voter types in our model, a change to a nil vote due to a treatment parameter change always originates in voting for a candidate, not in abstention.

None of the demographic terms in models M.1b and M.2b are significant at the 5% level, and our treatment parameter estimates are robust to their inclusion, that is, to random variations in the demographics across treatments.

The lower part of Table 3 reports average marginal effects of our treatment variables on the likelihood of uninformed voters to vote for a candidate or abstain. The results are consistent with the test results reported above. Compulsory voting increases uninformed votes for a candidate by about 32% when no nil vote option is offered, and by a lesser amount of about 25% when there is a nil vote option on the ballot. Compulsory voting reduces abstentions by about 40%, largely unaffected by whether there is a nil vote option or not. Adding a nil vote option to the ballot paper reduces uninformed votes for candidates by about 20%-30%, but does not have a significant effect on abstention choices.

V.B Voter types

Our strategic model allows us to use a Maximum Likelihood procedure to estimate the most likely distribution of types in the subject population that may have produced the results we observe across our four treatments. The probability of observing a particular voting choice in a particular treatment equals the sum of frequencies of voter types that predict that choice in equilibrium. The log likelihood of a dataset given a distribution of types then equals the sum of logs of the probabilities of each individual observed voting choice.[16]

The middle part of Table 4 reports the results of such an analysis. Our estimation indicates that all four types are present in the subject population, with all estimated frequencies significantly different from zero. Type 1 voters, with no psychological cost, are estimated at a frequency of about 14%. The largest share with 45% is assigned to Type 4, represented by voters who have psychological costs for abstaining, invalidating as well as submitting a nil vote. The share of Type 3 voters who do not mind submitting a nil vote is predicted at 15%, and Type 2 voters who only experience psychological costs for invalidation of votes are represented by about 26% of the population.

[16]Since none of our types are able to rationalize abstention in treatment C:NIL, we had to drop this single observation before applying the MLE procedure. Stata code is included in the Online Appendix.

TABLE 4: Results of Maximum Likelihood estimation of uninformed voter type frequencies

	Type 1	Type 2	Type 3	Type 4
Psychological costs for				
Invalidation i	0	$\bar{c}$	$\bar{c}$	$\bar{c}$
Abstention ϕ	0	0	$\bar{c}$	$\bar{c}$
Nil vote n	0	0	0	$\bar{c}$
Equilibrium choices				
V	ϕ	ϕ	0/1	0/1
V:NIL	ϕ	ϕ	n	0/1
C	i	0/1	0/1	0/1
C:NIL	i/n	n	n	0/1
Results of Maximum Likelihood Estimation of voter type frequency				
Estimate	0.139**	0.258***	0.153***	0.450***
StdErr	(0.058)	(0.078)	(0.049)	(0.054)

Comparison of MLE prediction and observed choice frequencies

	V		V:NIL		C		C:NIL	
	Obs	Pred	*Obs*	Pred	*Obs*	Pred	*Obs*	Pred
For candidate	*55%*	60%	*33%*	45%	*86%*	86%	*58%*	45%
Abstain (ϕ)	*45%*	40%	*45%*	40%	*0%*	0%	*3%*	0%
Nil Vote (n)	–		*21%*	15%	–		*39%*	55%
Invalid (i)	*0%*	0%	*0%*	0%	*14%*	14%	*0%*	0%

Notes: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

We can use these estimated frequencies of types in the population to derive a prediction of choice frequencies in our four different treatments. In the lower part of Table 3 we directly compare these predictions to the observed frequencies in our experiment. The model fit is not perfect (in particular, we overestimate the use of nil votes in C:NIL and underestimate it in V:NIL), but the predictions robustly replicate the comparative statics between treatments.

V.C Beliefs

In our post-experimental questionnaire we elicited voters' beliefs about other voters' choices. Table 5 shows the average beliefs of uninformed voters in each treatment. (The beliefs of informed voters are similar, but not of interest to our investigation.) In all treatments the uninformed believed that almost all of the informed would cast votes according to their signals. Thus, they do not seem to entertain beliefs that by themselves could rationalize the urge to cast a vote for a candidate.

Interestingly, comparative statics of beliefs about other uninformed voters follow our observed treatment differences closely. In particular, voters expect other uninformed voters to cast uninformed votes for a candidate, and they expect that a nil vote option will alleviate this problem to some extent.

TABLE 5: Average beliefs of uninformed voters

	V	V:NIL	C	C:NIL
Belief regarding the percentage of informed voters who would:				
Vote for their signal	87%	91%	93%	92%
Vote against their signal	8%	4%	7%	4%
Abstain	5%	3%	1%	1%
Vote for the nil option	-	3%	-	3%
Belief regarding percentage of uninformed voters who would:				
Vote for A	34%	23%	46%	33%
Vote for B	25%	21%	43%	27%
Abstain	38%	38%	11%	6%
Vote for the nil option	-	17%	-	35%

Note: Participants reported their beliefs in each treatment regarding the percentage of voters in the session that they expected would take particular actions. The table only includes the data from uninformed voters. The questionnaire did not ask for a belief on invalid votes since these were not officially part of the 'choice set'.

VI Conclusion

Our paper provides evidence that introducing a formal nil vote option can make a difference in election outcomes both when voting is voluntary and when it is compulsory, with a larger effect in the case of compulsory voting. In particular, providing the nil vote option reduces the number of uninformed voters casting a vote for a candidate, which increases the probability of selecting the right candidate and increases the welfare of all voters. An additional effect of introducing a nil vote option which we find in the case of compulsory voting is eliminating invalid votes.

We explain these findings with a model that assumes that some voters suffer psychological costs when choosing actions that they view as illegitimate, and that voters might be heterogeneous with respect to what action they consider illegitimate. These assumptions are along the lines of Niemi (1976), who argues that the costs of not voting are potentially important, whether they come from personal dissatisfaction or from embarrassment when asked to explain one's actions to others.

The presence of voters with heterogeneous views on what exactly constitutes a legitimate choice in a voting context raises important questions in designing voting rules. One possible way of providing a legitimate way to an uninformed voter to lessen her effect on the outcome of the election is allowing voters to express an intensity or strength of their vote, thereby creating options that are between the nil vote and casting a vote for a candidate. We leave the investigation of such alternative voting mechanisms to future research.[17]

References

Australian Electoral Commission (2003), 'Informal vote survey House of Representatives 2001 Election', Electoral Research Paper, Research Report Number 1.

Australian Electoral Commission (2009), 'Analysis of informal voting: House of Representatives 2007 Election', Electoral Research Paper, Research Report Number 11.

Battaglini, M., Morton, R. and Palfrey, T. (2009), 'The swing voter's curse in the laboratory', *Review of Economic Studies* **77(1)**, 61–89.

Bhattacharya, S. (2013), 'Preference monotonicity and information aggregation in elections', *Econometrica* **81**, 1229–1247.

Bhattacharya, S., Duffy, J. and Kim, S. (2014), 'Compulsory versus voluntary voting: an experimental study', *Games and Economic Behavior* **84**, 111–131.

Blais, A. (2000), *To vote or note to vote: The merits and limits of rational choice theory*, University of Pittsburgh Press, Pittsburgh.

Börgers, T. (2004), 'Costly voting', *American Economic Review* **94**, 57–66.

Büchner, S., Coricelli, G. and Greiner, B. (2007), 'Self centered and other regarding behavior in the solidarity game', *Journal of Economic Behavior and Organization* **62(2)**, 293–303.

Downs, A. (1957), *An economic theory of democracy*, Harper and Row, New York, NY.

[17] On existing work on elections at which voters can choose intensity of their votes, see Subsection 5.4 in Palfrey (2016).

Elbittar, A., Gomberg, A., Martinelli, C. and Palfrey, T. (2014), 'Ignorance and bias in collective decision:Theory and experiments', Working paper, CIDE.

Feddersen, T. (2004), 'Rational choice theory and the paradox of not voting', *Journal of Economic Perspectives* **18**, 99–112.

Feddersen, T., Gailmard, S. and Sandroni, A. (2009), 'Moral bias in large elections: theory and experimental evidence', *American Political Science Review* **103**(2), 175–192.

Feddersen, T. J. and Pesendorfer, W. (1996), 'The swing voter's curse', *The American Economic Review* **86(3)**, 408–424.

Feddersen, T. J. and Pesendorfer, W. (1997), 'Voting behavior and information aggregation in elections with private information', *Econometrica* **65**, 1029–1058.

Feddersen, T. J. and Pesendorfer, W. (1999), 'Abstention in elections with asymmetric information and diverse preferences', *American Political Science Review* **93**, 381–398.

Feddersen, T. and Sandroni, A. (2006), 'A theory of participation in elections', *American Economic Review* **96(4)**, 1271–1282.

Fiorina, M. P. (1976), 'The voting decision: Instrumental and expressive aspects', *Journal of Politics* **38**, 390–413.

Fowler, A. (2013), 'Electoral and policy consequences of voter turnout: Evidence from compulsory voting in Australia', *Quarterly Journal of Political Science* **8**, 159–182.

