Early Voting and Late-Election Information

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Abstract

Convenience voting offers voters a "low-cost" method of voting, but at a price: those who vote early cannot incorporate late-election information into their vote. Given this trade-off between voting cost and full information, when is early voting welfare-improving? I develop a model where voters choose to vote early, on election day, or not at all. Information and the realized cost of election day voting affect whether a voter votes or not. I show that early voting can improve social welfare when election day voting costs are correlated with ideological preferences.

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1 Introduction

Convenience voting, a blanket term for any form of voting which does not take place in one's voting precinct on election day, is often introduced with the intention of decreasing citizens' voting costs and increasing voter participation. Early in-person voting, absentee voting, and universal vote-by-mail are all methods of convenience voting. One consequence of convenience voting is a changed information environment: voters choosing to cast a ballot early give up the ability to incorporate late-election information into their vote. Many past elections have included important late-breaking events or information close to election day. Think of the "October surprise," which refers to an event in the month prior to a U.S. election that can impact candidates' chances of winning. Convenience voting thus presents voters with an understudied trade-off between the cost of voting and full information.

How might voters' preferences shift in response to information shocks occurring late in an election, and to what extent could early voting constrain the electorate's ability to express these preferences? More broadly, given this trade-off between voting cost and information, under what conditions does early voting improve social welfare? In order to answer these questions, I develop a two-period model where late-election information and the realized cost of election day voting (both unknown until period 2) affect whether a particular voter votes or not.

The model considers many voters and two candidates. Candidates are each endowed with a policy position (for a one-dimensional policy) and valence, some quality which is orthogonal to policy and representative of late-election information. In the first period, citizens choose to vote early or to wait. In the second period (election day), those who chose to wait in period 1 choose to vote or abstain. Voters act to maximize their expressive utility, but they also derive utility from the outcome of the election that matters for social welfare.

Citizens each have their own ideal policy point. In the early voting period, they are aware that new information may arrive between now and election day that might affect their voting decisions: both whether to vote and for whom. Thus, waiting until election day has an option value, in particular for ideologically moderate voters, who are more likely to be affected by valence realizations. However, there is also a benefit of voting early: a fixed, relatively low cost of voting. A voter that waits until election day faces the possibility of drawing a high voting cost, rendering her unable to vote.

Three "types" of voter behavior arise endogenously from this model, distinguished by how voters respond to late-election information. Some voters ("partisans") would never vote against their ideological interests, no matter the late-election information at hand. Partisans with sufficiently extreme policy preferences ("strong partisans") will only abstain in the face of extreme voting costs, but would never be driven to abstain by the information shock alone. Partisans with less extreme policy preferences ("weak partisans") may be driven to abstain as a "protest" in the face of certain late-election information, but they would still never vote for the other candidate. The final behavior type is labeled a "swing voter," as a voter may vote for the other candidate – against her ideological interests – in the face of sufficient late-election information. These voters have much more moderate bliss points. I find that strong partisans are the most likely to vote early, but given a sufficiently low cost of early voting, weak partisans and swing voters will vote early too.

Voters who vote early will be under-informed, as they will not yet know the valence of each candidate. This does not matter for strong partisans whose vote is independent of the information that they may receive – these voters simply benefit from being able to vote early and avoid a high cost shock on election day. In contrast, weak partisans and swing voters face a trade-off between voting cost savings from voting early and the opportunity to respond to late-election information, either by abstaining or, for swing voters, switching their vote. While these voters take the option value of waiting into account, their trade-off is not the socially optimal one because they do not consider their own impact on the outcome of the election. This externality is at the heart of the potential inefficiency of early voting. These voters only act on their own expressive utility and do not account for how their choice to vote with incomplete information affects all other voters' outcome utility.

To study the welfare implications of early voting, I focus on the outcome utility of the median voter and the aggregate voting cost paid by all voters. I detail three potential reasons for "bad" election outcomes in this context. The first two serve as reasons that early voting may be detrimental to social welfare: first, if the election outcome is decided by early voting, then the outcome will not reflect any late-election information. Second, even if the election is decided on election day, the median voter may not be the decisive voter due to differential "banking" of early votes by one candidate, meaning the outcome may not align with the median voter's preferences. The third reason highlights why early voting may be beneficial to social welfare: suppose that election day voting costs are correlated with ideological preferences.[1] Then, even if the election is decided on election day, it may be decided by an unrepresentative electorate. Here, early voting is beneficial to social welfare because it offers high-cost voters an opportunity to turn out, making the electorate more representative.

I show that early voting increases social welfare when there is a sufficient difference in ideological groups' election day voting cost distributions, to the extent that early voting raises the turnout of the majority relative to the minority. Early voting decreases social welfare when late-election information is sufficiently large since weak partisans and swing voters who vote early do not incorporate this late-election information into their vote. A cost of early voting which is low enough to incentivize strong partisans (whose behavior is unaffected by late-election information) to vote early but not low enough to convince weak partisans and swing voters to do the same *may* be welfare-best, depending on the difference in election day cost distributions and the size or relevance of late-election information.

[1]This assumption has empirical grounding: Chen et al. [2022] and Quealy and Parlapiano [2021] show that voters in poorer, less white neighborhoods face significantly larger voting wait times.

I find that late-election information can affect voter behavior along both the intensive (vote-switching) and extensive (turnout) margins. A body of empirical work has leveraged the idea that convenience voters and election day voters face different information environments [Meredith and Malhotra, 2011] to establish that late-election information can impact election outcomes [McCrary, 2025, Graham and Svolik, 2020, Montalvo, 2011]. The results in this paper provide a theoretical underpinning for the findings in this literature, identifying two distinct mechanisms through which late-election information can affect election results.

There exists a somewhat related literature on sequential voting, where information on earlier voters' choices is known to later voters [Dekel and Piccione, 2000, Battaglini, 2005, Battaglini et al., 2007, Deltas et al., 2016]. Most similar to this paper is Dekel and Piccione [2014], which models the endogenous timing of early voting in such a framework. However, in these models, the incentive to vote early stems from the influence one could have on later voters, either through "narrowing the field" of candidates or signaling some information with one's vote choice. Instead, in my model, early voters' choices are not revealed to later voters – the incentive to vote early comes from the desire to face a lower cost of voting, highlighting the trade-off between the cost of voting and full information. This is the first paper to study this trade-off and its implications for social welfare.

Building on models of expressive [Brennan and Hamlin, 1998, Hamlin and Jennings, 2011] and costly [Palfrey and Rosenthal, 1983, Ledyard, 1984] voting, the model illuminates how the individual's decision to vote early or not affects social welfare. Consequently, it is related to a broad literature studying optimal electoral institutions, including works that study welfare in the context of sequential elections [Hummel and Holden, 2014, Hummel and Knight, 2015] and costly voting [Börgers, 2004, Krasa and Polborn, 2009]. Institutions are a key factor in a voter's decision to vote early or not: a voter cannot vote early if her state does not provide the option to do so. Recently in the U.S., many states have moved to expand early voting access and many others have moved to restrict it. In a time where convenience voting laws are hotly debated in state legislatures, understanding the welfare implications of convenience voting is of the upmost importance.

2 Model Setup and Discussion

The objective of my model is to study how late-election information might affect voters' decisions regarding which candidate to vote for and whether to vote at all. To do so, I build on models of expressive voting and endogenous participation. Section 2.1 gives the formal setup of the model. Section 2.2 discusses the model setup in relation to this objective.

2.1 Formal Setup of the Model

Suppose there exists a continuum of voters and two candidates, L and R. Each candidate is endowed with a policy position in one dimension, x_j, and some valence, $v_j \in \mathbb{R}$. Let candidates' policy positions be given by $x_L = -1$ and $x_R = 1$.

The electorate consists of many citizens: each have their own bliss point $\theta \in \mathbb{R}$, according to some type distribution where $F_\theta(\cdot)$ is the cumulative distribution function.[2] A citizen's expressive utility is given by

$$u(x_j, x_{-j}, v_j, v_{-j}, \theta) = \begin{cases} m + (x_{-j} - \theta)^2 - (x_j - \theta)^2 + (v_j - v_{-j}) - c & \text{if vote for candidate } j \\ 0 & \text{if abstain,} \end{cases}$$

where $m > 0$ is the "warm-glow" utility from voting and c is the cost of voting. Note that a voter's expressive utility has four components: warm-glow, ideological $((x_{-j} - \theta)^2 - (x_j - \theta)^2)$,

[2] I allow $|\theta| > 1$, so that citizens can hold more extreme policy preferences than the candidates' set positions.

candidate valence $(v_j - v_{-j})$, and the cost of voting.

The true valence of each candidate is unknown prior to election day, representing the possibility of late-election information. Let v_L and v_R each be distributed over some interval $[-v, v]$, for sufficiently large v. Consider v indicative of the potential "size" of the late-election information. A large v means valence shocks could be quite extreme; a small one means valence shocks will be minute and unimportant. Assume that $\mathbb{E}[v_L - v_R] = 0$, so that the ex ante assumption of voters is that candidates do not differ in valence.

