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Voting as communicating: Mandates, multiple candidates, and the signaling voter's curse

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In this spatial model of common-value elections, votes convey citizens' private opinions regarding which policies are socially optimal, and the winning candidate utilizes this information in choosing policy. In equilibrium, large margins of victory convey *mandates* for candidates to make bold policy changes. To communicate extreme policy views, citizens support extreme parties that may be unlikely to win office. To convey moderate views, citizens deliberately abstain from voting, thereby avoiding the *signaling voter's curse* of encouraging overextremism. In large elections, mandates can identify the optimal policy from an entire continuum, thereby greatly strengthening Condorcet's (1785) classic "jury" theorem. Behavioral patterns are consistent with otherwise puzzling empirical features of elections, and can also apply to other political activities, such as public protests or writing letters to elected officials.

1. Introduction

Observers of elections commonly interpret large margins of victory as "mandates" from voters to elected officials—that is, as injunctions to take bold and decisive policy actions. Recent empirical studies document candidate responses that are consistent with this notion. According to Faravelli et al. (2015), for example, U.S. congressional votes shift in proportion to the most recent election's margin of victory; according to Peterson et al. (2003), they also shift after election outcomes that news media label as mandates. Conley (2001, Ch. 4) and Fowler and Smirnov (2007, Ch. 3) document evidence of mandates in U.S. presidential and senate elections. With only a few exceptions (discussed below), however, existing election models say nothing about mandates, focusing instead on the formal impact of a vote, which is to change the identity of the election

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winner. Indeed, restricting attention to such *pivotal* voting scenarios, even if they are rare, is treated in much of existing literature as an important hallmark of voter rationality.

Another theoretical implication of the pivotal voting calculus is Duverger's (1954) law, which predicts that majoritarian electoral systems should foster only two parties or candidates, because votes for third parties are unlikely to be pivotal, and so are wasted. Empirically, majoritarian systems do often tend to be dominated by two major parties, but minor parties also do often receive substantial electoral support. In the 2016 U.S. presidential election, for example, minor parties garnered about seven million votes (Leip, 2016); in 1992, they received over 20 million—a share of about 20% (Federal Election Commission, 1992). Presidential primaries regularly include a half-dozen candidates or more, each receiving substantial vote shares.

This paper provides a unified framework for understanding electoral mandates and votes for minor parties as two manifestations of a signaling incentive in common-value elections, building on the models of Lohmann (1993, 1994), Piketty (2000), and Razin (2003). Like standard spatial models, the model below assumes that candidates choose policy positions from a continuum of alternatives. As in the classic model of de Condorcet (1785), however, one policy in the continuum is ultimately best for society, and citizens each form an opinion regarding the location of the optimum, modeled as private signals that are each correlated with the truth.[2] By the logic of Condorcet's (1785) "jury" theorem, the candidate whose policy is truly superior has a high probability of winning the election. By Bayes' rule, then, a candidate who wins the election infers that truth was on her side.[3] If the candidate on the left receives a majority of votes, for example, it is likely that the optimal policy is left of center. If she wins only narrowly, the optimal policy is likely only slightly left of center, but if she wins by a large margin, the optimal policy is likely more extreme. Accordingly, a large margin makes a liberal candidate more confident in implementing liberal policies; symmetrically, a large margin makes a conservative more conservative.

When candidates respond to mandates, a citizen's task shifts from that of helping one candidate win office to that of shaping the beliefs of whoever wins. In the equilibrium characterized below, this is straightforward: a vote for the candidate on the left pushes the ultimately policy outcome to the left, whether by bolstering the confidence of the liberal candidate or weakening the confidence of the conservative. If a citizen is confident that the optimal policy is far left or right, he can nudge the policy outcome even further to the left or right by voting for an extreme party. That party may not win, but the citizen's vote can nevertheless influence the policy choice of the candidate who does.

When every vote exerts a marginal influence on the policy outcome, the standard pivotal voting calculus is no longer relevant. This raises new questions, however, because the implications of a pivotal vote have been useful in explaining voter participation patterns. Specifically, Feddersen and Pesendorfer (1996) show that when pivotal considerations contradict a citizen's initial opinion, it generates a *swing voter's curse*, leading the citizen to abstain from voting, in deference to those with better information. This can explain why citizens often cast only partial ballots, even after voting costs have been paid, and is consistent with extensive empirical evidence that voter participation increases with information.[4] It also lends strong support for the common-value paradigm of elections, since a citizen is only willing to defer to his peers if they share his basic objective.

The swing voter's curse does not arise in the model below, but a new incentive for abstention arises in its place, which exhibits the same patterns. This is because candidates can observe neither the precision nor the magnitude of the private signals underlying citizens' votes, and so merely respond as if each signal were of average quality and average magnitude. This reaction is appropriate on average, but overreacts to citizens with low expertise or moderate policy opinions. Accordingly, such citizens abstain to avoid the *signaling voter's curse* of pushing the policy outcome too far in the desired direction. Put differently, such citizens deliberately abstain, to avoid encouraging extremism on either side. As explained below, the signaling voter's curse can explain behaviors that the swing voter's curse cannot, such as split-ticket voting and blank or spoiled ballots. Since it doesn't rely on pivot probabilities, the signaling voter's curse can also apply to participation in political activities other than voting, such as writing letters, signing petitions, or attending protests, rallies, or marches. This is useful because, as shown below, these activities exhibit the same empirical pattern as voter participation.

The welfare consequence of electoral mandates is a greatly strengthened jury theorem: a large electorate can now identify not only the better of two alternatives, but the unique optimum from an entire continuum. Since abstention withholds private information that is socially valuable, it may seem that decisions would improve even further if voting were compulsory. As explained below, however, this is not the case: abstention improves communication so that the most informative signals receive the greatest weight. Adding candidates is beneficial for similar reasons. That these normative conclusions differ from those of conventional private-value models underscores the importance of considering both types of models before prescribing policy.

The remainder of this paper is as follows. First, Section 2 reviews related literature and Section 3 introduces the formal model. Section 4.1 then provides the basic equilibrium characterization, which formalizes the notion of electoral mandates.

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[2] McMurray (2016a, 2016b) adapts Condorcet's model to a spatial environment, and explains how a common-value paradigm can arise in spite of fundamental conflicts of interest, as citizens take one another's private interests into account, and view elections as if through the eyes of social planners (while disagreeing what a planner should prefer). Those papers also highlight several empirical features of elections that are puzzling from the standard private-value perspective, but arise quite naturally in the common-value framework, such as shifts in public opinion; patterns of information, extremism, and participation; lop-sided election outcomes; and the extreme polarization of political candidates.

[3] Throughout this paper, feminine pronouns refer to candidates and masculine pronouns refer to voters.

[4] See McMurray (2015) for a review of the empirical literature.

Section 4.2 introduces abstention and Section 4.3 introduces additional political parties. Empirical support is discussed throughout these sections, in the context of the various theoretical results. Section 4.4 constructs a series of illustrative examples to shed light on comparative static results, and Section 5 analyzes welfare. Section 6 then comments on how the main intuition of the analysis to that point could extend to settings with more general information structure. Section 7 concludes, and proofs of formal results are presented in the appendix.

2. Related literature

The structure of the model below builds closely on that of McMurray (2013, 2016a, 2016b). The first of those papers deals with a binary policy choice and focuses on voter participation, extending Feddersen and Pesendorfer (1996) to accommodate a continuous signal structure. The second considers a continuum of policy alternatives, so that the truth variable is continuous as well. Both of these papers limit attention to voting behavior, treating candidate positions as exogenous. The third paper endogenizes candidates' policy choice, under various assumptions about candidate motivations, but in all three papers candidate positions are fixed before voting takes place, so the policy outcome depends entirely on the identity of the winning candidate, and voters' influence hinges entirely on the event of a pivotal vote. The innovation of this paper relative to those is that candidates can infer information from the electoral outcome, and adjust their policy positions accordingly, ex post.[5] Relaxing the commitment assumption seems uncontroversial, as the difficulty of enforcing platform promises is widely recognized and, in this environment, policy adjustments actually benefit voters (as Section 5 makes clear) so enforcement is not even desirable.

The earliest model of political signaling seems to be that of Lohmann (1993). In her model, citizens choose whether or not to participate in a costly activity, such as a public protest or rally, and their participation decisions communicate their policy opinions to a policy maker who shares their preferences. Battaglini (2015) later extends this model to consider a policy maker whose preferences differ from citizens'. Lohmann (1994, 2000) introduces a model of sequential elections, where part of the role of votes in one election is to influence the beliefs (and therefore the votes) of voters in a future election. Morgan and Stocken (2008) later consider a similar model, where citizens who are biased in one direction or the other respond strategically to public opinion polls in an effort to manipulate later voting outcomes. In addition to these models, Piketty (2000) analyzes a model in which citizens in one faction have to coordinate on one of two alternatives to beat an opposing faction, but with a mixed strategy that influences which of multiple equilibria they will coordinate on in a subsequent election.

The models above each assume a binary policy outcome. Because of this, the utility consequence of a vote is limited to its ability to reverse the policy outcome, and behavior is accordingly governed by the standard pivotal voting calculus. In that regard, the model below is more similar to one by Razin (2003), where the winning candidate may choose any one of a large number of policies, after inferring voters' private information from observed vote totals. Razin's model posits only three states of the world, however, and two private signal realizations; the model below greatly enriches the information structure by allowing the optimal policy to lie anywhere in a continuum of feasible alternatives, and considering voter signals that are continuous, and of heterogeneous quality. Beyond adding realism to the model, these are crucial for the greatly strengthened jury theorem and for motivating behaviors that the models above do not consider, such as abstention and supporting multiple candidates.[6]

The models above all consider signaling in a fundamentally common-value environment (sometimes with idiosyncratic biases), and the model below does the same. Alternatively, Castanheira (2003a), Shotts (2006), and Fowler and Smirnov (2007) offer preference-based models of electoral mandates. In these papers, candidates converge in a second election to the median voter's preferred policy, and votes in a first election serve to communicate the median voter's location.[7] Shotts (2006) demonstrates in that context that abstention can have a moderating effect on candidates, and Castanheira (2003b) shows that votes for extreme parties can exert greater influence on the policy outcome. As Sections 4.1 through 4.3 discuss, however, empirical features such as the timing of candidates' responses to mandates favor the common-value paradigm.

3. The model

An electorate consists of N citizens where, for mathematical convenience, N is drawn from a Poisson distribution with mean n, as in Myerson (1998). Together, these citizens must choose and implement a policy from the interval $\mathcal{X} = [-1, 1]$ of alternatives, which will provide a common benefit to every citizen. One of these policies, denoted z, is ultimately optimal for society. Unfortunately for the electorate, the location of this optimal policy unknown: at the beginning of the game, z is

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[5] Herrera et al. (2016) analyze a similar model in which policy outcomes move continuously with vote shares, but this stems from an electoral rule which is specified exogenously, rather than from an equilibrium choice by candidates—in fact, candidates play no active role in that paper, and there are only two. Abstention arises in that model, but because of a "marginal voter's curse" that is conceptually distinct from the signaling voter's curse below. The welfare properties differ as well: in particular, a mechanical policy function does not achieve optimality.

[6] Piketty (2000) does treat voter abstention briefly. The protest models of Lohmann (1993) and Battaglini (2015) involve participation decisions, but the action set is still binary (i.e., join a protest or not), with no third neutral action akin to abstention in the election setting.

[7] In a similar model by Meirowitz (2005), candidates learn the location of the median voter from political polls, so it is poll respondents who signal their preferences.

drawn from a uniform distribution on $\mathcal{X}$. Whatever the optimal policy z is, implementing a policy $x \in \mathcal{X}$ gives each citizen utility $u(x,z) = -(x-z)^2$, which declines quadratically with the distance between x and z. The quadratic specification does not seem crucial to the logic below, but is convenient because, conditional on information Ω, expected utility is similarly quadratic in the policy choice.

$$E[u(x,z)] = -[x - E(z)]^2 - V(z) \tag{1}$$

That is, the optimal policy choice is the expectation of z, and preferences are single-peaked, as in standard spatial voting models. The concavity of $u(x,z)$ also implies that voters are risk averse, and thus favor moderate policies, which are guaranteed not to be too far from whatever is truly optimal. With no additional information, the optimal policy is $E(z) = 0$.[8]

Each citizen has a private "hunch" regarding the location of the optimal policy, represented by a private signal $s_i \in \mathcal{X}$ that is positively correlated with z. Conditional on z, private signals are independent. Because citizens differ in expertise, their signals vary in quality. Specifically, a citizen's expertise $q_i \in [0,1]$ is first drawn independently (from other citizens, and from z) from a common distribution G which is differentiable and has a strictly positive density g. Conditional on $q_i = q$ and on z, the density of $s_i = s$ is as follows.

$$h(s|q,z) = \frac{1}{2}(1 + qsz) \tag{2}$$

This specification is special both in that it is linear and in that it is symmetric in opposite states of the world (i.e. $h(-s|q,z) = h(s|q,-z)$). These features are crucial for tractability, but do not seem important for any of the results below. In particular, Section 6 shows that all of the central results of this paper hold for any information structure such that private signals are *affiliated* with z, in the sense of Milgrom and Weber (1982). With the specification in (2), q_i can also be interpreted as proportional to the correlation coefficient between s_i and z. For an individual with $q_i = 0$, for example, s_i is independent of z, and therefore completely uninformative.

After observing his private information $(q,s) \in [0,1] \times \mathcal{X}$, an individual uses (2) to update his beliefs $f(z|q,s)$ of the optimal policy by Bayes' rule. In terms of the product $\theta = qs$, this posterior can be written as follows.

$$f(z|q,s) = \frac{1}{2}(1 + qsz) = \frac{1}{2}(1 + \theta z) = f(z|\theta). \tag{3}$$

The expectation $E(z|q,s)$ is simply proportional to θ, which can therefore be interpreted as a voter's *ideology*. Formulated this way, ideology has the same sign as s: a liberal citizen has a hunch that the optimal policy is left of center while a conservative believes it to be on the right. Citizens also discount their private opinions according to the level of noise in their signals, with the result that those who lack confidence in their own opinions tend to remain ideologically moderate, consistent with the statistical evidence in McMurray (2016a).

Citizens do not choose policies directly. Instead, they vote (at no cost) for candidates from the set $\mathcal{C} = \{A, B\}$.[9] A voting strategy $v : [0,1] \times \mathcal{X} \to \mathcal{C}$ specifies a candidate choice $j \in \mathcal{C}$ for every realization $(q,s) \in [0,1] \times \mathcal{X}$ of private information, and $\mathcal{V}$ denotes the set of such strategies. Sections 4.2 and 4.3 expand the set of actions to allow abstention and larger numbers of candidates. In each case, votes are cast simultaneously and the candidate $w \in \mathcal{C}$ who receives the most votes (breaking ties with equal probability) wins the election and takes office.