Greiner, B. (2015), 'Subject pool recruitment procedures: Organizing experiments with ORSEE', *Journal of the Economic Science Association* **1**(1), 114–125.

Großer, J. and Seebauer, M. (2016), 'The curse of uninformed voting: An experimental study', *Games and Economic Behavior* **97**, 205–226.

Jakee, K. and Sun, G.-Z. (2006), 'Is compulsory voting more democratic?', *Public Choice* **129**(1), 61–75.

Krishna, V. and Morgan, J. (2011), 'Overcoming ideological bias in elections', *Journal of Political Economy* **119**, 183–211.

Krishna, V. and Morgan, J. (2012), 'Voluntary voting: Costs and benefits', *Journal of Economic Theory* **147**, 2083–2123.

Ledyard, J. (1981), The paradox of voting and candidate competition: A general equilibrium analysis, *in* G. Hoorwich and J. Quick, eds, 'Essays in the contemporary fields of Economics', Purdue University Press, pp. 54–80.

Ledyard, J. (1984), 'The pure theory of two candidate elections', *Public Choice* **44**, 7–41.

Matsusaka, J. G. (1995), 'Explaining voter turnout patterns: An information theory', *Public Choice* **84**, 91–117.

McAllister, I. and Makkai, T. (1993), 'Institutions, society or protest? Explaining invalid votes in Australian elections', *Electoral Studies* **12(1)**, 23–40.

Morton, R. and Tyran, J.-R. (2011), 'Let the experts decide? Asymmetric information, abstention, and coordination in standing committees', *Games and Economic Behavior* **72**(2), 485—509.

Niemi, R. G. (1976), 'Costs of voting and nonvoting', *Public Choice* **27(1)**, 115–119.

Palfrey, T. (2016), Experiments in Political Economy, *in* J. H. Kagel and A. E. Roth, eds, 'The Handbook of Experimental Economics, Volume 2', Princeton University Press, Princeton, NJ, pp. 347–434.

Palfrey, T. and Rosenthal, H. (1983), 'A strategic calculus of voting', *Public Choice* **41**, 7–53.

Palfrey, T. and Rosenthal, H. (1985), 'Voter participation and strategic uncertainty', *American Political Science Review* **79**, 62–78.

Power, T. J. and Garand, J. C. (2007), 'Determinants of invalid voting in Latin America', *Electoral Studies* **26**, 423–444.

Power, T. and Roberts, T. (1995), 'Compulsory voting, invalid ballots, and abstention in Brazil', *Political Research Quarterly* **48**, 795–826.

Riker, W. H. and Ordeshook, P. C. (1968), 'A theory of the calculus of voting', *The American Political Science Review* **62**(1), 25–42.

Ujhelyi, G., Chatterjee, S. and Szabo, A. (2016), '"None of the above" votes in India and the consumption utility of voting', mimeo, University of Houston.

A Appendix: Proofs

Proof of Claim 1: For $n = 3$ the probability that an equal number of other voters vote for the two candidates is:

$$\pi_I^*(z) = \sigma_{U\phi}^3[\sigma_{I\phi}^2 + 2\sigma_{Ia}\sigma_{Im}] + 3\sigma_{U\phi}^2\sigma_{Uv}[2\sigma_{I\phi}\sigma_{Ia} + 2\sigma_{I\phi}\sigma_{Im}] + \\ + 3\sigma_{U\phi}\sigma_{Uv}^2[\sigma_{Ia}^2 + \sigma_{Im}^2 + 2(\sigma_{I\phi}^2 + 2\sigma_{Ia}\sigma_{Im})] + 3\sigma_{Uv}^3[2\sigma_{I\phi}\sigma_{Ia} + 2\sigma_{I\phi}\sigma_{Im}]$$

Notice that $\pi_I^*(z)$ does not depend on z: $\pi_I^*(0) = \pi_I^*(1) \equiv \pi_I^*$. The probabilities of the other two pivotal events are:

$$\pi_I^0(z) = \sigma_{U\phi}^3[2\sigma_{I\phi}\sigma_{Iz1}] + 3\sigma_{U\phi}^2\sigma_{Uv}[\sigma_{I\phi}^2 + 2\sigma_{Ia}\sigma_{Im} + \sigma_{Iz1}^2] + \\ + 3\sigma_{U\phi}\sigma_{Uv}^2[2\sigma_{I\phi}\sigma_{Iz0} + 4\sigma_{I\phi}\sigma_{Iz1}] + \sigma_{Uv}^3[\sigma_{Iz0}^2 + 3\sigma_{Iz1}^2 + 3\sigma_{I\phi}^2 + 6\sigma_{Ia}\sigma_{Im}];$$
$$\pi_I^1(z) = \sigma_{U\phi}^3[2\sigma_{I\phi}\sigma_{Iz0}] + 3\sigma_{U\phi}^2\sigma_{Uv}[\sigma_{I\phi}^2 + 2\sigma_{Ia}\sigma_{Im} + \sigma_{Iz0}^2] + \\ + 3\sigma_{U\phi}\sigma_{Uv}^2[4\sigma_{I\phi}\sigma_{Iz0} + 2\sigma_{I\phi}\sigma_{Iz1}] + \sigma_{Uv}^3[3\sigma_{Iz0}^2 + \sigma_{Iz1}^2 + 3\sigma_{I\phi}^2 + 6\sigma_{Ia}\sigma_{Im}]$$

As $\sigma_{I00} = \sigma_{I11}$ and $\sigma_{I01} = \sigma_{I10}$, we get $\pi_I^0(0) = \pi_I^1(1)$ and $\pi_I^0(1) = \pi_I^1(0)$.
Therefore for any abstaining cost c_a:

$$Eu_{I1c_a}(1) - Eu_{I1c_a}(0) = Eu_{I0c_a}(0) - Eu_{I0c_a}(1) = \frac{1}{2}p[2\pi_I^*(0) + \pi_I^0(0) + \pi_I^1(0)] \\ - \frac{1}{2}(1-p)[2\pi_I^*(1) + \pi_I^0(1) + \pi_I^1(1)] = \left(p - \frac{1}{2}\right)[2\pi_I^*(0) + \pi_I^0(0) + \pi_I^1(0)] \geq 0$$

$\pi_I^*(0) = \pi_I^0(0) = \pi_I^1(0) = 0$ cannot hold, therefore in any equilibrium informed voters never vote against their signal: $\tau_{Ia}^* = 0$. ■

Proof of Claim 2: From the perspective of an uninformed voter, the probability that an equal number of other voters vote for the two candidates is:

$$\pi_U^*(z) = \sigma_{U\phi}^2[\sigma_{I\phi}^3 + 6\sigma_{I\phi}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{U\phi}\sigma_{Uv}[3\sigma_{I\phi}^2\sigma_{Ia} + 3\sigma_{I\phi}^2\sigma_{Im} + 3\sigma_{Ia}^2\sigma_{Im} + 3\sigma_{Ia}\sigma_{Im}^2] + \\ + \sigma_{Uv}^2[3\sigma_{I\phi}\sigma_{Ia}^2 + 3\sigma_{I\phi}\sigma_{Im}^2 + 2(\sigma_{I\phi}^3 + 6\sigma_{I\phi}\sigma_{Ia}\sigma_{Im})]$$

Notice that $\pi_U^*(z)$ does not depend on z: $\pi_U^*(0) = \pi_U^*(1) \equiv \pi_U^*$. The probabilities of the other two pivotal events are:

$$\pi_U^0(z) = \sigma_{U\phi}^2[3\sigma_{I\phi}^2\sigma_{Iz1} + 3\sigma_{Iz1}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{U\phi}\sigma_{Uv}[\sigma_{I\phi}^3 + 6\sigma_{I\phi}\sigma_{Ia}\sigma_{Im} + 3\sigma_{I\phi}\sigma_{Iz1}^2] +$$
$$+ \sigma_{Uv}^2[3\sigma_{I\phi}^2\sigma_{Iz0} + 6\sigma_{I\phi}^2\sigma_{Iz1} + 3\sigma_{Iz0}\sigma_{Ia}\sigma_{Im} + 6\sigma_{Iz1}\sigma_{Ia}\sigma_{Im} + \sigma_{Iz1}^3];$$
$$\pi_U^1(z) = \sigma_{U\phi}^2[3\sigma_{I\phi}^2\sigma_{Iz0} + 3\sigma_{Iz0}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{U\phi}\sigma_{Uv}[\sigma_{I\phi}^3 + 6\sigma_{I\phi}\sigma_{Ia}\sigma_{Im} + 3\sigma_{I\phi}\sigma_{Iz0}^2] +$$
$$+ \sigma_{Uv}^2[6\sigma_{I\phi}^2\sigma_{Iz0} + 3\sigma_{I\phi}^2\sigma_{Iz1} + 6\sigma_{Iz0}\sigma_{Ia}\sigma_{Im} + 3\sigma_{Iz1}\sigma_{Ia}\sigma_{Im} + \sigma_{Iz0}^3]$$

