Super Tuesday: Campaign Finance and the Dynamics of Sequential Elections*

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May 15, 2011

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 the ex-ante probability of electing the best candidate over all possible electoral calendars. Equilibrium play is consistent with regularities in U.S. presidential primaries, and the model provides insights into bandwagons, the usefulness superdelegates, and the importance of the money primary.

*I am grateful to Scott Ashworth, Marco Battaglini, Wioletta Dziuda, Navin Kartik, John Londregan, Adam Meirowitz, Stephen Morris and seminar participants at Princeton University, NYU, and the University of Chicago for their comments and encouragement.

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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[9])

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[35]). This dynamic has alarmed many in politics, the media, and academia who worry that the system favors frontrunner candidates and eliminates opportunities for voters to learn about candidates. 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[39]). 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. 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

[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.

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, candidates for the Democratic nomination raised a staggering $787 million, while Republicans raised $477 million[2]. 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 election when they can no longer raise enough funds to continue campaigning competitively. 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 and learning, campaign finance, special interest politics, and other topics. I take the view that campaigns are a means of providing information to the public (as in Coate 2004[11] and Ashworth 2006[5]), 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[19] and Serra 2007[38]). Policy differences within a party are taken to be negligible 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.

Within this framework, donating to a political campaign is a way of increasing the amount of information available to voters. Thus, it is a means of helping the party select a better candidate and increase its chances of winning the general election. Given mixed evidence (Ansolabehere, de Figueiredo and Snyder 2003[4]),

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

I am agnostic as to the motivation of donors. In the main body of the paper I speak of a single special interest group (SIG) who sees donations as investments which will yield future benefits in the form of access, policy favors, agenda setting, or other services if the receiving candidate wins the general election. The SIG has an interest in helping the party select the most electable candidate because that is the group's only chance of benefiting from favorable policies. In Section 4.3, I present an extension of the model with many altruistic donors which leads to donor behavior equivalent to the baseline model's (Proposition 1). The model of altruistic donations is of special interest as it reconciles the small average size of individual donations (individuals are currently subject to a $2400 donation limit) with donor behavior which is responsive to circumstances in ways suggestive of the expectation that a particular donation will affect outcomes and/or elicit future favors. Thus, it contributes to the theoretical understanding of campaign finance.

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

- Donors give gradually to candidates (McCarty and Rothenberg 2000[32]).
- Money follows electoral success (Aldrich 1980[2][1], Hinckley and Green 1996[26], Mayer 1996[30], Damore 1997[13]).
- Candidates drop out under financial duress (Mayer 1996 ch. 2[31], Norrander 2000[34], Haynes et al. 2004[24]).

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 the campaign, such as voters and parties, prefer to have as many campaigns funded as possible. These stakeholders may be best served

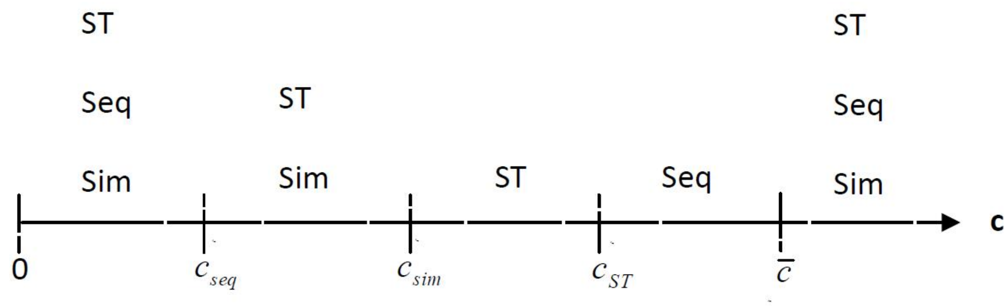


Figure 1.1: Optimal electoral calendar as function of campaign costs. ST: Super Tuesday, Seq: sequential, Sim: simultaneous.

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 Figure 1.1).

1.1. Related Literature

Sequential elections were first studied in a game-theoretic setting by Dekel and Piccione (2000)[15]. 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)[6] shows that, if voting is costly, voters will abstain once a candidate takes a sufficiently large lead. Callander (2007)[10] shows that bandwagons can arise when voters prefer to vote for the eventual winner. Ali and Kartik (2008)[3] 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 canonical framework as far as possible.

While the effect of campaign spending on voting behavior (e.g. Haynes, Gurian and Nichols 1997[25]) and the importance of accumulating campaign funds early in a contest (e.g. Goff 2004[21]) 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)[32] 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 (1980)[1] 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. Klumpp and Polborn (2006)[28] 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 consider electoral calendars which are neither purely sequential nor simultaneous. Battaglini (2005)[6] 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)[10] 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)[37] 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.

Klumpp and Polborn (2006)[28] 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.

Gershkov and Szentes (2009)[20] present a model where voters must decide whether to acquire costly information prior to voting. They 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)[33] 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 about sequential voting.

Knight (2011)[29] uses a model of learning and momentum and data from the 2004 Democratic nomination to compare the welfare implications of sequential and simultaneous primary calendars. He concludes that a simultaneous is preferable in spite of the risk of voters overweighting their prior beliefs. Deltas, Herrera, and Polborn (2010)[16] 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 a call the special interest group or SIG), and five voters ($V = \{V_1, ..., V_5\}$)[3] interact in an extensive form game which will determine which candidate, A or B, will represent the Party in the general election. There are seven periods $t \in \{0, 1, ..., 6\}$ divided into three 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.

3. Period 6 is the *general election stage*, during which the donor makes a final donation and payoffs are realized.

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 $t \in \{1, ..., 5\}$ 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. With a slight abuse of notation, I write $\theta(t)$

[3] 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.

when referring to the (possibly empty) set of voters who are scheduled to cast their ballots during period t.[4] $|\theta(t)|$ 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 ($\theta(t) = \varnothing \Rightarrow \theta(t+1) = \varnothing$). 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 $t \in \{1, ..., 5\}$. $d_i \in \{0, c\}$ is the donation given to the campaigns associated with voter i. At the general election stage, the SIG has one final chance to make donations to the Party's nominee: $A^6_{SIG} = \mathbb{R}_+$. The amount of money given to the nominee at time six is d_6.

