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Super Tuesday: campaign finance and the dynamics of sequential elections

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Abstract I develop a model of campaign finance in primary elections in which campaigns, which supply hard information about candidates' electability, must be financed by strategic donors. I provide a rationale for *Super Tuesday* electoral calendars in which a block of voters vote simultaneously early in the election followed by other voters voting sequentially. For a range of campaign costs, such a calendar maximizes expected donations to nomination campaigns and, thus, the ex-ante probability of electing the best candidate over all possible electoral calendars.

1 Introduction

> "People don't lose campaigns. They run out of money and can't get their planes in the air. That's the reality."
> —Robert Farmer, fundraiser for Michael Dukakis and Bill Clinton (quoted in Brown et al. 1995)

A prominent feature of recent U.S. presidential primary elections is *Super Tuesday*, in which a large group of states vote simultaneously early in the process. Super Tuesday is the result of party rules that stipulate only that primaries not be held before a given date.[1] Because states benefit from the media attention and political influence that comes with holding an early primary, many states choose to schedule their primaries on the first allowable date (see Putnam 2008). This dynamic has alarmed many in politics, the media, and academia who worry that the system favors frontrunners,

[1] In 2008, it was February 5th. Dramatically, Florida and Michigan decided to ignore this rule and hold their primaries in January. They were disciplined by having their right to seat delegates at the national conventions curtailed.

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eliminates opportunities for voters to learn about candidates and gives early voters undue influence over the process. Proposals for reform of the electoral calendar abound and include a national primary, voting in regional blocks, a scheduling lottery, and others (Smith and Springer 2009). However, these proposals lack the support they need to be implemented.

In spite of the interest that this topic has aroused, we have a limited understanding of the forces that shape the primary calendar and the possible outcomes of reform. This paper develops a model which sheds light on these issues by bringing the role of campaign donors to the forefront.[2] The paper's central insight is that, while party leaders and donors both want the party to be successful in the general election, only donors internalize the cost of campaigns. While a sequential primary calendar best enables donors to balance the costs and (informational) benefits of funding additional campaigns, an electoral calendar in which donors must decide whether to fund campaigns in a group of states may result in higher ex-ante expected spending. Because costly campaigns provide voters with the information they need to make better choices, party leaders benefit from such a primary calendar.

The case for giving donors a central role in a model of American presidential primary elections is quite strong. Running a competitive campaign is very costly and candidates depend on donors to keep their bids alive. During the 2008 primaries, the last open-seat race, candidates for the Democratic nomination raised a staggering \$787 million, while Republicans raised \$477 million.[3] Donors learn about candidates as the primary season progresses and donations fluctuate through time as candidates' performance in early states informs future donation decisions. As the opening quote highlights, contenders typically know they have lost the nomination when they can no longer raise enough funds to continue campaigning. Clearly, donors are major players in presidential primaries, and their behavior has a first-order impact on the dynamics of the nomination process.

The model I present builds on previous work on primary elections, sequential voting, campaign finance and special interest politics. I take the view that campaigns are a means of providing information to the public (as in Coate 2004; Ashworth 2006), and that the election itself is an information aggregation mechanism through which information dispersed in the population is elicited in order to make the best possible choice of nominee (as in Feddersen and Pesendorfer 1996; Serra 2011). Ideological differences *within* a party are taken to be of secondary importance relative to differences *between* parties and the information that is aggregated by the elections and revealed through campaigns is about the candidates' electability: the qualities which determine how likely a candidate is to win the general election.

The predictions of the model are in line with the following stylized facts about U.S. presidential primaries:

[2] The model abstracts from several important issues in U.S. presidential primaries including the prominent role of Iowa and New Hampshire as the first primaries in the nomination process (see Klumpp and Polborn 2006).

[3] Numbers from The Campaign Finance Institute. See http://www.cfinst.org/pr/prRelease.aspx?ReleaseID=205.

- Donors give gradually to candidates (Mccarty and Rothenberg 2000).
- Money follows electoral success (Aldrich 1980a, b; Hinckley and Green 1996; Mayer 1996; Damore 1997).
- Candidates drop out under financial duress (Mayer 1996b ch. 2; Norrander 2000; Haynes et al. 2004).

Because the electoral calendar determines what information donors will have when deciding whether to fund a campaign, the model studied in this paper provides a powerful framework in which to study the implications of adopting different electoral calendars. Donors would prefer to have sequential primaries so that the decision of whether to fund each campaign can be made individually, minimizing the expected cost of the process (Theorem 2). However, stakeholders who do not bear the cost of campaigns, such as voters and parties, prefer to have as many campaigns funded as possible. These stakeholders may be best served by electoral calendars, like those with a Super Tuesday, which are ‘lumpy’ and force donors to choose whether to fund campaigns in groups. Under the right cost conditions, these electoral calendars will maximize the expected amount of donations made and, thus, the expected amount of information revealed before a nominee is selected (Theorem 3). I conclude that a Super Tuesday calendar may be preferable to any alternative calendar if the cost of campaigning is low enough for competitive challengers to raise adequate funds for early primaries. Otherwise, a sequential election will be more effective at helping voters select the most competitive nominee (see Fig. 1).

These results illustrate a mechanism by which the Super Tuesday calendar is justified on the grounds that it enables the party to select the best possible nominee. The results rely on several key features of the model. First, voters vote *sincerely*, according to the information they receive (Theorem 1). Second, the party, which designs the electoral calendar, does not internalize the cost of campaigns. Third, donors fund campaigns in all periods so that they must take into account the effect of their decisions today on expected future expenditures. This distinguishes this paper's model from alternatives such as models of costly information acquisition by voters or costly voting; in Sect. 4 I show that the Super Tuesday calendar does not outperform a simultaneous election in these settings precisely because this assumption does not hold. While the model's predictions are sensitive to several modeling choices involving, for instance, the motivation of donors, the basic rationale for Super Tuesday presented is likely to arise in any model which incorporates these basic ingredients.

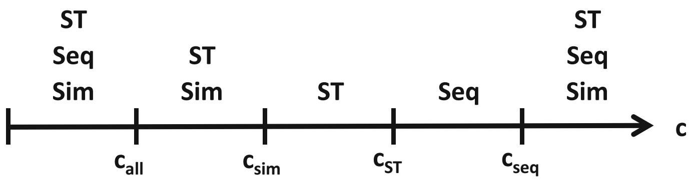

Fig. 1 Optimal electoral calendar as function of campaign costs. *ST* super Tuesday, *Seq* sequential, *Sim* simultaneous

1.1 Related literature

Sequential elections were first studied in a game-theoretic setting by Dekel and Piccione (2000). Their main result is that equilibria of a simultaneous election game are also equilibria of all sequential versions of the game. Because voters condition their vote on being pivotal, it does not matter whether some information is revealed before a voter casts his ballot. A series of follow-up papers focused mainly on identifying variants of the Dekel and Piccione model in which momentum or bandwagons arise. Battaglini (2005) shows that, if voting is costly, voters will abstain once a candidate takes a sufficiently large lead. Callander (2007) shows that bandwagons can arise when voters prefer to vote for the eventual winner. Ali and Kartik (2012) show that voting according to posterior beliefs is an equilibrium and can lead to herding.

These papers have established a canonical model of sequential elections in which there are two candidates and two states of the world. Voters receive private signals about the true state of the world and their utility depends on whether the election selects the 'right' candidate. In this paper I adhere to this framework as far as possible.

While the effect of campaign spending on voting behavior (e.g. Haynes et al. 1997) and the importance of accumulating campaign funds early in a contest (e.g. Goff 2004) have been widely studied, little attention has been paid to the timing of donations and the effect of campaign finance on the dynamics of primaries. A notable exception is Mccarty and Rothenberg (2000) who propose a model of the timing of donations and provide empirical support for their conclusions. Their focus, however, is on the bargaining between candidates and political action committees (PACs) rather than on the effect of donations on the dynamics of the election itself. Aldrich (1980a) who models momentum as explicitly arising from a feedback mechanism where electoral success increases donations which, in turn, make electoral success more likely. However, he stops short of explicitly modelling the decisions of voters and donors that are behind this feedback mechanism as this paper does. Similarly, Klumpp and Polborn (2006) propose a model of campaign spending and its effects on the dynamics of primary elections in which spending increases the chances of winning. However, they do not account for donors, assuming instead that campaign funds are available but costly to candidates.