As $\sigma_{I00} = \sigma_{I11}$ and $\sigma_{I01} = \sigma_{I10}$, we get $\pi_U^0(0) = \pi_U^1(1)$ and $\pi_U^0(1) = \pi_U^1(0)$. Hence for all c_a:

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(0) = 0$$
$$Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^1(1) - \pi_U^1(0)\right] - c + c_a$$

As $\sigma_{I10} < \sigma_{I00}$, we obtain $\pi_U^1(1) < \pi_U^1(0)$. As a result, for zero abstention cost $Eu_{Um0}(1) - Eu_{Um0}(\phi) = \frac{1}{4}\left[\pi_U^1(1) - \pi_U^1(0)\right] - c < 0$, uninformed voters prefer to abstain and $\sigma_{U\phi}^* = Pr(c_a = 0) = q_1 + q_2$; $\sigma_{Uv}^* = \sigma_{U0} = \sigma_{U1} = \frac{1}{2}(q_3 + q_4)$. Notice that for high abstention cost: $Eu_{Um\bar{c}}(0) = Eu_{Um\bar{c}}(1) > Eu_{Um\bar{c}}(\phi)$ and uninformed voters can mix between voting for and against the message in any way, but due to symmetry over messages the probability of voting for either candidate remains $\frac{1}{2}$ conditional on any state. ■

Proof of Theorem 1: Using our previous results, for zero abstention cost informed voters, the expected utility difference between voting for received signal and abstaining is:

$$\Delta(\tau_{I\phi}, p, q) \equiv Eu_{I10}(1) - Eu_{I10}(\phi) = \frac{1}{2}\left[p(\pi_I^* + \pi_I^1(1)) - (1-p)(\pi_I^* + \pi_I^1(0))\right] - c$$

$$= \left(p - \frac{1}{2}\right)\Big[\left[\frac{1}{4}(2q-1)(7q^2 - 4q + 1) + \frac{1}{4}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right]\tau_{I\phi}^2 +$$
$$\left[\frac{1}{2}(1-q)(7q^2 - 2q + 1) - \frac{1}{2}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right]\tau_{I\phi} +$$
$$\left[\frac{1}{8}(1-q)^2(1+5q) + \frac{1}{4}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right]\Big] - c$$

There are three possible types of equilibria, corresponding to the sign of $\Delta(\tau_{I\phi}, p, q)$.

1. If $\Delta(\tau_{I\phi}, p, q) > 0$ then it has to be that $\tau_{I\phi} = 0$ (all informed voters vote for their messages). The requirement $\Delta(\tau_{I\phi} = 0, p, q) > 0$ holds iff $c < c_1(p, q) \equiv \Delta(0, p, q) + c = \left(p - \frac{1}{2}\right)\left(\frac{1}{8}(1-q)^2(1+5q) + \frac{1}{4}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right)$.

2. If $\Delta(\tau_{I\phi}, p, q) < 0$ then it has to be that $\tau_{I\phi} = q$ (all informed voters with zero abstention cost abstain). The requirement $\Delta(\tau_{I\phi} = q, p, q) < 0$ holds iff $c > c_2(p, q) \equiv \Delta(q, p, q) + c =$
$\left(p - \frac{1}{2}\right)\left(\frac{1}{8}\left[1 + 7q - 23q^2 + 53q^3 - 58q^4 + 28q^5\right] + \frac{1}{4}p(1-p)(1-q)^2(7q^3 - 3q^2 + 3q + 1)\right)$.
Note that for any $p \in (\frac{1}{2}, 1]$ and $q \in [0, 1]$: $c_2(p, q) > c_1(p, q)$, so there is no cost for which always voting and always abstaining equilibria co-exist.

3. $\Delta(\tau_{I\phi}, p, q) = 0$. Here $\tau_{I\phi}$ has to belong to $[0, q]$ (high abstention cost voters never abstain, zero abstention cost informed voters may mix between voting and abstaining in any way).

   Denote

$$A = \left[\frac{1}{4}(2q-1)(7q^2 - 4q + 1) + \frac{1}{4}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right],$$
$$B = \left[\frac{1}{2}(1-q)(7q^2 - 2q + 1) - \frac{1}{2}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right],$$
$$E = \left[\frac{1}{8}(1-q)^2(1+5q) + \frac{1}{4}p(1-p)(7q^3 - 3q^2 + 3q + 1)\right].$$

   With this notation $c_1(p, q) = \left(p - \frac{1}{2}\right) E$ and $c_2(p, q) = \left(p - \frac{1}{2}\right)(Aq^2 + Bq + E)$. Also notice that $\Delta(\tau_{I\phi}) + c = (p - \frac{1}{2})(A\tau_{I\phi}^2 + B\tau_{I\phi} + E)$. As $2A + B > 0$, A and B can not be negative simultaneously and the following 3 combinations of signs are possible:

   (a) $A \geq 0$ and $B \geq 0$. Here $\Delta(\tau_{I\phi}) + c$ is increasing on $[0, q]$ and the mixed equilibrium exists for any cost $c \in (c_1(p, q), c_2(p, q))$.

   (b) $B < 0$ and hence $A > 0$. Here $\Delta(\tau_{I\phi}) + c$ is first decreasing and then increasing on $[0, q]$ (as $\Delta(q) > \Delta(0)$). The mixed equilibrium exists for any cost $c \in [c_0(p, q), c_2(p, q)]$, where $c_0(p, q) = \left(p - \frac{1}{2}\right)(E - \frac{B^2}{4A})$. Notice that in this region $E - \frac{B^2}{4A} > 0$.

   (c) $A < 0$ and hence $B > 0$. Here $\Delta(\tau_{I\phi}) + c$ is increasing on $[0, q]$ (as for any $p \in (\frac{1}{2}, 1]$ and $q \in [0, 1]$: $-\frac{B}{2A} > q$). The mixed equilibrium exists for any cost $c \in [c_1(p, q), c_2(p, q)]$.

The above implies that for any $p > \frac{1}{2}$ and $q \in [0, 1]$, there exists $c^*(p, q) = \left(p - \frac{1}{2}\right)\left(E - \mathbb{1}_{\{B<0\}} * \frac{B^2}{4A}\right) > 0$ such that for all $c < c^*(p, q)$ in symmetric state-neutral equilibria the only possibility is that informed voters always vote. ■

Proof of Claim 3: In the considered equilibrium the probability that that a correct candidate receives more votes is equal to:

$$\begin{aligned}\mathbb{P}^{win}(p,q) = \quad & p^3\left[1-\left(\frac{1-q}{2}\right)^3\right] + 3p^2(1-p)\left[q^3+3q^2\frac{1-q}{2}+9q\left(\frac{1-q}{2}\right)^2+4\left(\frac{1-q}{2}\right)^3\right] \\ & +3p(1-p)^2\left[3q\left(\frac{1-q}{2}\right)^2+\left(\frac{1-q}{2}\right)^3\right] \\ = \quad & \left[\frac{3}{8}p+\frac{3}{4}p^2-\frac{1}{4}p^3\right]+\left[\frac{9}{8}p-\frac{3}{4}p^3\right]q+\left[-\frac{27}{8}p+\frac{9}{4}p^2+\frac{3}{4}p^3\right]q^2+\left[\frac{15}{8}p-\frac{7}{4}p^3\right]q^3.\end{aligned}$$

The probability that a voting results in a tie is equal to:

$$\begin{aligned}\mathbb{P}^{draw}(p,q) = & p^3\left(\frac{1-q}{2}\right)^3 + 3p^2(1-p)\left[3q^2\frac{1-q}{2}+3\left(\frac{1-q}{2}\right)^3\right] \\ & + 3p(1-p)^2\left[3q^2\frac{1-q}{2}+3\left(\frac{1-q}{2}\right)^3\right]+(1-p)^3\left(\frac{1-q}{2}\right)^3 \\ = & \left[\frac{1}{8}+\frac{3}{4}p-\frac{3}{4}p^2\right]+\left[-\frac{3}{8}-\frac{9}{4}p+\frac{9}{4}p^2\right]q+\left[\frac{3}{8}+\frac{27}{4}p-\frac{27}{4}p^2\right]q^2+\left[-\frac{1}{8}-\frac{21}{4}p+\frac{21}{4}p^2\right]q^3.\end{aligned}$$

Hence, the probability of the right candidate being elected is equal to:

$$\begin{aligned}\mathbb{P}^{right}(p,q) &= \mathbb{P}^{win}(p,q)+\frac{1}{2}\mathbb{P}^{draw}(p,q) \\ &= \left[\frac{1}{16}+\frac{3}{4}p+\frac{3}{8}p^2-\frac{1}{4}p^3\right]+\left[-\frac{3}{16}+\frac{9}{8}p^2-\frac{3}{4}p^3\right]q \\ &+ \left[\frac{3}{16}-\frac{9}{8}p^2+\frac{3}{4}p^3\right]q^2+\left[-\frac{1}{16}-\frac{3}{4}p+\frac{21}{8}p^2-\frac{7}{4}p^3\right]q^3.\end{aligned}$$

$\mathbb{P}^{right}(p,q)$ is increasing in both p and q, so the probability of choosing a correct decision increases in informed voters signals' quality and decreases in noise caused by uninformed voting: $\mathbb{P}^{right}(\frac{1}{2},0)=\frac{1}{2}<\mathbb{P}^{right}(p,q)\leq 1=\mathbb{P}^{right}(1,1)$.