To simplify the cost distribution as much as possible, let c be a discrete random variable distributed according to the cdf F_C such that

$$c = \begin{cases} c_L & \text{with probability } q \\ c_H & \text{with probability } 1 - q, \end{cases}$$

where $0 < c_L < c_H$. Suppose that $c_H > m + 2v + 4\max\{\theta\} > c_L$, where $m + 2v + 4\max\{\theta\}$ is the maximum expressive voting utility, so that no one ever votes on election day if the realized voting cost is $c = c_H$.[3] Suppose that prior to election day, voters have uncertainty over the true values of c, v_L, and v_R; on election day, voters learn the true values.[4]

[3] In order to guarantee that there will be some cases where citizens abstain under $c = c_L$ and some cases where they vote, I assume the following throughout this section: $m < c_L < m + 2v$. The assumption $m < c_L$ means that warm-glow alone cannot drive turnout. The assumption $c_L < m + 2v$ means that an individual with a bliss point exactly at 0 (i.e., a voter ideologically indifferent between the two candidates) would turn out to vote for the candidate who has the larger valence.

[4] I make the assumption that the exact values are known to voters for simplicity of exposition. Of course, one could argue voters may never be fully informed of candidate valence; merely assuming that voters have less uncertainty regarding v_L and v_R on election day should generate similar predictions to those derived below.

2.2 Discussion of the Model

Traditional costly voting models predict a turnout rate of zero in large elections. Models of endogenous participation can come to more realistic turnout predictions by assuming that citizens vote expressively, meaning that no voter expects their vote to be pivotal. This can be accomplished by assuming citizens enjoy the act of voting itself, i.e. they receive some warm-glow utility from voting. However, warm-glow utility alone would not allow voters to be motivated by the release of late-election information. As such, I assume that citizens' utility depends on candidate valence, some quality independent of policy position (trustworthiness, competence, etc.) which represents late-election information in my model.

One can imagine that a voter's response to late-election information depends on the strength of her ideological beliefs. For example, negative information regarding a candidate on the left may prompt a left-leaning, but moderate, voter to vote for the candidate on the right instead. However, that same information may lead a left-leaning voter with stronger ideological preferences to simply abstain, as she would never vote for the candidate on the right. In order to draw out these different behavioral predictions, I assume each voter has some ideal policy and that candidates are endowed with (fixed) policy positions.

It is also possible that voters respond to information regarding not just their ideologically-preferred candidate, but the one they are ideologically further from as well. As such, I assume voters derive utility from the difference in payoffs she receives from the candidate she votes for and the candidate she does not. This mirrors conventional knowledge of how voters behave: consider a U.S. election where the two prominent candidates are a centrist Democrat and a far-right Republican. In such a race, many far-left voters would cast their vote for the Democrat. A model considering only the absolute ideological utility $(-(x_j - \theta)^2)$ would not predict that far-left voters turn out for someone so distant from their ideal point. Instead, these voters likely consider the *difference* in payoffs of endorsing the Democrat's policies over the Republican's. This applies not just to ideology, but valence issues too: voters' actions are not just driven by the valence of the candidate they prefer.

Before election day, there is uncertainty over both 1) the exact cost of voting and 2) the valence of each candidate. The former represents the unexpected troubles voters may face on election day: bad traffic, long lines, out-of-order voting machines. At times, such a large cost may occur that citizens abstain altogether. The latter illustrates the role of potential late-election information about candidates. In the weeks leading up to an election, candidates' policy positions are fairly set; however, October surprises can arise just before election day and shift perceptions of candidates. On the day of the election, all of these components are known to voters.

It is important to note that in this model, information shocks are exogenous. While it is true that politicians have incentives to strategically time the release of private information [Gratton et al., 2018, Gindin and Shimko, 2022], this candidate-supplied information will not be affected much by whether or not early voting is available. With the introduction of early voting, candidates would simply release this information earlier. Instead, this model focuses on information released by media and late-breaking events which might affect election outcomes. The release of this kind of information would not be moved earlier with the introduction of early voting because its release is not strategic.

Note that I employ expressive utility to generate realistic predictions of political participation. However, voters clearly derive some utility from the outcome of the election, which is important to social welfare. I argue that this outcome utility does not matter for a citizen's voting behavior (whether to turn out or not), but it is felt by all citizens, whether they vote or not: consider those who do not vote but are very much impacted by the policies of elected officials. I focus on this outcome utility in Section 4, where I analyze welfare.

3 Analysis

3.1 Election Day

On election day, when an individual knows the realizations of candidate valences and election day voting cost, she solves the following:

$$\max\{m + (x_R - \theta)^2 - (x_L - \theta)^2 + \Delta v - c, m + (x_L - \theta)^2 - (x_R - \theta)^2 - \Delta v - c, 0\}, \quad (1)$$

where $\Delta v \equiv v_L - v_R$ is L's relative valence. The solution to this problem for a voter with bliss point θ is described in the proposition below.

Proposition 1. *Suppose a voter with bliss point θ draws cost $c = c_L$ on election day. Then, she will vote for candidate R if and only if $\Delta v < 4\theta + m - c_L \equiv \Delta v_R$, vote for candidate L if and only if $\Delta v > 4\theta + c_L - m \equiv \Delta v_L$, and abstain otherwise.*

The proof can be found in the appendix. Each voter has threshold values for candidates' relative valences: they require a candidate's relative valence to be sufficiently "good" in order to vote for them. These thresholds are easier for candidate L to meet the further left a voter's bliss point is (and similarly for candidate R). Three distinct types of voter behavior arise endogenously from the model's setup. These behavior types are defined by their election day behavior – namely, how they incorporate late-election information into their votes. The following corollaries describe each behavior type.

Corollary 1. *If $\theta > \frac{1}{4}(c_L - m) + \frac{v}{2}$ ($\theta < \frac{1}{4}(m - c_L) - \frac{v}{2}$), then $\Delta v < 4\theta + m - c_L$ ($\Delta v > 4\theta + c_L - m$, resp.) for all realizations of Δv. Thus, the voter will always vote for candidate R (L, resp.) on election day (given she draws $c = c_L$) and is called a "strong partisan."*

Corollary 2. *If $\frac{v}{2} < \theta < \frac{1}{4}(c_L - m) + \frac{v}{2}$ ($\frac{1}{4}(m - c_L) - \frac{v}{2} < \theta < -\frac{v}{2}$), then $\Delta v < 4\theta + c_L - m$ ($\Delta v > 4\theta + m - c_L$, resp.) for all realizations of Δv. Thus, the voter will never vote for* *candidate L (R, resp.) on election day. She will vote for candidate R (L, resp.) whenever* $\Delta v < 4\theta + m - c_L$ ($\Delta v > 4\theta + c_L - m$, *resp.) – given she draws* $c = c_L$ *– and will abstain otherwise. This voter is called a "weak partisan."*

Corollary 3. *If* $0 < \theta < \frac{v}{2}$ ($-\frac{v}{2} < \theta < 0$)*, then the voter does not always prefer R (L, resp.) on election day: sometimes the utility from voting for candidate L (R, resp.) will be greater than the utility from voting for candidate R (L, resp.). This voter is called a "swing voter."*

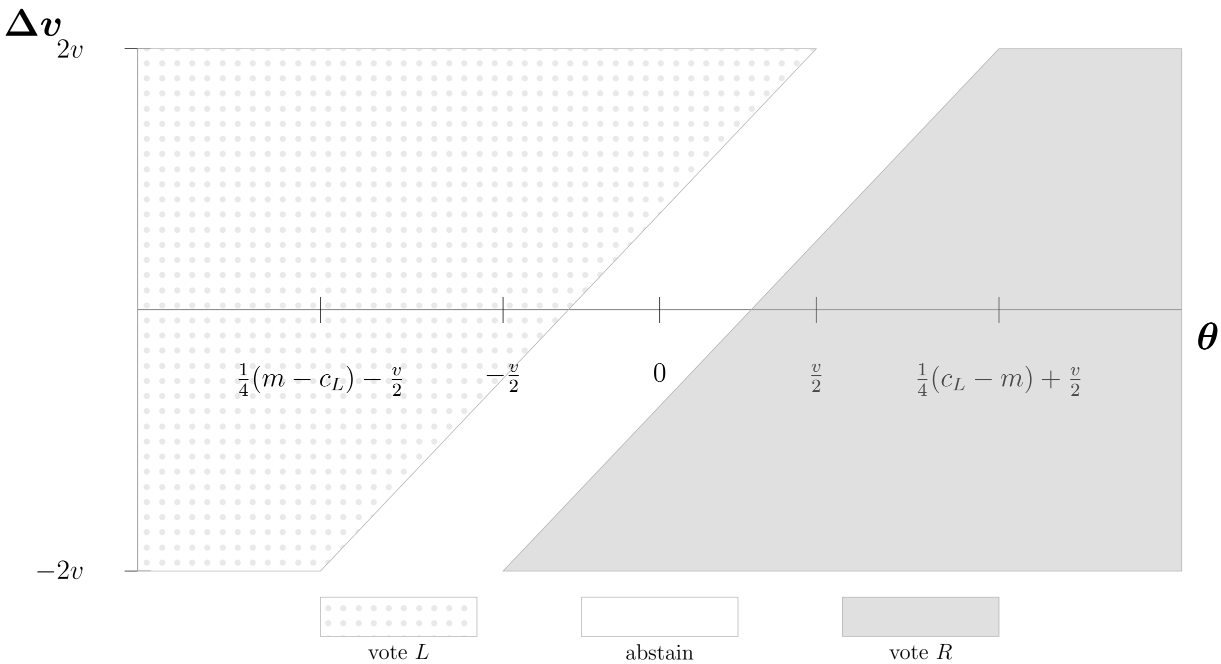
Corollary 4. *Note that* $|\theta_{strong\ partisan}| > |\theta_{weak\ partisan}| > |\theta_{swing\ voter}|$.