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

I use v_i to denote V_i's action. Voting determines which candidate becomes the *nominee* by majority rule:

$$N \equiv \{C \in \{A, B\} | \sum 1_{(v_i = C)} \geq 3\} \tag{2.1}$$

Candidates differ in their electability $e_C \in \{h, l\}$ with $1 \geq h > l \geq 0$. Electability is a summary variable capturing charisma, political ability, and other characteristics which help a candidate win elections. It is further interpreted as the probability with which the candidate will win the general election if nominated. Thus, if candidate A is highly electable and wins a majority of primary votes, $N = A$ and $e_N = e_A = h$.

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

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

$$u_P = u_V = \begin{cases} 1 \text{ if } e_N = h \\ 0 \text{ otherwise} \end{cases} \tag{2.2}$$

This utility function can be interpreted as an expected utility function where the value to the voters of having their party win the general election is $\frac{1}{h-l}$: $u_V(e_N) = \frac{1}{h-l}e_N - \frac{l}{h-l}$. Thus, if the h-type wins the primary: $u_V(h) = \frac{h-l}{h-l} = 1$. If the l-type wins the primary: $u_V(l) = \frac{l-l}{h-l} = 0$.

The SIG obtains benefits from donations given to the nominee[5], $d^N = \sum_{i=1}^{5} \frac{d_i}{2} + d_6$, according to an increasing and strictly concave function $b : \mathbb{R}_+ \to \mathbb{R}_+$. However, these benefits are only realized if the party wins the general election, so that the SIG's expected utility conditional on the nominee's electability is:

$$u_{SIG} = e_N b(d^N) - d^N - \hat{d} \tag{2.3}$$

where $\hat{d} = \sum_{i=1}^{5} \frac{d_i}{2}$ is the total donations given to the losing candidate, making total donations $d^N + \hat{d} = \sum_{i=1}^{6} d_i$.

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)[19], I say

[5] A donation of c is split evenly between candidates, who then spend the money campaigning against each other.

that voters who receive informative signals are *informed*, and those who do not are *uninformed*. These signals are privately observed by the voters.

At time 6, before the SIG makes its final donation decision and the general election is decided, the nominee's type is revealed[6].

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 ($t \in \{1, ..., 5\}$):

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 $v_i \in \{A, B\}$.

General Election Stage ($t = 6$):

1. The nominee's electability $e_N \in \{h, l\}$ is revealed to all players.

2. The SIG chooses $d_6 \in \mathbb{R}_+$.

3. Payoffs are realized.

The three stage game described above is Γ. I will use Γ_θ to refer to the continuation game consisting of the primary and general election stages, 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]:

[6] This is an assumption of the model. It's motivation and consequences are described in Section 3.1.

[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.

$$d_i : H_{\theta(V_i)} \to \{0, c\} \tag{2.4}$$

During the general election stage, the SIG's donation strategy also takes into account new information about the nominee's type:

$$d_6 : H_6 \times \{h, l\} \to \mathbb{R}_+ \tag{2.5}$$

In addition to the public t-history $h_{\theta(V_i)}$, V_i has access to information about current period donations $\{d_j\}_{j|\theta(V_j)=\theta(V_i)}$ and his signal s_i when making his voting decision. That is, V_i conditions his vote on his private history $h_{V_i} = \{h_{\theta(V_i)}, \{d_j\}_{j|\theta(V_j)=\theta(V_i)}, s_i\}$. H_{V_i} is the set of all possible private histories h_{V_i}.

$$v_i : H_{V_i} \to \{A, B\} \tag{2.6}$$

Let $d = \{d_i\}_{i=1}^{6}$, $v = \{v_i\}_{i=1}^{5}$, 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

The assumption of a single SIG is a strong one in the context of American presidential primaries in which thousands of donors give small amounts to campaigns (Ansolabehere, de Figueiredo and Snyder 2003[4]). In Section 4, I develop a behavioral model of many rule utilitarian donors which leads to the same equilibrium behavior as in the model with one SIG. Given the lumpy nature of donation decision, it is also possible to generate the same equilibrium behavior in a model with $K \geq 2$ identical SIGs (see Schwabe 2010[36]).

It is possible to include candidates as strategic players who can decide whether and where to spend their campaign funds. If this is the case, then candidates who get an early lead have an incentive to stop campaigning in order to eliminate the possibility that future signals will favor the opposing candidate. If candidates know their own type, there is an equilibrium in which candidates campaign whenever possible, supported by off-equilibrium beliefs that a candidate who does not campaign must have low electability. If candidates do not know their own type, some degree of concern for the Party's success is required for candidates to campaign. Details are in Schwabe (2010)[36].

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 Section 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[27]) 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.

That the signals generated by campaigns are privately observed by voters is meant to capture the effect of face-to-face impressions achieved through town hall meetings, rallies, TV commercials on local channels, etc. In the equilibrium I focus on, this information will be revealed to all players by means of election results. Because of this, a simpler specification in which there are no strategic voters and election results are a public signal of electability would lead to identical results.

Finally, the assumption of a symmetric prior considerably simplifies the analysis. If $\Pr(A) \in (1-q, q)$, the candidate who generates the most favorable signals will have the highest posterior probability of being the h-type. Thus, an equilibrium with voting strategies such as those described in Theorem 1 below is likely and, although the SIG will treat the candidates asymmetrically when deciding whether to continue funding campaigns, the same basic forces which generate the results in Section 3.3 will be present. When $\Pr(A) \notin (1-q, q)$, at least one voter will have to vote uninformatively in order for the candidate with the highest posterior to be nominated. I discuss some implications of this case in Section 4.3.

3. Analysis

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

3.1. General Election Stage

At time 6, the nominee's electability is revealed. The SIG can use this information to make final donation decisions. The SIG's problem at this stage is:

$$\begin{aligned} &\max_{d_6} e_N b(d^N) - d^N - \hat{d} \\ &or \\ &\max_{d_6} e_N b\left(\textstyle\sum_{i=1}^{5} \frac{d_i}{2} + d_6\right) - \textstyle\sum_{i=1}^{5} \frac{d_i}{2} - d_6 - \hat{d} \end{aligned} \tag{3.1}$$

Noting that $\sum_{i=1}^{5} \frac{d_i}{2}$ and $\hat{d}$ are sunk costs at this point, and the strict concavity of b, the solution to this problem is characterized by:

$$b'(d^N) = \frac{1}{e_N} \tag{3.2}$$

Let d^e be the solution to Equation 3.2 when $e_N = e$. Then, by concavity of b, $d^h > d^l$. I assume that:

$$d^l \geq \frac{5}{2}c \tag{3.3}$$

This ensures that the SIG is willing to fund the nominee's campaigns regardless of his type. It also ensures that the term d^N will depend on e_N, but be otherwise independent of past play[8]. The assumption is consistent with the observation in McCarty and Rothenberg (2000)[32] that most campaign donations are made after the primary season is over.