A expected utility of any informed voter is equal to $\mathbb{P}^{right}(p,q)-c$, while any uninformed voter on average gets $\mathbb{P}^{right}(p,q)-(1-q)c$, and both are increasing in p and q. Therefore, the total net social surplus from voting in the considered equilibrium is $6\mathbb{P}^{right}(p,q)-(6-3q)c$, increasing in both p and q. ■

Proof of Claim 4: From the perspective of an uninformed voter, the probability that an equal number of other voters vote for the two candidates is:

$$\begin{aligned}\pi_U^*(z) =& \sigma_{Uz}^2[\sigma_{Iz}^3 + 6\sigma_{Iz}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{Uz}\sigma_{Uv}[3\sigma_{Iz}^2\sigma_{Ia} + 3\sigma_{Iz}^2\sigma_{Im} + 3\sigma_{Ia}^2\sigma_{Im} + 3\sigma_{Ia}\sigma_{Im}^2] \\ &+ \sigma_{Uv}^2[3\sigma_{Iz}\sigma_{Ia}^2 + 3\sigma_{Iz}\sigma_{Im}^2 + 2(\sigma_{Iz}^3 + 6\sigma_{Iz}\sigma_{Ia}\sigma_{Im})]\end{aligned}$$

Notice that $\pi_U^*(z)$ does not depend on z: $\pi_U^*(0) = \pi_U^*(1) \equiv \pi_U^*$. The probabilities of the other two pivotal events are:

$$\begin{aligned}\pi_U^0(z) =& \sigma_{Uz}^2[3\sigma_{Iz}^2\sigma_{Iz1} + 3\sigma_{Iz1}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{Uz}\sigma_{Uv}[\sigma_{Iz}^3 + 6\sigma_{Iz}\sigma_{Ia}\sigma_{Im} + 3\sigma_{Iz}\sigma_{Iz1}^2] \\ &+ \sigma_{Uv}^2[3\sigma_{Iz}^2\sigma_{Iz0} + 6\sigma_{Iz}^2\sigma_{Iz1} + 3\sigma_{Iz0}\sigma_{Ia}\sigma_{Im} + 6\sigma_{Iz1}\sigma_{Ia}\sigma_{Im} + \sigma_{Iz1}^3]; \\ \pi_U^1(z) =& \sigma_{Uz}^2[3\sigma_{Iz}^2\sigma_{Iz0} + 3\sigma_{Iz0}\sigma_{Ia}\sigma_{Im}] + 2\sigma_{Uz}\sigma_{Uv}[\sigma_{Iz}^3 + 6\sigma_{Iz}\sigma_{Ia}\sigma_{Im} + 3\sigma_{Iz}\sigma_{Iz0}^2] \\ &+ \sigma_{Uv}^2[6\sigma_{Iz}^2\sigma_{Iz0} + 3\sigma_{Iz}^2\sigma_{Iz1} + 6\sigma_{Iz0}\sigma_{Ia}\sigma_{Im} + 3\sigma_{Iz1}\sigma_{Ia}\sigma_{Im} + \sigma_{Iz0}^3].\end{aligned}$$

As $\sigma_{I00} = \sigma_{I11}$ and $\sigma_{I01} = \sigma_{I10}$, we get $\pi_U^0(0) = \pi_U^1(1)$ and $\pi_U^0(1) = \pi_U^1(0)$. Hence for any abstention cost c_a:

$$\begin{aligned}&Eu_{Umc_a}(1) - Eu_{Umc_a}(0) = 0 \\ &Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^1(1) - \pi_U^1(0)\right] - c + c_a\end{aligned}$$

As $\sigma_{I10} < \sigma_{I00}$, we immediately get that $\pi_U^1(1) < \pi_U^1(0)$. Therefore, for voters of types 1 and 2 (with psychological costs $(0,0,0)$ and $(\bar{c},0,0)$) : $Eu_{Um0}(1) - Eu_{Um0}(\phi) < 0$, $u_{Um0}(n) - u_{Um0}(\phi) = -c < 0$, and so abstaining is optimal.

For voters of type 3 (with psychological costs $(\bar{c},\bar{c},0)$: $Eu_{Um\bar{c}}(1) - Eu_{Um\bar{c}}(n) = \frac{1}{4}\left[\pi_U^1(1) - \pi_U^1(0)\right] < 0$, and so casting a nil vote is optimal. For voters of type 4 (with psychological costs $(\bar{c},\bar{c},\bar{c})$: $Eu_{Um\bar{c}}(0) = Eu_{Um\bar{c}}(1) > Eu_{Um\bar{c}}(\phi) > Eu_{Um\bar{c}}(n)$, and so they can mix between voting for and against the message in any way. Therefore $\sigma_{U\phi}^* = q_1 + q_2$, $\sigma_{Un}^* = q_3$, $\sigma_{Uv}^* = \sigma_{U0} = \sigma_{U1} = \frac{1}{2}q_4$.

■

B Supplementary appendix (not for publication): Theoretical analysis for general numbers of informed and uninformed voters

Consider a general model with n informed and k uninformed voters. Recall that there are three situations in which an agent may be pivotal:

1. An equal number of other agents vote for each candidate.
2. Candidate 1 receives one more vote than candidate 0.
3. Candidate 0 receives one more vote than candidate 1.

For any *uninformed* agent the probabilities of each of these events, given state z and all other voters play strategy profile τ, are as follows. The probability an equal number of other agents have voted for each candidate, that is, a tie is:

$$\pi_U^*(z) = \sum_{j=0}^{(\frac{n+k-2}{2})} \sum_{\substack{(u_\phi,u_0,u_1,i_\phi,i_0,i_1): \\ u_\phi+i_\phi=n+k-1-2j, u_0+i_0=j, u_1+i_1=j, \\ u_\phi+u_0+u_1=k-1, i_\phi+i_0+i_1=n}} \frac{(k-1)!n!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!} \sigma_{Uz\phi}^{u_\phi}\sigma_{Uz0}^{u_0}\sigma_{Uz1}^{u_1}\sigma_{Iz\phi}^{i_\phi}\sigma_{Iz0}^{i_0}\sigma_{Iz1}^{i_1}. \tag{8}$$

The probability that candidate x receives exactly one less vote than candidate y is

$$\pi_U^x(z) = \sum_{j=0}^{(\frac{n+k-2}{2})} \sum_{\substack{(u_\phi,u_0,u_1,i_\phi,i_0,i_1): \\ u_\phi+i_\phi=n+k-2-2j, u_x+i_x=j, u_y+i_y=j+1, \\ u_\phi+u_0+u_1=k-1, i_\phi+i_0+i_1=n}} \frac{(k-1)!n!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!} \sigma_{Uz\phi}^{u_\phi}\sigma_{Uz0}^{u_0}\sigma_{Uz1}^{u_1}\sigma_{Iz\phi}^{i_\phi}\sigma_{Iz0}^{i_0}\sigma_{Iz1}^{i_1}. \tag{9}$$

Likewise, for any *informed* agent we get:

$$\pi_I^*(z) = \sum_{j=0}^{(\frac{n+k-2}{2})} \sum_{\substack{(u_\phi,u_0,u_1,i_\phi,i_0,i_1): \\ u_\phi+i_\phi=n+k-1-2j, u_0+i_0=j, u_1+i_1=j, \\ u_\phi+u_0+u_1=k, i_\phi+i_0+i_1=n-1}} \frac{k!(n-1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!} \sigma_{Uz\phi}^{u_\phi}\sigma_{Uz0}^{u_0}\sigma_{Uz1}^{u_1}\sigma_{Iz\phi}^{i_\phi}\sigma_{Iz0}^{i_0}\sigma_{Iz1}^{i_1}. \tag{10}$$

and

$$\pi_I^x(z) = \sum_{j=0}^{(\frac{n+k-2}{2})} \sum_{\substack{(u_\phi,u_0,u_1,i_\phi,i_0,i_1): \\ u_\phi+i_\phi=n+k-2-2j, u_x+i_x=j, u_y+i_y=j+1, \\ u_\phi+u_0+u_1=k, i_\phi+i_0+i_1=n-1}} \frac{k!(n-1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!} \sigma_{Uz\phi}^{u_\phi}\sigma_{Uz0}^{u_0}\sigma_{Uz1}^{u_1}\sigma_{Iz\phi}^{i_\phi}\sigma_{Iz0}^{i_0}\sigma_{Iz1}^{i_1}. \tag{11}$$

Let us introduce an alternative terminology for the analysis below. We call a vector $(u_\phi, u_0, u_1, i_\phi, i_0, i_1)$ *voting outcome* if from a sample with $u_\phi + u_0 + u_1$ uninformed and $i_\phi + i_0 + i_1$ informed voters exactly u_ϕ uninformed voters abstain, u_0 uninformed voters vote for 0, u_1 uninformed voters vote for 1; i_ϕ informed voters abstain, i_0 informed voters vote for 0, i_1 informed voters vote for 1. Denote by

$$Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|z) \equiv \frac{(u_\phi + u_0 + u_1)!(i_\phi + i_0 + i_1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!} \sigma_{Uz\phi}^{u_\phi}\sigma_{Uz0}^{u_0}\sigma_{Uz1}^{u_1}\sigma_{Iz\phi}^{i_\phi}\sigma_{Iz0}^{i_0}\sigma_{Iz1}^{i_1}$$

the probability that, when all voters follow strategy τ, in state z voting outcome $(u_\phi, u_0, u_1, i_\phi, i_0, i_1)$ is realized.