The proofs for Corollaries 1-4 can be found in the appendix. Strong partisans prefer the candidate they are ideologically closer to – no matter the realization of late-election information – and only abstain when they face election day cost c_H. Weak partisans always prefer the candidate they are ideologically closer to. However, they can abstain (even when facing cost c_L) for some valence realizations, but they will never switch their vote to the candidate ideologically further from them. Finally, swing voters would vote for the candidate they are ideologically further from for *some* realizations of the valence shocks. The distinction between behavior types comes directly from differing ideal points. Naturally, strong partisans have the most extreme bliss points, and swing voters have the most moderate ones.

Note that (weak) partisans are only influenced by late-election information in its capacity to determine their turnout decision: particularly bad information about their ideologically-preferred candidate may drive some partisans to stay home instead, for example. Strong partisans do not consider late-election information at all. Swing voters, however, are affected along another dimension besides turnout: negative revelations about their ideologically-preferred candidate may lead them to vote for the other candidate, something a partisan would never do. Recall that since voters derive utility from the difference in candidates' valence, particularly good information about the candidate the voter is ideologically further from can also lead to partisan abstention or vote-switching from the swing voter.

Each of these behavior types' solution to the problem faced on election day (shown in Equation 1) looks different: the same valence realization may lead a swing voter to vote against her ideological interests and a weak partisan to abstain altogether. Election day behavior for each type is characterized in Corollaries 1-3 and displayed in Figure 1.

Figure 1: Election day behavior: voter behavior types



Notes: This figure displays election day behavior for each behavior type along the policy spectrum, assuming the voter has drawn $c = c_L$. Left-leaning (strong) partisans have bliss points $\theta < \frac{1}{4}(m - c_L) - \frac{v}{2}$, left-leaning (weak) partisans have bliss points $\frac{1}{4}(m - c_L) - \frac{v}{2} < \theta < -\frac{v}{2}$, left-leaning swing voters have bliss points $-\frac{v}{2} < \theta < 0$, and so on. Note that left (right)-leaning voters can have ideal points to the left (right) of $x_L = -1$ ($x_R = 1$, resp.).

First, as mentioned above, strong partisans' election day behavior is trivial: they vote for their ideologically-preferred candidate if they face cost $c = c_L$ and abstain if they face cost $c = c_H$. Next, consider the left-leaning weak partisan. Recall that she will never vote for candidate R: she will vote L or abstain. Note that both positive late-election information about L and negative late-election information about R make the left-leaning weak partisan more likely to turn out and vote. This is because utility depends on the difference in candidates' valence: even late-election information that is solely about R, the candidate the left-leaning weak partisan would never vote for, can have an effect on her choice to turn out or abstain.

Then, a left-leaning weak partisan with bliss point θ abstains with probability $1 - q[1 - \mathbb{P}(\Delta v \leq \Delta v_L)]$.[5] The threshold (and thus the probability of abstaining) is decreasing in m and increasing in c_L. Notably, the likelihood of abstention decreases as one's policy preferences become more extreme (i.e., as $|\theta|$ increases). The expected utility of a left-leaning weak partisan on election day is simply the probability that she faces cost $c = c_L$ multiplied by the likelihood her utility from voting L would outweigh the cost, c_L, times the utility she would receive from doing so (conditional on that utility being large enough that she would do so).

The left-leaning swing voter faces a slightly more complicated problem: depending on the realizations of election day cost and relative valence, she may vote for L, vote for R, or abstain. Like the weak partisan, the valence realizations may render her indifferent enough between the two candidates such that she decides to abstain entirely. However, since she is more ideologically moderate than the weak partisan, sufficiently good information about candidate R (and/or sufficiently bad information about candidate L) may push her to vote against her ideological interests on election day.

Then, a left-leaning swing voter with bliss point θ abstains with probability $1 - q[1 - \mathbb{P}(\Delta v_R \leq \Delta v \leq \Delta v_L)]$.[6] The probability of abstaining is decreasing in m and increasing in c_L. Additionally, the likelihood of abstention increases as a citizen's policy preferences become more moderate (i.e., as $|\theta|$ grows closer to 0). The expected utility of a left-leaning swing voter on election day is the probability that she votes, multiplied by the utility she

[5] This comes from $\mathbb{P}(c = c_L)\mathbb{P}(\Delta v \leq 4\theta + c_L - m) + \mathbb{P}(c = c_H) \cdot 1$, where $\mathbb{P}(c = c_L) = q$ and $4\theta + c_L - m = \Delta v_L$.

[6] This comes from $\mathbb{P}(c = c_L)(\mathbb{P}(4\theta + m - c_L \leq \Delta v \leq 4\theta + c_L - m)) + \mathbb{P}(c = c_H) \cdot 1$, where $\mathbb{P}(c = c_L) = q$, $4\theta + m - c_L = \Delta v_R$, and $4\theta + c_L - m = \Delta v_L$.

would receive from doing so (there are two cases for the swing voter: one where she votes for R and one where she votes for L).

I summarize all behavior types' election day behavior below in Proposition 2. The proof can be found in the appendix, but the logic is as follows: suppose some voter votes for L on election day. Then, certainly another voter to her left would also vote for L (given she draws the low cost). The late-election information shifts all voters' preferences in the same direction.

Proposition 2. *Suppose that a voter with $\tilde{\theta}$ votes for L on election day. Then, any voter with $\theta < \tilde{\theta}$ who draws $c = c_L$ also votes for L on election day. Similarly, suppose that a voter with $\tilde{\theta}$ votes for R on election day. Then, any voter with $\theta > \tilde{\theta}$ who draws $c = c_L$ also votes for R on election day.*

The above characterization of election day behavior describes how all voters incorporate late-election information into their vote. However, not all ballots are cast on election day. How do voters behave if they do not yet know the late-election information? When will they choose to vote early, and when will they choose to wait until election day? In the following section, I introduce early voting into the model to answer these questions.

3.2 Early Voting

In the previous section, citizens only had the option to vote on election day, at which point any late-election information is public knowledge. Citizens are fully informed of each candidate's valence and can act to maximize their ex post utility. However, voting may be too costly on election day, leaving citizens unable or unwilling to vote. Many citizens might wish to avoid this risk and guarantee themselves a set, lower voting cost – something offered by early voting.

Consider an election with the same setup as above, but with one modification: a period of voting that occurs prior to election day. In this first period (called the early voting period), citizens may vote and pay a cost $c' < c_H$. This cost is less than what voters could see on election day, offering citizens a way to mitigate risk. However, late-election information (i.e., the realizations of v_L and v_R) is not yet known: voters who cast their ballot early are unable to consider relative valence and can only maximize their ex ante utility. This is the key trade-off of early voting: it offers a (potentially) lower cost of voting but leaves voters without full information.

A voter who casts her ballot early will vote for the candidate who maximizes her ex ante utility. Since valence is unknown at this point (and $\mathbb{E}[\Delta v] = 0$ by assumption),[7] she votes for the candidate whose policy she prefers. That is, voters with $\theta < 0$ vote for L and voters with $\theta > 0$ vote for R. Recall that voters need not vote early, though: they can choose to wait until election day. Therefore, in the first period, citizens have three options: vote early for L, vote early for R, or wait until election day. If they wait until election day, they maximize their ex post utility (i.e., they act according to the characterizations from Section 3.1). As such, in the early voting period, an individual solves

$$\max\{m + 4\theta - c', m - 4\theta - c', \mathbb{E}[u| \text{ wait until election day}]\}, \tag{2}$$

where $\mathbb{E}[u| \text{ wait until election day}]$ is the expected utility of a voter if she waits until election day, derived in Section 3.1. As above, I characterize the behavior of (left-leaning) strong partisans, weak partisans, and swing voters separately.