McMurray (2016b) assumes that candidates commit to policy platforms that they will implement if elected. In light of the evidence in Section 1, this paper instead assumes that candidates can adjust their policy positions after taking office. Since pre-election platforms are not binding, they are not modeled at all. Let $y_j : \mathbb{Z}_+^2 \longrightarrow \mathcal{X}$ denote the policy that candidate $j \in \mathcal{C}$ plans to implement if she wins the election, which may depend on the numbers $a, b \in \mathbb{Z}_+$ of votes for either candidate, and let $\mathcal{Y}$ denote the set of such policy strategies. Candidates are assumed to be *truth motivated*, meaning that they care only about the policy outcome, and wish to do what is truly optimal for society. This is in the spirit of Osborne and Slivinski (1996) and Besley and Coate (1997), who view candidates as having fundamentally the same motivations as other citizens.[10] For simplicity, and since the emphasis of this paper is on the aggregation of voter information, candidate signals are not modeled. Instead, candidates base their equilibrium beliefs about the optimal policy on the information they infer from voters.[11] Since candidates have identical preferences and identical information, citizens will be indifferent as to

8 The single-peakedness of $u(x,z)$ would make it nearly concave even if the utility loss function were linear or convex, so results would be similar to those below. Also, this paper only treats what McMurray (2016a) calls the case of *continuous truth*, but all of the results would also hold for the case of *binary truth*, meaning that the optimal policy is known ex ante to lie at one of the two policy extremes. Section 4.4 constructs examples of that case.

9 Voting costs are not modeled here, but other authors have attributed costly voting to precisely the types of ingredients that are present in this model. Faravelli et al. (2015), in particular, attribute costly voting specifically to the combination of electoral mandates and altruism.

10 Downs (1957) argues persuasively in favor of office motivation, but office motivation gives a candidate no guidance as to what policy to implement once she has already won the election. More importantly, when platforms are not binding, there is nothing a candidate can do before the election to influence her chance of winning: indeed, as Section 5 makes clear, the best promise an office-motivated candidate could make would be to mimic the behavior of a truth-motivated candidate. In that sense, truth motivation could reflect candidates' intrinsic desire to do the right thing, or a more selfish desire to leave a legacy that is admired by voters for having done the right thing.

11 The possibility that candidates might hold valuable private information of their own is an important direction for future extension, but given the current model's other assumptions, adding candidate signals would have essentially no consequence for voter or candidate behavior, because the informational content of a candidate's own signal would be overwhelmed by what is inferred from the N citizens.

the identity of the election winner. This is admittedly unrealistic, and candidate heterogeneity is an important direction for future extension, but completely eliminating pivotal voting considerations is useful for making the logic of mandates and the signaling voter's curse as transparent as possible.[12]

The ultimate policy outcome $x \in \mathcal{X}$ depends on both voter and candidate strategies, together with the realizations of N and z and the private information (q_i, s_i) of each citizen. Citizens and candidates form expectations regarding these outcomes, and a *Bayesian Nash equilibrium* (henceforth *equilibrium*) is a strategy vector $\left(v^*, y_A^*, y_B^*\right)$ such that y_A^* and y_B^* each maximize the expectation of $u(x, z)$, given the voting strategy v^*, and that v^* is optimal for a voter whose peers also follow v^*, given that candidates follow y_A^* and y_B^*. Given the structure of the model and the assumption of Poisson population uncertainty, such an equilibrium will necessarily be subgame perfect and *symmetric* in the sense that citizens each play the same voting strategy. For robustness and tractability, attention is further restricted to equilibria that are *informative* and *signal-symmetric*, as defined in the following section.

4. Equilibrium analysis

4.1. Mandates

How a citizen wishes to vote depends on how he expects others to vote, and how he expects candidates to react to those votes, with and without the addition of his own. Candidate incentives are more straightforward, as Remark 1 states: once a candidate has won the election, the policy choice that maximizes (1) is simply her expectation of z, updated in response to the total numbers of votes cast for either candidate (which are publicly known by that time). Let $\hat{z}_{a,b} = E(z|a, b)$ denote this expectation, given a votes for candidate A and b votes for candidate B. No candidate differences are imposed exogenously, so the optimal policy function in Remark 1 is the same for either candidate, and thus does not depend on j. Nevertheless, the two candidates will differ in equilibrium because they win office under different sets of circumstances.

Remark 1. For any candidate $j \in \{A, B\}$, the unique best response to any voting strategy $v \in \mathcal{V}$ and opponent strategy $y_{-j} \in \mathcal{Y}$ is given by $y_j^*(a, b) = \hat{z}_{a,b}$ for all $a, b \in \mathbb{Z}_+$.

How a candidate interprets each vote depends on what behavior she expects from citizens with different types of information. In other words, $\hat{z}_{a,b}$ depends implicitly on the voting strategy. If citizens follow $v \in \mathcal{V}$ then each votes for candidate $j \in \mathcal{C}$ in state $z \in \mathcal{Z}$ with the following probability,

$$\phi(j|z) = \int_0^1 \int_{-1}^1 1_{[v(q,s)=j]} h(s|q, z)\, g(q)\, ds dq \tag{4}$$

where $1_{[v(q,s)=j]}$ is an indicator function that equals 1 if $v(q, s) = j$ and equals 0 otherwise. By the decomposition property of Poisson random variables, the numbers $a \in \mathbb{Z}_+$ and $b \in \mathbb{Z}_+$ of A and B votes are then independent Poisson random variables with means $n\phi(A|z)$ and $n\phi(B|z)$, respectively, so the probability of a particular pair $(a, b) \in \mathbb{Z}_+^2$ of vote totals can be written as

$$\psi(a, b|z) = e^{-n\phi(A|z)} \frac{[n\phi(j|z)]^a}{a!} e^{-n\phi(B|z)} \frac{[n\phi(j|z)]^b}{b!} \tag{5}$$

and a candidate's expectation of the optimal policy is given by the following,

$$\hat{z}_{a,b} = \int_{\mathcal{Z}} z \frac{\psi(a, b|z)\, f(z)}{\psi(a, b)} dz \tag{6}$$

where $\psi(a, b) = \int_{\mathcal{Z}} \psi(a, b|z)\, f(z)\, dz$.

Let $E(\theta|j) = E[qs|v(q, s) = j]$ denote the average ideology of a citizen who votes for candidate j. As in other models of communication, there exist "babbling" equilibria in which citizens ignore their private information (e.g. vote randomly, or all vote for candidate A). In that case, the average ideology of A and B voters is the same, so the winning candidate learns nothing about a voter, and therefore nothing about the state variable, from an individual's vote. Accordingly, her updated expectation $\hat{z}_{a,b} = E(z) = 0$ of the optimal policy coincides with her prior expectation. Such equilibria would not be robust, however, to slight differences between the candidates.[13] Accordingly, the analysis below restricts attention to voting strategies that are *informative*, as defined in Definition 1, meaning that the average B voter is more conservative than the average A voter.[14]

[12] This also avoids the complications that arise in Razin (2003) when pivot and signaling incentives conflict.

[13] Voters would no longer be indifferent, for instance, if candidate A preferred the policy $E(z) - \varepsilon$ and candidate B preferred $E(z) + \varepsilon$ for arbitrarily small ε.

[14] Voting would be equally informative if A voters were more conservative than B voters, of course, and with no exogenous differences between candidates, this could actually be sustained in equilibrium. In that case, however, Definition 1 can be viewed simply as a relabeling of the candidates.

Definition 1. A voting strategy $v \in \mathcal{V}$ is *informative* if $E(\theta|A) < E(\theta|B)$. An equilibrium $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V} \times \mathcal{Y}^2$ is informative if v^* is informative.

Lemma 1 now states that, when voting is informative, the impact of vote totals on candidates' posterior beliefs is monotonic: each additional A vote pushes the winning candidate's expectation of the optimal policy to the left, while each B vote pushes it to the right.

Lemma 1 *(Monotone Expectations). If $v \in \mathcal{V}$ is informative then $\hat{z}_{a+1,b} < \hat{z}_{a,b} < \hat{z}_{a,b+1}$ for any $a, b \in \mathbb{Z}_+$.*

By the environmental equivalence property of Poisson games (Myerson, 1998), a voter within the game reinterprets a and b as the numbers of A and B votes cast by his peers; by voting himself, he can add one to either total. A citizen need not follow the voting strategy $v \in \mathcal{V}$ used by his peers, but candidates will have no way of knowing that he deviated: if they expect votes to be a particular function of private information they will interpret his vote accordingly, whether he follows that strategy or not. By voting A or B, therefore, the individual has the opportunity to push the candidate's policy choice to $\hat{z}_{a+1,b}$ or $\hat{z}_{a,b+1}$, respectively. For a citizen with private information $(q, s) \in \mathcal{Q} \times \mathcal{S}$, then, the expected benefit Δ_B of voting B can be written as the following, which only depends on q and s through the product $\theta = qs$ (which determines the posterior density $f(z|\theta)$ over which expectations are taken).

$$\begin{aligned}
\Delta_B(\theta) &= E_z\left\{E_{a,b}\left[u\left(\hat{z}_{a,b+1}, z\right) - u\left(\hat{z}_{a,b}, z\right)|z\right]|\theta\right\} \\
&= E_z\left\{E_{a,b}\left[-\left(\hat{z}_{a,b+1} - z\right)^2 + \left(\hat{z}_{a,b} - z\right)^2 |z\right]|\theta\right\} \\
&= E_z\left\{E_{a,b}\left[\left(\hat{z}_{a,b+1} - \hat{z}_{a,b}\right)\left(z - \frac{\hat{z}_{a,b} + \hat{z}_{a,b+1}}{2}\right)|z\right]|\theta\right\} \qquad (7)
\end{aligned}$$

Analogously, the expected benefit of voting A is

$$\Delta_A(\theta) = E_z\left\{E_{a,b}\left[\left(\hat{z}_{a+1,b} - \hat{z}_{a,b}\right)\left(z - \frac{\hat{z}_{a+1,b} + \hat{z}_{a,b}}{2}\right)|z\right]|\theta\right\} \qquad (8)$$

and a citizen prefers voting B to voting A if and only if the difference

$$\begin{aligned}
\Delta_{AB}(\theta) &= \Delta_B(\theta) - \Delta_A(\theta) \\
&= E_z\left\{E_{a,b}\left[u\left(\hat{z}_{a,b+1}, z\right) - u\left(\hat{z}_{a+1,b}, z\right)|z\right]|\theta\right\} \\
&= E_z\left\{E_{a,b}\left[\left(\hat{z}_{a,b+1} - \hat{z}_{a+1,b}\right)\left(z - \frac{\hat{z}_{a+1,b} + \hat{z}_{a,b+1}}{2}\right)|z\right]|\theta\right\} \qquad (9)
\end{aligned}$$

is positive.

Clearly, since $\hat{z}_{a+1,b} < \hat{z}_{a,b+1}$ when voting is informative, the benefit $u\left(\hat{z}_{a,b+1}, z\right) - u\left(\hat{z}_{a+1,b}, z\right)$ of voting B instead of A is increasing in the state of the world z. Intuitively, since a citizen with ideology further to the right expects z to be further to the right, it may seem that the benefit of voting B instead of A should therefore increase with θ. If so, the best response to any informative voting strategy would be *ideological*, meaning that citizens with sufficiently liberal ideology vote A while those who are sufficiently conservative vote B, as formalized in Definition 2.

Definition 2. A voting strategy $v \in \mathcal{V}$ is ideological if there is an ideology threshold $\tau \in \mathcal{X}$ such that

$$v(q, s) = v(\theta) = \begin{cases} A & \text{if } \theta < \tau \\ B & \text{if } \theta > \tau \end{cases}$$

for all $(q, s) \in [0, 1] \times \mathcal{X}$.

The logic in favor of ideological voting is compelling, but is actually incomplete: a citizen with ideology further to the right indeed expects z to be further to the right, but also expects other voters to receive signals on the right, so that B votes already outnumber A votes, generating a policy outcome that is already conservative. The question of whether to push this *further* to the right, then, is less straightforward, and best response voting cannot be characterized in general. Since beliefs about other voters stem from beliefs about the optimal policy, it might seem reasonable to conjecture that the latter will dominate behavioral decisions. Unfortunately, however, averaging across so many possible policy outcomes makes the issue intractable.

Taking advantage of the linear specification of (2), Theorem 1 makes headway by restricting attention to voting strategies that are *signal-symmetric*, meaning that citizens respond symmetrically to positive and negative signals of the same magnitude and precision, as formalized in Definition 3. Consistent with the intuition above, the best response to a signal-symmetric, informative voting strategy is indeed ideological.[15] In fact, the best-response ideological threshold is $\tau = 0$ in that case, meaning that citizens with negative signals all vote A and citizens with positive signals all vote B. Since this is the best response to any informative and signal-symmetric strategy and is itself informative and signal-symmetric, it constitutes (together with the candidate responses prescribed in Remark 1) a perfect Bayesian equilibrium, as Theorem 1 states.[16]

Definition 3. A voting strategy $v \in \mathcal{V}$ is signal-symmetric *if* $s \neq 0$ implies that $v(q, s) = A$ if and only if $v(q, -s) = B$. An equilibrium $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V} \times \mathcal{Y}^2$ is signal-symmetric if v^* is signal-symmetric.

Theorem 1 *(Mandates). $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V} \times \mathcal{Y}^2$ is an informative and signal-symmetric equilibrium if and only if (1) v^* is ideological, with ideology threshold $\tau^* = 0$, and (2) $y_j^*(a, b) = \hat{z}_{a,b}$ for any $j = A, B$ and any $a, b \in \mathbb{Z}_+$, where $\hat{z}_{a,b} = -\hat{z}_{b,a}$ and $\hat{z}_{a+1,b} < \hat{z}_{a,b} < \hat{z}_{a,b+1}$.*

The prediction of Theorem 1 exactly matches the empirical findings noted in Section 1: the larger a winning candidate's margin of victory, the more extreme her policy position; the smaller her margin, the more moderate she remains. Castanheira (2003a, 2003b), Shotts (2006), and Fowler and Smirnov (2007) offer an alternative explanation of this pattern, which is that votes reveal information about the preference composition of the electorate, which candidates utilize in positioning for future elections. The empirical references above suggest that candidates respond rather immediately to electoral mandates, however, rather than waiting till the upcoming election. In fact, reelection incentives are not always relevant. In 2006, for example, severe losses by congressional Republicans were widely interpreted as an expression of public dissatisfaction with U.S. President George W. Bush. The president was then in the middle of his second term, and therefore ineligible for reelection, but nevertheless responded immediately by announcing the resignation of his defense secretary, and promising to "find common ground" with Democrats on the Iraq war and on domestic issues.[17]

The example of the 2006 midterm elections illustrates another important point, which is that the audience of electoral mandates needs not be limited to the candidates currently running for office. As another example of this, Kousser et al. (2007) document how the 2003 recall election of California's Democratic governor produced a conservative shift in the voting patterns of incumbent state legislators. In partially autocratic societies, elections could even be useful in communicating with autocrats. By a similar token, mandates can be expressed through political activities other than voting, such as writing letters to legislators, signing petitions, and attending public rallies or protests. Recent U.S. examples of the latter include the conservative Tea Party movement of 2009, which Madestam et al. (2013) show influenced U.S. congressional voting, and the Occupy Wall Street movement of 2011.[18] In addition to these very visible political activities, mandates may well be conveyed via public opinion surveys. Page and Shapiro (1983) document how major policy changes are often preceded by shifts in public opinion, and Butler and Nickerson (2011) report a field experiment in which a public opinion survey influenced legislative voting in Mexico.