When n informed and $k-1$ uninformed voters vote, denote the set of voting outcomes that lead to a tie by

$$S_U^* = \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in \mathbb{Z}_+^6 : u_0 + i_0 = u_1 + i_1, u_\phi + u_0 + u_1 = k-1, i_\phi + i_0 + i_1 = n\},$$

and the set of outcomes that lead to x receiving exactly one less vote by

$$S_U^x = \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in \mathbb{Z}_+^6 : u_x + i_x = u_y + i_y - 1, u_\phi + u_0 + u_1 = k-1, i_\phi + i_0 + i_1 = n\}.$$

When $n-1$ informed and k uninformed vote, denote the set of voting outcomes that lead to a tie by

$$S_I^* = \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in \mathbb{Z}_+^6 : u_0 + i_0 = u_1 + i_1, u_\phi + u_0 + u_1 = k, i_\phi + i_0 + i_1 = n-1\},$$

and the set of outcomes that lead to x receiving exactly one less vote by

$$S_I^x = \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in \mathbb{Z}_+^6 : u_x + i_x = u_y + i_y - 1, u_\phi + u_0 + u_1 = k, i_\phi + i_0 + i_1 = n-1\}.$$

Then (8) - (11) can be rewritten as:

$$\pi_U^*(z) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_U^*} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|z) \tag{12}$$

$$\pi_U^x(z) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_U^x} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|z) \tag{13}$$

$$\pi_I^*(z) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_I^*} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|z) \tag{14}$$

$$\pi_I^x(z) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_I^x} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|z) \tag{15}$$

For any message $m \in M$ the expected utility differentials of any *uninformed* voter are given by:

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^*(1) - \pi_U^*(0) + \pi_U^1(1) - \pi_U^1(0)\right] - c + c_a \tag{16}$$

$$Eu_{Umc_a}(0) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^*(0) - \pi_U^*(1) + \pi_U^0(0) - \pi_U^0(1)\right] - c + c_a \tag{17}$$

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(0) = \frac{1}{4}\left[2(\pi_U^*(1) - \pi_U^*(0)) + \pi_U^1(1) - \pi_U^1(0) + \pi_U^0(1) - \pi_U^0(0)\right] \tag{18}$$

Also for any message $m \in M$ the expected utility differentials of any *informed* voter are given by:

$$Eu_{Imc_a}(m) - Eu_{Imc_a}(\phi) = \frac{1}{2}\left[p(\pi_I^*(m) + \pi_I^m(m)) - (1-p)(\pi_I^*(1-m) + \pi_I^m(1-m))\right] - c + c_a \tag{19}$$

$$Eu_{Imc_a}(1-m) - Eu_{Imc_a}(\phi) = \frac{1}{2}\left[(1-p)(\pi_I^*(1-m) + \pi_I^{1-m}(1-m)) - p(\pi_I^*(m) + \pi_I^{1-m}(m))\right] - c + c_a \tag{20}$$

$$\begin{aligned} Eu_{Imc_a}(m) - Eu_{Imc_a}(1-m) = &\frac{1}{2}p[2\pi_I^*(m) + \pi_I^m(m) + \pi_I^{1-m}(m)] \\ &- \frac{1}{2}(1-p)[2\pi_I^*(1-m) + \pi_I^m(1-m) + \pi_I^{1-m}(1-m)] \end{aligned} \tag{21}$$

B.A Symmetry over messages

Recall that state neutrality implies the following restrictions: $\tau_{t0\phi} = \tau_{t1\phi} \equiv \tau_{t\phi}$, $\tau_{t00} = \tau_{t11} \equiv \tau_{tm}$, and $\tau_{t01} = \tau_{t10} \equiv \tau_{ta}$. Here we defined $\tau_{t\phi}$, τ_{tm} and τ_{ta} as the probabilities that a voter with information type t (unconditional on psychological type) abstains, votes according to her message, and votes against her message, respectively.

We defined $\sigma_{Uv} \equiv \sigma_{U0} = \sigma_{U1} = \frac{1}{2}\tau_{Um} + \frac{1}{2}\tau_{Ua}$, $\sigma_{U\phi} \equiv \tau_{U\phi}$, $\sigma_{I\phi} \equiv \sigma_{I0\phi} = \sigma_{I1\phi} = \tau_{I\phi}$, $\sigma_{Im} \equiv \sigma_{I00} = \sigma_{I11} = p\tau_{Im} + (1-p)\tau_{Ia}$, and $\sigma_{Ia} \equiv \sigma_{I01} = \sigma_{I10} = (1-p)\tau_{Im} + p\tau_{Ia}$.

Recall that we denote a probability of zero psychological costs for abstention ($c_a = 0$) by $q = q_1 + q_2$.

Below we assume that $p < 1$ and $q < 1$. First we show that informed voters never vote against their signal.

Claim 5 *In any symmetric and state-neutral equilibrium $\tau_0(I, 1, c_p) = \tau_1(I, 0, c_p) = 0$ for any $c_p \in A$.*

Proof: First, from $\sigma_{U0} = \sigma_{U1} = \sigma_{Uv}$, $\sigma_{I00} = \sigma_{I11}$, and $\sigma_{I01} = \sigma_{I10}$, we get:

$$Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0) = \frac{(u_\phi + u_0 + u_1)!(i_\phi + i_0 + i_1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!}\sigma_{U\phi}^{u_\phi}\sigma_{Uv}^{u_0}\sigma_{Uv}^{u_1}\sigma_{I0\phi}^{i_\phi}\sigma_{I00}^{i_0}\sigma_{I01}^{i_1}$$
$$= \frac{(u_\phi + u_0 + u_1)!(i_\phi + i_0 + i_1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!}\sigma_{U\phi}^{u_\phi}\sigma_{Uv}^{u_1}\sigma_{Uv}^{u_0}\sigma_{I1\phi}^{i_\phi}\sigma_{I10}^{i_1}\sigma_{I11}^{i_0} = Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|1)$$

Second, $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in S_I^0$ iff $u_0 + i_0 = u_1 + i_1 - 1, u_\phi + u_0 + u_1 = k, i_\phi + i_0 + i_1 = n - 1$ and iff $(u_\phi, u_1, u_0, i_\phi, i_1, i_0) \in S_I^1$.
From these two facts and (15), we get:

$$\pi_I^0(0) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_I^0} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_I^1} Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|1) = \pi_I^1(1)$$

$$\pi_I^0(1) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_I^0} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|1)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_I^1} Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|0) = \pi_I^1(0)$$

Also, in the same way from (14) we get:

$$\pi_I^*(0) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_I^*} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_I^*} Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|1) = \pi_I^*(1)$$

Therefore for any abstaining cost c_a:

$$Eu_{I1c_a}(1) - Eu_{I1c_a}(0) = Eu_{I0c_a}(0) - Eu_{I0c_a}(1) = \frac{1}{2}p[2\pi_I^*(0) + \pi_I^0(0) + \pi_I^1(0)]$$
$$-\frac{1}{2}(1-p)[2\pi_I^*(1) + \pi_I^0(1) + \pi_I^1(1)] = \left(p - \frac{1}{2}\right)[2\pi_I^*(0) + \pi_I^0(0) + \pi_I^1(0)] \geq 0$$

$p < 1$ implies that either (i) $\sigma_{I\phi} = 1$ or (ii) $\sigma_{Ia} > 0$ and $\sigma_{Im} > 0$. As $q < 1$, $\sigma_{U0} = \sigma_{U1} > 0$ and $\pi_I^*(0) = \pi_I^0(0) = \pi_I^1(0) = 0$ is not possible. Therefore $Eu_{I1c_a}(1) > Eu_{I1c_a}(0)$ and in any equilibrium informed voters never vote against their signal: $\tau_{Ia}^* = 0$. ■

Claim 6 *In any symmetric and state-neutral equilibrium* $\tau_\phi(U, m, (0, 0, 0)) = \tau_\phi(U, m, (\bar{c}, 0, 0)) = 1$ *for any* $m \in M$, *and* $\sigma_{U0} = \sigma_{U1} = \frac{1}{2}(q_3 + q_4)$.