Results on the optimal sequencing of elections have been derived in a variety of models, with some of the papers mentioned above weighing in. However, this paper's results are distinct as it is the first to take the incentives of donors into consideration and to bring electoral calendars which are neither purely sequential nor simultaneous to the forefront.

Battaglini (2005) proves a partial result: for low enough voting costs, the simultaneous electoral calendar outperforms its sequential counterpart. Because of the possibility of bandwagon voting, Callander (2007) shows that simultaneous elections dominate sequential voting when voters derive utility from voting for the eventual winner and prior beliefs about the best candidate are close to $\frac{1}{2}$; sequential voting may be optimal in lopsided elections. In a model with posterior-based voting, Selman (2010) shows that sequential elections are optimal when one candidate has an advantage in the number of partisan voters, and uncommitted voters' information is of low quality. Hummel and Holden (2014) derive conditions under which primaries aggregate information most effectively when states are ordered from smallest to largest or from those with the best information to those with the noisiest.

Klumpp and Polborn (2006) argue that sequential voting is preferable to simultaneous elections because it leads to a lower level of advertising expenditures. This result parallels my Theorem 2, which states that donors would prefer a strictly sequential electoral calendar precisely for this reason. In Section 7 of Klumpp and Polborn (2006), the authors consider calendars which are neither strictly sequential nor simultaneous. They present numerical results showing that, given certain assumptions on the number of voters and the efficacy of campaign spending, a calendar in which a few states vote sequentially followed by a large group of states voting simultaneously minimizes expenditures. The threat of a spending war during the second, simultaneous stage incentivizes trailing candidates to drop out after the sequential stage. The calendar structure and the intuition for the result contrasts with those presented in this paper because I do not consider cost minimization, independent of information aggregation, as a criteria for calendar design.

Gershkov and Szentes (2009) present a model where voters must decide whether to acquire costly information prior to voting and characterize optimal voting mechanisms. However, they consider a class of mechanisms broader than that reasonable for presidential primaries; in the optimal mechanism, a social planner sequentially asks voters to acquire information without revealing their position in the sequence or previous reports.

Morton and Williams (1999) analyze a theoretical model with three candidates comparing simultaneous and sequential voting and go on to test their predictions in the laboratory. They conclude that sequential voting can better aggregate information when the best candidate (a Condorcet winner) is relatively unknown. However, the (non-) representativeness of early voters can affect election outcomes, raising other concerns.

Hummel and Knight (2012) use a model of learning and momentum, along with data from the 2004 Democratic nomination, to compare the welfare implications of sequential and simultaneous primary calendars. They conclude that a simultaneous calendar is preferable in spite of the risk of voters overweighting their prior beliefs.

Deltas et al. (2010) present a model of primary elections with three candidates. They argue that sequential elections allow voters to coordinate on one candidate when two offer the same platform, thus avoiding vote-splitting. However, there is a risk of coordinating on a candidate with low valence. After structurally estimating their model using data from the 2008 U.S. presidential primary, they conclude that the benefits of a sequential electoral calendar are likely to outweigh its costs.

2 Model

A party (P), a donor (which we call the special interest group or SIG), and five voters[4,5] ($V = \{V_1, \ldots, V_5\}$) interact in an extensive form game which will determine which

[4] In the context of U.S. presidential primaries, it is natural to interpret this as five states, each with a representative voter.

[5] Five is the smallest number of voters with which the paper's main results can be derived. When there are three voters, sequential {1-1-1} and Super Tuesday {2-1} calendars are strategically equivalent.

candidate, A or B, will represent the Party in the general election. There are six periods $t \in \{0, 1, \ldots, 5\}$ divided into two stages:

1. Period 0 is the *election design stage*, during which the Party chooses an electoral calendar.
2. Periods 1–5 are the *primary election stage*, during which the donor funds campaigns, voters cast their ballots, and the nomination is decided.

At time 0, the party chooses an electoral calendar specifying when each voter will vote. That is, for each voter V_i, an electoral calendar assigns a date $t \in \{1, \ldots, 5\}$ when V_i will vote.

Definition 1 An *electoral calendar* is a function $\theta : V \to \{1, 2, 3, 4, 5\}$ assigning a period to each voter.

Θ is the set of all possible electoral calendars.

The party's action set is $A_P = \Theta$. For a given calendar $\theta \in \Theta$, $\theta(V_i)$ specifies the period in which V_i will vote. Slightly abusing notation, I write $\theta(t)$ when referring to the (possibly empty) set of voters who are scheduled to cast their ballots during period t.[6] $|\theta(t)|$ is the number of elements in $\theta(t)$. Without loss of generality, I restrict attention to calendars in which voters vote in order ($i > j \Rightarrow \theta(V_i) \geq \theta(V_j)$), and inactive dates come at the end of the primary election stage ($\theta(t) = \varnothing \Rightarrow \theta(t+1) = \varnothing$). For example, in a sequential calendar $\theta(V_i) < \theta(V_{i+1})$ and $|\theta(t)| = 1$ for all t; in a simultaneous calendar $\theta(V_i) = \theta(V_{i+1})$ and $|\theta(1)| = 5$, $|\theta(t)| = 0$ for $t > 1$.

During each period in the primary election stage, the donor has the option of funding campaigns at cost $c > 0$. Thus, the SIG's action sets during the primary election stage are $A^t_{SIG} = \{0, c\}^{|\theta(t)|}$ for $t \in \{1, \ldots, 5\}$. $d_i \in \{0, c\}$ is the donation given to the campaigns associated with voter i.

Each voter can vote for one of two candidates, A or B, during the period specified by the electoral calendar. Alternatively, the voter may abstain: $\varnothing$. V_i's action set during period t is $A^t_{Vi} = \begin{cases} \{A, B, \varnothing\} & \text{if } V_i \in \theta(t) \\ \varnothing & \text{otherwise} \end{cases}$.

I use v_i to denote V_i's action. Voting determines which candidate becomes the *nominee* N by majority rule: the candidate who receives the most votes cast (excluding abstentions) wins the election. If neither candidate receives a majority of votes cast, the tie is broken with each candidate nominated with probability $\frac{1}{2}$.

Candidates differ in their electability $e_C \in \{h, l\}$. Electability is a summary variable capturing charisma, political ability, and other characteristics which help a candidate win elections. Thus, if candidate A is highly electable and wins a majority of primary votes, $N = A$ and $e_N = e_A = h$.

Voters and the Party have the single goal of nominating the candidate who has the best chance of winning the general election:

$$u_P = u_V = \begin{cases} 1 & \text{if } e_N = h \\ 0 & \text{otherwise} \end{cases} \tag{2.1}$$

[6] The two uses of $\theta(\cdot)$ should not cause confusion as one has a number as an argument while the other has a voter.

The SIG also has an interest in nominating the most electable candidate for the party, but it is negatively affected by the cost of campaign donations. The SIG's utility is:

$$u_{SIG} = u_V - \sum_{i=1}^{5} d_i \tag{2.2}$$

2.1 Information and strategies

There are two states of the world A and B. In state A, $e_A = h$ and $e_B = l$; in state B, $e_B = h$ and $e_A = l$. All players have the same symmetric prior: $Pr(A) = Pr(B) = \frac{1}{2}$.

Each voter receives a possibly informative signal s_i. If a campaign is run for voter i ($d_i = c$), then V_i's signal is informative with precision q: $s_i \in \{A, B\}$ where $\Pr(s_i = A|A) = \Pr(s_i = B|B) = q > \frac{1}{2}$. If $d_i = 0$, then V_i's signal is uninformative: $s_i = \varnothing$. Following Feddersen and Pesendorfer (1996), I say that voters who receive informative signals are *informed*, and those who do not are *uninformed*. These signals are privately observed by the voters.