In this regard, the interpretation of the model above is quite flexible: candidates can easily be reinterpreted as incumbent office holders or other decision-makers, and citizens' votes can be reinterpreted as letters to legislators, petition signatures, attendance at public protests, or even responses to public opinion polls. The same is not true of standard election models, which focus on the discontinuous change of events that occurs when one side barely outnumbers the other. A legislator's policy position does not shift abruptly, for example, when the number of constituent letters favoring one side of an issue suddenly exceeds the number of opposing letters by one; presumably, every letter a legislator receives instead nudges her policy position slightly, in one direction or the other.

4.2. Participation and abstention

Section 4.1 assumes that all citizens participate in an election or other political activity, while in most real-world political settings, participation is far from universal. Accordingly, this section extends the set of candidates to $\mathcal{C}_\emptyset = \{A, B, \emptyset\}$, where a vote for $\emptyset$ represents abstention. Let $\mathcal{V}_\emptyset$ denote the set of redefined voting strategies $v : [0, 1] \times \mathcal{X} \to \mathcal{C}_\emptyset$. In addition to the numbers a and b of A votes and B votes, the winning candidate can now base her policy decision on the number o

[15] Symmetry aids tractability as each policy outcome can be paired with a corresponding policy outcome on the opposite end of the policy space. Linearity ensures that pushes to the left can be compared with pushes to the right. Another consequence of symmetry is useful for quantifying the net effects: technical Lemma L2 in the appendix states that adding one A vote *and* one B vote has the net effect of making the policy outcome more moderate.

[16] If the above conjecture is correct that best-response voting is ideological even in the absence of signal symmetry, it seems reasonable to conjecture further that no informative equilibrium exists other than the signal-symmetric one identified in Theorem 1. If citizens followed an ideological strategy with positive τ, for example, meaning that citizens vote A in response to a large number of signals and vote B in response to fewer signals, then a B vote would communicate more precise information about a citizen's private information than an A vote, allowing candidates to calibrate their policy responses more precisely. This would make a B vote more valuable, relative to an A vote, so that a citizen with ideology right at τ might strictly prefer to vote B in response.

[17] See Stolberg, Sheryl Gay and Rutenberg, Jim (2006, November 9). Rumsfeld Resigns; Bush Vows to 'Find Common Ground'. The New York Times, http://www.nytimes.com/2006/11/09/us/politics/09elect.html?pagewanted=all (accessed 5 Oct 2016).

[18] See also Gillion (2012).

of abstentions. As before, a candidate makes best use of this information to estimate the location of the optimal policy. As Remark 2 now states, her optimal policy choice is her expectation $\hat{z}_{a,b,o} = E(z|a,b,o)$ of the optimum.

Remark 2. For any candidate $j \in \mathcal{C}$, the unique best response to any voting strategy $v \in \mathcal{V}_\emptyset$ and opponent strategy $y_{-j} \in \mathcal{Y}_\emptyset$ is given by $y_j^*(a,b,o) = \hat{z}_{a,b,o}$ for all $a,b,o \in \mathbb{Z}_+$.

As before, the best-response strategy highlighted in Remark 2 has to interpret votes in light of the voting strategy used by citizens. Of interest again are strategies that are *informative*, as redefined for $\mathcal{V}_\emptyset$ in Definition 4, such that the average ideologies of A and B voters are to the left and right, respectively, of the average ideology of a citizen who abstains.[19]

Definition 4. A voting strategy $v \in \mathcal{V}_\emptyset$ is *informative* if $E(\theta|A) < E(\theta|\emptyset) < E(\theta|B)$. An equilibrium $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$ is informative if v^* is informative.

Like Lemma 1, Lemma 2 now states that candidates' best responses to informative voting strategies are monotonic: each additional A vote pushes the winning candidate's expectation of the optimal policy to the left, while each B vote pushes it to the right.

Lemma 2. *If $v \in \mathcal{V}_\emptyset$ is informative then $\hat{z}_{a+1,b,o} < \hat{z}_{a,b,o+1} < \hat{z}_{a,b+1,o}$ for any $a,b,o \in \mathbb{Z}_+$.*

If A votes push the policy outcome to the left and B votes push the policy outcome to the right then the benefit of voting B instead of A again increases in z. Since higher realizations of θ signal a higher realization of z, this suggests the conjecture that citizens with sufficiently liberal signals should vote A while citizens with sufficiently conservative signals should vote B, so that best-response voting is *ideological*, as redefined in Definition 5 for strategies in $\mathcal{V}_\emptyset$. As before, however, a high realization of z generates high realizations of a voter's fellow citizens' signals, implying that the winning candidate's policy choice is likely already to be high, even without a citizen's vote. Once again, this prevents a general characterization of best-response voting. As before, however, tractability can be regained by focusing on strategies that are *signal-symmetric*, as redefined for $\mathcal{V}_\emptyset$ in Definition 6.

Definition 5. A voting strategy $v \in \mathcal{V}_\emptyset$ is ideological if there are ideology thresholds $\tau_1 \le \tau_2$ such that

$$v(q,s) = v(\theta) = \begin{cases} A & \text{if } \theta < \tau_1 \\ 0 & \text{if } \tau_1 < \theta < \tau_2 \\ B & \text{if } \theta > \tau_2 \end{cases}$$

for all $(q,s) \in [0,1] \times \mathcal{X}$.

Definition 6. A voting strategy $v \in \mathcal{V}_\emptyset$ is signal-symmetric *if* $s \neq 0$ implies that $v(q,s) = A$ if and only if $v(q,-s) = B$. An equilibrium $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$ is signal symmetric if v^* is signal symmetric.

Like Theorem 1, Theorem 2 states that equilibrium voting is informative and signal-symmetric if and only if it is ideological. According to Definition 5, this means that citizens more liberal than τ_1 vote A and those more conservative than τ_2 vote B. This leaves open the possibility that citizens between τ_1 and τ_2 abstain from voting, but also leaves open the possibility that τ_1 and τ_2 coincide, so that everyone votes. Intuitively, it may not be obvious whether citizens in this setting should abstain or not. On one hand, the logic of Feddersen and Pesendorfer (1996) seems compelling, that citizens who lack information should abstain in deference to those who know more. On the other hand, the swing voter's curse results from restricting attention to pivotal votes, and the reason for doing this in a standard model is because these are the only events in which a citizen's action influences the policy outcome; in this model with informative voting, Lemma 2 states that *every* vote is pivotal in the sense that every vote changes the position of the final policy outcome, one way or the other.

As Theorem 2 states, it turns out that the ideology thresholds are distinct in equilibrium, meaning that some citizens do abstain from voting. In a signal-symmetric equilibrium, of course, these thresholds are symmetric around the origin, with the result that candidates' policy responses to symmetric electoral outcomes are symmetric, as well. A signal-symmetric ideological strategy with abstention is illustrated in Fig. 1, reproduced from McMurray (2016a).

[19] As noted in Footnote 14, voting would be just as informative if one or both of the inequalities in Definition 4 were reversed. If $E(\theta|A) < E(\theta|B) < E(\theta|\emptyset)$, for example, then an A victory would suggest that z is on the left, a B victory would suggest that z is moderate, and low turnout would indicate that z is on the right. Not only would the subsequent analysis be more cumbersome in that case, however, it would be less robust to campaign commitments that are at least partially binding: with binding platforms, McMurray (2016a) shows that if one citizen prefers to vote A then all who are more liberal do as well.

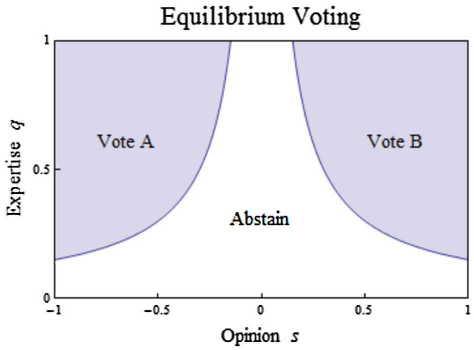

Fig. 1. Voting behavior, by opinion and expertise, for a signal-symmetric ideological strategy, reproduced from McMurray (2016a).

Theorem 2 *(Signaling voter's curse).* $\left(v^*, y_A^*, y_B^*\right) \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$ *is an informative and signal-symmetric equilibrium only if (1)* v^* *is ideological, with ideology thresholds* $\tau_1^* = -\tau_2^*$ *satisfying* $-1 < \tau_1^* < 0 < \tau_2^* < 1$*, and (2)* $y_j^*(a, b, o) = \hat{z}_{a,b,o}$ *for any* $j = A, B$ *and any* $a, b, o \in \mathbb{Z}_+$*, where* $\hat{z}_{a,b,o} = -\hat{z}_{b,a,o}$ *and* $\hat{z}_{a+1,b,o} < \hat{z}_{a,b,o+1} < \hat{z}_{a,b+1,o}$*. Furthermore, such an equilibrium exists.*

One intuition for Theorem 2 is that, by voting for A or for B, each citizen has the opportunity to push the policy outcome to the left or the right, respectively. By abstaining, however, a citizen allows his peers to steer the winning candidate toward the approximate location of the optimal policy. If he himself is unsure where the optimum lies, he prefers this: by voting, he would only push the winning candidate away from the optimum, thereby inviting a *signaling voter's curse*. This intuition is actually incomplete because the distribution of signals is continuous, so the probability of a completely neutral private opinion is zero. If a citizen's signal is sufficiently noisy, however, a similar disincentive applies.

A second intuition for Theorem 2 is that, ideally, the winning candidate would calibrate her reaction to each vote according to the expertise of the voter. Since votes are cast anonymously, she instead responds as if each vote were of average quality. This is the appropriate response, on average, but under-reacts to expert votes and over-reacts to non-expert votes. A citizen who is moderately well-informed prefers this over-reaction to the under-reaction that will occur if he abstains, but a citizen who knows that his expertise is very low does not.

As the number of votes grows large, the impact of a single additional vote diminishes. This means that individual voter errors inflict less damage, which intuitively might seem to ameliorate the signaling voter's curse, suggesting that abstention might not occur in large elections. On the other hand, however, the benefit of a single vote diminishes at the same rate, and what really matters is the comparison of the two. A formal analysis of large elections is beyond the scope of this paper, but the intuition above actually favors the conjecture that abstention should be quite robust: no matter how large an electorate grows, the winning candidate will calibrate her policy response to the citizen with average expertise, thereby over-reacting to a substantial fraction of the electorate. If anything, abstention likely *increases* with the size of the electorate, because a citizen is increasingly satisfied with the decision of his peers. The fractions of the electorate who vote and abstain are both likely to remain substantial, however, because this would produce the most informative communication, and is therefore socially optimal; in a common-value setting such as this, socially optimal behavior also maximizes individual utility, as noted by McLennan (1998) and discussed further below, and so can always be sustained in equilibrium.

The result that citizens with low levels of expertise abstain strategically, even though voting is costless, is reminiscent of the pivotal voting model of Feddersen and Pesendorfer (1996). As those authors point out, strategic abstention provides a plausible explanation for citizens who "roll off" by casting incomplete ballots even after voting costs are sunk, and for the empirical tendency for citizens who lack information to remain ideologically moderate and to abstain from voting. There, however, uninformed voters abstain to avoid the *swing voter's curse* of erroneously putting an undesirable candidate into office, whereas here they instead abstain to avoid nudging the policy outcome in the wrong direction. The rationale differs, but either type of curse could generate the behavior that is observed empirically. Herrera et al. (2016) demonstrate an analogous "marginal voter's curse" in environments where policy outcomes depend mechanically on vote shares. Together, these results suggest that strategic abstention is not an artifact specific to a particular voting calculus, but is a robust consequence of asymmetric information.

In a pivotal voting model, McMurray (2016a) points out that citizens with low levels of expertise are not the only ones who experience a swing voter's curse: a citizen whose expertise is high but whose private signal indicates that the optimal policy is moderate suffers a swing voter's curse as well. While he is confident regarding the approximate location of the optimal policy, he recognizes in that model that a slight change in the value of his signal would lead him to opposite voting behavior (in contrast with a citizen of comparable expertise, and a more extreme signal realization). In other words, the question that is relevant for his behavior is not the location of the optimal policy, but the question of which is worse between an extremely liberal policy and an extremely conservative policy; about this question, such a citizen still lacks information.

As Fig. 1 makes clear, ideological moderates face a signaling voter's curse, just as they face a swing voter's curse in a pivotal voting model. Again, however, the rationale differs. In particular, abstention in this case in this model need not

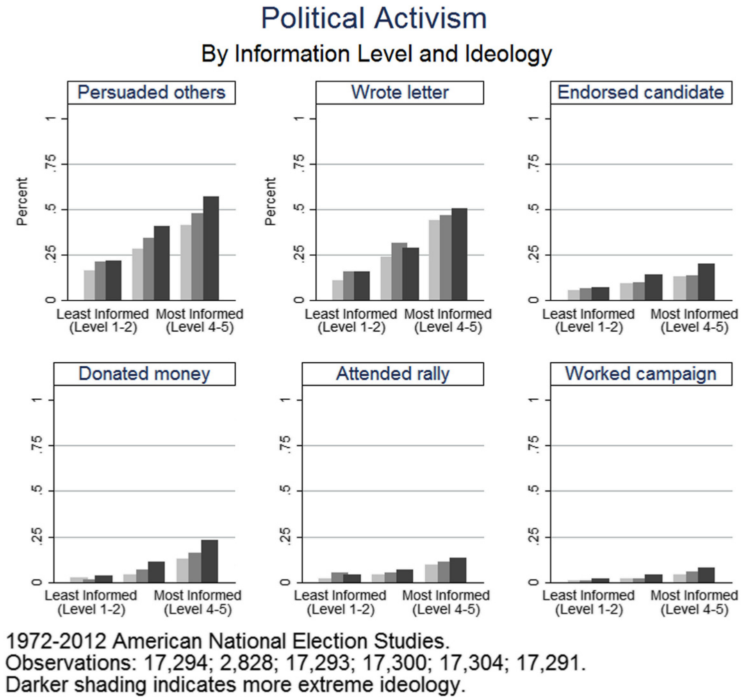

Fig. 2. Like voter participation, political activism increases both with information and with ideological distance from the center.

reflect uncertainty of any sort. Rather, a citizen who believes that z is slightly left of center unambiguously prefers voting A to voting B, but also expects candidate A to win, and recognizes that adding one vote to candidate A's margin of victory will strengthen the mandate that she perceives, thus pushing her to be overly liberal. Similarly, a citizen who believes that z is slightly right of center prefers voting B to voting A, but abstains to avoid encouraging B toward extreme conservatism. In essence, an ideological moderate wishes to *shrink* the mandate perceived by whichever candidate wins, and the best way to do this is to avoid showing enthusiasm for either side.[20]

At least since Davis et al. (1970), observers of elections have noted an empirical tendency for citizens to abstain out of "alienation" when neither candidate is attractive. In line with this, De Benedetto and De Paola (forthcoming) find that low-quality candidates attract low aggregate levels of turnout. From the perspective of private value models, however, this behavior seems misguided: no matter how bad a voter's preferred candidate is, her opponent is worse, so it should be beneficial to vote.[21] The explanation that citizens abstain to avoid strengthening either candidate's popular mandate is particularly plausible in that it closely resembles a sentiment commonly expressed by citizens who abstain out of protest against candidates that they view as being overly extreme on either side.