Taking this into consideration, we may conceptualize the SIG's utility as consisting of two distinct elements: the term $e_N b(d^N) - d^N$ which reflects the benefit of nominating a candidate with electability e_N, and $\hat{d}$ which is an expenditure undertaken in the interest of learning and enabling voters to choose a highly electable candidate with higher probability. Note that $\Delta b = \left(hb(d^h) - d^h\right) - \left(lb(d^l) - d^l\right) > 0$ so that the SIG shares the voters' and the Party's interest in nominating the most electable candidate. However, the SIG's preferences differ from the voters' and the Party's in that they internalize the informational cost of campaigns $\hat{d}$.

3.2. Primary Election Stage

We now turn our attention to donations and voting during the primary election stage. The main result in of 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:*

$$v_i^*(s_i) = \begin{cases} s_i & \text{if } s_i \in \{A, B\} \\ A & \text{if } s_i = \varnothing \text{ and } \sum_{j=1}^{i} 1_{(s_j = \varnothing)} \text{ is odd} \\ B & \text{otherwise} \end{cases}$$

[8] If the nominee's electability were not revealed prior to the SIG's last donation, the SIG's utility would depend on the posterior probability of $e_N = h$.

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 (2008)[3]. Uninformed voters would abstain if they had the option, as in Feddersen and Pesendorfer (1996)[19]. Instead, they avoid affecting the outcome of the nomination process by alternating their votes. 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[8]).

Note that, taking the SIG's funding decisions as given, v^* leads to the full information outcome. The only way in which voter utility can improve is by getting the SIG to fund more campaigns. However, any deviation from v^* puts the nomination of the candidate with the best posterior at risk and complicates the SIG's future funding decisions. In general, voting strategies other than v^* discourage donations and this is the best equilibrium for the voter. However, it is possible to construct an example with higher voter utility in which the voters punish the donor (and themselves) if he does not make enough contributions[9].

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 makes possible 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.

3.3. Election Design Stage

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

[9] Details available from the author upon request.

be nominated, anticipating equilibrium behavior by voters[10] and the SIG. 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. As a point of contrast, I first show that the SIG would always choose a sequential calendar.

It is useful to introduce some easy to understand 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. Thus, the sequential calendar is {1-1-1-1-1}, while a simultaneous election corresponds to the calendar {5}.

From the SIG's perspective, the choice of electoral calendar is akin to a statistician's experiment scheduling problem. That the SIG will prefer a sequential calendar is a result derived in a different setting by DeGroot (1970)[14]. Intuitively, the sequential calendar lets the SIG condition their funding decisions on the latest voting, therefore giving the SIG a larger strategy set.

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

Although the SIG's preferred primary schedule is of a simple form, and the result provides some insight into the choice of electoral calendar, it does not coincide with presidential primary calendars in the United States. The key to understanding this discrepancy is to recognize that the primary schedule is determined by the National Committees of the parties[11]. The members of these committees have more in common with voters than with the SIG. That is, they want their nominee to win the general election, but they do not bear the cost of the campaigns. In

[10] In particular, I assume that the Party correctly anticipates that voter strategies are v^*.

[11] In practice, the National Committee sets certain ground rules and state Committees individually decide when to hold their primary election. However, setting the rules goes a long way toward determining the final outcome.

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, and thus the voters' and the Party's ex-ante expected utility.

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

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

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

Thus, the Party will choose a calendar which dominates all others for the relevant triple $\{c, b, q\}$. There are many possible electoral calendars in a world with five voters (16 in fact, they are listed in the appendix). The following lemma narrows the field to two: a pure sequential election ({1-1-1-1-1}) and a mixed calendar in which there is a block of three voters voting simultaneously at date 1 followed by the two remaining voters voting sequentially ({3-1-1})[12]. I call this 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.

Lemma 1. *For any c, b, and q, one of the following electoral calendars dominates all possible calendars: sequential {1-1-1-1-1} or Super Tuesday {3-1-1}.*

Proof. In the appendix. ■

[12] 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.

The proof proceeds by listing all possible calendars in a five voter election. Then, I derive equivalence relationships which allow me to focus on a subset of calendars. For example, because of the symmetry of the election, which candidate takes a 1-0 lead after voter 1's informed vote does not matter for the SIG's funding strategy. That is, conditioning on the outcome of the first vote will have no effect on the SIG's funding strategy at that moment. Therefore, any calendar in which the first voter votes before all others is strategically equivalent to the calendar identical to it but in which voter 1 votes at the same time as voter 2.

I then establish dominance relationships among equivalence classes of calendars until I am left only with the candidates listed above. For example, a Super Tuesday calendar will always lead to the election of the high type candidate with at least as high a probability as a {4-1} calendar and, for some values of c, it will do so with strictly higher ex-ante probability. This is because the SIG may not be willing to commit to funding four campaigns at the beginning of the process. However, it may be willing to commit to funding three, and then funding the fourth if one candidate has a 2-1 lead. On the other hand, if the SIG is willing to commit to funding four campaigns, it must be that it will commit to funding three and then fund the fourth if the election is still in play (if it is 2-1).

The preceding lemma sets the stage for the following result describing the voter-optimal electoral calendars. Given that I know that either a sequential or a Super Tuesday calendar is optimal, it is much easier to make comparisons among them and arrive at a result describing when one dominates another. The following theorem is the central result of this paper. It is the first result in this literature in which a hybrid calendar (not strictly sequential or simultaneous) plays a major role. It also provides an effectiveness-based explanation for the existence of Super Tuesdays.