To summarize, the timing of each stage of the game is as follows:

Election Design Stage ($t = 0$):

The party chooses an electoral calendar $\theta \in \Theta$.

Primary Election Stage ($t \in \{1, \ldots, 5\}$):

1. SIG chooses $d_i \in \{0, c\}$ for i s.t. $V_i \in \theta(t)$.
2. Voters $V_i \in \theta(t)$ receive signals $s_i \in \{A, B, \varnothing\}$.
3. These voters cast their ballots $v_i \in \{A, B, \varnothing\}$. Voting decisions are observed by all voters as well as the SIG.

The two-stage game described above is Γ. Γ_θ refers to the subgame consisting only of the primary election stage, taking the Party's choice of electoral calendar θ as given.

When making donation decisions, the SIG is aware of the electoral calendar, as well as all past donations and votes. Thus, a t-history is $h_t = \left\{\theta, \{d_i, v_i\}_{i=1}^{\max\{j|\theta(V_j)<t\}}\right\}$. Let H_t be the set of all possible t-histories.

The SIG's donation strategies map histories to voter-specific donation decisions during the primary election stage:[7]

$$d_i : H_{\theta(V_i)} \rightarrow \{0, c\} \tag{2.3}$$

Note that, depending on the electoral calendar, several voters may vote during the same period so that the SIG must make several donation decisions simultaneously.

In addition to the public t-history $h_{\theta(V_i)}$, V_i has access to his signal s_i when making his voting decision. That is, V_i conditions his vote on his private history $h_{V_i} = \{h_{\theta(V_i)}, s_i\}$. H_{V_i} is the set of all possible private histories h_{V_i}.

$$v_i : H_{V_i} \rightarrow \{A, B, \varnothing\} \tag{2.4}$$

[7] To lessen the reader's notational burden, I use the same notation for actions and strategies. I could allow for mixed strategies, but they do not play a role in my analysis.

Let $d = \{d_i\}_{i=1}^5$, $v = \{v_i\}_{i=1}^5$, and $v_{-i} = \{v_j\}_{j \neq i}$. I look for perfect Bayesian equilibria of this game, that is, strategy profiles θ, d, and v, and beliefs such that:

- $E(u_P|\theta, d, v, h_0) \geq E(u_P|\theta', d, v, h_0)$ for all θ';
- $E(u_{SIG}|\theta, d, v, h_t) \geq E(u_{SIG}|\theta, d', v, h_t)$ for all d', every t, and every h_t;
- $E(u_V|\theta, d, v, h_{V_i}) \geq E(u_V|\theta, d, v_i', v_{-i}, h_{V_i})$ for all v_i', each i, and every h_{V_i};
- Beliefs are updated according to Bayes' rule whenever possible.

2.2 Discussion of assumptions

In U.S. presidential primaries, more than two candidates typically seek the nomination. I choose to model a nomination campaign with two candidates to keep the model tractable and for continuity with previous theoretical research on sequential elections and information aggregation (see Sect. 1.1). Nevertheless, there are two ways in which the model may be interpreted that make the assumption seem less stringent. First, one may consider the model as pitting the front-runner versus the field. Second, some researchers (e.g. Kessel 1992) divide the nomination process into stages. During the first, non-competitive candidates are winnowed out. During the second, the contest begins in earnest. This model may be interpreted as studying only the second phase of the primary.

The results presented in Sect. 3 are sensitive to the assumptions made regarding the motivation of campaign donors. As Sect. 4 shows, the paper's main results do not hold when voters bear the cost of information acquisition. When donors' aim is to have a favored candidate nominated, equilibrium predictions are sensitive to assumptions about information. For instance, leaving other aspects of the model unchanged, a SIG which is motivated only by getting its favored candidate nominated will stop funding campaigns when its favored candidate obtains a lead as this stops the flow of information and gives later voters no reason to vote for the trailing candidate. If this SIG has private information about the electability of its favored candidate, however, voters may read into the SIGs funding decisions and learning may take place even when campaigning has ceased; this case is similar to the case in which candidates know their own type and can decide whether donations are spent on campaigns or not (see Schwabe 2010).

Other extensions such as asymmetric priors, bandwagons, many altruistic voters and the importance of early donations or "the money primary" (Goff 2004) are discussed in Schwabe (2010).

3 Analysis

I solve for equilibrium behavior in each stage of the game, starting with the primary election stage.

3.1 Primary election stage

The main result in this section is that there is a perfect Bayesian equilibrium in which voting strategies make full use of the information contained in the campaigns (s_i), and are independent of past play and the electoral calendar θ. This is important as it provides a consistent standard of voter behavior with which to compare equilibrium outcomes across electoral calendars.

Theorem 1 *For any electoral calendar θ, there exists a perfect Bayesian equilibrium of the continuation game Γ_θ in which voting strategies are $v_i^*(h_{\theta(V_i)}, s_i) = s_i$.*

In these equilibria, informed voters vote according to their signal, regardless of their beliefs about the candidates' types, ruling out bandwagons created by posterior-based voting as in Ali and Kartik (2012). Uninformed voters abstain as in Feddersen and Pesendorfer (1996). These voting strategies make minimal requirements of voters' rationality and computational ability. Indeed, they are consistent with a wide range of theories of voter behavior, including expressive voting (Brennan and Lomasky 1993).

Taking the SIG's funding decisions as given, v^* leads to the full information outcome. The only way in which a deviation from v^* could increase voter utility is if it induces the SIG to fund more campaigns than it otherwise would have. On the other hand, even if the number of campaigns financed increases, a deviation from v^* can lead to the nomination of the candidate with the lower posterior probability of being highly electable if the vote in question turns out to be pivotal. Indeed, with only five voters, there are few opportunities for additional campaigns to be funded and a reasonable chance that any given vote will be pivotal, so that deviations from v^* are never worthwhile. This logic simplifies the proof of Theorem 1, but is not applicable to models with many voters. In fact, it can be shown that, in the spirit of Callander (2007), when there are infinitely many possible future voters and campaign costs are sufficiently low, a voter who would end the flow of money and information by voting his signal would choose not to do so. Thus, having a small, finite number of voters is crucial for this result.

Because the information generated by campaigns is revealed to the SIG through voting, and the candidate who has the highest period-5 posterior probability of being the h-type is nominated, Theorem 1 enables a correspondence between the SIG's problem and the problem which a statistician faces when deciding how many costly experiments to run before making an investment decision—a correspondence which I will exploit when looking at the choice of electoral calendar.

In the remainder of the paper, I restrict attention to perfect Bayesian equilibria in which voters' strategies are v^*.

3.2 Election design stage

This section contains the paper's main results, Theorems 3 and 4, which characterize the Party's choice of electoral calendar as a function of campaign costs. At t=0, the Party must set an electoral calendar $\theta \in \Theta$. It will choose a calendar which maximizes the probability with which the more electable candidate will be nominated. As a point of reference, I first show that the SIG would always choose a sequential calendar.

It is useful to introduce notation for particular electoral calendars. I use brackets $\{\}$ to denote a calendar. The first number in brackets is the number of voters voting at date 1 ($|\theta(1)|$). The second number, separated from the first by a dash, denotes the number of voters voting at date 2 ($|\theta(2)|$). I repeat this process until all voters are accounted for. There are many possible electoral calendars in a world with five voters (16 in fact, they are listed in the "Appendix" section). Three calendars are especially important in this paper:

- Sequential {1-1-1-1-1}
- Super Tuesday {3-1-1}
- Simultaneous {5}.

I call the second calendar a *Super Tuesday calendar* because of its structural similarity to presidential primary calendars in which large blocks of states vote on the same "Super Tuesday" early in the primary season.[8]

From the SIG's perspective, the choice of electoral calendar is identical to the problem facing a statistician who must schedule several costly experiments. Thus, the result that the SIG will prefer a Sequential calendar has been derived in a different setting by DeGroot (2004). Intuitively, the Sequential calendar lets the SIG decide whether to continue its funding of campaigns following each vote, therefore giving the SIG a larger strategy set than alternative calendars which demand that the SIG make funding decisions for more than one campaign at a time.