The result that two types of citizens abstain in equilibrium implies that communication is somewhat muffled: a citizen can abstain to communicate her confident opinion that the optimal policy is moderate, but her behavior may be mistaken for ignorance or apathy. This observation offers a plausible explanation for why citizens often take care to demonstrate that their abstention is deliberate. Rather than merely abstaining, for example, many citizens turn out to vote but then cast blank or spoiled ballots (sometimes called "protest votes"). In fact, some ballots explicitly list a "none of the above" option, and Ujhelyi et al. (2016) report an Indian election where many citizens turned out to vote *only* so that they could choose this option (which has no mechanical impact on the electoral outcome). A similar motivation might explain why citizens sometimes vote against a preferred candidate who is likely to win, as documented by Franklin et al. (1994), or vote for opposite parties to fill various offices within the government (i.e. "split ticket" voting), as documented by Zupan (1991).

As Section 4.1 discusses, one strength of a mandates model is that it can be reinterpreted outside the narrow context of elections. This is useful because, empirically, participation in a variety of political activities follows the same pattern as voting and abstention. This can be seen in Fig. 2, which displays participation levels for various forms of political activism, among citizens grouped by information level and ideology. According to the probit regression estimates in Table 1, each

[20] With the linear densities assumed in Section 3, it is actually never the case, per se, that a citizen believes the optimal policy to be moderate; when s_i is moderate, a citizen's posterior merely reduces to the uniform prior. The intuition expressed here is nevertheless correct, as illustrated in Section 6, which complements the above analysis with a more general specification of private signals.

[21] Considerations such as these are frequently cited in the context of the present U.S. presidential election, where favorability ratings for both major candidates are extremely low. See Enten (2016, May 5). Americans' Distaste for both Trump and Clinton is Record-breaking. *Five-Thirty-Eight.com*, http://fivethirtyeight.com/features/americans-distaste-for-both-trump-and-clinton-is-record-breaking/ (accessed 5 Oct 2016).

Table 1
Probit regressions of political activism on information and ideological polarization.

Information, ideology, and political activism	Dependent variable					
	Persuaded others	Wrote letter	Endorsed candidate	Donatec money	Attended rally	Worked campaign
	Means					
	0.382	0.344	0.124	0.112	0.078	0.041
	(0.004)	(0.009)	(0.003)	(0.003)	(0.002)	(0.002)
	Marginal effects					
Information	0.108	0.131	0.035	0.064	0.039	0.021
	(0.004)	(0.008)	(0.003)	(0.003)	(0.003)	(0.002)
Polarization	0.043	0.020	0.020	0.022	0.010	0.007
	(0.003)	(0.007)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	17,294	2,828	17,304	17,291	17,300	17,293
Pseudo R square	0.058	0.065	0.027	0.081	0.048	0.043

1972–2012 ANES. Probit marginal effects are evaluated at average values of explanatory variables. Standard errors are in parentheses.

information level makes the average citizen 11% more likely to report having tried to persuade others to vote for or against a particular candidate, 13% more likely to have ever written a letter to a public official, 4% more likely to have endorsed a candidate by displaying a bumper sticker, yard sign, or campaign button, 6% more likely to have donated money to a candidate or party, 4% more likely to have attended a political campaign rally, and 2% more likely to have worked for a political campaign. Moving one ideological category further from the center increases the average citizen's participation in these activities by 4%, 2%, 2%, 2%, 1%, and 1%, respectively.[22] Given the low baseline rates for these activities, these effects are substantial.

4.3. Multiple candidates

So far, the analysis of this paper has included only two candidates. As Section 1 points out, however, many elections feature multiple candidates. Accordingly, this section considers elections with more than two candidates. To preserve the symmetry that keeps the analysis tractable, consider a set $\mathcal{C}' = \{A, B, C, D\}$ of four candidates, and expand the set $\mathcal{C}'_\emptyset = \mathcal{C}' \cap \emptyset$ of voting actions to include these plus an action $\emptyset$ that again denotes abstention from voting.[23] Let $\mathcal{V}'_\emptyset$ denote the set of voting strategies $v : [0,1] \times \mathcal{X} \to \mathcal{C}'_\emptyset$, and let elections now be decided by plurality rule. Let $\mathcal{Y}'_\emptyset$ denote the set of candidate strategies $y_j : \mathbb{Z}^5_+ \to \mathcal{X}$, which may depend on the numbers $a, b, c, d \in \mathbb{Z}_+$ of votes for each candidate as well as on the number $o \in \mathbb{Z}_+$ of abstentions.

Analogous to (5), the probability of a votes for A, b votes for B, c votes for C, and d votes for D, and o abstentions can be written as follows.

$$\psi\,(a,b,c,d|z) = \prod_{j=a,b,c,d} \frac{e^{-n\phi(j|z)}}{j!}\,[n\phi\,(j|z)]^j \tag{10}$$

Based on vote totals $a, b, c, d \in \mathbb{Z}_+$, the winning candidate's expectation $\hat{z}_{a,b,c,d,o} = E\,(z|a,b,c,d,o)$ of the optimal policy is then given by the following.

$$\hat{z}_{a,b,c,d,o} = \frac{\int_{\mathcal{Z}} z\psi\,(a,b,c,d,o|z)\,f\,(z)\,dz}{\int_{\mathcal{Z}} \psi\,(a,b,c,d,o|z)\,f\,(z)\,dz}$$

Reiterating the observation of Remarks 1 and 2, Remark 3 now states that $\hat{z}_{a,b,c,d,o}$ is a candidate's optimal response to the vector of vote totals.

Remark 3. For any candidate $j \in \mathcal{C}$, the unique best response to any voting strategy $v \in \mathcal{V}'_\emptyset$ and opponent strategy $y_{-j} \in \mathcal{Y}'_\emptyset$ is given by $y^*_j\,(a,b,c,d,o) = \hat{z}_{a,b,c,d,o}$ for all $a, b, c, d, o \in \mathbb{Z}_+$.

As above, the analysis below focuses on strategies that are *informative*, redefined in Definitions 7 for multiple candidates. When voting is informative, Lemma 3 states that A and B votes shift the winning candidate's expectation $\hat{z}_{a,b,c,d}$ to the left,

[22] Similar findings are reported by Keith et al. (1992, Ch. 3), Francia et al. (2005), Abramowitz and Saunders (2008), and Bafumi and Herron (2010). Coupé and Noury (2004) find that knowledgeable individuals also participate more frequently in opinion polls. Lafky (2014) finds a similar pattern for consumer reviews in online retail.

[23] Other than the problem of intractability, there is no intuitive reason why the logic of the analysis below should not extend to other numbers of candidates.

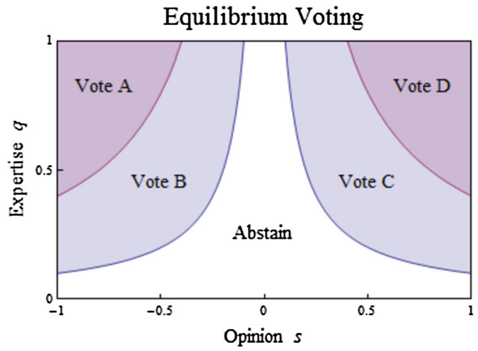

Fig. 3. Voting behavior, by opinion and expertise, for a signal-symmetric ideological strategy with multiple candidates.

while C and D votes shift her beliefs to the right. A votes and D votes have a larger impact on expectations than B votes and C votes.[24] The proof of Lemma 3 is virtually identical to that of Lemmas 1 and 2.

Definition 7. A voting strategy $v \in \mathcal{V}'_0$ is informative if $E(\theta|A) < E(\theta|B) < E(\theta|\emptyset) < E(\theta|C) < E(\theta|D)$. An equilibrium $(v^*, y^*_A, y^*_B, y^*_C, y^*_D) \in \mathcal{V}'_\emptyset \times \mathcal{Y}'^4_\emptyset$ is informative if v^* is informative.

Lemma 3. *If $v \in \mathcal{V}'_\emptyset$ is informative then $\hat{z}_{a+1,b,c,d,o} < \hat{z}_{a,b+1,c,d,o} < \hat{z}_{a,b,c,d,o+1} < \hat{z}_{a,b,c+1,d,o} < \hat{z}_{a,b,c,d+1,o}$ for any $a, b, c, d, o \in \mathbb{Z}_+$.*

Anticipating that candidates will respond to votes as in Lemma 3, it is once again reasonable to conjecture that voting should be *ideological*, as redefined in Definition 8. Restricting attention again to strategies that are signal-symmetric, as redefined in Definition 9, to make the problem tractable, Theorem 3 states that this is indeed the case.

Definition 8. A voting strategy $v \in \mathcal{V}'_\emptyset$ is ideological if there are ideology thresholds $-1 \le \tau_1 \le \tau_2 \le \tau_3 \le \tau_4 \le 1$ such that

$$v(q,s) = v(\theta) = \begin{cases} A & \text{if } -1 < \theta < \tau_1 \\ B & \text{if } \tau_1 < \theta < \tau_2 \\ 0 & \text{if } \tau_2 < \theta < \tau_3 \\ C & \text{if } \tau_3 < \theta < \tau_4 \\ D & \text{if } \tau_4 < \theta < 1 \end{cases}$$

for all $(q, s) \in [0, 1] \times \mathcal{X}$.

Definition 9. A voting strategy $v \in \mathcal{V}'_\emptyset$ is signal-symmetric *if* $s \neq 0$ implies that $v(q,s) = A$ if and only if $v(q,-s) = D$ and $v(q,s) = B$ if and only if $v(q,-s) = C$. An equilibrium $(v^*, y^*_A, y^*_B, y^*_C, y^*_D) \in \mathcal{V}'_\emptyset \times \mathcal{Y}'^4_\emptyset$ is signal-symmetric if v^* is signal-symmetric.

In redefining ideological voting for this setting, Definition 8 uses four ideology thresholds instead of two. This leaves open the possibility that two or more thresholds coincide, which would mean that some candidate receives no votes. In pivotal voting models, this is indeed to be expected, as citizens strategically restrict attention to viable candidates, consistent with Duverger's law, and ignore candidates for whom a vote is least likely to be pivotal. Here, however, Theorem 3 states that equilibrium ideological thresholds are distinct, implying that each candidate receives support from a positive fraction of the electorate. As in Theorem 2, a positive fraction of the electorate also abstain. A signal-symmetric ideological strategy with distinct ideology thresholds is illustrated in Fig. 3.

Theorem 3 *(Multiple candidates). $(v^*, y^*_A, y^*_B, y^*_C, y^*_D) \in \mathcal{V}'_\emptyset \times \mathcal{Y}'^4_\emptyset$ is an informative and signal-symmetric equilibrium only if (1) v^* is ideological, with ideology thresholds $\tau^*_1 = -\tau^*_4$ and $\tau^*_2 = -\tau^*_3$ satisfying $-1 < \tau^*_1 < \tau^*_2 < 0 < \tau^*_3 < \tau^*_4 < 1$, and (2) $y^*_j(a,b,c,d,o) = \hat{z}_{a,b,c,d,o}$ for any $j \in \mathcal{C}'$ and any $a, b, c, d, o \in \mathbb{Z}_+$, where $\hat{z}_{a+1,b,c,d,o} < \hat{z}_{a,b+1,c,d,o} < \hat{z}_{a,b,c,d,o+1} < \hat{z}_{a,b,c+1,d,o} < \hat{z}_{a,b,c,d+1,o}$. Furthermore, such an equilibrium exists.*

The reason that citizens do not limit attention to the two front-running candidates is that votes for losing candidates in this model are not wasted: each influences the beliefs of the winning candidate, either strengthening or weakening her

[24] The caveat of Footnote 19 applies here, which is that Definition 7 ignores other orderings of $E(\theta|j)$, which would be informative in a similar sense, and such strategies could be sustained in equilibrium. As before, however, strategies in which moderate citizens abstain would be the most robust to candidate commitment.

mandate. If candidate B wins, for example, then she will likely take a policy position left of center. By voting for B, a citizen pushes this candidate to be slightly more liberal; by voting for A, he pushes her to be more liberal still. On the flip side, voting for C causes candidate B to be more moderate after she wins, while voting for D makes her more moderate still. Thus, for example, a liberal citizen in the U.S. can achieve a more liberal policy outcome by voting for the Green party instead of the Democratic candidate: a Democrat or Republican is much more likely to win than a Green candidate, but an additional vote for the Green party will make the Democrat more liberal, or the Republican more moderate, than an additional vote for the Democrat will.

It might seem strange that anyone should vote B or C, when voting A or D would have greater impact. In the real world, of course, one reason for this may be Duvergerian logic: this model has assumed for simplicity that candidates are identical and perfectly responsive to mandates, but if candidates were heterogeneous or responded imperfectly to mandates, the identity of the winning candidate would matter, and a vote for B or C would be more likely to be pivotal than a vote for A or D. According to Theorem 3, however, a positive fraction of the electorate votes for B or C even in the present model, where pivotal considerations do not apply. The reason for this is analogous to the signaling voter's curse: a citizen with moderate political views or limited political information actually worries about nudging the policy outcome too far; voting for B or C instead of A or D enables a citizen to adjust the winning candidate's mandate slightly, without overdoing it. Put differently, voting for B or C can be viewed as a middle ground between voting A or D and abstaining.