Theorem 3. *For any given b and q, there exist values $0 < c_{\text{seq}} < c_{st} < \bar{c}$ such that:*

- *The Super Tuesday calendar dominates all others, and strictly dominates*

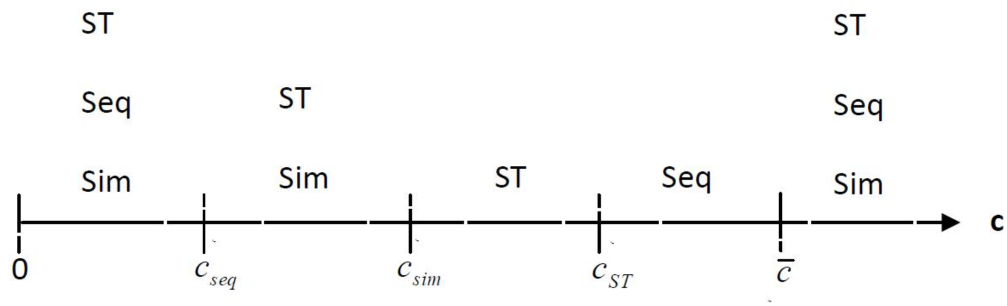


Figure 3.1: Optimal electoral calendar as function of campaign costs. ST: Super Tuesday, Seq: sequential, Sim: simultaneous.

the sequential calendar, when $c \in (c_{\text{seq}}, c_{st})$.

- *The sequential calendar dominates all others, and strictly dominates the Super Tuesday calendar, when* $c \in (c_{st}, \bar{c})$.

Proof. In the appendix. ■

The simultaneous calendar, which has been widely studied and is usually used as a point of comparison to the sequential calendar, is dominated by the Super Tuesday calendar in this model. That is not to say, however, that it is not 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 b and q, there exist campaign costs $c_{sim} \in (c_{\text{seq}}, c_{st})$ such that the simultaneous electoral calendar dominates all others whenever $c < c_{sim}$ or $c > \bar{c}$.*

Proof. In the appendix. ■

As this result shows, for some campaign costs, a simultaneous calendar strictly outperforms a sequential calendar, a result reminiscent of Battaglini (2005)[6]. Figure 3.1 summarizes the results of Theorems 3 and 4.

4. Extensions

In this section, I explore the implications of extending the basic model described above. I do this in order to gain further insights into the applicability of the model to issues relevant to U.S. presidential primaries, as well as to check the robustness of the model to the relaxation of some important assumptions.

4.1. Multiple Donors

Although it is common in the micro-founded literature on campaign finance to assume a small number of donors (Ashworth '06[5], Coate 2004[11] to name just two examples), the assumption is rather restrictive. During the 1999-2000 U.S. election cycle 21 million individuals donated to the candidates' campaigns. Small average donation sizes and the large number of donors to political campaigns make any theory of campaign finance in which donations are seen as investments which are expected to produce returns in the form of altered results or influence on policy-making implausible. Ansolabehere, de Figueiredo and Snyder (2003)[4] survey 40 articles which attempt to find a link between donations and voting records and find little evidence of one. However, research looking at the behavior of donors (e.g. Brown et al. 1995[9] and Gordon et al. 2007[22]) finds that at least some groups of donors behave *as if* their donation were an investment with policy implications or could change the outcome of the election.

One way to reconcile these pieces of evidence is to propose a model of campaign donations as an altruistic act. A popular explanation of altruistic behavior holds that some agents use a version of Kant's categorical imperative to evaluate an action's moral salience (Harsanyi 1980[23], Brekke et al. 2003 [7]). In particular, an action is morally salient if, when adopted by all moral agents, it maximizes a social welfare function. This type of motivation, known as rule-utilitarian, has been used to explain altruistic behavior in recycling, community service, voting (Feddersen and Sandroni 2006[17], Coate and Conlin 2004[12]), information acquisition by voters (Feddersen and Sandroni 2006[18]), and other prosocial behavior.

Consider an extension of the model presented in Section 2 in which there are a continuum of voters, and voters are also potential donors. Voters are grouped into five states $\{V_i\}_{i=1}^5$, each containing Lebesgue measure $\frac{1}{5}$ of voters ($\mu(V_i) = \frac{1}{5}$ $\forall i$). In each state, a subset $M_i \subset V_i$ consists of identical moral or ethical voters. Ethical voters are a minority in each state, $\mu(M_i) = \frac{m}{5} < \frac{1}{10}$ $\forall i$. The set of all voters is $V = \cup_{i=1}^5 V_i$; $\mu(V) = 1$. Similarly, $M = \cup_{i=1}^5 M_i$; $\mu(M) = m$.

Index voters by j. Then d_i^j is the amount donated to the campaigns in state i by voter j. Total donations to i are $d_i = \int_V d_i^j dj$. Even though a single donation cannot influence the outcome of the election, ethical voters receive satisfaction from performing morally salient actions and receive utility

$$u_M = 1_{(e_N=h)} + \sum_{i=1}^{5} \left(R1_{\left(d_i^{MS}\right)} - d_i^j \right) \tag{4.1}$$

where $1_{(e_N=h)}$ is an indicator function which takes the value 1 if the highly electable candidate wins the primary and 0 otherwise, $1_{\left(d_i^{MS}\right)}$ is an indicator function which takes the value 1 if the agent performed the morally salient action concerning the i'th campaign and 0 otherwise, and $R > 0$ is the utility reward to taking the morally salient action.

A donation is morally salient if $d_i^j = d_i^{MS}(h_{\theta(i)})$:

$$\begin{aligned} d_i^{MS} &= \arg\max_z E\left[\int_V 1_{(e_N=h)} - 1_{(j\in M)} \sum_{i=1}^{5} d_i^j dj \;\mid\; h_{\theta(i)}, d_i^j = z \;\forall j \in M\right] \\ &= \arg\max_z \left\{ \Pr(e_N = h \;\mid\; h_{\theta(i)}, d_i^j = z \;\forall j \in M) - mE\left[\sum_{i=1}^{5} d_i^j \;\mid\; h_{\theta(i)}, d_i^j = z \;\forall j \in M\right]\right\} \end{aligned} \tag{4.2}$$

That is, if it is the action that would maximize the welfare[13] of all voters if taken by all ethical voters.

[13] Following Feddersen and Sandroni 2006, I assume that psychological rewards R are not included in the welfare calculation.

In my model, where total donations of c are necessary for candidates to continue informative campaigning, $d_i = c$ ($d_i^j = \frac{c}{m}$) is the only relevant level since there is no loss from funding future state campaigns at a later date, making higher donations redundant and lower donations are merely wasteful[14]. Furthermore, because there is a continuum of morally motivated agents, an individual's decision not to donate will not affect outcomes. Thus, I need not consider strategic deviations sacrificing R now in order to make future morally salient actions cheaper.