A left-leaning strong partisan will vote early if and only if the ex ante utility of voting for L outweighs her expected maximized ex post utility. Since she will always vote for L as long as she faces $c = c_L$ on election day, there is no benefit to waiting. In particular, she votes

[7] One could consider an extension of the model which relaxes this assumption to allow some initial information on the candidates' valence. In theory, all this initial information would do is shift the populations who vote early for L and R to not necessarily directly correspond to ideological preferences.

early if and only if

$$c' < (1-q)[m-4\theta] + qc_L. \tag{3}$$

The first term on the right-hand side is the expected opportunity cost of waiting: if the strong partisan votes early, she forgoes receiving $m - 4\theta$ with certainty and only receives it with the probability she votes on election day, q. The second term is the expected cost of voting on election day: q, the probability she faces $c = c_L$, times c_L. There is no opportunity cost of voting early (i.e., there is no option value to waiting), since her election day behavior does not depend on the realization of the valence shock.

A left-leaning weak partisan will vote early if and only if the ex ante utility of voting for L outweighs her expected maximized ex post utility. Since she would never vote for R no matter what the late-election information is, the only benefit of waiting until election day is the option to abstain as a protest of sorts. If she learns the relative valence is sufficiently negative for L, she might prefer to stay home than vote. In particular, she votes early if and only if

$$c' < [1 - q(1 - F_{\Delta v}(\Delta v_L))][m - 4\theta] + q(1 - F_{\Delta v}(\Delta v_L))c_L - q\int_{\Delta v_L}^{2v} \Delta v f_{\Delta v}(\Delta v) d\Delta v. \tag{4}$$

Note that the first term on the right-hand side is the expected opportunity cost of waiting: if the voter chooses not to vote early, she gives up getting $m - 4\theta$ with certainty and only receives it with the probability she ends up voting on election day, $q(1 - F_{\Delta v}(\Delta v_L))$. The second term represents the expected cost of voting on election day: the election day voting cost, multiplied by the probability the voter will vote. Finally, the expected opportunity cost of voting early is subtracted: rather than receiving $\mathbb{E}[\Delta v | \Delta v > \Delta v_L]$ with the probability that she votes for L on election day, the voter gets $\mathbb{E}[\Delta v] = 0$ if she votes early.

A left-leaning swing voter will also vote early if and only if the ex ante utility of voting for L outweighs her expected maximized ex post utility. However, she must consider that she will have *two* more options on election day: abstention or switching her vote and voting for R. As such, she votes early if and only if

$$\begin{aligned} c' &< [1 - q(1 - F_{\Delta v}(\Delta v_L))][m - 4\theta] + qc_L[F_{\Delta v}(\Delta v_R) + 1 - F_{\Delta v}(\Delta v_L)] \\ &\quad - q[\int_{\Delta v_L}^{2v} \Delta v f_{\Delta v}(\Delta v) d\Delta v + \int_{-2v}^{\Delta v_R} -\Delta v f_{\Delta v}(\Delta v) d\Delta v] - qF_{\Delta v}(\Delta v_R)[m + 4\theta]. \end{aligned} \tag{5}$$

Here, the first term on the right-hand side gives the expected opportunity cost of waiting: if the voter chooses not to vote early, she gives up getting $m - 4\theta$ with certainty and only receives it with the probability she ends up voting for L on election day, $q(1 - F_{\Delta v}(\Delta v_L))$. The second term represents the expected cost of voting on election day: the election day voting cost, multiplied by the probability the voter will vote. Finally, we subtract off the expected opportunity cost of voting early: rather than receiving $\mathbb{P}(\text{vote } L) \cdot \mathbb{E}[\Delta v | \Delta v > \Delta v_L] + \mathbb{P}(\text{vote } R) \cdot \mathbb{E}[-\Delta v | \Delta v < \Delta v_R]$ if she voted on election day, the voter gets $\mathbb{E}[\Delta v] = 0$ if she votes early. In addition, she gives up receiving $m + 4\theta$ with the probability that she votes for R on election day if she chooses to vote early.

Ultimately, the decision to vote early or not boils down to a simple equation for both partisans and swing voters: a voter votes early if and only if the sum of the actual and expected opportunity costs of voting early is less than the sum of the expected actual and opportunity costs of voting on election day. Then, a low cost of early voting (c') or low opportunity cost of early voting (the difference in expected relative valence one receives if voting early versus on election day) makes voters more likely to cast their ballot before election day, i.e. without knowledge of the candidates' relative valence. Note that some voters have more to gain by waiting and learning this late-election information. Since all voters pay the same voting cost, this difference comes from the *opportunity costs*. In particular, swing voters and weak partisans have an option value of waiting and strong partisans do not.

Proposition 3. *Suppose that a voter with $\tilde{\theta} > 0$ votes early for R. Then, any voter with $\theta > \tilde{\theta}$ votes early for R as well. Likewise, for any voter with $\tilde{\theta} < 0$ that votes early for L, any voter with $\theta < \tilde{\theta}$ votes early for L as well.*

The proof is in the appendix. The above is clear intuitively: strong partisans (who have the most extreme bliss points) have nothing to gain from waiting until election day, since late-election information does not impact their actions. Weak partisans have less to gain from waiting until election day than swing voters do, as the late-election information would never cause them to switch their vote (like it might for swing voters). Notably, this means the cost threshold for early voting is higher for partisans than it is for swing voters: if swing voters vote early, then so do partisans.

The decision of whether (and for whom) to vote is only driven by expressive voting. As discussed above, voters also receive utility from the election outcome. This outcome utility does not impact voters' behavior (they do not believe their vote has any impact on the outcome), but it does matter for social welfare. I focus on social welfare and how it is affected by early voting in the following section.

4 Welfare

The voters in this model balance a trade-off between a lower cost of voting and voting with full information: early voting limits a voter's ability to react to late-election information, which can matter for election outcomes. I now turn to the key question behind this paper: what are the welfare implications of early voting? Would society benefit from increased access to early voting and the expansion of convenience voting laws, or is early voting already too convenient?

So far, I have shown how single-person optimization problems can be used to characterize how individuals behave on election day and, when they have the option, during periods of early voting. However, as the ultimate goal of any election is to combine individuals' preferences and decide some *outcome*, it is important to determine whether this outcome is something the individuals are ultimately pleased with. This requires assigning voters some utility derived from the winner of the election (not just from the act of voting for a candidate): let a citizen's "outcome utility" be given by

$$u(x_w, v_w, \theta) = v_w - (x_w - \theta)^2$$

where candidate w is the winner. Citizens receive this utility regardless of which candidate they voted for (or if they voted at all).

In order to study the welfare implications of early voting, I focus on the outcome utility of the median voter and the aggregate voting cost (i.e., the sum of costs paid by all who vote). If the type distribution $F_\theta(\cdot)$ were symmetric around the median voter, then maximizing the ex ante outcome utility of the median voter would be equivalent to maximizing the utilitarian outcome utility (i.e., the sum of all voters' ex ante outcome utilities). Most of the interesting cases in the early voting dilemma arise when the distribution is asymmetric. However, focusing on the utilitarian outcome utility would bring the focus to intensity of preferences, something I wish to abstract away from in the context of this model. That is to say, the main insights of this model should not be driven by the intensity of voters' preferences but rather the tension between full information and lower costs.

By focusing on the ex ante utility of the median voter, the question becomes: if the electorate were offered a referendum on whether to allow early voting or not, what would the outcome of this referendum be? This notion of efficiency is related to the notions of majority-efficiency and competition-efficiency in Krasa and Polborn [2010a] and Krasa and Polborn [2010b]; i.e., is it possible to make a majority of voters better off than they are in equilibrium? Studying the aggregate voting cost does not lead to these same "intensity" issues as voting costs are comparable across voters. Focusing on just the cost paid by the median voter would not necessarily be representative of the experience of the entire electorate.

4.1 Welfare Objective #1: Median Voter's Outcome Utility

Define the median voter as an individual with bliss point θ_M such that $F_\theta(\theta_M) = \frac{1}{2}$; that is, her bliss point is the median of the type distribution. Then, the outcome utility of the median voter (called Welfare Objective #1) is

$$W_1(\theta_M) = v_w - (x_w - \theta_M)^2.$$

We can determine the winner of the election according to the behavior of the median voter as follows: note that, for any election, there exist cutoffs $\theta_1 < 0$, $\theta_2 > 0$ such that any voter with $\theta \leq \theta_1$ or $\theta \geq \theta_2$ votes early (see Proposition 3). If the median voter has a bliss point more extreme than these cutoffs (i.e. $\theta_M < \theta_1$ or $\theta_M > \theta_2$), she votes early; consequently, whichever candidate she votes for will win.[8]

If the median voter waits until election day, i.e. $\theta_1 < \theta_M < \theta_2$, then she is still the median voter after preferences are adjusted for late-election information (as the valence shock moves all voters' preferences in the same direction). The median voter now acts to maximize her ex post expressive utility: after observing the late-election information and election day voting costs, she can vote for L, vote for R, or abstain. If she does vote on election day, then

[8] Suppose $\theta_M < \theta_1$. Then, the median voter votes early for L since $\theta_M < 0$. All voters to the left of the median voter also vote early for L by Proposition 3. Thus, L wins.

whoever she casts her ballot for wins.[9]

If instead the median voter abstains on election day, denote the median bliss point of those who *do* vote (including those who voted early) as θ'_M. If $\theta'_M < \theta_M$, then L wins; if $\theta'_M > \theta_M$, then R wins.[10,11]

4.2 Welfare Objective #2: Aggregate Voting Cost

The second welfare objective is minimizing the aggregate voting cost of voters. Addressing costly voting is a primary motivator for policy-makers to offer early voting and certainly an objective that matters for social welfare. However, unlike with the first objective, I do not focus on the experience of the median voter alone. One voter's cost of voting is not necessarily representative of the experience of the entire electorate. Policy-makers cannot credibly claim to have "solved costly voting" by ensuring a singular voter faces a low cost. Therefore, I consider the aggregate voting cost, i.e. the sum of all costs paid by those who choose to vote.