Since candidates in this model are identical, voters need not care about the identity of the election winner. With candidate heterogeneity or imperfect responsiveness, however, signaling and pivotal considerations would both be present. In that case, signaling considerations could explain cross-party endorsements: often times, minor parties simply endorse major party candidates, rather than sponsoring candidates of their own. In light of the analysis above, this can be viewed as an effort to convey different messages, without upsetting the victory of a major party candidate. In the 2010 New York state governor's race, for example, residents could vote for Andrew Cuomo via the Democratic, Working Families, or Independence party lines, and for Carl Paladino on the Republican, Conservative, or Taxpayers party lines; ultimately, each candidate received more than 10% of his votes from minor party lines, even though they were lower on the ballot (New York State Board of Elections, 2010). Major and minor party lines have the same formal impact on the election outcome, but the latter allow citizens to express extreme political views without the risk of upsetting the election for their preferred major party.[25]

Private-value literature offers alternative explanations for supporting minor parties, but each is somewhat problematic empirically. For example, the entry model of Osborne and Slivinski (1996) exhibits equilibria with multiple candidates, but this requires that minor parties attract vote shares as large as major parties', which is counterfactual. That analysis also assumes sincere voting, so that Duvergerian considerations do not apply; with strategic voting and symmetric voter preferences, Besley and Coate (1997) find that equilibria with more than two candidates do not exist. If voter preferences are asymmetric, losing candidates in the latter model can enter elections in a "spoiler" capacity, but only an ideological moderate can fill this role, whereas minor parties in real world elections are typically viewed as being more extreme than mainstream parties. In sequential election settings, Castanheira (2003b) points out that voting for extreme parties in one election can influence candidates' platform locations in a subsequent election. However, this requires a substantial probability that the median voter is ideologically extreme, which in most applications seems implausible. An information model is also consistent with evidence from Palfrey and Poole (1987) that citizens who support the most extreme candidates tend to have more extreme political views, and also to be more knowledgeable, on average, about politics. Private-value literature offers no explanation for this observation.

4.4. Large elections and comparative statics: numerical examples

In models of voter participation, a natural question is what happens when the electorate grows large. In a model with both private- and common-value components, for example, Feddersen and Pesendorfer (1999) show that the private-value component comes to dominate behavior as n grows large, so that the swing voter's curse fades, and in the limit all citizens participate. In the purely common-value setting of McMurray (2013), the swing voter's curse instead grows stronger with n—because a citizen grows increasingly willing to rely on his peers—but a substantial fraction of the electorate continue to vote no matter how large n grows. The latter paper also derives comparative static results on how the swing voter's curse responds to changes in the underlying distribution of voter information. Specifically, improving voter information can raise or lower turnout, because it lifts non-voters above the participation threshold but also strengthens the swing voter's curse, so that the threshold rises. Turnout is also lower in more heterogeneous electorates, where the gap between the most- and least-informed is largest. The marginal voting model of Herrera et al. (2016) exhibits the same patterns.

The complexity of the model above prevents a general analysis of comparative statics and of turnout in large elections, but Table 2 sheds some light on these issues by displaying equilibrium thresholds and turnout levels for various distributions G of expertise, and for election sizes as large as are computationally feasible. To construct these examples, fix a number n of citizens and a distribution G of expertise, and posit an ideology threshold $\tau_2 \in [0, 1]$ that, together with the symmetric threshold $\tau_1 = -\tau_2$, characterizes a signal-symmetric ideological strategy. Given these, expected vote shares $\phi(j|z;\tau_2)$ for

[25] Similarly, in parliamentary systems, votes for various parties within a coalition might have the same formal impact on the coalition's fortunes, but send different messages.

Table 2
Equilibrium voter participation for elections of various size, with binary or continuous uncertainty, and various distributions of expertise.

Equilibrium voter participation					
		Binary truth		Continuous truth	
Expertise	n	Threshold	Turnout	Threshold	Turnout
Uniform	1	0.333	67%	0.229	43%
	2	0.378	62%	0.229	43%
	3	0.387	61%	0.230	43%
	5	0.397	60%	0.231	43%
	10	0.405	60%	–	–
	20	0.409	59%	–	–
Skewed	1	0.250	56%	0.173	36%
	3	0.265	54%	0.173	36%
	5	0.270	53%	–	–
	10	0.274	53%	–	–
	20	0.277	52%	–	–
Highly Skewed	1	0.005	56%	0.003	36%
	3	0.005	56%	0.003	36%
	5	0.005	56%	–	–
Low Variance	1	0.250	100%	0.171	65%
	3	0.250	100%	0.172	65%
	5	0.250	100%	–	–

each candidate can be derived analytically for every $j \in \mathcal{C}_{\emptyset}$ as a function of $z \in \mathcal{Z}$ and these provide the parameters for the multinomial probabilities $\psi(a, b, o|z; \tau_2)$ associated with every electoral outcome. Integrating numerically yields approximations of the winning candidate's policy response $\hat{z}_{a,b,o}(\tau_2)$ for every voting outcome (a, b, o) with $a + b + o = n + 1$. Given these policy outcomes, (1) and (7) then together give the expected benefit $\Delta_B(\tau_2)$ of voting B for a citizen with ideology $\theta = \tau_2$ right at the threshold, and numerically solving $\Delta_B(\tau_2) = 0$ yields an equilibrium threshold τ_2^*.[26] Numerically integrating $\phi\left(\emptyset|z; \tau_2^*\right)$ over z then gives the fraction of the electorate who abstain, and the complementary fraction specifies voter turnout.

The complexity of the model above severely limits the number of voters for which equilibria can be computed. Somewhat larger elections can be accommodated for the case that McMurray (2016a) calls *binary truth*, meaning that the optimal policy $z \in \{-1, 1\}$ is restricted to lie at one of the extremes of the policy space, and that private signals $s_i \in \{-1, 1\}$ are binary as well (but the policy space is still $\mathcal{X} = [-1, 1]$). Conveniently, (2) and (3) double as mass functions to accommodate that case. For simplicity, the first set of examples in Table 2 assumes a uniform distribution of expertise. The next set assumes a density $g(q) = 2 - 2q$ that is skewed, such that non-experts outnumber experts. The third set assumes a density $g(q) = 100 - 5000q$ (with domain restricted to $q \in [0, .02]$) that is more skewed still, reflecting the possibility that non-experts far outnumber experts, and that even the most expert citizens actually have quite limited information, so that elections are close in expectation (approximately a 1% margin). The final set assumes a uniform distribution again, but with smaller variance (domain $\left[\frac{1}{4}, \frac{3}{4}\right]$ instead of $[0, 1]$), representing a more homogeneous electorate.

The results displayed in Table 2 suggest that turnout in the signaling model above follows patterns identical to those of the pivotal and marginal voting models of McMurray (2013) and Herrera et al. (2016). Specifically, improving voter information has an ambiguous impact on voter participation, but turnout is lower when the electorate is more homogeneous. For all of the distributions and electoral sizes considered, turnout decreases with n, but it seems that a substantial fraction of the electorate continues voting even as n grows large. In fact, for binary uncertainty, the turnout levels in Table 2 are identical to the analytical limits derived in McMurray (2013): 59%, 52%, and 56%, respectively, for uniform, skewed, and highly skewed G. This is remarkable on one hand, since the structure of the pivotal voting model and the signaling model are so different, but is also consistent with the fact that citizens in the two models have the same private information and the same goal.

Table 3 displays numerical examples with four candidates instead of two. Consistent with the prediction of Theorem 3, a positive fraction of the electorate votes for each candidate. In fact, with binary uncertainty, a uniform distribution of expertise, and an electorate consisting of only a single voter, the equilibrium strategy optimizes communication by partitioning the signal space evenly, so that the voter is 20% likely to vote for each candidate and 20% likely to abstain. As the number of voters increases to two, however, both thresholds rise, so that in expectation a larger fraction of the electorate abstains, and moderate candidates receive larger vote shares than extremists.[27] A skewed distribution of expertise can favor moder-

[26] The analysis above does not guarantee a unique equilibrium threshold, but numerical solutions seem not to depend on the initial guess, suggesting that uniqueness does hold for the distributions considered here.

[27] Unfortunately, computational limitations with two simultaneous thresholds prevent the treatment of elections larger than $n = 2$.

Table 3
Equilibrium support for multiple candidates in elections of various size, with binary or continuous uncertainty, and various distributions of expertise.

Equilibrium support for multiple candidates					
Expertise	n	Threshold 1	B, C shares	Threshold 2	AD share
Binary truth					
Uniform	1	0.200	20%	0.600	20%
	2	0.214	21%	0.632	18%
Skewed	1	0.150	22%	0.474	14%
	2	0.158	23%	0.495	13%
Highly skewed	1	0.003	22%	0.010	14%
	2	0.003	22%	0.010	14%
Expertise	n	Threshold 1	BC share	Threshold 2	AD share
Continuous truth					
Uniform	1	0.131	20%	0.437	10%
Skewed	1	0.103	22%	0.351	7%
Highly skewed	1	0.002	19%	0.007	7%

ate candidates, by making extreme opinions less prevalent, but also weakens the signaling voter's curse, so that ideology thresholds are lower. Thus, as with turnout, the general comparative static is ambiguous.

5. Welfare

The analysis above has focused on characterizing equilibrium behavior. This section turns now to the consequences of this equilibrium behavior for social welfare. Since candidates and voters share a common interest, it is uncontroversial to measure social welfare simply as the expected utility $E\left[u\left(x_n^*, z\right)\right]$ of the policy outcome x_n^* that occurs in equilibrium when the expected number of citizens is n. In models with binary outcomes, Condorcet's (1785) jury theorem states that majority opinion in large elections almost surely favors the policy or candidate that in truth is superior—a result that Krishna and Morgan (2011) call the "first welfare theorem of political economy". With electoral mandates, however, a much stronger result can be obtained, which is stated now as Theorem 4. Namely, electoral mandates allow citizens to steer candidates not only to the superior of two policies, but to the precise optimum from within an entire continuum of alternatives. The logic for this is straightforward: vote shares in large elections converge to their expectations, which are monotonic in the state variable, and therefore invertible. Thus, when the electorate is large, the true state of the world can be perfectly inferred from the magnitude of the margin of victory.[28] This result holds whether abstention is allowed or not, and whether there are two candidates or four.

Theorem 4. *If, for any n, the strategy vector* $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V} \times \mathcal{Y}^2$ *maximizes* $E\left[u\left(x_n^*, z\right)\right]$ *then it also constitutes an equilibrium. Moreover,* $\left|x_n^* - z\right| \rightarrow_p 0$*. This results also hold if* $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$ *or* $\left(v^*, y_A^*, y_B^*, y_C^*, y_D^*\right)_n \in \mathcal{V}'_\emptyset \times \mathcal{Y}'^4_\emptyset$.

Theorem 4 states that whatever combination of voter and candidate behavior is socially optimal can prevail in equilibrium. This follows from the logic of McLennan (1998): with common values, whatever is socially optimal is also individually optimal, so no one has an incentive to deviate. For candidates, of course, one feasible strategy is to implement the same policy regardless of vote totals, which is precisely what they would do if platform commitments were binding, as in standard pivotal voting models. Clearly, then, it is socially desirable in this setting to allow candidates ex post flexibility in choosing policy. This differs from the conventional view, which could arise in a more standard private-value setting (e.g. Alesina, 1988), that enforcing platform commitments improves social welfare, by ensuring that candidates put voters' interests ahead of their own.

Theorem 4 states that electorates reach good decisions asymptotically, whether or not abstention is allowed (i.e., whether $v \in \mathcal{V}$ or $v \in \mathcal{V}_\emptyset$). In finite electorates, however, Theorem 2 predicts that some citizens abstain from voting in equilibrium, implying that some information is lost. Intuitively, then, this might seem to vindicate the popular view that higher voter turnout is better, and justify efforts to increase voter participation, for example by making voting compulsory. To the contrary, however, Theorem 4 actually implies that equilibrium abstention is good for voter welfare, not bad: a strategy with no abstention is feasible in $\mathcal{V}_\emptyset$, but the optimal strategy in $\mathcal{V}_\emptyset$ constitutes an equilibrium, and therefore includes abstention.

When there are multiple candidates, Theorem 3 predicts that all will receive positive vote shares in equilibrium. From the conventional perspective of private-value pivotal voting models, this can be detrimental, as minor candidates can become spoilers, splitting majority support so that a Condorcet winner loses the election. Related to this, pundits often blame mainstream candidates' extremism on the need to prevent voters with extreme ideologies from abandoning them for more

[28] McMurray (2016a) discusses the possibility of *aggregate uncertainty*, in which case z is not optimal in a global sense, but represents the policy that, in expectation, makes best use of citizens' collective information.

extreme minor parties. In this model, Theorem 3 corroborates the prediction that votes for minor parties can lead major parties to adopt more extreme policy positions, but the implication of Theorem 4 is that this is good for voters' welfare, not bad: if it were optimal to do so, voters could ignore candidates A and D in equilibrium, but according to Theorem 3, it does not.[29]

One way to understand how abstaining and withholding private signals could improve the eventual policy outcome is to note that the *decision* of whether to vote or abstain conveys private information beyond the content of the vote itself; if voting were made mandatory, this additional information would be lost. Ideally, every citizen's opinion would be reported and utilized, but would be weighted according to the precision of its underlying signal. By design, however, democratic institutions instead weight each vote (that is cast) equally. Thus, when voting is mandatory, the sign of $q_i s_i$ is recorded for each citizen, but its magnitude is not utilized. Abstention is beneficial in that it provides some (albeit coarse) information regarding magnitude (namely that $|q_i s_i|$ is larger or smaller than τ_2^*), thus providing a crude mechanism by which citizens with weak opinions can shift weight from their own votes to the votes of those peers who—as evidenced by their equilibrium participation—either have more accurate information or have detected larger quality differences between the two policy extremes.

An alternative intuition for how abstention can enhance social welfare comes from viewing voters and candidates in this model as senders and receivers in a communication game with no conflict of interest. In that light, voters have every incentive to report their private information as accurately as possible, but are handicapped by the discreteness of the message space: there are a continuum of possible signal realizations but, with only two candidates, only two messages that can be sent. Allowing abstention expands the message space from two to three.[30] This logic also explains why it is beneficial to have additional candidates: more candidates allow citizens to partition the space of signals more finely, thereby making communication more informative.[31]

McMurray (2016b) emphasizes how similar behavior in private- and common-value election models can have starkly different implications for welfare. The insights of this section extend that theme: whereas pundits frequently worry about low voter participation, candidates' failure to keep campaign promises, and the polarizing influence of minor parties, Theorem 4 shows that voter abstention, policy flexibility, and minor party influence may actually benefit citizens, by better utilizing available information.

6. Nonlinearity and asymmetry

The model of Section 3 describes s_i as a citizen's "hunch" regarding the location of the optimal policy. In one sense, this label is appropriate: s_i is correlated with z and lies in the same policy space, and a voter would favor s_i over any other policy were it not for the noise inherent in his signal. On the other hand, the notion of a hunch suggests a maximum-likelihood estimate of z. To maintain tractability, Section 3 models z and s_i as draws from linear density functions; with this specification, the most likely value of z is either -1 or 1. When $s_i = 0$ exactly, the posterior reduces to the prior, so any realization of z is equally likely. This matters for the interpretation of Theorem 2: Section 4.2 argues that citizens with high levels of expertise but moderate signals might wish to distinguish themselves from citizens who simply lack information, by deliberately casting blank or spoiled ballots rather than merely abstaining. As specified above, however, there is no group who actually believe z is likely to be moderate; ideological "moderates" are merely those who have no evidence that z is extreme.