Proof: We use the same steps as in Claim 5. First, recall that:

$$Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0) = Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|1)$$

Second, $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in S_U^0$ iff $u_0 + i_0 = u_1 + i_1 - 1, u_\phi + u_0 + u_1 = k - 1, i_\phi + i_0 + i_1 = n$ and iff $(u_\phi, u_1, u_0, i_\phi, i_1, i_0) \in S_U^1$.

From these facts and (13), we obtain:

$$\pi_U^0(0) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_U^0} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_U^1} Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|1) = \pi_U^1(1)$$

$$\pi_U^0(1) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_U^0} Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|1)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_U^1} Pr(u_\phi, u_1, u_0, i_\phi, i_1, i_0|0) = \pi_U^1(0)$$

Also, in the same way from (12) we get:

$$\pi_U^*(0) = \sum_{(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in S_U^*} Pr(u_\phi,u_0,u_1,i_\phi,i_0,i_1|0)$$
$$= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_U^*} Pr(u_\phi,u_1,u_0,i_\phi,i_1,i_0|1) = \pi_U^*(1)$$

Hence for all c_a:

$$Eu_{Umc_a}(1) - Eu_{Umc_a}(0) = 0$$
$$Eu_{Umc_a}(1) - Eu_{Umc_a}(\phi) = \frac{1}{4}\left[\pi_U^1(1) - \pi_U^1(0)\right] - c + c_a$$

Next we prove that $\pi_U^1(1) \leq \pi_U^1(0)$.
Denote $\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \equiv Pr(u_\phi,u_0,u_1,i_\phi,i_0,i_1|0) - Pr(u_\phi,u_0,u_1,i_\phi,i_0,i_1|1)$. Then

$$\pi_U^1(0) - \pi_U^1(1) = \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_U^1} \alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1)$$

and

$$\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1) = \frac{(u_\phi+u_0+u_1)!(i_\phi+i_0+i_1)!}{u_\phi!u_0!u_1!i_\phi!i_0!i_1!}\sigma_{U\phi}^{u_\phi}\sigma_{Uv}^{u_0}\sigma_{Uv}^{u_1}\sigma_{I\phi}^{i_\phi}(\sigma_{Im}^{i_0}\sigma_{Ia}^{i_1} - \sigma_{Ia}^{i_0}\sigma_{Im}^{i_1}).$$

As $\tau_{Ia} = 0$, $\sigma_{Im} = p\tau_{Im} > (1-p)\tau_{Im} = \sigma_{Ia}$, $\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1) < 0$ is possible only if $i_0 < i_1$.
Denote by M_U^1 a set of voting outcomes from S_U^1, which are strictly more likely in state 1, that is

$$M_U^1 \equiv \{(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \in S_U^1 : \alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1) < 0\} \subset \{(u_\phi,u_0,u_1,i_\phi,i_0,i_1) : i_0 < i_1\}.$$

Define function $\theta : M_U^1 \to S_U^1$ such that for any $(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \in M_U^1$:

$$\theta(u_\phi,u_0,u_1,i_\phi,i_0,i_1) = (u_\phi,u_1+1,u_0-1,i_\phi,i_1,i_0).$$

Notice that if $(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \in M_U^1 \subset S_U^1$, then $u_0+i_0 = u_1+i_1+1$ (from the definition of S_U^1) and $i_0 < i_1$, hence $u_0 > u_1+1$, $u_0 - 1 \in \mathbb{Z}_+$ and $(u_\phi,u_1+1,u_0-1,i_\phi,i_1,i_0) \in S_U^1$. As $i_0 < i_1$, $\theta(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \in S_U^1 \backslash M_U^1$. Moreover, it is easy to see that θ is an injective function. For any $(u_\phi,u_0,u_1,i_\phi,i_0,i_1) \in M_U^1$:

$$\begin{aligned}\alpha(\theta(u_\phi,u_0,u_1,i_\phi,i_0,i_1)) &= \alpha(u_\phi,u_1+1,u_0-1,i_\phi,i_1,i_0)\\ &= \frac{(u_\phi+u_0+u_1)!(i_\phi+i_0+i_1)!}{u_\phi!(u_0-1)!(u_1+1)!i_\phi!i_0!i_1!}\sigma_{U\phi}^{u_\phi}\sigma_{Uv}^{u_0+u_1}\sigma_{I\phi}^{i_\phi}(\sigma_{Im}^{i_1}\sigma_{Ia}^{i_0}-\sigma_{Ia}^{i_1}\sigma_{Im}^{i_0})\\ &= -\frac{u_0}{u_1+1}\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1)>0\end{aligned}$$

As mentioned before, $(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\in M_U^1$ implies $u_0>u_1+1$, therefore $\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1)+\alpha(\theta(u_\phi,u_0,u_1,i_\phi,i_0,i_1))>0$. From the definition of M_U^1 and injectivity of θ, we have:

$$\begin{aligned}\pi_U^1(0)-\pi_U^1(1) &= \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in S_U^1}\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1)\\ &\geq \sum_{(u_\phi,u_1,u_0,i_\phi,i_1,i_0)\in M_U^1}(\alpha(u_\phi,u_0,u_1,i_\phi,i_0,i_1)+\alpha(\theta(u_\phi,u_0,u_1,i_\phi,i_0,i_1))\geq 0\end{aligned}$$

As a result, for zero abstention cost $Eu_{Um0}(1)-Eu_{Um0}(\phi)=\frac{1}{4}\left[\pi_U^1(1)-\pi_U^1(0)\right]-c<0$, uninformed voters prefer to abstain and $\sigma_{U\phi}^*=Pr(c_a=0)=q_1+q_2$; $\sigma_{Uv}^*=\sigma_{U0}=\sigma_{U1}=\frac{1}{2}(q_3+q_4)$. Notice that for high abstention cost $Eu_{Um\bar{c}}(0)=Eu_{Um\bar{c}}(1)>Eu_{Um\bar{c}}(\phi)$, and uninformed voters can mix between voting for and against the message in any way, but due to symmetry over messages the probability of voting for either candidate remains $\frac{1}{2}$ conditional on any state. ■

Theorem 2 *There exists a critical cost threshold $c_1>0$ such that a symmetric state-neutral equilibrium with $\tau_0(I,0,c_p)=\tau_1(I,1,c_p)=1$ for any c_p (all informed voters vote for their signals) exists iff $c\leq c_1$.*

Proof: Using our previous results, it is enough to check the strategic incentives for informed voters with zero abstention cost only. Their utility differential between voting for the received signal and abstaining is:

$$Eu_{I10}(1)-Eu_{I10}(\phi)=\frac{1}{2}\left[p(\pi_I^*(1)+\pi_I^1(1))-(1-p)(\pi_I^*(0)+\pi_I^1(0))\right]-c.$$

Recall that $\pi_I^*(1)=\pi_I^*(0)=\pi_I^*$. To prove the theorem, it is enough to establish that if all informed voters vote for their signal ($\tau_{Im}=1$), then

$$c_1\equiv\Delta_{policy}=\frac{1}{2}\left[p(\pi_I^*+\pi_I^1(1))-(1-p)(\pi_I^*+\pi_I^1(0))\right]=\left(p-\frac{1}{2}\right)\pi_I^*+\frac{1}{2}\left[p\pi_I^1(1)-(1-p)\pi_I^1(0)\right]>0. \tag{22}$$

First we prove that $p\pi_I^1(1) - (1-p)\pi_I^1(0) \geq 0$ and that this inequality is strict for even $k+n$. Denote $\beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \equiv pPr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|1) - (1-p)Pr(u_\phi, u_0, u_1, i_\phi, i_0, i_1|0)$. Then

$$p\pi_I^1(1) - (1-p)\pi_I^1(0) = \sum_{(u_\phi, u_1, u_0, i_\phi, i_1, i_0) \in S_I^1} \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1)$$

As $\sigma_{U\phi} = q$, $\sigma_{Uv} = \frac{1-q}{2} > 0$, $\sigma_{I_\phi} = 0$, $\sigma_{Im} = p$, and $\sigma_{Ia} = 1-p$, we get

$$\beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) =$$
$$\mathbb{1}_{i_\phi=0} \frac{(u_\phi + u_0 + u_1)!(i_0 + i_1)!}{u_\phi! u_0! u_1! i_0! i_1!} q^{u_\phi} \left(\frac{1-q}{2}\right)^{u_0+u_1} \left[p^{i_1+1}(1-p)^{i_0} - (1-p)^{i_1+1} p^{i_0}\right].$$

$\beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) < 0$ is possible only if $i_1 + 1 < i_0$. Denote by M_I^1 a subset of such voting outcomes:

$$M_I^1 \equiv \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in S_I^1 : \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) < 0\} \subset \{(u_\phi, u_0, u_1, i_\phi, i_0, i_1) : i_1 + 1 < i_0\}.$$

Define a function $\psi : M_I^1 \to S_I^1$ such that for any $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in M_I^1$:

$$\psi(u_\phi, u_0, u_1, i_\phi, i_0, i_1) = (u_\phi, u_1, u_0, i_\phi, i_1 + 1, i_0 - 1).$$