Campaigns will continue to be funded as long as the satisfaction of undertaking the morally salient action (R) is higher than the cost, and as long as it is morally salient for the campaign to be funded, that is:

$$\begin{aligned} R &> \frac{c}{m} \text{ and} \\ \Delta \Pr_i &> mE\left[\sum_{i=1}^{5} d_i^j \;\middle|\; h_{\theta(i)}, d_i^j = z \;\forall j \in M\right] \end{aligned} \tag{4.3}$$

where $\Delta \Pr_i$ denotes the increase in the probability of $e_N = h$ given that $d_i = c$. In contrast, a SIG will fund an additional campaign if $\Delta b \Delta \Pr_i > E\left[\sum_{i=t}^{5} \hat{d}_i | h_t, \hat{d}_t\right]$. Note that the SIG only considers donations to the eventual loser as informational costs, while morally motivated donors see all donations as informational expenses. Therefore, keeping a campaign going implies informational costs of $\frac{c}{2}$ for the SIG and c for ethical voters. Nevertheless, the problem they are solving is isomorphic[15].

Proposition 1. *If $R > \frac{c}{m}$, then donations to political campaigns will be made as if a single SIG with $\Delta b = \frac{1}{2m}$ were funding the campaigns.*

[14] Mixed strategies in which agents give c in expectation are also solutions to the maximization above, but can be ruled out by making the utility cost of money convex.

[15] Because ethical voters are a minority in each state, their collective voting choices do not change outcomes. The voting strategies v^* described in Theorem 1 are collective best responses for non-ethical voters. Trivially, their individual voting strategies are best responses because no single voter can affect the outcome of a primary, making any vote a best response.

4.2. Bandwagons

In this section I confirm the intuition developed by Aldrich (1980) [1] that momentum may arise because donors are more willing to fund candidates who have been successful in early contests. Furthermore, I argue that the formation of a bandwagon must always be accompanied by a cessation of funding of the trailing candidate's campaigns.

While previous research has referred to bandwagons as situations in which voters ignore informative signals to vote for the front-runner, in this context in which signals are costly and are not automatically sent, I propose a definition of a bandwagon which is based on the probability of receiving votes. The actual voting behavior I refer to as a bandwagon is the same as in previous work.

Definition 3. *A bandwagon has formed if the leading candidate will receive all subsequent votes with probability 1.*

When the electoral calendar is sequential, there is an equilibrium in which one of the candidates receives all subsequent votes once he develops a large enough lead. This happens because the SIG is no longer willing to make donations for their informational value, making further updating impossible. In contrast to previous theories, the bandwagon does not arise from learning by voters, but rather from learning by the donor.

Proposition 2. *Suppose the electoral calendar is sequential. Then, there exist campaign costs $0 < c_{\text{seq}} < \bar{c}$ and a perfect Bayesian equilibrium such that, if $c \in (c_{\text{seq}}, \bar{c})$, a bandwagon forms with positive probability.*

Furthermore, only the leading candidate may continue to receive campaign donations once a bandwagon has formed.

Proof. In the appendix. ■

4.3. Asymmetric Priors: The Money Primary and Superdelegates

In the context of U.S. presidential primaries, it has been observed that those candidates who are able to raise the most money before the voting begins are also most likely to go on to win their party's nomination (see, for instance, Goff 2004[21]). From 1980 to 2009, the fundraising leader on the eve of the first primary went on to win his party's nomination in all but three contests[16]. Furthermore, the parity between Clinton's and Obama's warchests as of December 2007 seemed a portent of the race's parity. The apparent importance of this pre-primary period has led scholars to refer to it as "the money primary" or "the invisible primary." I argue that the relation between fundraising during the money primary and successful nomination campaigns is hardly surprising given the incentives of donors. If one candidate is perceived to be the best candidate with higher probability than his competitors, it will take more primary defeats for donors to give up on him. Therefore, donors will be willing to commit to funding this candidate's campaigns further into the electoral calendar, that is, they will be willing to donate more to this candidate before the voting starts.

To fix ideas about this, suppose that voters and donors receive a signal favorable to candidate A before the voting starts. This makes the probability of A being the better candidate $q > \frac{1}{2}$. In order to nominate the candidate with the highest posterior probability of being a high type, one voter should vote uninformatively for A so that B can only win if voters receive two more b signals than a signals, making the total signal count at least +1 for B. Thus, while B might lose the election after only one competitive campaign (if the SIG will stop funding after a candidates takes a two vote lead), A must campaign in and lose at least two contests before dropping out. Furthermore, if A is more likely to be the h-type, he is more likely to win the nomination since he is more likely to campaign effectively. I summarize in the following Remark.

[16] The exceptions are relatively recent: Howard Dean (2004), Rudy Giuliani, and Hilary Clinton (both 2008) led their parties in pre-vote fundraising but went on to lose the nomination.

Remark 1. *A candidate who is believed to be the high type with higher ex-ante probability will be able to raise more campaign funds prior to the start of voting and will win the nomination with higher probability.*

The arguments above highlight a second issue: if one candidate is ex-ante more likely to be the h-type, some voters must vote uninformatively if they are to nominate the candidate who ends up with the better posterior. This is clearly inefficient because a source of additional information remains unused. This inefficiency would be mitigated if there were additional votes which could be cast before the voting started and made it so that the winning candidate would be the ex-post most likely h-type. This is a rationale for superdelegates which is in line with the explanation usually given by parties: they are there to make sure that the 'right candidate for the party' is nominated. Indeed, most superdelegate votes are committed before the primary season begins.

Remark 2. *If one candidate is believed to be the high electability type with higher ex-ante probability, the presence of superdelegates can make the voting strategy v^* remain optimal. Furthermore, this enables full use of all available information.*

5. Conclusion

Campaign fund 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 and behavior 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 encourage 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 suggests 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.

It is possible to use my results to draw conclusions about the historical development of the nomination calendar. Perhaps the rise in campaign costs led to the emergence of Super Tuesday in the 1980's by taking us from the low-cost indifference region to the region of Super Tuesday dominance (see Figure 3.1). However, given that primary-dominated nominations are a relatively recent institution, in place since the 1972 nomination, the emergence of Super Tuesday may have been a consequence of learning by state and national party leaders about how the system works. Others point to a lack of national coordination, self-interested state parties, and political and legal constraints as determining factors. Explaining the historical evolution of the nomination calendar remains an important topic for future work.