This section complements the analysis above with a more general specification of private information that includes the linear model above as a special case. Let the policy space $\mathcal{X}$ be some symmetric subset of the real line, meaning that $x \in \mathcal{X}$ implies that $-x \in \mathcal{X}$, and let $z \in \mathcal{X}$ denote the optimal policy, as before, with a symmetric but otherwise general prior distribution $f(z) = f(-z)$. Maintaining the assumption that the number N of voters follows a Poisson distribution, let s denote the $N \times 1$ vector of private signals, and assume that, for any realization of N, the joint distribution of z and s is symmetric as well, meaning that $f(z, s) = f(-z, -s)$. Assume further that, for any realization of N, private signals are *affiliated* with z (and with each other), in the sense of Milgrom and Weber (1982): $f\left(z', s'\right) f(z, s) \geq f\left(z, s'\right) f\left(z', s\right)$ for any $z' \geq z$ and any $s' \geqq s$ (where the latter denotes a vector inequality).

With this generalized model of private signals, it is still the case that a candidate's optimal policy response to any voting outcome is her expectation $\hat{z}_{a,b,o}$ of the optimal policy, as in Remark 2. Moreover, if voters follow an ideological voting strategy $v \in \mathcal{V}_\emptyset$ then the outcome of each individual's vote will be affiliated with z (by Theorem 5 of Milgrom and Weber), implying that $\hat{z}_{a+1,b,o} < \hat{z}_{a,b,o+1} < \hat{z}_{a,b+1,o}$, just as in Lemma 2 above. If v is also signal-symmetric then these policy outcomes $\hat{z}_{a,b,o} = -\hat{z}_{b,a,o}$ will be symmetric, as well. Accordingly, citizens with positive signals will prefer voting B

[29] By the same logic, additional candidates beyond four would always attract votes, and further improve social welfare. If non-policy heterogeneity between candidates were added to the model, however, the identity of the winning candidate would matter to voters, and standard pivotal considerations would limit the value of adding candidates, and voters' willingness to support them.

[30] Allowing citizens to cast fractional ballots would eliminate this coarseness and improve welfare. With the linear specification of signals above, all citizens would then vote, as doing so would reveal all relevant private information. With other specifications of signals, citizens could still use abstention (or minor party votes) to distinguish voters with precise, moderate signals from those with extreme but imprecise signals, who favor the same policy.

[31] Multiple candidates could be especially useful in a multidimensional setting such as McMurray (2016c), communicating opinions on multiple policy issues that cannot be conveyed by a unidimensional margin of victory.

to voting A, while citizens with negative signals prefer voting A to voting B.[32] If everyone else votes, however, citizens with moderate signal realizations will prefer to abstain from voting, to avoid the signaling voter's curse.

To see that some citizens prefer to abstain, first suppose that the rest of the electorate followed an ideological voting strategy with ideology thresholds $\tau_1 = \tau_2 = 0$ so that, even though abstention is allowed, everyone voted. In that case, the only citizen who candidates would expect to abstain would be one who is perfectly moderate (i.e. $s_i = 0$). A citizen who truly *is* perfectly moderate would therefore be able to perfectly reveal his signal, by abstaining. This he would prefer to do, since the winning candidate shares his preferences, and so will react to his own information optimally, given the other votes that are cast.[33] By continuity, citizens with signals in a neighborhood would prefer to abstain as well. Thus, it is not an equilibrium for all citizens to vote.[34] In fact, symmetry is not important for this argument: for arbitrary prior and signal structure, if there is any strategy in which citizens vote in response to all signal realizations but one, a citizen with that one special signal realization can benefit from abstaining, as doing so fully communicates his information, and by continuity, citizens in a neighborhood benefit from abstention as well.

As is well known, the condition that signals are affiliated with the true state of the world is quite general. One specification that would satisfy this condition is that z follows a normal distribution, and that s_i are i.i.d. (conditional on z) and normally distributed, as well, each with mean z and variance σ^2. With this specification, moderate citizens would abstain from voting even though all signals are equally precise, thus highlighting how the signaling voter's curse need have nothing to do with expertise, but rather reflects the desire of moderately informed citizens to shrink the winning candidate's man-

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32 Formally, the difference $\Delta_{AB}(s)$ in expected benefit from voting B instead of A can then be written as

$$\begin{aligned}\Delta_{AB}(s_i) &= E_z\left\{E_{a,b,c}\left[\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(z-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)|z\right]|s_i\right\}\\ &= E_{a,b,c}\left\{\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left[E(z|a,b,c,s_i)-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right]|s_i\right\}\\ &> E_{a,b,c}\left[\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(\hat{z}_{a,b,c}-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)|s_i\right]\\ &= \sum_{a<b}\sum_{c}\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(\hat{z}_{a,b,c}-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)\psi(a,b,c|s_i)\\ &\quad+\sum_{a>b}\sum_{c}\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(\hat{z}_{a,b,c}-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)\psi(a,b,c|s_i),\end{aligned}$$

where the inequality follows because s_i is affiliated with z and the final equality follows because $\hat{z}_{a,b,c} = (\hat{z}_{a+1,b,c} + \hat{z}_{a,b+1,c})/2 = 0$ when $a = b$. The second term of this sum can be written as

$$\begin{aligned}&\sum_{b>a}\sum_{c}\left(\hat{z}_{b,a+1,c}-\hat{z}_{b+1,a,c}\right)\left(\hat{z}_{b,a,c}-\frac{\hat{z}_{b+1,a,c}+\hat{z}_{b,a+1,c}}{2}\right)\psi(b,a,c|s_i)\\ &= -\sum_{a<b}\sum_{c}\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(\hat{z}_{a,b,c}-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)\psi(b,a,c|s_i),\end{aligned}$$

so $\Delta_{AB}(s_i)$ reduces further to the following,

$$\Delta_{AB}(s_i) > \sum_{a<b,c}\left(\hat{z}_{a,b+1,c}-\hat{z}_{a+1,b,c}\right)\left(\hat{z}_{a,b,c}-\frac{\hat{z}_{a+1,b,c}+\hat{z}_{a,b+1,c}}{2}\right)\left[\psi(a,b,c|s_i)-\psi(b,a,c|s_i)\right]$$

which is positive when s_i is positive. By a symmetric derivation, $\Delta_{AB}(s_i)$ is negative when s_i is negative.

33 Formally, the winning candidate formulates the same expectation $E(z|a,b,c+1) = E(z|a,b,c,s_i)$ that she would form if she had observed the voter's private signal s_i, so the expected benefit $\Delta_{0B}(s_i)$ reduces to the following,

$$\begin{aligned}\Delta_{0B}(s_i) &= E_z\left\{E_{a,b,c}\left[\left(\hat{z}_{a,b+1,c}-\hat{z}_{a,b,c+1}\right)\left(z-\frac{\hat{z}_{a,b,c+1}+\hat{z}_{a,b+1,c}}{2}\right)|z\right]|s_i\right\}\\ &= E_{a,b,c}\left\{\left(\hat{z}_{a,b+1,c}-\hat{z}_{a,b,c+1}\right)\left[E(z|a,b,c,s_i)-\frac{\hat{z}_{a,b,c+1}+\hat{z}_{a,b+1,c}}{2}\right]|s_i\right\}\\ &= E_{a,b,c}\left[\left(\hat{z}_{a,b+1,c}-\hat{z}_{a,b,c+1}\right)\left(\hat{z}_{a,b,c+1}-\frac{\hat{z}_{a,b,c+1}+\hat{z}_{a,b+1,c}}{2}\right)|s_i\right]\\ &= -\frac{1}{2}E_{a,b,c}\left[\left(\hat{z}_{a,b+1,c}-\hat{z}_{a,b,c+1}\right)^2|s_i\right]\end{aligned}$$

which is negative.

34 It seems intuitive to conjecture that the expected benefit $\Delta_B(s_i)$ of voting B (relative to abstaining) should be monotonic in s_i (which in turn would characterize best-response voting as ideological, and guarantee equilibrium existence) but this is difficult to guarantee beyond the linear case, because of the logic explained earlier: a citizen with a higher signal expects z to be higher, making it desirable to have a policy outcome that is further to the right, but also expects his peers to be voting B in higher numbers already, making the policy outcome further to the right than before even without his vote. Whether he should push the policy outcome *even* further to the right depends on the net size of these offsetting effects, which is inherently difficult to establish without a more structured model.

date. In fact, the affiliation assumption also includes the possibility that a perfectly moderate signal only arises when $z = 0$; in that case, a citizen who receives this signal would have *perfect* information about z, but would nevertheless abstain from voting.

7. Conclusion

Standard election models give no account of the popular notion of electoral mandates, or of empirical evidence that policy outcomes vary systematically with electoral margins of victory. Exceptions to this rely on reelection incentives, which are not always relevant. This paper has proposed instead that candidates react to the information revealed by public consensus (or lack thereof). This leads to a signaling calculus for voters, who use abstention and minor-party votes to fine-tune their communication, thus providing novel explanations for common political behavior such as protest abstention and support for candidates who are unlikely to win office, and generating welfare implications that are rather opposite those of standard analyses. With no informational impediments, such mandates can steer the winning candidate not only to the better of two policies, but to the unique optimum from an entire continuum of alternatives. Political activities other than voting can contribute to mandates in the same way, and empirically exhibit the same patterns of information and participation.

For simplicity, the paper above has followed de Condorcet (1785) in assuming perfectly homogeneous voter preferences. It has also modeled candidates as being identical to each other and to voters. More realistically, of course, it is likely that there are important differences between voters, between candidates, and between voters and candidates. Even in a broadly common-value environment, for example, some individuals might be more averse to mistakes on one side of an issue or the other, or could have prior beliefs that are biased in one direction or the other. Candidates may also differ in their competence, incumbency status, charisma, or other non-policy ("valence") characteristics. With differences between candidates, signaling incentives would likely be similar, but voters would then also care about the identity of the winning candidate, so pivotal considerations would be relevant as well. This can complicate the analysis substantially since, as Razin (2003) points out, some citizens may then wish to help a liberal candidate win with a conservative mandate, or vice versa.

A formal analysis of conflicts between voters or between voters and candidates is beyond the scope of this paper, but existing literature lends some intuition. First, it is clear that citizens whose preferences or beliefs are biased in one direction will vote more readily in response to signals that favor these biases—and may ignore opposing signals completely. If candidates know voters' preferences and strategies, however, they can discount uninformative votes appropriately, and calibrate their policy responses only to the information revealed by informative voters. As long as some voters have preferences and prior beliefs similar to candidates', these should vote informatively, and as the electorate grows, this should still steer candidates to the optimal policy.[35] On the other hand, individual contributions to the electoral mandate will also shrink as the number of votes grows large, so even citizens who are only slightly more extreme than candidates may eventually just vote in the direction of their biases, as in Morgan and Stocken (2008).

These various conflicts are an important direction to explore, but one rationale for a common-value model is that conflicts of interest exist are mitigated as voters already take one another's preferences into account in determining how to vote: as I explain further in McMurray (2016a), for example, large elections can potentially amplify small levels of voter altruism to the point that conflicts of interest become unimportant. On the other hand, however, common values and perfect rationality ought to lead citizens' opinions to essentially converge once private information is made public. Empirically, citizens do seem more confident when majority opinion corroborates their own, but many individuals also maintain minority views, condemning public decisions as erroneous. At the very least, this suggests a more complicated information structure than that above, such that election outcomes do not perfectly reveal the truth. Voters might also misinterpret their signals, as in Fryer et al. (2013), or exhibit overconfidence, as in Ortoleva and Snowberg (2015). Extensions such as these are beyond the scope of this paper, but as long as individual opinions are correlated with the truth, a weakened version of Theorem 4 seems likely to hold, guaranteeing that policy outcomes are at least positively correlated with the truth.[36] If so, the optimal policy response is likely to still be monotonic in vote totals, which is the key feature of the mandates model above.

Appendix

Lemma L1. *If $v \in \mathcal{V}$ is informative then, for any $j \in \mathcal{C}$, $\frac{\partial \phi(j|z)}{\partial z}$ has the same sign as $E(\theta|j)$.*

Proof. Differentiating (4) yields

$$\frac{\partial \phi(j|z)}{\partial z} = \int_0^1 \int_{-1}^1 I_{[v(q,s)=j]} \frac{1}{2} q s g(q)\, ds dq$$

which has the same sign as the ideology of the average j voter.

[35] A common theme from communication literature is that if preferences are too dissimilar then informative equilibria may fail to exist. As Battaglini (2015) shows, pivotal voting considerations can make this problem especially severe.

[36] This theme arises in Ladha (1992) and Dietrich and Spiekermann (), for example, for the analysis of binary settings with correlated voter errors.

$$E(\theta|j)=\frac{\int_{-1}^{1}\int_{0}^{1}\int_{-1}^{1} qs1_{[v(q,s)=j]}\frac{1}{2}(1+qsz)\,g(q)\,f(z)\,dsdqdz}{\int_{-1}^{1}\int_{0}^{1}\int_{-1}^{1} 1_{[v(q,s)=j]}\frac{1}{2}(1+qsz)\,g(q)\,f(z)\,dsdqdz}=\frac{\int_{0}^{1}\int_{-1}^{1} qs1_{[v(q,s)=j]}g(q)\,dsdq}{\int_{0}^{1}\int_{-1}^{1} 1_{[v(q,s)=j]}g(q)\,dsdq}\qquad\square$$

Lemma 1 *(Monotone Expectations). If $v\in\mathcal{V}$ is informative then $\hat{z}_{a+1,b}<\hat{z}_{a,b}<\hat{z}_{a,b+1}$ for any $a,b\in\mathbb{Z}_+$.*

Proof. $E(\theta|A)$ and $E(\theta|B)$ have opposite signs, since the weighted average of the two is $\phi(A)E(\theta|A)+\phi(B)E(\theta|B)=E(\theta)=0$. Specifically, if $v\in\mathcal{V}$ is informative then $E(\theta|A)<0<E(\theta|B)$. By Lemma L1, this implies that $\phi(A|z)$ and $\phi(B|z)$ are decreasing and increasing in z, respectively. Since $\psi(a,b+1|z)=\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{a!(b+1)!}[n\phi(A|z)]^a[n\phi(B|z)]^{b+1}=\psi(a,b|z)\frac{n\phi(B|z)}{b+1}$, this implies the following,

$$\hat{z}_{a,b+1}=\frac{\int_{-1}^{1} z\psi(a,b+1|z)\,f(z)\,dz}{\int_{-1}^{1}\psi(a,b+1|z)\,f(z)\,dz}=\frac{\int_{-1}^{1} z\psi(a,b|z)\,\phi(B|z)\,f(z)\,dz}{\int_{-1}^{1}\psi(a,b|z)\,\phi(B|z)\,f(z)\,dz}>\hat{z}_{a,b}$$

where $\hat{z}_{a,b}$ is given by (6) and where the inequality follows because $\phi(B|z)$ increases in z. Symmetric logic implies that $\hat{z}_{a+1,b}<\hat{z}_{a,b}$. $\square$