Theorem 2 (DeGroot 1970) *The Sequential {1-1-1-1-1} calendar maximizes the SIG's expected utility.*

In order to determine which electoral calendar the Party will choose, we must solve for the primary schedule which maximizes the ex-ante probability of selecting the highly electable candidate, keeping in mind that the Party does not bear the costs of campaigns. The following definitions will be used to classify calendars according to this criterion.

Definition 2 An electoral calendar is said to weakly *dominate* another if the ex-ante probability of having a highly electable nominee ($e_N = h$) is weakly higher for all c and q.

A calendar *strictly dominates* another if it weakly dominates it and the ex-ante probability of having a highly electable nominee ($e_N = h$) is strictly higher for some c and q.

If the relation holds only for certain values of c and q, we say that a calendar (weakly or strictly) dominates another *over the relevant ranges of* c and q.

The weak dominance concept is useful because it is often the case that several electoral calendars to lead to the same outcomes (for instance, see footnote 8). The Party will choose a calendar which weakly dominates all others for the relevant pair $\{c, q\}$. Because donations that have already been made are sunk costs for the SIG, a calendar which groups several voters in the first period weakly dominates all other calendars if all period-1 campaigns are funded. This implies that the Simultaneous

[8] The calendars {3-1-1} and {1-2-1-1} are strategically equivalent so I could refer to either as a Super Tuesday calendar. Perhaps the second is more reminiscent of Super Tuesday since it allows for a single early vote, like Iowa and New Hampshire might be in the U.S. presidential primary, to happen before the block of voters are scheduled.

calendar is weakly dominant for low enough c. As c increases, the number of period-1 voters in this type of weakly dominant calendar decreases.

Grouping voters 4 and 5 together with previous voters is never a strict improvement over having these vote sequentially after voter 3; that is, **a Simultaneous calendar never strictly dominates a Super Tuesday calendar**. When the SIG funds the first three campaigns, campaigns 4 and 5 only contribute relevant information to the electorate if one candidate has a 2-1 lead rather than a 3-0 victory. Thus, when comparing the benefits of funding these campaigns to their cost, the SIG conditions on this outcome. If it has not observed the votes of voters 1, 2 and 3, however, it must scale the benefit of funding campaigns 4 and 5 by the probability that the election will be 2-1 at that point. This means that the SIG will always fund campaigns 4 and 5 in a Super Tuesday calendar if it would do so in a Simultaneous calendar, but not the other way around. This reasoning also shows that the Super Tuesday calendar weakly dominates calendar $\{4\text{-}1\}$. Thus, there is a weakly dominant electoral calendar in which the last two voters vote in separate periods from other voters.

By symmetry, the outcome of the first vote cannot change the donor's equilibrium behavior (the election will be 1-0 or 0-1) so that having two votes during period 1 cannot improve on a Sequential calendar. Since we have argued that having two, four or five votes during period 1 cannot be strictly dominant, we know there is a weakly dominant electoral calendar in which one or three voters vote during the first period.

The Super Tuesday calendar strictly dominates the Sequential calendar when the SIG funds all three period-1 campaigns in a Super Tuesday calendar but would stop funding in a Sequential election after a 2-0 start. After a lopsided 2-0 start, the posterior probability that the leading candidate is highly electable is $\frac{q^2}{q^2+(1-q)^2}$, so the probability that the trailer is the true high electability candidate and will make a comeback is quite low: $\frac{q^2}{q^2+(1-q)^2}q^3$. This means that funding additional campaigns is very unlikely to pay off. However, after a 1-1 start the candidates are equally likely to be highly electable and additional information is very valuable. Under a Super Tuesday calendar, the SIG's perceived benefit of funding voter 3's campaign is a weighted average of these two scenarios. Thus, for certain campaign costs the Super Tuesday calendar always induces at least three campaigns to be financed but this is only sometimes the case with a Sequential calendar. Conversely, **the Sequential calendar strictly dominates the Super Tuesday calendar** when the SIG is not willing to fund voter 3's campaign in a Super Tuesday calendar but would do so after a 1-1 start in a Sequential calendar. This is the case for campaign costs higher than those in the Super Tuesday dominance area.

These arguments, along with additional computations presented in the "Appendix" section, lead to the following theorem which is the main result of this paper. It is one of the few results in this literature in which a hybrid calendar (not Sequential or Simultaneous) plays a major role. It also provides an effectiveness-based explanation for the existence of Super Tuesdays.

Theorem 3 *For any q, there exist values $0 < c_{all} < c_{st} < c_{\text{seq}}$ such that:*

- *For the cost interval $c \in (c_{all}, c_{st})$, the Super Tuesday calendar weakly dominates all others, and strictly dominates the Sequential calendar.*

- *For the cost interval* $c \in (c_{st}, c_{\text{seq}})$*, the Sequential calendar weakly dominates all others, and strictly dominates the Super Tuesday calendar.*

Proof In the "Appendix" section. □

The Simultaneous calendar, which has been widely studied and is often used as a point of comparison to the Sequential calendar, is weakly dominated by the Super Tuesday calendar in this model. That is not to say, however, that it is not weakly optimal over some range of costs. It is not strictly dominated by any other calendar whenever the costs of campaigning are low enough for the SIG to fund all five campaigns in a Simultaneous election, or high enough so that at most one campaign is funded under any electoral calendar. The following Theorem clarifies.

Theorem 4 *For any given* q*, there exist campaign costs* $c_{sim} \in (c_{all}, c_{st})$ *such that the Simultaneous electoral calendar weakly dominates all others whenever* $c < c_{sim}$ *or* $c > c_{\text{seq}}$*.*

Proof In the "Appendix" section. □

As this result shows, for some campaign costs, a Simultaneous calendar strictly outperforms a Sequential calendar, a result reminiscent of Battaglini (2005). Figure 1 summarizes the results of Theorems 3 and 4.

4 Information acquisition by voters and costly voting

In the model presented in Sect. 2, voters and the SIG share the goal of nominating the most electable candidate. However, only the SIG bears the cost of campaigns. In other words, it is a common value election with a free-riding problem associated with costly information acquisition. This description is also applicable to the situation in which voters themselves must bear the cost of acquiring information—each voter considers only their personal costs and benefits of acquiring information. An equally interesting, and strategically equivalent, possibility is that voters have private information and must pay a cost to turn out to vote. Thus, it is natural to ask if the results from Sect. 3.2 also hold in this related set-up.

The answer to this question is *no*: a Super Tuesday electoral calendar never outperforms a Simultaneous calendar if each voter must bear the cost of information acquisition or turning out to vote. The key difference between the two models is that the SIG takes expected future expenditures on information acquisition into account when funding campaigns, whereas voters only internalize their own information acquisition cost. The SIG is more likely to fund a best-out-of-five campaign under a Super Tuesday calendar than under a Simultaneous calendar because this strategy is cheaper in expected value when it can condition the funding of the last two campaigns on the outcome of the first three elections. In contrast, voter 3 will not benefit if voters 4 and 5 have the option of abstaining if the election is decided.