Notice that if $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in M_I^1$, then $i_1 + 1 < i_0$, hence $i_0 - 1 \in \mathbb{Z}_+$ and $(u_\phi, u_1, u_0, i_\phi, i_1 + 1, i_0 - 1) \in S_I^1$. As $i_0 > i_1 + 1$, $\phi(u_\phi, u_1, u_0, i_\phi, i_1 + 1, i_0 - 1) \in S_I^1 \backslash M_I^1$. Note that ψ is an injective function. Also for any $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in M_I^1$:

$$\begin{aligned}
&\beta(\psi(u_\phi, u_0, u_1, i_\phi, i_0, i_1)) = \beta(u_\phi, u_1, u_0, i_\phi, i_1 + 1, i_0 - 1) \\
&= \mathbb{1}_{i_\phi=0} \frac{(u_\phi + u_0 + u_1)!(i_0 + i_1)!}{u_\phi! u_0! u_1! (i_0 - 1)!(i_1 + 1)!} q^{u_\phi} \left(\frac{1-q}{2}\right)^{u_0+u_1} \left[p^{i_0}(1-p)^{i_1+1} - (1-p)^{i_0} p^{i_1+1}\right] \\
&= -\frac{i_0}{i_1 + 1} \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) > 0.
\end{aligned}$$

Notice that $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in M_I^1$ implies $i_0 > i_1 + 1$, therefore $\beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) + \beta(\psi(u_\phi, u_0, u_1, i_\phi, i_0, i_1)) > 0$. From definition of M_I^1 and injectivity of ψ, we have:

$$\begin{aligned}
p\pi_I^1(1) - (1-p)\pi_I^1(0) &= \sum_{(u_\phi, u_1, u_0, i_\phi, i_1, i_0) \in S_I^1} \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \\
&\geq \sum_{(u_\phi, u_1, u_0, i_\phi, i_1, i_0) \in M_I^1} (\beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) + \beta(\psi(u_\phi, u_0, u_1, i_\phi, i_0, i_1)) \geq 0.
\end{aligned}$$

$p\pi_I^1(1) - (1-p)\pi_I^1(0) = 0$ is possible only if M_I^1 is empty. In such a case, for any $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in S_I^1 : \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \geq 0$. Therefore, $p\pi_I^1(1) - (1-p)\pi_I^1(0) > 0$ if there exists $(u_\phi, u_0, u_1, i_\phi, i_0, i_1) \in S_I^1 : \beta(u_\phi, u_0, u_1, i_\phi, i_0, i_1) > 0$.

If $k+n$ is even, then $\left(0, [\frac{k+2}{2}], [\frac{k-1}{2}], 0, [\frac{n-1}{2}], [\frac{n}{2}]\right) \in S_I^1$ and

$$\beta\left(0, [\frac{k+1}{2}], [\frac{k}{2}], 0, [\frac{n}{2}], [\frac{n-1}{2}]\right) > 0.$$

Hence, in this case:

$$c_1 = \Delta_{policy} = \left(p - \frac{1}{2}\right)\pi_I^* + \frac{1}{2}\left[p\pi_I^1(1) - (1-p)\pi_I^1(0)\right] \geq \frac{1}{2}\left[p\pi_I^1(1) - (1-p)\pi_I^1(0)\right] > 0.$$

If $k+n$ is odd, then

$$\begin{aligned} c_1 &= \left(p - \frac{1}{2}\right)\pi_I^* + \frac{1}{2}\left[p\pi_I^1(1) - (1-p)\pi_I^1(0)\right] \\ &\geq \left(p - \frac{1}{2}\right)\pi_I^* \geq \left(p - \frac{1}{2}\right) Pr\left(0, \left[\frac{k}{2}\right], \left[\frac{k+1}{2}\right], 0, \left[\frac{n}{2}\right], \left[\frac{n-1}{2}\right]\right) > 0. \end{aligned}$$

■

C Supplementary appendix (not for publication): Experiment materials

Brackets [] indicate where the instructions and forms differed between treatments.

C.A Instructions

Thank you for participating in today's experiment. You can earn money in this experiment. Please note that talking and communication between participants is not allowed. If you fail to follow this rule you will forfeit your payment. If you have any questions during the experiment, please raise your hand.

The Monitor

At the beginning of the experiment, one participant will be randomly selected as an "experiment monitor" by drawing tickets out of a box. All but one of these tickets will be blank. On the one non-blank ticket is written the word "monitor". Please raise your hand if you have the "monitor" ticket. At the end of the experiment, the monitor will receive the average payment of all other participants.

The monitor's task is to manage all interactions between the researchers and the participants (random ID allocation, handing out decision forms, collecting decision forms) and to observe that all procedures described in these instructions are followed. The decisions you make today will all be made under a randomly allocated ID number. Additionally, all payments at the end of the session will be handled by the ASB Lab Manager. Therefore, while the researchers are able to collect and record your decisions, they will never be able to connect your decisions with your personal identity. In this sense, your decisions are anonymous.

The Experiment

First, the monitor will let each participant randomly draw an envelope out of a box, we will refer to this as Envelope 1. Envelope 1 contains an ID number, 3 other pieces of paper, and another envelope we refer to as the Return Envelope. Each of these items is described in more detail below. Participants will be divided into groups of 6 according to ID number. Participants with IDs 1 to 6 are in one group, participants with IDs 7 to 12 are in a second group, and participants with IDs 13 to 18 are in a third group. Participants will only interact within their group.

In the experiment, participants in each group can vote about whether payoff option A or payoff option B should be implemented for the group. One of these payoff options will have a high payoff for each participant in the group (the HIGH option), and the other payoff option will pay a lower payoff to each participant in the group (the LOW option).

Which of the two payoff options is actually the HIGH option for a particular group was randomly determined before the experiment. There is a 50% probability that payoff option A is the HIGH option for a group, and a 50% probability that option B is the HIGH option for a group. However, at the beginning of the experiment **it is not known** which payoff option, A or B, is the HIGH payoff option for a group and which is the LOW payoff option. The first piece of paper in your Envelope 1 is a “Hint Sheet”. This sheet is different for each participant as follows:

- For 3 of the participants in your group of 6, the sheet contains a “hint” about which payoff option is the HIGH payoff option for the group, A or B. This hint is correct with a probability of 90%, and wrong with a probability of 10%.
- The other 3 participants in your group of 6 will not receive any more information beyond what has already been stated, that is, that payoff option A is the HIGH option for the group with 50% probability, and payoff option B is the HIGH option for a group with 50% probability. For these participants the “Hint Sheet” will say “No Hint”.

The second and third pieces of paper in Envelope 1 are labelled “Voting Instructions”, and “Ballot Paper”. The voting instruction sheet informs you of how to fill in the ballot paper. Please read both carefully. Each participant is then allowed to vote, you will be given some time to read and make your decision.

Participants can **choose to vote** for“Payoff option A” or “Payoff option B” ***[VNV and CNV:*** or “Neither of these options”***]*** by filling in the ballot paper, putting it into the Return Envelope and handing it to the monitor, or **to abstain from voting** by submitting an empty Return Envelope without a ballot paper.

You will be given some time to make your decision. If you decided to vote, please complete the ballot paper and place it inside the Return Envelope. Hand this envelope to the monitor during collection time. If you decided not to vote, please keep your ballot paper, and submit an empty Return Envelope to the monitor during collection time. Once voting has finished the monitor will collect all Return Envelopes, shuffle them, and then hand them to the researchers.

The researchers will open the envelopes and tally the submitted votes. (Again, your vote remains anonymous, as the researchers do not know which participant has which ID number.) In each group, the payoff option which received the most votes wins. Invalid votes will not be counted towards the result, please see the voting instruction sheet for further information. If there is a tie, a coin will be tossed to determine the outcome.

The ballot papers will be kept by the researchers, and the outcome of the voting procedure will then be made known to all participants. The following information will be announced by the monitor for each group:

- The number of votes submitted.
- The number of valid votes.
- The number of votes for each payoff option.
- The payoff option selected by the group.
- Which payoff option was the randomly pre-determined HIGH payoff option for the group.

The information announced will not refer to any individual ID numbers.

Payoffs

Your payoff will be calculated as follows:

- All participants receive the $5 show-up payment.
- When the payoff option (A or B) selected by a group is the **HIGH** payoff option, then all group members will receive an additional amount of **$15**.
- When the payoff option (A or B) selected by a group is the **LOW** payoff option, then all group members will receive an additional amount of **$5**.
- Note that the payoff you receive from your groups choice is independent of your individual voting decision. If your group chose the HIGH payoff option through the vote, you will receive $15 regardless of your individual voting decision. If your group chose the LOW payoff option through the vote, you will receive $5 regardless of your individual voting decision.
- There are **additional costs** associated with voting, which are outlined in your voting instruction sheet. These costs (where applicable) are deducted when determining your final payment.

The payoffs for each ID number will be placed in envelopes which we will refer to as Envelope 2, and will be labelled with your ID number. The monitor will distribute the payoff envelopes. When the monitor reaches you, please discretely show them the paper which has your ID number written on it. The monitor will then give you the correct envelope.