Lemma L2. *If $v\in\mathcal{V}$ is signal-symmetric and informative then, for any $a,b\in\mathbb{Z}_+$, $\left|\hat{z}_{a,b}\right|-\left|\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\right|$ has the same sign as $\hat{z}_{a,b}$.*

Proof. By signal symmetry, $a=b$ implies that $\hat{z}_{a,b}=0$ and $\hat{z}_{a+1,b}=-\hat{z}_{a,b+1}$, implying that the desired result holds with equality. Together with Lemma 1 (which relies on informedness), this implies that $\hat{z}_{a,b}$, $\hat{z}_{a+1,b}$, and $\hat{z}_{a,b+1}$, and therefore $\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}$ all have the same sign. Consider the case of $a<b$, so that all of these are positive. In that case, the absolute value notation can be omitted, and $\left|\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\right|$ and $\left|\hat{z}_{a,b}\right|$ can be rewritten as

$$\begin{aligned}\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}&=\int_{-1}^{1} z\left[\frac{1}{2}\frac{\psi(a+1,b|z)\,f(z)}{\psi(a+1,b)}+\frac{1}{2}\frac{\psi(a,b+1|z)\,f(z)}{\psi(a,b+1)}\right]dz\\&=\int_{-1}^{1} z\left[\frac{\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{(a+1)!b!}[n\phi(A|z)]^{a+1}[n\phi(B|z)]^{b}}{2\int_{-1}^{1}\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{(a+1)!b!}[n\phi(A|z)]^{a+1}[n\phi(B|z)]^{b}f(z)dz}+\frac{\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{a!(b+1)!}[n\phi(A|z)]^{a}[n\phi(B|z)]^{b+1}}{2\int_{-1}^{1}\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{a!(b+1)!}[n\phi(A|z)]^{a}[n\phi(B|z)]^{b+1}f(z)dz}\right]f(z)\,dz\\&=\int_{-1}^{1} z\phi(A|z)^a\phi(B|z)^b\left[\frac{\phi(A|z)}{2\int_{-1}^{1}\phi(A|z)^{a+1}\phi(B|z)^b f(z)dz}+\frac{\phi(B|z)}{2\int_{-1}^{1}\phi(A|z)^{a}\phi(B|z)^{b+1} f(z)dz}\right]f(z)\,dz\end{aligned}\tag{11}$$

and

$$\begin{aligned}\hat{z}_{a,b}&=\int_{-1}^{1} z\frac{\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{(a+1)!b!}[n\phi(A|z)]^a[n\phi(B|z)]^b}{\frac{e^{-n\phi(A|z)-n\phi(B|z)}}{(a+1)!b!}[n\phi(A|z)]^a[n\phi(B|z)]^b f(z)}f(z)\,dz\\&=\int_{-1}^{1} z\phi(A|z)^a\phi(B|z)^b\left[\frac{1}{\int_{-1}^{1}\phi(A|z)^a\phi(B|z)^b f(z)\,dz}\right]f(z)\,dz\end{aligned}\tag{12}$$

respectively, where exponential terms drop out because $\phi(A|z)+\phi(B|z)=1$ for any voting strategy.

Signal symmetry implies that $\phi(A|z) = \phi(B|-z)$, so differentiating the bracketed term in (11) with respect to z yields

$$\frac{\partial\phi(B|z)}{\partial z}\left[-\frac{1}{2\int_{-1}^{1}\phi(A|z)^{a+1}\phi(B|z)^{b}\,dz}+\frac{1}{2\int_{-1}^{1}\phi(A|z)^{a}\phi(B|z)^{b+1}\,dz}\right]$$
$$=\frac{\partial\phi(B|z)}{\partial z}\frac{\int_{-1}^{1}\phi(A|z)^{a+1}\phi(B|z)^{b}\,dz-\int_{-1}^{1}\phi(A|z)^{a}\phi(B|z)^{b+1}\,dz}{2\int_{-1}^{1}\phi(A|z)^{a+1}\phi(B|z)^{b}\,dz\int_{-1}^{1}\phi(A|z)^{a}\phi(B|z)^{b+1}\,dz}.$$

Since informativeness implies that $\frac{\partial\phi(B|z)}{\partial z} > 0$ (by Lemma L1), this derivative is proportional to the following.

$$\int_{-1}^{1}\phi(A|z)^{a}\phi(B|z)^{b}\left[\phi(A|z)-\phi(B|z)\right]dz$$
$$=\int_{-1}^{0}\phi(A|z)^{a}\phi(B|z)^{a}\phi(B|z)^{b-a}\left[\phi(A|z)-\phi(B|z)\right]dz$$
$$+\int_{0}^{1}\phi(A|z)^{a}\phi(B|z)^{a}\phi(B|z)^{b-a}\left[\phi(A|z)-\phi(B|z)\right]dz$$
$$=\int_{0}^{1}\phi(B|z)^{a}\phi(A|z)^{a}\phi(A|z)^{b-a}\left[\phi(B|z)-\phi(A|z)\right]dz$$
$$+\int_{0}^{1}\phi(A|z)^{a}\phi(B|z)^{a}\phi(B|z)^{b-a}\left[\phi(A|z)-\phi(B|z)\right]dz$$
$$=\int_{0}^{1}\phi(B|z)^{a}\phi(A|z)^{a}\left[\phi(A|z)^{b-a}-\phi(B|z)^{b-a}\right]\left[\phi(B|z)-\phi(A|z)\right]dz$$
$$<0.$$

In other words, the bracketed term in (11) decrease in z. Since the bracketed term in (12) is constant, the expectation in (11) must be smaller than that in (12). This establishes the desired result for the case of $a < b$; the case of $a > b$ follows by symmetric arguments.

Theorem 1 *(Mandates). $(v^*, y_A^*, y_B^*) \in \mathcal{V}\times\mathcal{Y}^2$ is an informative and signal-symmetric equilibrium if and only if (1) v^* is ideological, with ideology threshold $\tau^* = 0$, and (2) $y_j^*(a,b) = \hat{z}_{a,b}$ for any $j = A, B$ and any $a, b \in \mathbb{Z}_+$, where $\hat{z}_{a,b} = -\hat{z}_{b,a}$ and $\hat{z}_{a+1,b} < \hat{z}_{a,b} < \hat{z}_{a,b+1}$.*

Proof. Part 2 follows from Remark 1 and Lemma 1, given the informativeness and signal symmetry of v^*. A citizen who expects this behavior from candidates perceives $\Delta_{AB}(\theta)$, as defined in (9), to be the expected benefit of voting B instead of A. If v is informative and signal-symmetric then this is increasing in θ. To see this, first differentiate with respect to θ.

$$\frac{d\Delta_{AB}(\theta)}{d\theta}=\int_{-1}^{1}\sum_{a,b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)\left(z-\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\right)\psi(a,b|z)\,\frac{1}{2}z\,dz$$
$$=\sum_{a,b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)\left[E\left(z^2|a,b\right)-\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\hat{z}_{a,b}\right]\psi(a,b)$$
$$=\sum_{a<b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)\left[E\left(z^2|a,b\right)-\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\hat{z}_{a,b}\right]\psi(a,b)$$
$$+\sum_{a<b}\left(\hat{z}_{b,a+1}-\hat{z}_{b+1,a}\right)\left[E\left(z^2|b,a\right)-\frac{\hat{z}_{b+1,a}+\hat{z}_{b,a+1}}{2}\hat{z}_{b,a}\right]\psi(b,a)$$

By signal symmetry, the second term in this sum equals

$$\sum_{a<b}\left(-\hat{z}_{a+1,b}+\hat{z}_{a,b+1}\right)\left[E\left(z^2|a,b\right)-\frac{-\hat{z}_{a+1,b}-\hat{z}_{a,b+1}}{2}\left(-\hat{z}_{a,b}\right)\right]\psi\left(a,b\right)$$

which is the same as the first term in the sum. $\frac{d\Delta_{AB}(\theta)}{d\theta}$ therefore reduces to the following,

$$\begin{aligned}\frac{d\Delta_{AB}\left(\theta\right)}{d\theta}&=2\sum_{a<b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)\left[E\left(z^2|a,b\right)-\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\hat{z}_{a,b}\right]\psi\left(a,b\right)\\&>2\sum_{a<b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)\left[E\left(z^2|a,b\right)-\hat{z}_{a,b}^2\right]\psi\left(a,b\right)\\&=2\sum_{a<b}\left(\hat{z}_{a,b+1}-\hat{z}_{a+1,b}\right)V\left(z|a,b\right)\psi\left(a,b\right)\end{aligned}$$

where the inequality follows from Lemmas 1 and L2. This expression is positive, meaning that the benefit of voting B rather than A increases in θ, which implies that the best response to v (given candidates' best responses y_A and y_B) is ideological.

For a perfectly moderate citizen (i.e. $\theta=0$), the posterior density (3) reduces to the prior, implying that the benefit (7) of voting B reduces as follows,

$$\begin{aligned}\Delta_B\left(0\right)&=E_z\left\{E_{a,b}\left[\left(\hat{z}_{a,b+1}-\hat{z}_{a,b}\right)\left(z-\frac{\hat{z}_{a,b}+\hat{z}_{a,b+1}}{2}\right)|z\right]\right\}\\&=E_{a,b}\left[\left(\hat{z}_{a,b+1}-\hat{z}_{a,b}\right)\left(\hat{z}_{a,b}-\frac{\hat{z}_{a,b}+\hat{z}_{a,b+1}}{2}\right)\right]\end{aligned}\tag{13}$$

which, since v is signal-symmetric, is equivalent to

$$\begin{aligned}&E_{a,b}\left[\left(-\hat{z}_{b+1,a}+\hat{z}_{b,a}\right)\left(-\hat{z}_{b,a}-\frac{-\hat{z}_{b,a}-\hat{z}_{b+1,a}}{2}\right)\right]\\&=E_{a,b}\left[\left(-\hat{z}_{a+1,b}+\hat{z}_{a,b}\right)\left(-\hat{z}_{a,b}-\frac{-\hat{z}_{a,b}-\hat{z}_{a+1,b}}{2}\right)\right]\\&=E_{a,b}\left[\left(\hat{z}_{a+1,b}-\hat{z}_{a,b}\right)\left(\hat{z}_{a,b}-\frac{\hat{z}_{a+1,b}+\hat{z}_{a,b+1}}{2}\right)\right]\\&=\Delta_A\left(0\right),\end{aligned}$$

implying that $\Delta_{AB}\left(0\right)=\Delta_B\left(0\right)-\Delta_A\left(0\right)=0$. In other words, a citizen with $\theta=0$ is indifferent between voting A and voting B, and since $\Delta_{AB}\left(\theta\right)$ increases with θ, it has the same sign as θ. Thus, the ideological strategy v^* with ideology threshold $\tau=0$ is the unique best response to any informative, signal-symmetric voting strategy (together with the best-response policies specified for candidates in Remark 1). In particular, it is the best response to itself, implying that $\left(v^*,y_A^*,y_B^*\right)$ constitutes the unique informative, signal-symmetric equilibrium, as claimed. □

Lemma 2. *If $v\in\mathcal{V}_0$ is informative then $\hat{z}_{a+1,b,o}<\hat{z}_{a,b,o+1}<\hat{z}_{a,b+1,o}$ for any $a,b,o\in\mathbb{Z}_+$.*

Proof. The proof of this lemma is a straightforward extension of the proof of Lemma 1. In particular, the probability of a votes for candidate A, b votes for B, and o abstentions is analogous to (5).

$$\psi\left(a,b,o|z\right)=e^{-n\phi(A|z)}\frac{\left[n\phi\left(j|z\right)\right]^a}{a!}e^{-n\phi(B|z)}\frac{\left[n\phi\left(j|z\right)\right]^b}{b!}e^{-n\phi(\emptyset|z)}\frac{\left[n\phi\left(\emptyset|z\right)\right]^o}{o!}$$

Lemma L1 can then be restated for strategies in $\mathcal{V}_\emptyset$ and $j\in\mathcal{C}_\emptyset$. This lemma then follows because informativeness, as defined in Definition 5, implies that $\frac{\phi(B|z)}{\phi(\emptyset|z)}$ and $\frac{\phi(\emptyset|z)}{\phi(A|z)}$ both increase in z. □

Theorem 2 *(Signaling voter's curse). $\left(v^*,y_A^*,y_B^*\right)\in\mathcal{V}_\emptyset\times\mathcal{Y}_\emptyset^2$ is an informative and signal-symmetric equilibrium only if (1) v^* is ideological, with ideology thresholds $\tau_1^*=-\tau_2^*$ satisfying $-1<\tau_1^*<0<\tau_2^*<1$, and (2) $y_j^*\left(a,b,o\right)=\hat{z}_{a,b,o}$ for any $j=A,B$ and any $a,b,o\in\mathbb{Z}_+$, where $\hat{z}_{a,b,o}=-\hat{z}_{b,a,o}$ and $\hat{z}_{a+1,b,o}<\hat{z}_{a,b,o+1}<\hat{z}_{a,b+1,o}$. Furthermore, such an equilibrium exists.*

Proof. Part 2 follows from Remark 2 and Lemma 2, given the informativeness and signal symmetry of v^*. Given these responses from candidates and an informative and signal-symmetric strategy by his peers, Theorem 1 shows that a citizen prefers voting A to voting B if and only if θ is negative. Signal symmetry further implies that $\Delta_A\left(-\theta\right)=\Delta_B\left(\theta\right)$; that is, liberal and conservative citizens with opposite ideologies of equal intensities have equal incentive to vote. Together, these observations imply that $\Delta_A\left(\theta\right)$ and $\Delta_B\left(\theta\right)$ decrease and increase in θ, respectively. This implies the existence of ideology thresholds $\tau_1^{br} \le \tau_2^{br}$ such that a citizen prefers to vote A if $\theta < \tau_1^{br}$, vote B if $\theta > \tau_2^{br}$, and abstain otherwise. Given signal symmetry, it must also be the case that $\tau_1^{br} = -\tau_2^{br}$. In particular, the best response to a signal-symmetric ideological strategy with thresholds $(-\tau_2, \tau_2)$ is a signal-symmetric ideological strategy with thresholds $\left(-\tau_2^{br}, \tau_2^{br}\right)$, so the threshold τ_2^{br} can be viewed as a continuous function from the compact set $[0, 1]$ of thresholds into itself. A fixed point $\tau_2^* \in [0, 1]$ exists by Brouwer's theorem, such that the signal-symmetric ideological strategy with $\tau_1^* = -\tau_2^*$ (together with y_A^* and y_B^* from above) constitutes an equilibrium.