Here, I also include the sum of expressive utilities from all voters. Although I do not wish for my welfare results to be driven by intensity of preferences, simply aiming to minimize the aggregate voting cost would imply that fewer voters is better from a welfare perspective. This is, of course, not the goal of convenience voting policies – a welfare function that assumes that the welfare-best outcome is one where very few citizens vote is not appropriate here.

[9] Suppose the median voter votes for L on election day. Then all voters to the left of her vote for L too – those with $\theta < \theta_1$ voted early for L by Proposition 3 and those with $\theta_1 < \theta < \theta_M$ vote for L on election day by Proposition 2. Then, L wins.

[10] Suppose $\theta'_M < \theta_M$. Then, it must be that the voter with θ'_M votes for L – if she voted for R, then type θ_M would also vote for R by Proposition 2. All voters with $\theta < \theta'_M$ vote for L too – those with $\theta < \theta_1$ by Proposition 3 and those with $\theta_1 < \theta < \theta'_M$ by Proposition 3. Then, L wins.

[11] Note that this case is concerned with abstentions due to the late-election information and not when the median voter is faced with election day cost c_H. If type θ_M draws voting cost c_H but would have voted had she drawn c_L, there is an identical voter with bliss point θ_M that draws c_L (since there is a continuum of voters) and so the outcome would be identical to the case where type θ_M draws c_L.

Therefore, the second welfare objective in an electorate of N voters is given by:

$$W_2(k_1, k_2, \hat{r}, \hat{\ell}) = m(k_1 + k_2) + \sum_{i=\hat{r}}^{N} 4\theta - \sum_{i=1}^{\hat{\ell}} 4\theta + \Delta v(\hat{\ell} - (N + 1 - \hat{r})) - k_1 \cdot c' - k_2 \cdot c_L,$$

where k_1 citizens vote early, k_2 citizens vote on election day, and $\hat{r}$ ($\hat{\ell}$) gives the index of the left (right)-most voter who votes for R (L) in either period (early or on election day). All who cast a ballot (given by $k_1 + k_2$) receive m, all who vote early (k_1) pay cost c', and all who vote on election day (k_2) pay cost c_L.[12] Everyone who votes for L receives $\Delta v \equiv v_L - v_R$: this number is given by $\hat{\ell}$, the index of the right-most voter who votes for L. Similarly, everyone who votes for R ($N + 1 - \hat{r}$ voters) receives $-\Delta v$. Finally, recall that the ideological expressive utility is 4θ for those who vote for R and -4θ for those who vote for L; the welfare function above aggregates these over all who vote for R and L, respectively.

4.3 Election Decided by Early Voting

One potential issue with early voting arises if the election is decided in the early voting period. This occurs if the difference in early votes garnered by the two candidates is larger than the maximum number of (expected) votes remaining on election day (i.e., the number of voters who waited times q, the probability that a voter receives the low cost). If this is true, then late-election information is not at all influential to the outcome of the election, and the winner may not maximize the median voter's outcome utility.

Figure 2 shows an example: if 45% of the electorate votes early for L and 15% votes early for R, then L leads R by 30% of the electorate. This means R needs the votes of at least $\frac{3}{4}$ of

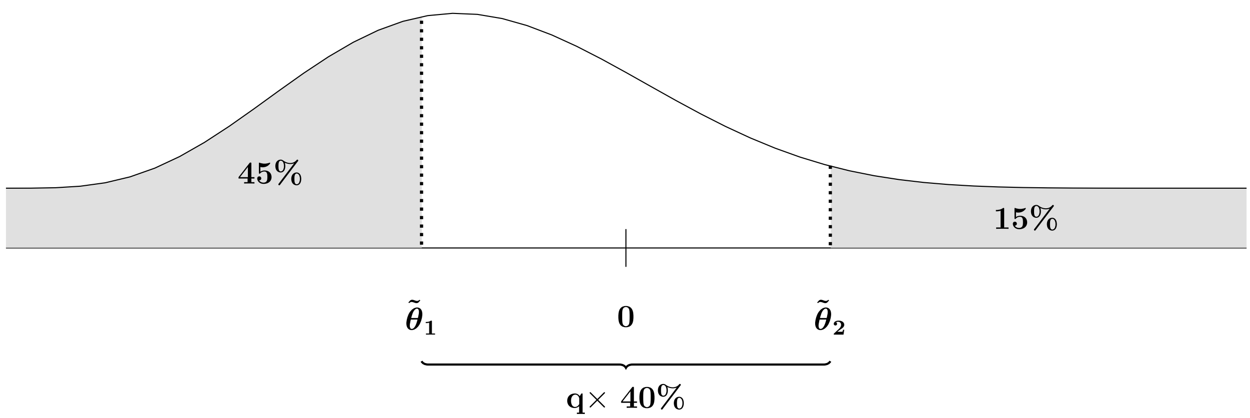
[12] The index $\hat{r}$ can be found as follows: denote as $\hat{r}_1$ the index of the cutoff for early voting for those with $\theta > 0$, i.e., all types with $\theta > \theta_{\hat{r}_1}$ vote early for R. Denote as $\hat{r}_2$ the index of the cutoff for those who vote for R on election day: i.e., all types with $\theta > \theta_{\hat{r}_2}$ vote for R on election day. Denote $\hat{\ell}_1$ and $\hat{\ell}_2$ similarly. Then, the left-most voter who votes for R in any period is $\hat{r} \equiv \min\{\hat{r}_1, \max\{\hat{r}_2, \hat{\ell}_1\}\}$. Similarly, the right-most voter who votes for L in any period is $\hat{\ell} \equiv \max\{\hat{\ell}_1, \min\{\hat{\ell}_2, \hat{r}_1\}\}$.

the 40% of the electorate who waited. However, recall that not everyone who waits will be able to vote on election day: some voters will draw c_H and have to abstain. For any $q < \frac{3}{4}$, R will be unable to make up for the initial lead won by L: the election is decided by early voting. More generally, an election is decided by early voting whenever

$$q < \frac{|F_\theta(\tilde{\theta}_1) - (1 - F_\theta(\tilde{\theta}_2))|}{F_\theta(\tilde{\theta}_2) - F_\theta(\tilde{\theta}_1)}, \tag{6}$$

where $|F_\theta(\tilde{\theta}_1) - (1 - F_\theta(\tilde{\theta}_2))|$ is the early voting lead and $F_\theta(\tilde{\theta}_2) - F_\theta(\tilde{\theta}_1)$ is the number of citizens who wait until election day.

Figure 2: Election decided before election day



Notes: Suppose the distribution of types $F_\theta(\cdot)$ is given according to this graph and that $\tilde{\theta}_1$ and $\tilde{\theta}_2$ are such that 45% of the electorate votes early for L and 15% of the electorate votes early for R. Then, the maximum amount of votes a candidate can earn on election day is $q \times 40\%$ of the electorate's votes. It is therefore impossible for R to win (meaning the election is decided by early voting) whenever $q < \frac{30}{40} = \frac{3}{4}$.

4.4 Median Voter is Not Decisive

Even if the election is decided on election day, the outcome may not align with the median voter's preferences. This occurs if the median voter is not the decisive voter (i.e., the voter whose vote is pivotal to the election outcome). Consider a simple case where $c_L = m$, so that anyone who receives c_L will turn out on election day. The median voter is not necessarily decisive here: if candidate L earned many more early votes than candidate R did, then the decisive voter will lie to the left of the median voter, as L already has a large number of votes "locked in." Formally, the decisive voter, with bliss point θ_D, is defined as follows:[13]

$$F_\theta(\theta_D) = \frac{1}{2} + \frac{1-q}{2q}[1 - F_\theta(\tilde{\theta}_2) - F_\theta(\tilde{\theta}_1)]. \tag{7}$$

Note that if R receives more early votes than L, then $1 - F_\theta(\tilde{\theta}_2) > F_\theta(\tilde{\theta}_1)$, meaning $F_\theta(\theta_D) > \frac{1}{2}$, i.e. the decisive voter lies to the right of the median voter. Then, candidate R will win the election with a higher likelihood than the median voter would prefer – conflicting with Welfare Objective #1. Formally, consider the following proposition:

Proposition 4. *Suppose that the election is not decided by early voting and that $c_L = m$. Suppose that candidate R (L) receives more early votes than candidate L (R, resp.). Then, the decisive voter is shifted to the right (left, resp.) of the median voter, and candidate R (L, resp.) wins the election with a higher probability than the median voter prefers.*

The proof is in the appendix. In this section, I have shown that early voting can negatively impact social welfare even in cases where the election is not yet decided before election day. If one candidate differentially "banks" early votes, then she is able to win the election with a higher likelihood than the median voter would like. However, the introduction of early voting can be welfare-improving, as I will show in the following section.