6. Appendix

Throughout the appendix, I distinguish between the *vote count* and the *informative vote count.* 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. The informative vote count at a given history is w-z if $\sum 1_{(s_i=A)} = w$ (similarly for B). Only the informative vote count is used in calculating posterior beliefs. The informative vote count is only publicly observable if voting strategies are such that $v_i = s_i$ when $s_i = \{A, B\}$ (as in v^*), and will only be used in that context.

6.1. Proof of Theorem 1.

I proceed by considering each voter's decision problem, from last to first. In evaluating the utility effects of deviations, I assume that the voter knows how earlier voters have voted. If this is not the case, and there are voters of a lower number voting at the same time, the expected benefit of a deviation will be a weighted average of those considered. Thus, if deviating is never worthwhile when the voter is able to condition on previous voters' votes, it is not profitable when the voter cannot condition on this information. Recall the voting strategies of Theorem 1 are v^*. Let

$$BR(v^*, \theta) = \{d | u_{SIG}(d, v^*, \theta) \geq u_{SIG}(d', v^*, \theta) \text{ for all } d'\}$$

be the set of SIG strategies which maximize the SIG's expected utility given that the voters are playing v^* and the electoral calendar is θ.

I begin by establishing some basic facts about the SIG's donation strategy which will help simplify the arguments in the proof of Theorem 1. The following lemma states that whenever the SIG funds at least one, or at least two campaigns, it is optimal for it to fund voter 1 and 2's.

Lemma 2. *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. ■

Lemma 3. *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, uninformed votes will never decide the election, and v_i^* is a best response to $\{\theta, d, v_{-i}^*\}$ for uninformed voters.*

Proof. Consider first the SIG's decision whether to fund one or two campaigns. Funding one campaign leads to selecting an h-type with probability q. Funding two campaigns leads to an h-type nominee with probability $q\left(q + 2\frac{1}{2}(1-q)\right) = q$. Intuitively, conditional on the first vote, adding an additional campaign can only tie the informative vote count or increase the frontrunners lead. At worst, the frontrunner's posterior will be $\frac{1}{2}$ for each candidate and does not change the optimal choice of candidate. The same logic applies to the difference between funding three and four campaigns. In that case, funding three campaigns selects the h-type with probability $q^2(q + 3(1-q)) = q^2(3-2q)$. Funding four leads to a probability of success of $q^2\left(q^2 + 4q(1-q) + 6\frac{1}{2}(1-q)^2\right) = q^2(3-2q)$. 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.

If there is an odd number of campaigns funded, whenever $d_i = 0$ there will be a voter $j \neq i$ s.t. $d_j = 0$. According to v^*, this means that uninformed votes cancel each other out and candidate who finishes the election with the highest posterior probability of being an h-type will win. Therefore, v^* is a best response for uninformed voters.

After a 2-0 lead in informed votes, if $\sum_{i=3}^{5} d_i = 0$, v^* specifies that the final vote count will be 4-1 or 3-2 with the frontrunner winning, so that v^* is a best response for uninformed voters. After a 3-1 or 4-0 informed vote lead, the election is decided and v^* is also a best response for the remaining uninformed voters. ■

Lemma 4. *Choose $d \in BR(v^*, \theta)$ such that $d_1 = d_2 = c$ whenever $\sum_{j=1}^{5} d_j \geq 2c$ for any h_5. Then, v_i^* is a best response to $\{\theta, d, v_{-i}^*\}$ for informed voters.*

Proof. Recall that, under v^*, the identity of informed voters is publicly known because d_i is publicly observable and the value of informative signals is revealed through voting.

Fifth voter:

V_5 is either pivotal or has no effect on the nomination. Whenever V_5 is pivotal, $u_V(v_5 = s_5) = q > 1 - q = u_V(v_5 \neq s_5)$.

Fourth voter:

V_4 will only be relevant if the vote is 1-2 or 2-1. Otherwise, the election is already decided. Suppose the informative vote count is 2-1.

If $s_4 = A$, $v_4 = A$ leads to a win by candidate A having received 3 positive signals. The worst outcome for A in terms of signals from this point on is 3-2, where A is the state of the world with prob. q>1-q.

If $s_4 = B$, $v_4 = B$ will lead to the correct candidate being chosen with prob. q. Voting for A leads to A winning the election which will be the correct choice with prob. $\frac{1}{2} < q$.

If the vote is 1-2, the arguments are symmetric.

If the informative vote count is 1-1, 2-0, or 0-2 (i.e. one of the first three voters did not receive an informative signal), voter 4 will receive an informative signal only if it is the last one of the election by Lemma 3. Therefore, V_4 is either pivotal (after 1-1) and his choice the same as V_5's or irrelevant (after 2-0).

Third Voter:

V_3 can receive an informative signal when the informative voting has been 1-1, 2-0, or 0-2.

If the vote is 2-0 and $s_3 = A$, state A will have received three positive signals and is the correct choice with probability at least q. Similarly, if the vote is 0-2 and $s_3 = B$, it is a strict best response for him to vote for B and end the election.

That leaves scenarios in which the signal count, including 3's signal, is 2-1 or 1-2.

Suppose the signal count is 2-1.

The probability of a correct outcome if 3 votes his signal and all future campaigns are financed is:

$q(1-(1-q)^2)+(1-q)q^2 = -q^2(2q-3)$

The probability of a correct outcome if 3 votes B and all future campaigns are financed is:

$q^3+(1-q)(1-(1-q)^2) = q(2q^2-3q+2)$

Clearly, $q(1-(1-q)^2)+(1-q)q^2 > q^3+(1-q)(1-(1-q)^2)$ since

$-q(2q-3)-(2q^2-3q+2) = -4q^2+6q-2$

The first derivative of this difference is: $6-8q$

$-4q^2+6q-2$ has roots at 1 and .5, so the two expressions are equal at .5 and 1, while the derivative of the expression is positive at .5 and negative after 3/4, meaning that the expression is (weakly) positive for all $q \in [.5, 1]$.

If the campaign ends with 3's vote, he is pivotal and voting his signal is a strict best response by the arguments made above.

Second Voter:

V_2 necessarily inherits either a 1-0 or 0-1 vote count. Therefore, if he receives an informative signal, Claim 2 confirms that his signal count is either 2-0 or 1-1.

If $d_3 = c$ regardless of v_2, a deviation by 2 is equivalent to a deviation by 3, which we have seen above is never profitable.

If $d_3 = 0$ if the vote goes to 2-0, then one must verify directly that a deviation is not profitable.