It remains to show that the equilibrium ideology thresholds $\tau_1^* \ne \tau_2^*$ do not coincide—in other words, that $\tau_2^* \ne 0$. To see this, simply note that $\Delta_B(0) < 0$, implying that a perfectly moderate citizen prefers to abstain. This is because the posterior $f(z|\theta)$ reduces from (3) for the case of $\theta = 0$ to the prior $f(z)$, so (13) reduces to the following,

$$\begin{aligned}
\Delta_B(0) &= E_z\left\{E_{a,b,o}\left[\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)\left(z - \frac{\hat{z}_{a,b,o} + \hat{z}_{a,b+1,o}}{2}\right)|z\right]\right\} \\
&= E_{a,b,o}\left[\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)\left(\hat{z}_{a,b,o} - \frac{\hat{z}_{a,b,o} + \hat{z}_{a,b+1,o}}{2}\right)\right] \\
&= -\frac{1}{2}E_{a,b,o}\left[\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)^2\right]
\end{aligned}$$

which is negative.

If citizens follow a signal-symmetric ideological strategy with ideology thresholds $(-1, 1)$, meaning that only citizens with $\theta = -1$ vote A and only citizens with $\theta = 1$ vote B, then a citizen with either of these ideologies can perfectly reveal his private information to the winning candidate. In that case, the winning candidate's policy choice $\hat{z}_{a,b+1,o} = E(z|a, b, o, \theta)$ coincides with the expectation that the citizen himself would formulate in response to the same vote totals. Because of this, (7) reduces to

$$\begin{aligned}
\Delta_B(\theta) &= E_z\left\{E_{a,b,o}\left[\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)\left(z - \frac{\hat{z}_{a,b,o} + \hat{z}_{a,b+1,o}}{2}\right)|z\right]|\theta = 1\right\} \\
&= E_{a,b,o}\left\{\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)\left[E(z|a, b, o, \theta) - \frac{\hat{z}_{a,b,o} + \hat{z}_{a,b+1,o}}{2}\right]|\theta = 1\right\} \\
&= E_{a,b,o}\left\{\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)\left[\hat{z}_{a,b+1,o} - \frac{\hat{z}_{a,b,o} + \hat{z}_{a,b+1,o}}{2}\right]|\theta = 1\right\} \\
&= \frac{1}{2}E_{a,b,o}\left[\left(\hat{z}_{a,b+1,o} - \hat{z}_{a,b,o}\right)^2\right],
\end{aligned}$$

which is positive. In response to such a strategy, therefore, a citizen with $\theta = 1$ (or, symmetrically, with $\theta = -1$) strictly prefers to vote, implying a best-response threshold $\tau_2^{br} < 1$. The equilibrium threshold must therefore satisfy $\tau_2^* < 1$, as well, and $\tau_1^* > -1$ by symmetric arguments. □

Lemma 3. *If $v \in \mathcal{V}'_\emptyset$ is informative then $\hat{z}_{a+1,b,c,d,o} < \hat{z}_{a,b+1,c,d,o} < \hat{z}_{a,b,c,d,o+1} < \hat{z}_{a,b,c+1,d,o} < \hat{z}_{a,b,c,d+1,o}$ for any $a, b, c, d, o \in \mathbb{Z}_+$.*

Proof. The proof of this lemma is essentially identical to that of Lemmas 1 and 2, noting that informativeness, as defined in Definition 8, implies that $\frac{\phi(B|z)}{\phi(A|z)}$, $\frac{\phi(\emptyset|z)}{\phi(B|z)}$, $\frac{\phi(C|z)}{\phi(\emptyset|z)}$, and $\frac{\phi(D|z)}{\phi(C|z)}$ all increase in z. □

Theorem 3 *(Multiple candidates). $\left(v^*, y_A^*, y_B^*, y_C^*, y_D^*\right) \in \mathcal{V}'_\emptyset \times \mathcal{Y}'^4_\emptyset$ is an informative and signal-symmetric equilibrium only if (1) v^* is ideological, with ideology thresholds $\tau_1^* = -\tau_4^*$ and $\tau_2^* = -\tau_3^*$ satisfying $-1 < \tau_1^* < \tau_2^* < 0 < \tau_3^* < \tau_4^* < 1$, and (2) $y_j^*(a, b, c, d, o) = \hat{z}_{a,b,c,d,o}$ for any $j \in C'$ and any $a, b, c, d, o \in \mathbb{Z}_+$, where $\hat{z}_{a+1,b,c,d,o} < \hat{z}_{a,b+1,c,d,o} < \hat{z}_{a,b,c,d,o+1} < \hat{z}_{a,b,c+1,d,o} < \hat{z}_{a,b,c,d+1,o}$. Furthermore, such an equilibrium exists.*

Proof. Part 2 follows from the informativeness and signal symmetry of v^*. Derivations analogous to those in Theorem 1 show that $\Delta_D(\theta) - \Delta_A(\theta)$ and $\Delta_C(\theta) - \Delta_B(\theta)$ have the same sign as θ. That is, a liberal citizen prefers voting A to voting D and prefers voting B to voting C, while a conservative prefers the opposite. A perfectly moderate citizen is indifferent between voting A and D and indifferent between voting $\not{B}$ and C. Given signal symmetry, it is straightforward to show that $\Delta_A(-\theta) = \Delta_D(\theta)$ and $\Delta_B(-\theta) = \Delta_C(\theta)$. That is, if a liberal and a conservative are equally extreme in their ideologies then the benefit to the liberal of voting A (respectively, B) is the same as the benefit to the conservative of voting D (respectively, C). Since all of these expected benefits are linear in θ, it must be the case that $\Delta_A(\theta)$ and $\Delta_B(\theta)$ decrease in θ while $\Delta_C(\theta)$ and $\Delta_D(\theta)$ increase in θ.

By a derivation essentially identical to the one for $\Delta_B(0)$ in the proof of Theorem 2, $\Delta_C(0)$ and $\Delta_D(0)$ can be shown to reduce to the following.

$$\Delta_C(0) = -\frac{1}{2} E_{a,b,c,d,o}\left[\left(\hat{z}_{a,b,c+1,d,o} - \hat{z}_{a,b,c,d,o+1}\right)^2\right]$$
$$\Delta_D(0) = -\frac{1}{2} E_{a,b,c,d,o}\left[\left(\hat{z}_{a,b,c,d+1,o} - \hat{z}_{a,b,c,d,o+1}\right)^2\right].$$

Both of these are negative, implying that a perfectly moderate citizen prefers to abstain rather than vote for either candidate. Furthermore, Lemma 3 implies that $\Delta_D(0) < \Delta_C(0)$: if he had to vote for one of the two candidates, a perfectly moderate citizen would prefer C over D.

Since $\Delta_C(0)$ is negative and $\Delta_C(\theta)$ increases linearly in θ, there is some threshold $\tau_{0C} \in [0,1]$ such that a citizen with ideology between 0 and τ_{0C} prefers to abstain but a citizen more conservative than τ_{0C} prefers to vote C. (If $\Delta_C(1) < 0$ then $\tau_{0C} = 1$.) By analogous reasoning, there is also some threshold $\tau_{0D} \in [0,1]$ such that a citizen with ideology between 0 and τ_{0D} prefers to abstain but a citizen more conservative than τ_{0D} prefers to vote D. (If $\Delta_D(1) < 0$ then $\tau_{0D} = 1$.) Moreover, since $\Delta_C(0) > \Delta_D(0)$, there is some threshold $\tau_{CD} \in [0,1]$ such that a citizen with ideology between 0 and τ_{CD} prefers voting C to voting D but a citizen more conservative than τ_{CD} prefers voting D to voting C. (If $\Delta_C(1) > \Delta_D(1)$ then $\tau_{CD} = 1$.) Together, these observations imply that a citizen with ideology lower than $\tau_3^{br} \equiv \min\{\tau_{0C}, \tau_{0D}\}$ prefers to abstain, a citizen more conservative than $\tau_4^{br} \equiv \max\{\tau_{0D}, \tau_{CD}\}$ prefers to vote D, and a citizen with ideology between τ_3^{br} and τ_4^{br} prefers to vote C. Symmetrically, there exist thresholds $\tau_1^{br} = -\tau_4^{br}$ and $\tau_2^{br} = -\tau_3^{br}$ such that a citizen prefers to vote A if $\theta < \tau_1^{br}$, vote B if $\tau_1^{br} < \theta < \tau_2^{br}$, and abstain if $\tau_2^{br} < \theta < 0$. In other words, the best response to an informative and signal-symmetric voting strategy (together with candidates' best policy responses) is an ideological strategy with ideology thresholds $\left(-\tau_4^{br}, -\tau_3^{br}, \tau_3^{br}, \tau_4^{br}\right)$. In particular, this is the best response to a signal-symmetric ideological strategy with ideology thresholds $(-\tau_4, -\tau_3, \tau_3, \tau_4)$. Thus, the threshold pair $\left(\tau_3^{br}, \tau_4^{br}\right)$ can be viewed together as a single continuous function from the compact set $\{(\tau_3, \tau_4) : 0 \le \tau_3 \le \tau_4 \le 1\}$ into itself. A fixed point $\left(\tau_3^*, \tau_4^*\right)$ exists by Brouwer's theorem, and the corresponding ideology thresholds $\left(-\tau_4^*, -\tau_3^*, \tau_3^*, \tau_4^*\right)$ characterize an ideological strategy that (together with candidates' policy responses) constitutes an equilibrium.

The inequalities in Part 1 of the theorem are more numerous than before, but are strict for the same reason as in Theorem 2. Suppose, for example, that $\tau_3 = \tau_4$, so that a citizen votes C with zero probability. In that case, a citizen whose ideology $\theta = \tau_3$ coincides exactly with the two thresholds is the only type who should ever vote C. By voting C, therefore, such a citizen can perfectly convey his private information to the winning candidate. This he prefers to do, since the winning candidate shares his preferences, and will utilize his information optimally from his own perspective (i.e., $\hat{z}_{a,b,c+1,d,o} = E(z|a,b,c,d,o,\theta = \tau_3)$). Accordingly, $\Delta_C(\theta)$ reduces to

$$\begin{aligned}\Delta_C(\tau_3) &= E_{a,b,c,d,o}\left\{\left(\hat{z}_{a,b,c+1,d,o} - \hat{z}_{a,b,c,d,o+1}\right)\left[E(z|a,b,c,d,o,\theta) - \frac{\hat{z}_{a,b,c,d,o+1} + \hat{z}_{a,b,c+1,d,o}}{2}\right] |\theta = \tau_3\right\} \\ &= E_{a,b,c,d,o}\left[\left(\hat{z}_{a,b,c+1,d,o} - \hat{z}_{a,b,c,d,o+1}\right)\left(\hat{z}_{a,b,c+1,d,o} - \frac{\hat{z}_{a,b,c,d,o+1} + \hat{z}_{a,b,c+1,d,o}}{2}\right) |\theta = \tau_3\right] \\ &= \frac{1}{2} E_{a,b,c,d,o}\left[\left(\hat{z}_{a,b,c+1,d,o} - \hat{z}_{a,b,c,d,o+1}\right)^2 |\theta = \tau_3\right],\end{aligned}$$

which is positive. Since a citizen with $\theta = \tau_3$ prefers voting C to abstaining, an ideological strategy with thresholds $(\tau_1, \tau_2, \tau_3, \tau_3)$ is not its own best response, and therefore not an equilibrium. The other inequalities in part 1 of the theorem follow from analogous logic. □

Theorem 4. *If, for any n, the strategy vector* $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V} \times \mathcal{Y}^2$ *maximizes* $E\left[u\left(x_n^*, z\right)\right]$ *then it also constitutes an equilibrium. Moreover,* $\left|x_n^* - z\right| \to_p 0$. *This results also hold if* $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$ *or* $\left(v^*, y_A^*, y_B^*, y_C^*, y_D^*\right)_n \in \mathcal{V}_\emptyset' \times \mathcal{Y}_\emptyset'^4$.

Proof. That an optimal strategy vector constitutes an equilibrium follows from McLennan (1998), whether $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V} \times \mathcal{Y}^2$, $\left(v^*, y_A^*, y_B^*\right)_n \in \mathcal{V}_\emptyset \times \mathcal{Y}_\emptyset^2$, or $\left(v^*, y_A^*, y_B^*, y_C^*, y_D^*\right)_n \in \mathcal{V}_\emptyset' \times \mathcal{Y}_\emptyset'^4$: since voters and candidates have identical preferences, whatever is socially optimal is also individually optimal for each of these actors. For each of these cases, Remarks 1, 2, and 3 imply that candidates' component of the optimal strategy vector is characterized by the expectation of the optimal policy. Thus, characterizing the entire vector only requires specifying the optimal voting strategy v^* in $\mathcal{V}$, $\mathcal{V}_\emptyset$, or $\mathcal{V}_\emptyset'$.

To see the limit result for the case of $v \in \mathcal{V}$, consider the equilibrium voting strategy identified in Theorem 1, which is ideological with ideology threshold $\tau = 0$. The fact that the optimal voting strategy constitutes an equilibrium does not by itself guarantee that *this* equilibrium strategy is optimal, as there are other equilibria that are not signal-symmetric and informative. However, if voters follow this strategy then, as n grows large, the realized vote share $\frac{a}{a+b}$ converges in probability to $\frac{\phi(A|z)}{\phi(A|z)+\phi(B|z)}$. Since v_n is informative, $\phi(A|z)$ and $\phi(B|z)$ are decreasing and increasing in z, respectively, implying that $\frac{\phi(A|z)}{\phi(A|z)+\phi(B|z)}$ is a decreasing—and therefore invertible—function of z. Thus, conditional on z, $y_j^*(a,b) = E(z|a,b)$ converges in probability to $\left[\frac{\phi(A|z)}{\phi(A|z)+\phi(B|z)}\right]^{-1} = z$, implying that utility under this voting strategy (and candidate best-response strategies) converges in probability to $u(z,z) = 0$. The optimal strategy vector $\left(v^*, y_A^*, y_B^*\right)_n$ might differ from this strategy vector, but provides at least as high expected utility for every n, implying that utility converges to $u(z,z)=0$ in that case as well, which requires $x_n^* \to_p z$. That this holds for any z implies that $|x_n^* - z| \to_p 0$, as claimed.

When the option of abstention is introduced, simply consider an ideological strategy with $\tau_1 = \tau_2 = 0$. That is, no one actually abstains, and voting behavior is identical to the strategy in $\mathcal{V}$. As before, following this strategy produces utility approaching $u(z,z)=0$, and the optimal strategy in $\mathcal{V}_\emptyset$ provides weakly greater utility, implying once again that $x_n^* \to_p z$ for any z, and therefore that $|x_n^* - z| \to_p 0$. This same approach can be taken for strategies in $\mathcal{V}'_\emptyset$: consider, for example, an ideological strategy with thresholds $\tau_1 = 0$ and $\tau_2 = \tau_3 = \tau_4 = 1$, for which citizens with signals left or right of center vote A or B, respectively, and no one abstains or votes for C or D. □

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