4.5 None Vote Early: Correlated Costs and Preferences

Given the above sections, it may be tempting to think that an electorate with *no* early voting is welfare-maximizing – all citizens wait until election day and are fully informed of

[13] This comes from rearranging $\frac{F_\theta(\tilde{\theta}_1)+q[F_\theta(\theta_D)-F_\theta(\tilde{\theta}_1)]}{1-(1-q)[F_\theta(\tilde{\theta}_2)-F_\theta(\tilde{\theta}_1)]} = \frac{1}{2}$, where $F_\theta(\tilde{\theta}_1) + q[F_\theta(\theta_D) - F_\theta(\tilde{\theta}_1)]$ gives the total number of votes L receives and $1 - (1-q)[F_\theta(\tilde{\theta}_2) - F_\theta(\tilde{\theta}_1)]$ gives the total number of votes cast.

candidates' valence before casting their ballots. This relies on the idea that the group of voters which turns out to vote on election day is representative of the electorate's ex post preferences on election day. What if those who turned out to vote on election day were not representative of the electorate's preferences as a whole?

Voting in the U.S. is not mandatory, and many of those who choose to abstain cite the difficulty of casting a ballot as their reason: 58.8% of those who reported not voting in November 2018 in the CPS Voting and Registration supplement cited reasons pertaining to difficulty of voting [U.S. Census Bureau].[14] Clearly, election day voting costs serve as a barrier to voting for some citizens, no matter how excited they are about a candidate. Thus far, I have assumed that all voters face the same voting cost distribution on election day, which may not be true in the real world. In fact, it might be reasonable to assume that voting costs are correlated with ideological preferences: Chen et al. [2022] use evidence from smartphone data to show that in 2016, "relative to entirely-white neighborhoods, residents of entirely-black neighborhoods waited 29% longer to vote and were 74% more likely to spend more than 30 minutes at their polling place." An analysis from Cuebiq and The New York Times found that in 2020, "casting a vote typically took longer in poorer, less white neighborhoods than it did in whiter and more affluent ones" [Quealy and Parlapiano, 2021].

To incorporate this into the model, suppose that left and right-leaning voters draw their election day voting costs from two different distributions, F_{C_ℓ} and F_{C_r}, where

$$c = \begin{cases} c_L & \text{with probability } q_p \\ c_H & \text{with probability } 1 - q_p \end{cases}$$

for $p \in \{\ell, r\}$, where $q_\ell \neq q_r$. For example, if $q_\ell < q_r$, then left-leaning voters' election day voting cost distribution is right-shifted from right-leaning voters' distribution, disadvantaging

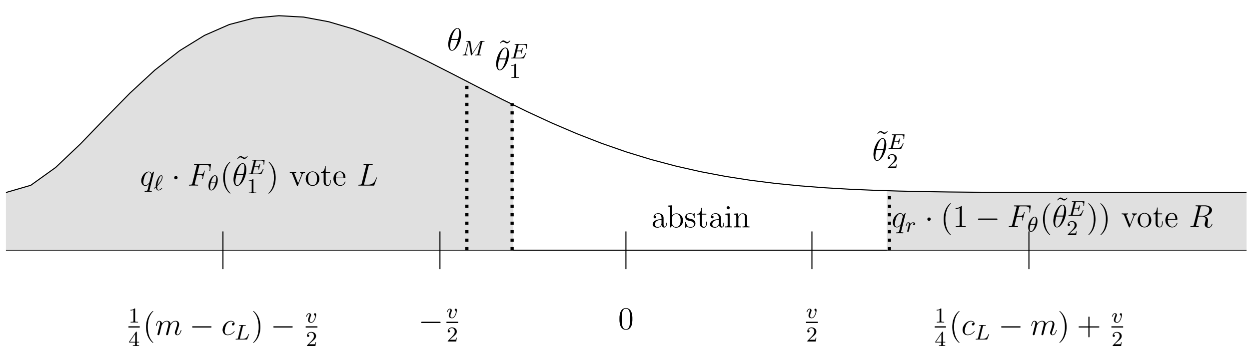
[14] These reasons are: Illness or disability, Out of town, Too busy/conflicting schedule, Transportation problems, Registration problems, Bad weather conditions, and Inconvenient polling place.

L. If left and right-leaning citizens face different costs of voting on election day, then the median voter may be *worse off* under election day voting than under early voting.

For example, suppose the electorate does not have the option to vote early and must wait until election day. Let $\theta_M < 0$ so that the distribution of voter types is skewed left. Consider a revelation of Δv such that types with $\theta < \tilde{\theta}_1^E$ vote for L if they receive c_L and types with $\theta > \tilde{\theta}_2^E$ vote for R if they receive c_L, and assume Δv is such that $\theta_M < \tilde{\theta}_1{}^E$, i.e. the median voter will vote for L upon receiving c_L.

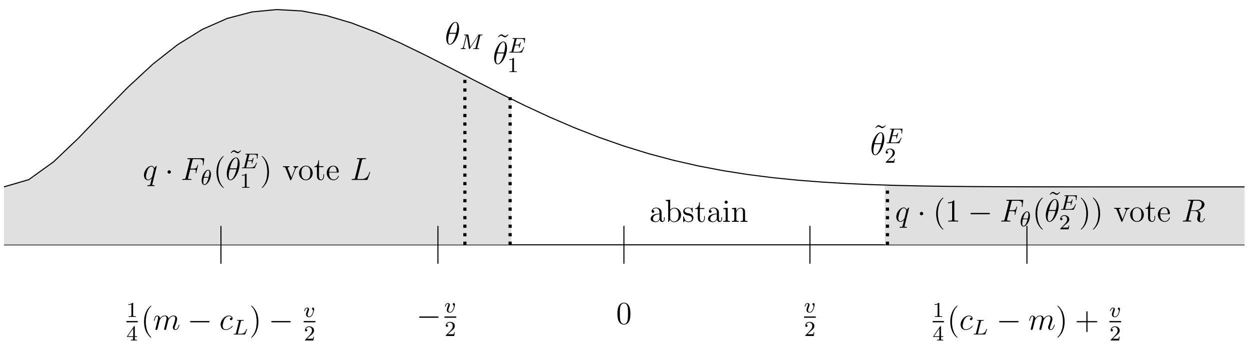
Now, suppose that $0 < q_r < 1$ and $q_\ell < \frac{1-F_\theta(\tilde{\theta}_2^E)}{F_\theta(\tilde{\theta}_1^E)} \cdot q_r$. Then, we have that $F_\theta(\tilde{\theta}_1^E) \cdot q_\ell < (1 - F_\theta(\tilde{\theta}_2^E)) \cdot q_r$, i.e., L receives fewer votes on election day than R does, even though more people would have voted for L had they received c_L. This can be seen in Figure 3: all types $\theta < \tilde{\theta}_1^E$ abstain with probability $1 - q_\ell$, which is sufficiently greater than the abstention probability of all types $\theta > \tilde{\theta}_2^E$, $1 - q_r$, such that R wins. Had all types faced an identical cost distribution, then L would have won instead (see Figure 4).

Figure 3: Correlated costs and preferences



Notes: Suppose the distribution of types $F_\theta(\cdot)$ is given according to this graph and that $v_L - v_R \equiv \Delta v = \frac{v}{2}$; the median voter's bliss point, θ_M, is then to the left of the cutoff to vote for L, $\tilde{\theta}_1^E$. Consider cost distributions where types $\theta > 0$ draw c_L with $0 < q_r < 1$ but types $\theta < 0$ draw c_L with probability $q_\ell < \frac{1-F_\theta(\tilde{\theta}_2^E)}{F_\theta(\tilde{\theta}_1^E)} \cdot q_r$. All types to the right of $\tilde{\theta}_2^E = \frac{1}{4}(c_L - m) + \frac{v}{8}$ vote R with probability q_r and all types to the left of type $\tilde{\theta}_1^E = \frac{1}{4}(m - c_L) + \frac{v}{8}$ vote L with probability q_ℓ. Since the cost differential (and thus, the probability of voting) is so large, R wins, even though more voters prefer L.

Figure 4: No correlation of costs and preferences



Notes: Suppose the distribution of types $F_\theta(\cdot)$ is given according to this graph and that $v_L - v_R \equiv \Delta v = \frac{v}{2}$. Here, suppose all voters face the same cost distribution and draw c_L with probability q. The median voter's bliss point, θ_M, is displayed. Then, all to the left of type $\tilde{\theta}_1^E = \frac{1}{4}(m - c_L) + \frac{v}{8}$ vote L with probability q (this includes the median voter) and all to the right of type $\tilde{\theta}_2^E = \frac{1}{4}(c_L - m) + \frac{v}{8}$ vote R. Then, L wins under this realization of Δv when all voters face the same election day voting cost distribution.