Let the signal count be 2-0. If 2 votes his signal, A is elected which is the correct choice with probability $\frac{q^2}{q^2+(1-q)^2}$.

If 2 deviates making the vote count 1-1, the correct choice will be made with prob. at most:

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

$\frac{q^2}{q^2+(1-q)^2}+q^2\left(2q-3\right)=2q^2\left(2q-1\right)\frac{(q-1)^2}{2q^2-2q+1}>0$

Which is clearly less than $\frac{q^2}{q^2+(1-q)^2}$ since $2q<3$.

Now, let the signal count be 1-1. If 2 deviates, he will end the election and $u_V=\frac{1}{2}$. If he votes his signal, the campaign continues and, because other voters are voting informatively and the SIG is willing to fund campaigns so that a correct decision can be made with probability at least q, $u_V \geq q > \frac{1}{2}$.

First Voter:

If v_1 will decide the election, it is a strict best response for him to vote his signal, as argued above.

If this is not the case, the campaign will continue regardless of his vote. Thus, a deviation by V_1 will have the same effects as if V_2 voted first (informatively) and then V_1 deviated. We have seen in the step above that deviations by the second voter are not profitable. ■

Together, Lemmas 2-4 prove Theorem 1.

6.2. Proof of Lemma 1.

I begin by listing all possible electoral calendars in a five voter election. I then prove through a series of claims that we may focus on only three. Given Theorem 1, I assume throughout that voting strategies are v^*. This allows me to focus on the SIG's funding decisions.

There are 16 possible electoral calendars:

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

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 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, 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. ■

This allows us to ignore calendars 7, 10, 11, 12, 13, 14, 15, and 16 and look only at 1, 5, 4, 6, 9, 8, 3, and 2 (or vice-versa).

Claim 2. *Any calendar in which $\theta(V_3) < \theta(V_4) = \theta(V_5)$ (calendars 5, 9, 10, and 13), is 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 3, 16, 15, and 2).*

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 2, $d_1 = c$ 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 3, 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 $d_3 = c$. ■

Claim 3. *The calendar {4-1} (no. 6) is 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\}. ■

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

Proof. By Lemma 2, $d_1 = d_2 = c$ 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 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. 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 Claim 2, if the first three campaigns have been funded, the calendar with voters 4 and 5 voting sequentially dominates the one in which they vote simultaneously.
■

Application of these claims leaves us with three contenders for the voter-optimal electoral calendar: sequential, simultaneous, and Super Tuesday. 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.

6.3. Proof of Theorems 3 and 4

Theorem 5. *There exist values* $c_{\text{seq}} < c_{sim} < c_{st} < \hat{c}_{\text{seq}} = \bar{c}$ *such that:*

- *The Super Tuesday calendar dominates all other calendars, and strictly* *dominates the sequential calendar, when* $c \in (c_{\text{seq}}, c_{st})$.

- *The sequential calendar dominates all other calendars, and strictly dominates the Super Tuesday calendar, when* $c \in (c_{st}, \hat{c}_{\text{seq}})$.

- *The simultaneous calendar weakly dominates all other calendars when* $c < c_{sim}$ *or* $c > \bar{c}$.

Proof. Recall that only $\frac{c}{2}$ of the cost c of each campaign is an informational cost as the remaining $\frac{c}{2}$ would be given to the nominee during the general election stage in any case.

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

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

$q^2 (q + 3(1-q)) = q^2 (3 - 2q)$

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

$q^2 (3 - 2q) - q = -q(2q^2 - 3q + 1) = -2q^3 + 3q^2 - q > 0$

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

$c < \Delta b (-2q^3 + 3q^2 - q)$

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

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

Subtracting the first expression from the second, we get the increase in probability of success from funding voters 4 and 5:

$q^3 (10 - 15q + 6q^2) - q^2 (3 - 2q) = 3q^2 (2q - 1)(q - 1)^2 = 6q^5 - 15q^4 + 12q^3 - 3q^2$

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

$c < \Delta b \left(6q^5 - 15q^4 + 12q^3 - 3q^2\right) = c_{sim}$

In a Super Tuesday election, funding all three date-1 campaigns leads to selecting the right candidate with probability:

$q^3 \left[1 + 3(1-q) + 6(1-q)^2\right] = 10q^3 - 15q^4 + 6q^5$

at an expected cost of:

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

Funding only two campaigns in the first block leads to selecting the right candidate with probability:

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

at an expected cost of:

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

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 the difference in cost from funding only one campaign to following this strategy is $\frac{c}{2} + cq(1-q) < c$, while the benefits of the change are the same.

The increase in the probability of nominating an h-type from funding voter 3's campaign is:

$6q^5 - 15q^4 + 12q^3 - 3q^2$

Subtracting the expected cost of the fund 2 strategy from that of the fund 3 I find the difference in expected cost:

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

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

$c < 2\Delta b \frac{6q^5 - 15q^4 + 12q^3 - 3q^2}{1 + q(1-q)(1 + 6q(1-q))} = c_{st}$

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

Funding only one campaign leads to selecting the h-type with probability q. The increase in the probability of success from this strategy to funding two date-1 voters in a Super Tuesday election is:

$q^2(3-2q)-q=-q(2q^2-3q+1)=-2q^3+3q^2-q>0$

The increase in cost from funding one campaign to funding two date-1 campaigns in a Super Tuesday election is:

$\frac{1}{2}c+cq(1-q)<c$

Therefore, at least two date-1 campaigns will be funded in a Super Tuesday election if:

$c<2\Delta b\left(\frac{-2q^3+3q^2-q}{1+2q(1-q)}\right)=\bar{c}$

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:

$\frac{q^2}{q^2+(1-q)^2}\left(q+(1-q)q+(1-q)^2q\right)+\frac{(1-q)^2}{q^2+(1-q)^2}q^3=\frac{q^3}{2q^2-2q+1}(2q^2-5q+4)$

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

$\frac{q^3}{2q^2-2q+1}(2q^2-5q+4)-\frac{q^2}{q^2+(1-q)^2}=q^2(2q-1)\frac{(q-1)^2}{2q^2-2q+1}$

or,

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

This strategy brings with it an additional cost of:

$\frac{1}{2}c+\frac{1}{2}c\left(\frac{q^2}{q^2+(1-q)^2}(1-q)+\frac{(1-q)^2}{q^2+(1-q)^2}q\right)+\frac{1}{2}c\left(\frac{q^2}{q^2+(1-q)^2}(1-q)^2+\frac{(1-q)^2}{q^2+(1-q)^2}q^2\right)$
$=\frac{c}{q^2+(1-q)^2}(2q^4-4q^3+3q^2-q+1)$

or,

$\frac{1}{2}c\left(\frac{q^2}{q^2+(1-q)^2}q+\frac{(1-q)^2}{q^2+(1-q)^2}(1-q)\right)+c\left(\frac{q^2}{q^2+(1-q)^2}(1-q)q+\frac{(1-q)^2}{q^2+(1-q)^2}q(1-q)\right)$
$+\frac{3}{2}c\left(\frac{q^2}{q^2+(1-q)^2}(1-q)^2+\frac{(1-q)^2}{q^2+(1-q)^2}q^2\right)=\frac{c}{2(2q^2-2q+1)}(2q^4-4q^3+3q^2-q+1)$

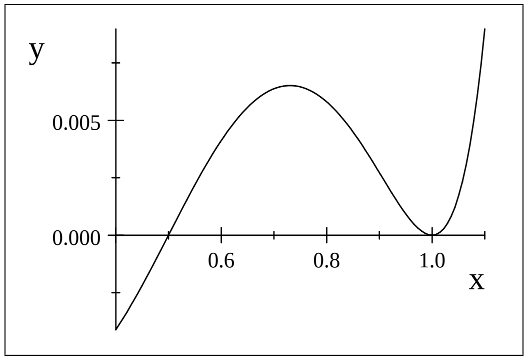
Therefore, the SIG will fund voter 3 after a 2-0 start if:

$c<2\Delta b\frac{q^2(2q-1)\frac{(q-1)^2}{q^2+(1-q)^2}}{\frac{1}{q^2+(1-q)^2}(2q^4-4q^3+3q^2-q+1)}=2\Delta bq^2(2q-1)\frac{(q-1)^2}{2q^4-4q^3+3q^2-q+1}=c_{\text{seq}}$

Note that $c_{\text{seq}}<c_{sim}$, so that a simultaneous calendar is sometimes strictly preferable to a sequential one, a result in line with the findings in Battaglini

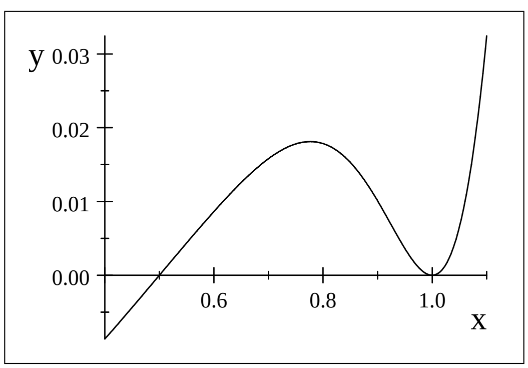
2005[6]. I verify this numerically:

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



If $c_{\text{seq}} < c_{st}$, then there will be circumstances under which a Super Tuesday calendar outperforms a sequential calendar. This is because, when $c \in (c_{\text{seq}}, c_{st})$, the Super Tuesday calendar will continue to fund campaigns when they start 2-0 and go to 2-1, while with the sequential calendar funding would stop at 2-0. The Super Tuesday calendar takes advantage of the uncertainty about whether the election will start 2-0 or 1-1. Because the two calendars are identical after voter 3, this advantage is the only difference in this range. It is difficult to verify algebraically that $c_{\text{seq}} < c_{st}$, but straight forward to do so numerically as we need only check that the inequality holds for values of q in $\left(\frac{1}{2}, 1\right)$:

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



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 $q^2(3-2q)$, 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:

$$q^2(3-2q) - q = -q(2q^2 - 3q + 1)$$

This strategy leads to additional expected costs of $\frac{1}{2}c + cq(1-q) = \frac{1}{2}c(-2q^2 + 2q + 1)$. Or if we derive it differently: $\frac{1}{2}c\left(q^2 + (1-q)^2\right) + 2cq(1-q) = \frac{1}{2}c(-2q^2 + 2q + 1)$. Therefore, the SIG will continue this funding if:

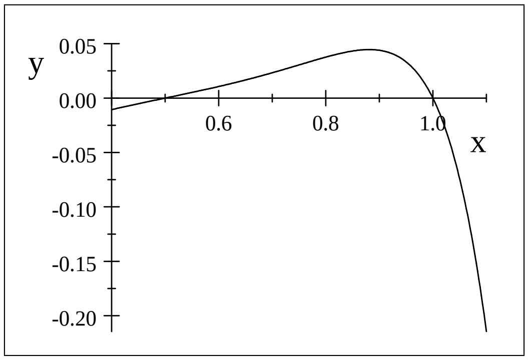
$$c < 2\Delta b \frac{-q\left(2q^2 - 3q + 1\right)}{-2q^2 + 2q + 1} = \hat{c}_{\text{seq}} = \bar{c}$$

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 $c > \hat{c}_{\text{seq}}$, the SIG will fund at most one campaign. If this is the case, then the electoral calendar is irrelevant and the voter is indifferent among them all. This is further confirmed by noting that $\hat{c}_{\text{seq}} = \bar{c}$.

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 may be a range of costs, $c \in (c_{st}, \hat{c}_{\text{seq}})$, over which the sequential calendar strictly outperforms the Super Tuesday calendar in expected terms.

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

Again, I verify this inequality numerically.



■

6.4. Proof of Proposition 2

I begin by explaining the mechanics of a bandwagon in this model. When the SIG stops making donations to the trailer, it rules out the possibility of further informative signals being sent. Thus, the remaining voters will be uninformed ($s = \varnothing$). Given this, along with the symmetric prior $p = \frac{1}{2}$, the current leader will have a higher posterior probability of being the high type at the end of the nomination period. Therefore, voting for the frontrunner is a best response for these voters.

For the SIG to fund the first campaign, it must be that $c < \bar{c} = 2\Delta b \left(q - \frac{1}{2}\right)$.

As I show in the proof of Theorem 5, the SIG will fund voter 3 after a 2-0 start only if:

$c < 2\Delta b q^2 \left(2q - 1\right) \frac{(q-1)^2}{2q^4 - 4q^3 + 3q^2 - q + 1} = c_{\text{seq}}$

Therefore, if $c \in (c_{\text{seq}}, \bar{c})$, the frontrunner will win all remaining votes after either a 2-0 or 1-0 start.

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