Consider a variation of the subgame consisting of the primary election stage of the model presented in Sect. 2 (Γ_θ) in which:

- The SIG plays no role;

- In addition to voting, voter i must decide whether to pay a cost $c > 0$ in order to receive an informative signal about candidate quality at time $\theta(V_i)$; his action sets are $d_i \in \{0, c\}$ and $v_i \in \{A, B, \varnothing\}$;
- Voter utility is $u_v = \begin{cases} 1 - d_i & \text{if } e_N = h \\ -d_i & \text{otherwise} \end{cases}$.[9]

This is the *information acquisition game*. As above, voters vote according to their signal when they have one and abstain if they do not. When the electoral calendar is Sequential, there is a unique equilibrium which may be solved for by backward induction. A voter who acquires information is privately providing a public good.[10] Thus, early voters (1 and 2) always abstain expecting that later voters will bear the cost of acquiring information, unless they find enabling a best-out-of-five contest worthwhile. When more than one voter votes during the same period, however, there are multiple equilibria, possibly including mixed strategy equilibria. In order to facilitate comparisons across electoral calendars, I focus on pure strategy equilibria. Because there is no gain to having an even number of informed votes,[11] there are equilibria in which at most one voter acquires information. This is supported by the belief that all remaining voters will not acquire information regardless of the history of play. Here, I focus on equilibria in which voters coordinate on the highest level of information acquisition achievable. I call the equilibria which satisfy these properties *efficient pure strategy equilibria*.

The following theorem confirms the intuition outlined in the second paragraph of this subsection: the Super Tuesday calendar is not superior to the Simultaneous calendar. However, a similar logic to that which separated Super Tuesday from the Sequential calendar in Theorem 3 is applicable here. A 2-0 start can make a reversal of results so unlikely that voter 3 does not find it worthwhile to acquire information. However, if he cannot condition his information acquisition decision on the first two votes, he will choose to become informed. Thus, calendars which group the first three votes together outperform those that do not. In particular, the Simultaneous and Super Tuesday calendars outperform the Sequential calendar in this cost interval. Figure 2 illustrates this result.

Theorem 5 *In an efficient pure strategy equilibria of the information acquisition game, there exist c_1 and c_2 such that $c_1 < c_2$ and, if $c \in (c_1, c_2)$, any electoral calendar in which $\theta(V_2) = \theta(V_3)$ strictly dominates calendars in which this does not hold. For $c \notin (c_1, c_2)$, no calendar strictly dominates any other.*

The Super Tuesday and Simultaneous calendars lead to the same outcomes when voters bear the cost of information acquisition. However, they both strictly dominate Sequential voting for a range of the cost parameter. This result can be seen as both

[9] Note that this utility function is identical to the SIG's utility function described in equation 2.3 with the significant difference that the SIG subtracts the sum of all information acquisition costs while, in this case, voters internalize only their own information acquisition cost.

[10] Dragon slaying as in Palfrey and Conlin (1984).

[11] Having funded an odd number n of campaigns, the biggest impact an additional informed vote can have is to tie the election.

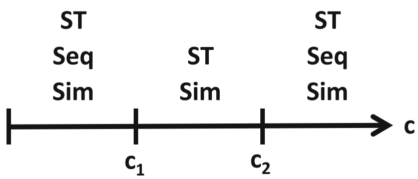

Fig. 2 Optimal electoral calendar as function of campaign costs. *ST* super Tuesday, *Seq* sequential, *Sim* simultaneous

a special case (five voters, majority rule) and a generalization (considers all possible electoral calendars) of Proposition 3 in Battaglini (2005).[12]

5 Conclusion

Campaign donors are major players in the presidential nomination game. If we are to understand the dynamics of the nomination process, and the consequences of reforming it, we must account for the interests of those who make campaigns possible. In this paper, I have built on previous theoretical work by incorporating strategic donors into a canonical model of sequential elections. The central insight which arises from this exercise relates to the conflict between political parties, who want to win the White House, and their contributors, who want to do so at minimal cost. Parties may enable the formation of a "Super Tuesday," in which a large proportion of U.S. states hold their primaries on the same day, in order to maximize expected campaign contributions. In turn, these campaign contributions enable candidates to conduct competitive campaigns which provide voters with the information they need to nominate the best candidate. My results suggest that attempts to reform the nomination process will continue to fail unless we reach a point at which the top candidates cannot afford to campaign in all Super Tuesday states. They also suggest that, given the importance of the post and the benefits of having an informed electorate, it may be socially optimal to leave the current system in place.

This paper illustrates a theoretical mechanism which rationalizes the existence of Super Tuesday on the grounds that it enables the selection of better nominees for the party. As such, it stops short of presenting general results or providing a full positive theory of primary elections. Work in both of these directions is likely to be productive. A characterization of optimal electoral calendars for an arbitrary number of voters and under alternative assumptions about SIG and voter behavior would be valuable. Perhaps more importantly, further empirical and theoretical work on the motivation of donors during the primary process, the effects of their funding decisions and the determinants of the timing of donations is needed.

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12 Battaglini's result only holds for a large number of voters.

Appendix

The *vote count* at a given history is x-y if A has received x total votes ($\sum 1_{(v_i=A)} = x$), and B has received y total votes.

Proof of Theorem 1

Proof Taking donations as given, v^* selects the candidate with the highest posterior probability of being highly electable. Thus, there is no purely informational incentive for an informed voter to deviate from this voting strategy. However, voting against one's signal could conceivably lead to more campaigns being funded. We must ensure that this possibility does not make deviation from v^* profitable. We do so by considering the largest possible benefit which such a deviation could have and showing that it is outweighed by the damage done by casting a vote for the wrong candidate. This maximum benefit is only possible if the SIG can condition its future funding on the outcome of the relevant votes—an assumption we maintain throughout this proof. If this is not the case, the benefits of deviation are more limited, strengthening our results.

If the SIG will only fund one campaign, the voter's decision is pivotal and it is clearly in his interest to vote according to his signal. By symmetry, whether the first vote goes to candidate A or B cannot influence the SIG's best-response continuation strategy. Future votes, however, could plausibly do so.

Consider the case in which the SIG will fund at least two campaigns. The largest benefit from a voter's deviation would come if voting according to his signal would mean the end of informative campaigns, while voting against his signal would mean that all five campaigns would be funded.

Case 1: If the first two signals are for the same candidate, the posterior probability that this candidate is highly electable is $\frac{q^2}{q^2+(1-q)^2}$. Voting against his signal leads to a 1-1 vote count, so that the probability of electing the highly electable candidate is at most:

$$\frac{q^2}{q^2+(1-q)^2}\left(q^2\,(1+2(1-q))\right)+\frac{(1-q)^2}{q^2+(1-q)^2}\left(q^2\,(1+2(1-q))\right)$$
$$=\left(q^2\,(1+2(1-q))\right)=q^2\,(3-2q)<\frac{q^2}{q^2+(1-q)^2}$$

Thus, the deviation is not profitable for the voter.

Case 2: If the first two signals are for different candidates, the posterior probability that any candidate is highly electable is $\frac{1}{2}$. Thus, deviating and making the vote count 2-0 leads to nominating the highly electable candidate with probability no higher than:

$$\frac{1}{2}\left(q^3\right)+\frac{1}{2}\left(1-(1-q)^3\right)$$

Given that the SIG was willing to fund at least one campaign, it will also be willing to fund an additional campaign if the vote count is 1-1 (it must be that $q-\frac{1}{2}>c$). Thus, the probability of nominating the highly electable candidate will be at least:

$$q > \frac{1}{2}\left(q^3\right) + \frac{1}{2}\left(1 - (1-q)^3\right)$$

Thus, the deviation is not profitable for the voter.

We have now shown that deviating by voting against one's signal cannot be profitable for a voter in this model. We must also verify that abstaining when informed or voting when not informed is not profitable. This type of deviation is detectable by all other players, so that its profitability depends on out of equilibrium beliefs.

Detectable deviations

Because donations d_i are observable, all players will know that a deviation has taken place when an informed voter abstains and vice-versa. Indeed, we specify off-equilibrium beliefs for the SIG such that all future voters will vote for the frontrunner regardless of their signal. Thus, the SIG has no motivation to fund future campaigns, removing the voter's incentive to deviate from v^*. □

Proof of Theorems 3 and 4

I begin by listing all possible electoral calendars in a five voter election. I then state two lemmas which simplify comparisons across calendars by establishing basic facts about the SIG's equilibrium donation strategies. A series of claims narrows the set of calendars we must consider to three: Simultaneous, Super Tuesday and Sequential. Finally, I state Theorem 1 which gathers the results of Theorems 3 and 4 and prove it by explicitly calculating and comparing expected payoffs to campaign contributions. Given Theorem 1, I assume throughout that voting strategies are v^*.