The outcome of the election thus differs in Figures 3 and 4, even though the valence realization is the same in each case. This notion is formalized in the proposition below (proof in appendix). If the ideological majority faces a worse cost distribution than the minority, the median voter may be better off in a scenario where all vote early so that voting costs are equalized. In the context of Welfare Objective #1, an improvement can be made by offering early voting. Additionally, an improvement can be made in terms of Welfare Objective #2 here too: if early voting is offered, then more left-leaning voters can now turn out to vote and obtain some expressive utility for a relatively low cost, and right-leaning strong partisans can choose a lower-cost method of voting as well.

Proposition 5. *Suppose that early voting is not offered (all citizens must wait until election day) and left (right)-leaning voters draw voting costs from F_{C_ℓ} (F_{C_r}). Consider $\tilde{\theta}_1^E < 0 < \tilde{\theta}_2^E$ and suppose that $\tilde{\theta}_1^E > \theta_M$. Then, L wins the election if and only if $q_\ell > \frac{1 - F_\theta(\tilde{\theta}_2^E)}{F_\theta(\tilde{\theta}_1^E)} \cdot q_r$.*

According to the above proposition, even if more voters in the electorate prefer L to R, if right-leaning voters have a sufficiently higher probability of drawing the low cost, R will win the election. The proposition can be written analogously for a median voter who would vote for R if she received c_L ($\theta_M > \tilde{\theta}_2^E$).[15] Waiting until election day offers voters the option to incorporate late-election information into their vote; however, a world without early voting is not necessarily a welfare-maximizing one if election day voting costs are correlated with ideological preferences, which may well be the case. There are certainly scenarios where early voting offers potential welfare improvements: to the extent that any cost reduction is likely larger for the high-cost group, and therefore is likely to increase the turnout of the high-cost group relative to the turnout of the low-cost group, convenience voting is beneficial from a welfare perspective. However, it is clearly not a Pareto improvement and is likely to be opposed by the party supported by more low-cost voters – offering a potential explanation for Republicans' opposition to convenience voting in the United States in recent years.[16]

5 Conclusion

Early voting poses a trade-off between easier access to the ballot and full information. Given this tension, one might wonder when early voting is welfare-improving. The model of voter behavior in this paper attempts to shed light on this question. Expressive voters are faced with the choice of voting early and paying a (potentially) smaller cost or waiting until election day and learning late-election information regarding the two candidates. Voters in the model might respond to late-election information on the extensive margin (voter turnout)

[15]Here, I focus on cases where the median voter feels strongly enough to vote. If she did not, then it is not a priori clear that equalizing voting costs across ideological preferences would lead to a different outcome. Additionally, the proposition can be generalized such that $\tilde{\theta}_1^E$ and $\tilde{\theta}_2^E$ need not be on either side of 0, but this would require imposing structure on the type distribution such that there are not so many swing voters voting against their ideological preferences that the differing cost distributions lose relevance.

[16]In 2021, fourteen states passed laws to restrict convenience voting access [Brennan Center for Justice at New York University School of Law, 2021]; thirteen of these fourteen states had Republican-controlled legislatures [The National Conference of State Legislatures]. According to surveys done by Pew Research Center, the share of Republicans who support no-excuse early or absentee voting fell 19 percentage points in less than three years, from 57% in Oct. 2018 to 38% in Apr. 2021. In contrast, the share of Democrats who support no-excuse early or absentee voting was 83% in Oct. 2018 and 84% in Apr. 2021 [Pew Research Center, 2021]. Partisan support remains virtually unchanged for convenience voting today, with 37% of Republicans and 82% of Democrats in favor as of May 2024 [Pew Research Center, 2024].

or intensive margin (vote-switching).

The model considers three types of voting behavior: first, strong partisans, who will always vote for their ideologically-preferred candidate if they draw a feasible voting cost and are therefore not influenced by late-election information. Next, weak partisans, who would never vote for the other candidate but might abstain in protest, and therefore can only be influenced on the extensive margin. Finally, swing voters, who may switch their vote upon learning certain late-election information, and therefore can be influenced on both the extensive and intensive margins.

Thus, weak partisans and swing voters create an externality when they vote early, as they do not consider their own impact on the outcome of the election: social welfare as determined by the outcome of the election would be improved if these voters waited and incorporated the late-election information into their vote. However, early voting can be welfare-improving: in particular, early voting is beneficial to society when 1) election day voting costs are correlated with ideological preferences and 2) late-election information is not too prevalent.

One potential solution to the trade-off of lower costs and full information is universal vote-by-mail, where all registered voters are automatically mailed a ballot each election. This system of voting does not require voters to cast their ballot too far in advance of election day (oftentimes, the ballot must be postmarked by election day itself), but it does lower voting costs – circumventing the tension created by early voting.

6 Appendix: Omitted Proofs

Proposition 1. *Suppose a voter with bliss point θ draws cost $c = c_L$ on election day. Then, she will vote for candidate R if and only if $\Delta v < 4\theta + m - c_L \equiv \Delta v_R$, vote for candidate L if and only if $\Delta v > 4\theta + c_L - m \equiv \Delta v_L$, and abstain otherwise.*

Proof. Suppose that a voter with bliss point θ draws cost $c = c_L$ on election day. Note that her utility from voting for candidate R is $u_R \equiv m + 4\theta - \Delta v - c_L$, her utility from voting for candidate L is $u_L \equiv m + \Delta v - 4\theta - c_L$, and her utility from abstaining is $u_A \equiv 0$. First, note that it cannot be true that both u_R and u_L are positive: that is, if $u_R > 0$, then $u_L \leq 0$. To see this, suppose that $u_R > 0$. For the sake of contradiction, suppose that $u_L > 0$. Then, $\Delta v < 4\theta + m - c_L$ by the first assumption, and $\Delta v > 4\theta + c_L - m$ by the second assumption. Thus, $4\theta + m - c_L > 4\theta + c_L - m \iff m > c_L$. However, $m < c_L$ by the assumption discussed in Footnote 11 – a contradiction.

Now, suppose that $\Delta v < 4\theta + m - c_L$. Then, $u_R = m + 4\theta - \Delta v - c_L > m + 4\theta - (4\theta + m - c_L) - c_L = 0$. Given that $u_R > 0$, $u_L \leq 0$ by the argument made above. Thus, u_R is greater than $u_L (\leq 0)$ and $u_A (= 0)$, so the voter votes for candidate R. For the opposite direction, suppose that the voter votes for candidate R. Then it must be that $u_R > 0 = u_A$ (i.e., voting for R is better than abstaining). That is, $u_R = m + 4\theta - \Delta v - c_L > 0 \iff \Delta v < 4\theta + m - c_L$. Symmetric arguments can be made for the case where the voter votes for L. □

Corollary 1. *If $\theta > \frac{1}{4}(c_L - m) + \frac{v}{2}$ ($\theta < \frac{1}{4}(m - c_L) - \frac{v}{2}$), then $\Delta v < 4\theta + m - c_L$ ($\Delta v > 4\theta + c_L - m$, resp.) for all realizations of Δv. Thus, the voter will always vote for candidate R (L, resp.) on election day (given she draws $c = c_L$) and is called a "strong partisan."*

Proof. Suppose $\theta > \frac{1}{4}(c_L - m) + \frac{v}{2}$ and $c = c_L$. Then, $4\theta + m - c_L > 4(\frac{1}{4}(c_L - m) + \frac{v}{2}) + m - c_L =$

$2v \geq \Delta v$ for all realizations of Δv, since $2v \geq \Delta v$ by definition. If $\Delta v < 4\theta + m - c_L$, then the voter votes for candidate R by Proposition 1. □

Corollary 2. *If $\frac{v}{2} < \theta < \frac{1}{4}(c_L - m) + \frac{v}{2}$ ($\frac{1}{4}(m - c_L) - \frac{v}{2} < \theta < -\frac{v}{2}$), then $\Delta v < 4\theta + c_L - m$ ($\Delta v > 4\theta + m - c_L$, resp.) for all realizations of Δv. Thus, the voter will never vote for candidate L (R, resp.) on election day. She will vote for candidate R (L, resp.) whenever $\Delta v < 4\theta + m - c_L$ ($\Delta v > 4\theta + c_L - m$, resp.) – given she draws $c = c_L$ – and will abstain otherwise. This voter is called a "weak partisan."*

Proof. Suppose $\frac{v}{2} < \theta < \frac{1}{4}(c_L - m) + \frac{v}{2}$ and $c = c_L$. Then, $4\theta + c_L - m > 4(\frac{v}{2}) + c_L - m = 2v + c_L - m > 2v \geq \Delta v$ for all realizations of Δv, since $c_L > m$ by the assumption discussed in Footnote 11 and $2v \geq \Delta v$ by definition. Thus, $\Delta v < 4\theta + c_L - m \equiv \Delta v_L$ for all Δv – i.e., the voter will never vote for candidate L according to Proposition 1. □