Envelope 2 also contains a receipt. You will be asked to fill in and sign this receipt in exchange for your payment. The ASB Lab Manager will collect and administer these receipts, such that the researchers are not able to identify the amount each participant was paid, and your choices made during the experiment remain anonymous.

After all receipts have been collected, the Monitor will come around with a bag. Please place all experiment materials (instructions, hint sheets, remaining ballot sheets, voting instructions, etc.) in the bag. Do not take any material with you.

The researchers will confirm that you are free to leave.

C.B Voting Instructions

ID Number: XX

Please read the following instructions carefully about the costs and payoffs associated with voting, and about completing your ballot paper.

Costs

- The cost of voting, i.e. of submitting a non-empty Return Envelope which contains a ballot paper, is 20 cents.
- ***[CS and CNV:*** The cost of abstaining (submitting a Return Envelope which is empty) is $5.***]***

Payoffs

- If the payoff option selected by the majority of voters in the group is the HIGH payoff option, all group members receive an additional $15 payoff.
- If the payoff option selected by the majority of votes in the group is the LOW payoff option, all group members receive an additional $5 payoff.
- In case of a tie, a coin toss will determine the outcome of the vote.

Completing the Ballot Paper

- You can vote for "Payoff option A" or "Payoff option B" ***[VNV and CNV:*** or "Neither of these options"***]*** or you can abstain from voting.
- To vote, draw one cross "X" in the box to the left next to the choice you would like to vote for. Place this ballot paper in your Return Envelope for collection.
- If you choose to abstain please retain your ballot paper and submit your empty Return Envelope for collection.

- If we receive a Return Envelope containing the ballot paper associated with your ID number inside, you will be considered as having submitted a non-empty envelope, and will incur the 20 cent cost. If we do not receive a Return Envelope containing the ballot paper associated with your ID number inside, i.e. you submitted an empty envelope, you will be considered as having abstained *[**CS and CNV:*** and will incur the $5 cost*]*.

Invalid Votes

The following ballots will be considered as invalid, and will not count towards the election result.

- Ballots which are left blank.
- Ballots with a tick, numbering, or any other kind of mark apart from the cross "X".
- Ballots with any writing on them other than the cross "X" selection.

Your choices remain anonymous at all times.

C.C Hint Sheets

Informed participants:

ID Number: XX

HINT SHEET Hint (correct with 90% probability, wrong with 10% probability):
The HIGH payoff option for your group is payoff option A.

Uninformed participants:

ID Number: XX

HINT SHEET No hint.

C.D Ballot Papers

ID Number: XX

BALLOT PAPER

Place a cross "X" only in the box next to the option you would like to vote for.

☐ Payoff option A

☐ Payoff option B

*[**VNV and CNV:*** ☐ Neither of these options*]*

C.E Post-Experimental Questionnaire

Please answer the following questions. Your answers are anonymous, as you cannot be personally identified from this information.
Please answer these questions truthfully. Your truthful answers are very important for our research. If you feel uncomfortable answering a question, please leave it empty or write "no answer" rather than giving an inaccurate answer.
Thank you for your responses

1) ID Number:

2) Age in years:

3) Gender: ☐ Male ☐ Female

4) Field of study: Degree:

5) Country of origin:

6) Country or countries of parents' origin:

7) Main language(s) spoken at home:

8) The following questions are about what you think the other people in the experiment did. We would like your estimate of what percentage of people in the room took certain actions, that is, all people in the experiment not just in your group of 6.

8a) Of the people in the room who received a hint which was 90% correct, what percentage of those do you think:

- Voted for the payoff option indicated by their hint:
- Voted for the payoff option opposite to that indicated by their hint:
- ***[VNV and CNV:*** Voted for "Neither of these options":*]*
- Abstained from voting:

(The percentages should add to 100%)

8b) Of the people in the room who received no hint, what percentage of those do you think:

- Voted for Payoff Option A:
- Voted for Payoff Option B:
- ***[VNV and CNV:*** Voted for "Neither of these options":*]*
- Abstained from voting:

(The percentages should add to 100%)

9) Have you participated in any elections/voting in real life before? ☐ Yes ☐ No

10) If you answered yes to question 9 please provide some detail. For example, the country, number and type of elections, level of government, voluntary or compulsory voting, etc.

C.F Experimenter Script

Participant Informed Consent (PIS) forms

- Distribute PIS forms on seats before experiment

Registration

- Participants checked in, allocated to seat, read PIS and sign consent forms

"Please read and sign the consent forms found on your seat. Please note that from this point onwards any talking or communication between participants is not allowed. Please turn off all mobile phones. Please do not turn on the computers, they will not be required today."

- Payment of alternates

"We will now collect the signed consent forms."

- Collect PIS forms

"We will now distribute the instructions for todays experiment. Please read the instructions carefully and in full, as they describe how you can earn money in this experiment."

Participant Instructions

- Distribute Participant Instructions - Reading time

"Please raise your hand if you have any questions at this point."

- Questions

"We will now randomly select the Monitor for todays experiment, as described in the instructions. Please take a ticket from this box. If the ticket you draw from the box says Monitor, please raise your hand"

Monitor Selection

- Random draw
- Monitor is chosen

"Please wait while we give the monitor a few minutes to read their specific instructions. You may wish to read over your own instructions again during this time. And a reminder that no talking or communication is allowed."

- Monitor given their schedule and time to read and ask questions

"The monitor will now bring around a box with the envelopes referred to as "Envelope 1" in the instructions. Please take one envelope from the box. Please do not open your envelope yet."

ID numbers

- Monitor given box of "Envelope 1"s
- Participants draw envelopes

"Inside Envelope 1 is an ID number from 1 to 18, this is unrelated to your seat number. For the duration of the experiment please do not share your ID number with anyone other than the monitor. There are also 3 other pieces of paper inside as described in the instructions. Please read all the forms inside carefully. You will now be given 10 minutes to read and to vote. You may now open your envelopes."

Voting

- Reading and voting time.

"The monitor will now collect all the Return Envelopes."

- Monitor collects Return Envelopes, they are shuffled and given to researchers

"While we are tallying the results, we would like you to complete a post-experimental questionnaire. We ask that the monitor distribute a questionnaire and an additional envelope to each person. After you have completed your questionnaire please place it in the envelope for collection. Also, please ensure you write your ID number on the Questionnaire."

Questionnaires and Payment

- Monitor distributes the questionnaire sheets
- Participants given time to fill them in
- Meanwhile, researchers will tally the votes, and determine the winner for each group.
- Ask the monitor to open envelopes containing the pre-determined HIGH payoff for each group, and to confirm with researchers.
- Fill in receipts, put in numbered payoff envelopes, close envelopes.
- Fill in results sheet for monitor

"The monitor will now collect your questionnaire envelopes"

- Monitor collects the questionnaires.

"The monitor will now announce the results for each group."

- The results are given to the monitor to announce

"The monitor will now distribute the envelopes referred to as Envelope 2 in the instructions. Envelope 2 contains your payoff and a receipt. Please check these amounts and fill in the receipt which will be collected by the lab manager."

- Monitor is given the “Envelope 2”s to distribute
- Monitor is then given their payment envelope.
- They are given some time to sign

“The Lab Manager will now collect your receipts”

- Lab manager collects receipts and checks signature.

“The Monitor will now come around with a bag. Please place all the experiment materials you received into the bag. Do not take any materials with you.”

- Monitor collects materials

“You are now free to leave. Thank you for your participation today.”

C.G Monitor Instructions

Please read and follow these instructions during the experiment. If you have any questions please ask the researchers.

As the monitor you will receive the $5 show up payment, plus an additional amount equal to the average payoff of the group.

Distribute Envelope 1

- You will be given a box of envelopes.
- Go around the room and let each person take one random envelope.

Voting - Collect Return Envelope

- When asked to, please collect the return envelope from each person.
- Note that envelopes are allowed to be empty.
- Shuffle envelopes before giving them to the researchers.

Announce Results

- A piece of paper with the results will be given to you.
- When asked to, please read this out exactly as it is written on the paper to everyone.

Payments - Distribute Envelope 2

- You will be given a stack of envelopes. Each is labelled with an ID number. They will be in numerical order of ID number from 1 to 18.
- Go around the room and discretely wait for each person to show you their ID number, and then hand them the envelope with their ID written on it.

Receive Your Payment Envelope

- Collect your envelope from the researchers.
- Fill in your receipt and return it to the Lab Manager.

Collect all Materials

- You will be given a large bag.

- When asked to go around the room and everyone will place all their leftover experiment materials in the bag.

- Give this bag to the researchers.

Thank you for your participation.

C.H Results Announcement Script

For the monitor: please read aloud for everyone the following results exactly as they are written here for each group, one by one.

For Group X, ID Numbers XX to XX:

- X votes were submitted
- X were valid votes
- X people voted for payoff option A
- X people voted for payoff option B
- ***[VNV and CNV:*** X people voted for neither of these options***]***
- X was the option selected by the majority of the group (OR There was a tie, and the winner was randomly determined to be X)
- X was the randomly pre-determined HIGH payoff option for Group 1