There are $2^4 = 16$ possible electoral calendars:

$$\Theta = \left\{\begin{array}{llll} 1.\ \textbf{Simultaneous}, \{5\} & 5.\ \{3\text{-}2\} & 9.\ \{2\text{-}1\text{-}2\} & 13.\ \{1\text{-}1\text{-}1\text{-}2\} \\ 2.\ \textbf{Sequential}\ \{1\text{-}1\text{-}1\text{-}1\text{-}1\} & 6.\ \{4\text{-}1\} & 10.\ \{1\text{-}2\text{-}2\} & 14.\ \{1\text{-}1\text{-}2\text{-}1\} \\ 3.\ \textbf{SuperTuesday}\ \{3\text{-}1\text{-}1\} & 7.\ \{1\text{-}4\} & 11.\ \{1\text{-}1\text{-}3\} & 15.\ \{1\text{-}2\text{-}1\text{-}1\} \\ 4.\ \{2\text{-}3\} & 8.\ \{2\text{-}2\text{-}1\} & 12.\ \{1\text{-}3\text{-}1\} & 16.\ \{2\text{-}1\text{-}1\text{-}1\} \end{array}\right\}$$

The following Lemma states that, if the SIG will fund some campaigns, without loss of generality we may assume that it will fund voter 1 and 2's.

Lemma 1 *If there is $d \in BR(v^*, \theta)$ s.t. $\sum_{i=1}^{5} d_i \geq c$ for some $h_5 \in H_5$, then $\sum_{i=1}^{5} d_i \geq c$ for all $h_5 \in H_5$ and there is $d' \in BR(v^*, \theta)$ s.t. $d'_1 = c$.*

If there is $d \in BR(v^*, \theta)$ s.t. $\sum_{i=1}^{5} d_i \geq 2c$ for some $h_5 \in H_5$, then $\sum_{i=1}^{5} d_i \geq 2c$ for all $h_5 \in H_5$ and there is $d' \in BR(v^*, \theta)$ s.t. $d'_1 = d'_2 = c$.

Proof Note that voters are identical except for the order they vote in. If the SIG will fund at least one campaign, its choice set is largest if it chooses to fund V_1's. This implies that the SIG's payoffs when it funds V_1's campaign are weakly larger than when it waits and funds voter i(> 1)'s campaign first.

The SIG's posterior belief about A's type after observing v_1 will either be q or $1-q$. By symmetry, the value of funding future campaigns must be the same in either case, so the SIG gains nothing by waiting until v_1 is observed. Thus, funding V_2's campaign must weakly dominate waiting to fund a later campaign. □

The following lemma states that, for any given electoral calendar and SIG donation strategy, the maximum number of donations which will be observed on the equilibrium path is odd or zero.

Lemma 2 *Suppose* $v = v^*$ *and* $d \in BR(v^*, \theta)$. *Then,* $\max_{h_5 \in H_5} \{\sum_{i=1}^{5} 1_{(d_i = c)}\}$ *is either odd or zero.*

Proof Suppose a SIG has funded an odd number of campaigns n. The frontrunner has a lead of at least one vote. Thus, funding an additional campaign to get to an even n+1 will either confirm the frontrunner's lead or tie the election. Tying the election does not change the identity of the candidate most likely to be highly electable. Thus, nothing is gained by funding campaign n+1. Therefore, the SIG will fund zero campaigns, one campaign, or fund until one candidate receives two out of three or three out of five informed votes. That is, an election will end with an even number of campaigns funded only if one candidate has a 2-0, 3-1, or 4-0 lead in informed votes. □

The following series of claims narrow the set of calendars which we must consider. The first allows us to ignore calendars 7, 10, 11, 12, 13, 14, 15, and 16 and look only at **1, 2, 3, 4, 5, 6, 8 and 9** (or vice-versa).

Claim 1 *Let* θ *be any calendar s.t.* $\theta(V_1) < \theta(V_2)$ *and* θ' *be a calendar s.t.* $\theta'(V_1) = \theta'(V_2)$ *and* $\theta'(V_i) = \theta(V_i) - 1$ *for* $i \in \{3, 4, 5\}$. *Then,* θ *weakly dominates* θ' *and vice-versa.*

Proof The donor knows that the election will either be 1-0 or 0-1 after one informative vote. Because of symmetry ($\Pr(A) = \Pr(B) = \frac{1}{2}$), continuation strategies lead to the same expected utility in either case. Therefore, the optimal d_2 will be the same regardless of whether the donor can condition on the outcome of v_1. □

The following claim eliminates calendars 5 and 9 from consideration, leaving **1, 2, 3, 4, 6, and 8**.

Claim 2 *Any calendar in which* $\theta(V_3) < \theta(V_4) = \theta(V_5)$ *(calendars 5, 9, 10, and 13), is weakly dominated by* θ' *s.t.* $\theta'(V_4) < \theta'(V_5)$ *and* $\theta'(V_i) = \theta(V_i)$ *for* $i \in \{1, 2, 3\}$ *(calendars 2, 3, 15, and 16).*

Proof If $d_1 = d_2 = d_3 = c$, the election will either be 2-1 or 3-0. Only the first case is relevant since the election is over if it is 3-0. If the last two voters vote simultaneously, the SIG will either fund both or neither since only two votes against the front-runner can change the result. Whenever c is such that $d_4 = d_5 = c$ under $\theta(V_4) = \theta(V_5)$, $d_4 = c$ if $\theta(V_4) < \theta(V_5)$, and $d_5 = c$ if the election is still undecided. This is because the expected benefit of both continuation strategies is the same, but the expected cost is strictly lower in the Sequential case.

By Lemma 1, $d_1 = c$ whenever $\sum_{i=1}^{5} d_i > 0$ for some h_5, and $d_2 = c$ whenever $\sum_{i=1}^{5} d_i > c$ for some h_5. If $d_3 = 0$, either $d_4 = c$ or $d_5 = c$ is possible only if the informative vote count is 1-1 (a 2-0 lead cannot be overcome by two votes).

The only remaining question is whether d_3 could be adversely affected by having V_4 and V_5 vote sequentially ($\theta(V_4) < \theta(V_5)$) rather than simultaneously ($\theta(V_4) = \theta(V_5)$). Suppose that the informative vote count is 1-1. It will be 2-1 after an informative v_3. Applying Lemma 2, if $d_3 = 0$ it will fund at most one more campaign, but in this case it may as well fund V_3 's. If the election is 2-0, it is only optimal to fund further campaigns if the SIG is prepared to fund campaigns until a candidate reaches a 3 informative votes. This continuation strategy must include $d_3 = c$. □

Next we eliminate calendar 6 from contention, leaving **1, 2, 3, 4, and 8**.

Claim 3 *The calendar {4-1} (no. 6) is weakly dominated by Super Tuesday {3-1-1}.*

Proof If all four campaigns in the first block of {4-1} are funded, it must be that the donor would fund the fourth campaign conditional on the election being 2-1 since it will either be 2-1 or 3-0, in which case the election is over. Therefore, if $d_4 = c$ under {4-1}, then $d_4 = c$ if $\theta =$ {3-1-1} and the election is 2-1.

Under {4-1}, the SIG will never fund only 3 date-1 campaigns. Funding three voters in the first block of a {4-1} means that $d_5 = 0$ because $d_5 = c$ only if the informative vote count is tied, which is impossible when an odd number of informative votes have been cast thus far. Moreover, if the SIG funds 2 date-1 campaigns, he can make the funding decision for the third (V_5) after conditioning on the outcome of the first two (i.e. fund it only if the informative vote count is 1-1 and not 2-0). Therefore, it is strictly better for the SIG to fund two campaigns on date 1 and then fund voter 5 if the informative vote count is tied, thus giving the same probability of success at a strictly lower expected cost.