Corollary 3. *If $0 < \theta < \frac{v}{2}$ ($-\frac{v}{2} < \theta < 0$), then the voter does not always prefer R (L, resp.) on election day: sometimes the utility from voting for candidate L (R, resp.) will be greater than the utility from voting for candidate R (L, resp.). This voter is called a "swing voter."*

Proof. Suppose $0 < \theta < \frac{v}{2}$ and $c = c_L$. For the sake of contradiction, suppose that $u_L < u_R$ for all Δv. Then, $m + \Delta v - 4\theta - c_L < m + 4\theta - \Delta v - c_L \iff \Delta v < 4\theta$ for all Δv. Consider $\theta = \frac{v}{2} - \epsilon$ and $\Delta v = 2v - \epsilon$ for some small $\epsilon > 0$. Then, $\Delta v < 4\theta \iff 2v - \epsilon < 4(\frac{v}{2} - \epsilon) = 2v - 4\epsilon$ – a contradiction. There are some values of θ and some realizations of Δv for which $u_L > u_R$. □

Corollary 4. *Note that $|\theta_{strong\ partisan}| > |\theta_{weak\ partisan}| > |\theta_{swing\ voter}|$.*

Proof. Clearly, $\frac{1}{4}(c_L - m) + \frac{v}{2} > \frac{v}{2} > 0$. Note that $|\theta_{\text{strong partisan}}| > \frac{1}{4}(c_L - m) + \frac{v}{2} > |\theta_{\text{weak partisan}}| > \frac{v}{2} > |\theta_{\text{swing voter}}| > 0$. □

Proposition 2. *Suppose that a voter with $\tilde{\theta}$ votes for L on election day. Then, any voter with $\theta < \tilde{\theta}$ who draws $c = c_L$ also votes for L on election day. Similarly, suppose that a voter with $\tilde{\theta}$ votes for R on election day. Then, any voter with $\theta > \tilde{\theta}$ who draws $c = c_L$ also votes for R on election day.*

Proof. Suppose that a voter with $\tilde{\theta}$ votes for R on election day. Then, by Proposition 1, $\Delta v < 4\tilde{\theta} + m - c_L$. Consider a voter with $\theta > \tilde{\theta}$ who draws $c = c_L$ on election day. Then, $4\theta + m - c_L > 4\tilde{\theta} + m - c_L > \Delta v$, so this voter also votes for R on election day by Proposition 1. Suppose a voter with $\tilde{\theta}$ votes for L on election day. Then, by Proposition 1, $\Delta v > 4\tilde{\theta} + c_L - m$. Consider a voter with $\theta < \tilde{\theta}$ who draws $c = c_L$ on election day. Then, $4\theta + c_L - m < 4\tilde{\theta} + c_L - m < \Delta v$, so this voter also votes for L on election day by Proposition 1. □

Proposition 3. *Suppose that a voter with $\tilde{\theta} > 0$ votes early for R. Then, any voter with $\theta > \tilde{\theta}$ votes early for R as well. Likewise, for any voter with $\tilde{\theta} < 0$ that votes early for L, any voter with $\theta < \tilde{\theta}$ votes early for L as well.*

Proof. Consider two voters, 1 and 2, with $\theta_1 > \theta_2 > 0$. Suppose that voter 2 votes early. Note that a voter with $\theta > 0$ votes early if and only if the expected utility of voting early (for R) is greater than the expected utility of waiting until election day. That is, $m + 4\theta - \mathbb{E}[\Delta v] - c' > \mathbb{P}(c = c_L)[\mathbb{P}(\text{vote } R)\mathbb{E}[u|\text{ vote } R] + \mathbb{P}(\text{vote } L)\mathbb{E}[u|\text{ vote } L]]$. Note that $\mathbb{E}[\Delta v] = 0$ by assumption. Then, we can rewrite this condition as:

$$c' < m(1-q) + qc_L + (1+q)4\theta - q(m - c_L)[F_{\Delta v}(\Delta v_R) - F_{\Delta v}(\Delta v_L)] - 4\theta \cdot q[F_{\Delta v}(\Delta v_R) + F_{\Delta v}(\Delta v_L)]$$
$$+ q[\int_{-2v}^{4\theta+m-c_L} \Delta v f_{\Delta v}(\Delta v) d\Delta v - \int_{4\theta+c_L-m}^{2v} \Delta v f_{\Delta v}(\Delta v) d\Delta v] \equiv \hat{c}.$$

This cost threshold, $\hat{c}$, is a function of θ. In particular, it is increasing in θ:

$$
\begin{aligned}
\frac{\partial \hat{c}}{\partial \theta} &= 4 + 4q[1 - (F_{\Delta v}(\Delta v_R) + F_{\Delta v}(\Delta v_L))] + 4q(c_L - m)[f_{\Delta v}(\Delta v_R) - f_{\Delta v}(\Delta v_L)] \\
&\quad - 4\theta \cdot q[f_{\Delta v}(\Delta v_R) + f_{\Delta v}(\Delta v_L)] + 16\theta \cdot q[f_{\Delta v}(\Delta v_R) + f_{\Delta v}(\Delta v_L)] \\
&\qquad\qquad - 4q(c_L - m)[f_{\Delta v}(\Delta v_R) - f_{\Delta v}(\Delta v_L)] \\
&= 4 + 4q[1 - (F_{\Delta v}(\Delta v_R) + F_{\Delta v}(\Delta v_L))] + 12\theta \cdot q[f_{\Delta v}(\Delta v_R) + f_{\Delta v}(\Delta v_L)] > 0.
\end{aligned}
$$

Since voter 2 votes early, it must be that $c' < \hat{c}_2$, the threshold for her bliss point, θ_2. Since the threshold is increasing in θ, we have $\hat{c}_2 < \hat{c}_1$. Therefore, $c' < \hat{c}_2 < \hat{c}_1$, so voter 1 also votes early. Symmetric arguments can be made for the case where a voter with $\theta < 0$ votes early. □

Proposition 4. *Suppose that the election is not decided by early voting and that $c_L = m$. Suppose that candidate R (L) receives more early votes than candidate L (R, resp.). Then, the decisive voter is shifted to the right (left, resp.) of the median voter, and candidate R (L, resp.) wins the election with a higher probability than the median voter prefers.*

Proof. Suppose that the election is not decided by early voting and that $c_L = m$. Suppose that candidate R receives more early votes than candidate L: $1 - F_\theta(\tilde{\theta}_2) > F_\theta(\tilde{\theta}_1)$. Then, $F_\theta(\theta_D) = \frac{1}{2} + \frac{1-q}{2q}[1 - F_\theta(\tilde{\theta}_2) - F_\theta(\tilde{\theta}_1)] > \frac{1}{2} = F_\theta(\theta_M)$, so that $\theta_D > \theta_M$. Note that R wins with probability $\mathbb{P}(u_R(\theta_D) > u_L(\theta_D)) = F_{\Delta v}(4\theta_D)$. The median voter wants candidate R to win with probability $\mathbb{P}(u_R(\theta_M) > u_L(\theta_M)) = F_{\Delta v}(4\theta_M)$. Since $\theta_D > \theta_M$, we have $F_{\Delta v}(4\theta_D) > F_{\Delta v}(4\theta_M)$. That is, R wins more often than the median voter would like. A similar argument can be made for the case where L earns more early votes than R. □

Proposition 5. *Suppose that early voting is not offered (all citizens must wait until election day) and left (right)-leaning voters draw voting costs from F_{C_ℓ} (F_{C_r}). Consider $\tilde{\theta}_1^E < 0 < \tilde{\theta}_2^E$ and suppose that $\tilde{\theta}_1^E > \theta_M$. Then, L wins the election if and only if $q_\ell > \frac{1-F_\theta(\tilde{\theta}_2^E)}{F_\theta(\tilde{\theta}_1^E)} \cdot q_r$.*

Proof. Suppose that early voting is not offered (all citizens must wait until election day) and left (right)-leaning voters draw voting costs from F_{C_ℓ} (F_{C_r}). Consider $\tilde{\theta}_1^E < 0 < \tilde{\theta}_2^E$ and suppose that $\tilde{\theta}_1^E > \theta_M$. Then, L obtains $q_\ell \cdot F_\theta(\tilde{\theta}_1^E)$ votes and R obtains $q_r \cdot (1 - F_\theta(\tilde{\theta}_2))$ votes. Therefore, L wins if and only if $q_\ell \cdot F_\theta(\tilde{\theta}_1^E) > q_r \cdot (1 - F_\theta(\tilde{\theta}_2))$. Rearranging, the condition is $q_\ell > \frac{1-F_\theta(\tilde{\theta}_2)}{F_\theta(\tilde{\theta}_1^E)} \cdot q_r$. □

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