If only two campaigns are funded in the first block of {4-1}, at least two will be funded if $\theta =${3-1-1}. In both cases, only one additional campaign may be funded: if the informative vote count is 2-0 after the first block, the lead cannot be overcome; if the informative vote count is 1-1, one additional signal will make it 2-1 and that lead cannot be overcome. Therefore, if it is optimal to fund the first two voters when $\theta =$ {4-1}, it is also optimal when $\theta =${3-1-1}. □

The following result shows that calendars 4 and 8 are weakly dominated by the Sequential calendar and narrows our set of contenders to **1, 2 and 3**.

Claim 4 *Any calendar in which $\theta(V_2) < \theta(V_3)$ is weakly dominated by the Sequential calendar {1-1-1-1-1}.*

Proof By Lemma 1, $d_1 = d_2 = c$ whenever the comparison of these calendars is in question. Therefore, I compare calendars conditional on two informative votes having been cast.

Suppose a candidate has a 2-0 lead. Then, the SIG will only fund further campaigns if it is willing to fund campaigns until one candidate has received three favorable informed votes. This may be done at a lower expected cost when the final three voters vote sequentially because the SIG can choose to stop funding as soon as one candidate reaches 3 votes. Therefore, having the final three voters vote sequentially weakly dominates all other arrangements of the last three voters conditional on the first two voters voting informatively for the same candidate.

Now suppose the election is tied 1-1. The SIG will fund voter 3's campaign since the cost of previous campaigns is sunk and it was willing to fund the campaign of voter 1 (it must be that $q - \frac{1}{2} > c$). One candidate will have a 2-1 lead after voter 3's vote. Because of the symmetry of the game, it does not matter which candidate it is for the SIG's funding decision and therefore a calendar in which voters 3 and 4 vote simultaneously is strategically identical to one in which they vote sequentially. By the second claim in this section, if the first three campaigns have been funded, the calendar with voters 4 and 5 voting sequentially weakly dominates the one in which they vote simultaneously. □

These claims leave us with three contenders for the voter-optimal electoral calendar: Sequential, Simultaneous, and Super Tuesday. As is proven in Theorem 1 below, the Simultaneous calendar is dominated by the Super Tuesday calendar. However, because of its special role in the literature, I will examine it more closely than other dominated calendars. I include the proof of this dominance relation in the proof of the following theorem.

Rather than prove Theorems 3 and 4 separately, we present the results contained in both into Theorem 1.

Theorem 1 *There exist values $c_{all} < c_{sim} < c_{st} < c_{\text{seq}}$ such that:*

- *The Super Tuesday calendar weakly dominates all other calendars, and strictly dominates the Sequential calendar, when $c \in (c_{all}, c_{st})$.*
- *The Sequential calendar weakly dominates all other calendars, and strictly dominates the Super Tuesday calendar, when $c \in \left(c_{st}, c_{\text{seq}}\right)$.*
- *The Simultaneous calendar weakly dominates all other calendars when $c < c_{sim}$ or $c > c_{\text{seq}}$.*

Proof Funding one (or two) campaigns results in the h-type winning the nomination with probability $p(1) = q$. The first voter will be funded under any electoral calendar if $\Delta(1) = q - \frac{1}{2} > c$.

Simultaneous calendar

In a Simultaneous election, funding three (or four) campaigns leads to selecting the correct candidate with probability:

$$q^2\left(q + 3\left(1 - q\right)\right) = q^2\left(3 - 2q\right) = p(3)$$

The increase in the probability of selecting the h-type resulting from funding three campaigns rather than one is:

$$\begin{aligned} q^2\left(3 - 2q\right) - q &= -q\left(2q^2 - 3q + 1\right) \\ &= -2q^3 + 3q^2 - q = \Delta(3) > 0 \end{aligned}$$

The additional cost, given that one campaign is being funded, is $2c$. Therefore, the SIG will fund three campaigns if:

$$c < \frac{1}{2}\Delta(3)$$

Funding five campaigns leads to selecting the correct candidate with probability:

$$q^3\left(q^2+5q\,(1-q)+10\,(1-q)^2\right)=q^3\left(10-15q+6q^2\right)=p(5)$$

The increase in probability of success from funding voters 4 and 5 is:

$$\begin{aligned}p(5)-p(3)&=q^3\left(10-15q+6q^2\right)-q^2\,(3-2q)=3q^2\,(2q-1)\,(q-1)^2\\&=6q^5-15q^4+12q^3-3q^2=\Delta(5)>0\end{aligned}$$

The difference in cost between the two funding strategies is $2c$, so the SIG will fund all five campaigns if:

$$c<\frac{1}{2}\Delta(5)=c_{sim}$$

When this inequality holds, the Simultaneous electoral calendar weakly dominates all others.

Super Tuesday calendar

In a Super Tuesday election, funding two campaigns in the first block leads to selecting the right candidate with probability $p(3)$ at an expected cost of:

$$2c+c\left(1-q^2-(1-q)^2\right)=2c\,(1+q\,(1-q))<3c$$

The increase in cost from funding only one campaign to following this strategy is $c+2cq\,(1-q)$,Therefore, at least two date-1 campaigns will be funded in a Super Tuesday election if:

$$c<\frac{\Delta(3)}{1+2q\,(1-q)}=c_{\text{seq}}$$

Note that the SIG will be willing to fund this strategy for higher c than it is to fund three campaigns in a Simultaneous election because $1+2q\,(1-q)<2$.

In a Super Tuesday election, funding all three period-1 campaigns leads to selecting the right candidate with probability $p(5)$at an expected cost of:

$$3c+c\left(1-q^3-(1-q)^3\right)+c\left(6q^2\,(1-q)^2\right)=3c\left(1+q+q^2-4q^3+2q^4\right)$$

The increase in the probability of nominating an h-type from funding voter 3's campaign is $\Delta(5)$. Subtracting the expected cost of the "fund 2" strategy from that of the "fund 3" I find the difference in expected cost:

$$\begin{aligned}&3c\left(1+q+q^2-4q^3+2q^4\right)-c\,(1+q\,(1-q))=c\left(6q^4-12q^3+5q^2+q+1\right)\\&\quad=c\,(1+q\,(1-q)\,(1+6q\,(1-q)))\end{aligned}$$

Therefore, the SIG will fund all 3 date-1 campaigns in a Super Tuesday election if:

$$c < \frac{\Delta(5)}{1 + q\,(1-q)\,(1 + 6q\,(1-q))} = c_{st}$$

When this inequality holds, the Super Tuesday calendar weakly dominates all others.

Because $q\,(1-q)$ reaches a maximum for $q \in (0, 1)$ at $\frac{1}{4}$, $q\,(1-q)\,(1+6q\,(1-q)) \leq \frac{5}{8}$ and therefore $c_{st} > c_{sim}$.

Sequential calendar

Suppose that one of the candidates has a 2-0 lead in informed votes in a Sequential election. The SIG's posterior belief about the probability that the leading candidate is the correct choice is $\frac{q^2}{q^2+(1-q)^2}$. That is also the probability of the correct candidate winning the election if the SIG funds no further elections. If the SIG does continue to fund campaigns, it must be willing to do so until a candidate reaches 3 votes. This increases the probability of electing the correct candidate to:

$$\begin{aligned} &\frac{q^2}{q^2+(1-q)^2}\left(q + (1-q)\,q + (1-q)^2\,q\right) + \frac{(1-q)^2}{q^2+(1-q)^2}q^3 \\ &= \frac{q^3}{2q^2-2q+1}\left(2q^2 - 5q + 4\right) \end{aligned}$$

So that the increase in the probability of electing the correct candidate is:

$$\frac{(1-q)^2}{q^2+(1-q)^2}q^3 - \frac{q^2}{q^2+(1-q)^2}\,(1-q)^3 = q^2\,(2q-1)\,\frac{(q-1)^2}{2q^2-2q+1}$$

This strategy brings with it an additional cost of:

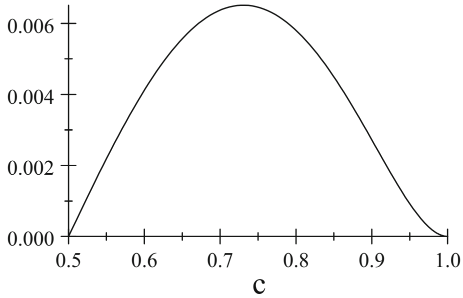
$$\begin{aligned} &c + c\left(\frac{q^2}{q^2+(1-q)^2}\,(1-q) + \frac{(1-q)^2}{q^2+(1-q)^2}q\right) \\ &+c\left(\frac{q^2}{q^2+(1-q)^2}\,(1-q)^2 + \frac{(1-q)^2}{q^2+(1-q)^2}q^2\right) \\ &= \frac{2c}{q^2+(1-q)^2}\left(2q^4 - 4q^3 + 3q^2 - q + 1\right) \end{aligned}$$

Therefore, the SIG will fund voter 3 after a 2-0 start if:

$$\begin{aligned} c &< \frac{q^2\,(2q-1)\,\frac{(q-1)^2}{q^2+(1-q)^2}}{\frac{1}{q^2+(1-q)^2}\left(2q^4 - 4q^3 + 3q^2 - q + 1\right)} \\ &= q^2\,(2q-1)\,\frac{(q-1)^2}{2q^4 - 4q^3 + 3q^2 - q + 1} = c_{all} \end{aligned}$$

Note that $c_{all} < c_{sim} < c_{st}$, so that the *Simultaneous and Super Tuesday calendars strictly dominate the Sequential* when $c \in (c_{all}, c_{sim})$, a result in line with the findings in Battaglini (2005). Moreover, the *Super Tuesday calendar strictly dominates the Sequential* calendar over the campaign cost interval (c_{sim}, c_{st}). I verify $c_{all} < c_{sim}$ numerically:

$$\left(6q^5 - 15q^4 + 12q^3 - 3q^2\right) - 2q^2(2q-1)\frac{(q-1)^2}{2q^4 - 4q^3 + 3q^2 - q + 1} > 0$$



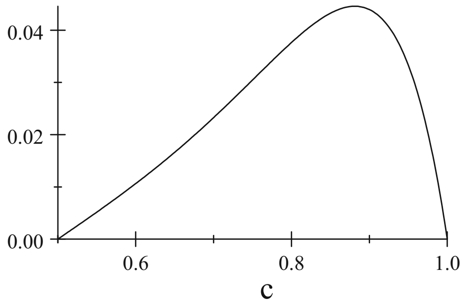
In a Sequential election, if three campaigns have been financed leading to a 2-1 vote lead by one of the candidates, continuing to fund campaigns makes sense for the SIG only if it is willing to fund until one candidate has three votes. This leads to electing the correct candidate with probability $p(3)$, while stopping funding now means the frontrunner will win the election, which is the correct choice with probability q. The increase in the probability of selecting the correct candidate is therefore $\Delta(3)$. This strategy leads to additional expected costs of $c(1 + 2q(1-q))$. Therefore, the SIG will continue this funding if:

$$c < \frac{\Delta(3)}{1 + 2q(1-q)} = c_{\text{seq}}$$

Note that the SIG's problem following a 2-1 vote and following a 1-0 vote while expecting not to fund more than three campaigns are identical. Therefore, when $c > c_{\text{seq}}$, the SIG will fund at most one campaign. If this is the case, *the voter is indifferent among all electoral calendars.*

On the other hand, if the SIG funds only two date-1 campaigns in a Super Tuesday election it will fund a third if the election is tied 1-1 in informed votes after the first block has voted, but will never fund more than that because a 2-1 lead which would ensue could never be overcome by a single informed vote. Therefore, there is a cost interval $c \in \left(c_{st}, c_{\text{seq}}\right)$ over which *the Sequential calendar strictly dominates the Super Tuesday calendar*. This interval in non-empty if:

$$c_{\text{seq}} - c_{st} = \left(\frac{-q\left(2q^2 - 3q + 1\right)}{1 + 2q(1-q)} - \frac{6q^5 - 15q^4 + 12q^3 - 3q^2}{1 + q(1-q)(1 + 6q(1-q))}\right) > 0$$



Again, I verify this inequality numerically. □

Proof of Theorem 5

Each voter must determine whether he is willing to invest c in order to receive an informative signal about candidate quality. Note that, in contrast to the model presented in Section 3, information acquisition decisions here do not depend on the expected cost of future expenditures on information. This makes the proof of Theorem 5 somewhat simpler than the proof of Theorems 3 and 4. To avoid repetition, we will use notation and probability calculations developed in the proof of Theorems 3 and 4; in particular, $\Delta(3)$, $\Delta(5)$ and $p(3)$ are defined in that proof, and the value of pursuing a best out of five strategy when after a 2-0 start is calculated there.

Whenever the electoral calendar allows it, early voters will not acquire information, choosing instead to free-ride on later voters. In some cases, such as Simultaneous elections, the ordering of voters is not meaningful and there may be multiple equilibria in which the identity of the voters who vote varies.

Voters are most likely to acquire information if they believe that other voters will not compensate for their failure to do so by acquiring information themselves. Thus, in efficient pure strategy equilibria voters who acquire information compare their cost of doing so, c, with the expected social benefit of doing so.

We proceed by analyzing several information acquisition cost intervals separately and checking whether any voter could have the incentive to acquire information that would lead to a one signal, three signal or five signal equivalent outcome.

If $c > q - \frac{1}{2}$ the informational value of the first signal is less than its cost, so that no voter will choose to acquire information.

If $q - \frac{1}{2} \geq c > \Delta(3)$ the informational value of the first signal is more than its cost, so that voter 5 will acquire information if no other voter has or is expected to. However, the incremental value of eliciting three signals rather than one, $\Delta(3)$, is lower than the cost of acquiring a signal so that no voter will be willing to invest c in order to increase the probability of nominating the high type from q to $p(3)$. Thus, the efficient equilibrium in this case involves only one signal being acquired.

If $\Delta(3) \geq c > \Delta(5)$ the value of eliciting three signals rather than one is higher than c, so that any individual voter who believes he is pivotal for that outcome will be willing to acquire information. However, going from a three signal outcome to a five signal outcome does not justify the expense c, so that equilibria involving more than three voters acquiring information are not feasible. Furthermore, in an equilibrium in which a maximum of three voters are expected to acquire information, being able to condition one's vote on prior votes or signals does not affect the voter's decision, except in the case in which the election has already been decided and is 2-0. The only alternative is that the election is 1-1 and acquiring information brings benefits of $q - \frac{1}{2} < c$. Therefore, the probability of selecting a high-type nominee in an efficient pure strategy equilibrium of the information acquisition game when $c \in [\Delta(3), \Delta(5))$ is independent of the electoral calendar.

In these first three cases, the electoral calendar plays no role in determining the efficient pure strategy equilibrium. However, in part of the remaining interval of information costs c, $[0, \Delta(5)]$, electoral calendars affect the amount of information acquisition in the set of efficient pure strategy equilibria.

If $\Delta(5) = c_2 \geq c$ and voter 3 can condition his information acquisition decision on voter 1 and 2's votes or signals, he will not acquire information after a 2-0 start if the benefit of doing so $\frac{q^2(2q-1)(q-1)^2}{2q^2-2q+1} = c_1$ is less than its cost c. However, if voter 3 cannot condition on the first two votes or signals, the expected value of acquiring information is $\Delta(5) \geq c$ so that he will choose to do so. Therefore, for the cost interval $(c_1, c_2]$, calendars which allow voter 3 to condition his decision on the outcome of the first two votes, that is calendars in which $\theta(V_2) < \theta(V_3)$, underperform other calendars.

The class of electoral calendars which satisfy $\theta(V_2) = \theta(V_3)$ includes the Simultaneous and the Super Tuesday calendars while the Sequential calendar satisfies $\theta(V_2) < \theta(V_3)$.

Finally, if $c \leq c_1$ all voters will be willing to acquire information regardless of the electoral calendar.

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