Stepwise Presidential Election Reform: The Biased Proportional Plan and its Implementation (Full Version)

Shai Vardi*

Abstract

There are numerous problems with the current method of electing the President of the United States; many of them stem from the phenomenon of swing states. Our goal in this paper is to find *pragmatic* reform that addresses this issue. Looking at presidential elections through a game-theoretic lens, we treat the states as strategic agents and design a system that keeps the Electoral College, requires no constitutional amendment, and can be implemented gradually—only two states change their method of allocating electoral votes at each step. The transitions from the current to the new system are compatible with the incentives of both Republican- and Democratic- leaning states.

*Krannert School of Management, Purdue University, West Lafayette, IN 47907. svardi@purdue.edu

"Each generation is as independent as the one preceding, as that was of all which had gone before. It has then, like them, a right to choose for itself the form of government it believes most promotive of its own happiness; consequently, to accommodate to the circumstances in which it finds itself, that received from its predecessors; and it is for the peace and good of mankind, that ... it may be handed on, with periodical repairs, from generation to generation."

Thomas Jefferson, *Letter to Samuel Kercheval*, June 12, 1816. [39]

1 Introduction

The system for electing the President of the United States has seen little change in the past two hundred years. This is not for lack of trying: over 700 resolutions have been proposed—by both parties—to change or abolish the Electoral College[1] since the ratification of the Twelfth Amendment in 1804 [12]; none have passed, only two have passed one house.[2] There have been a multitude of books and articles arguing for reforming the Electoral College, replacing it with one of several alternate plans or for keeping it as is (e.g., [1, 7, 18, 31, 33, 36, 60]); despite the many different opinions, there is a consensus that there are numerous problems with the current system that stem from the existence of *battleground* or *swing* states. These are states that have a reasonable chance of being won by either the Democratic or Republican presidential candidate; there are typically only a handful in each election. Swing states are primarily a product of the *winner-take-all* method (sometimes called the "unit method") of assigning electoral votes: all states, except Maine and Nebraska, assign all of their electoral votes to the winner of the statewide plurality of votes.

1.1 The problem with swing states

Before each presidential election, political analysts appraise each candidate's chances of winning each state. Based upon this, one can roughly partition the states into two categories: *safe* and *battleground*. Safe states are ones in which the outcome is all but certain; battleground states are ones where it is not. For example, in the elections of 2008, 2012 and 2016, Alabama, Oklahoma and Wyoming were considered safe Republican states, and California,

[1] We assume that the reader has some basic knowledge of the workings of the Electoral College; for good introductions to the Electoral College, we refer the reader to e.g., [18, 32].

[2] In 1950 and 1969, we remark upon this further in Section 1.2.

Maryland and Massachusetts were considered safe Democratic states. In each of these states and elections, the projected winner received over 60% of the popular vote. The voters in safe states have, for all practical purposes, no influence on the winner of the presidential election (e.g., [12, 64, 70]). Indeed, voter turnout is lower in safe states, at least in part due to many voters feeling that their vote would not make a difference, e.g., [28, 58].

Given the above reasoning, it is not surprising that presidential candidates devote very little time and resources, if any, to safe states. In 2016, over two-thirds of all Clinton campaign events (104 out of 151) and one half of the Trump campaign events (124 out of 248) were held in just four states: Florida, North Carolina, Ohio and Pennsylvania. Table 1.1 shows the number of general-election campaign events held by the Democratic and Republican candidates per state in 2016. Similarly, roughly three quarters and one half of the TV and radio ads for the Clinton and Trump campaigns respectively aired in these four states in the weeks leading up to the election [17]. It is well-established that candidates strongly bias time and resource allocation towards battleground states, e.g., [11, 14, 29, 30, 38, 69]. Stonecash [69] writes, *"There is no national campaign for the office which presumably is the most concerned with national issues ... What should be a debate before the nation ends up confined to a limited number of states."*

The attention that battleground states receive from presidential candidates translates to economic benefits. In 2012, Obama and Romney spent $173 million on TV ads in Florida and over $150 million in both Ohio and Virginia out of a total of $896 million spent on TV ads [71] (see Table 1.2 for a breakdown of spending vs. number of electoral votes). In 2004, Florida, Ohio, Pennsylvania and Iowa received 66 percent of the total funds allocated by the candidates for ads, and 58 percent of campaign visits [21]. The gain to the states is amplified by collateral effects; for example, comparable TV stations sell at a much higher price in swing states due to advertising revenue from campaigns [68].

The benefit that swing states reap is not restricted to the campaign. Research shows that incumbent presidents target federal dollars to swing states during the presidency, and in particular, in the immediate lead-up to an election, e.g., [37, 46, 65]. Shor [65] writes, *"States that have more electoral votes per capita, that are more competitive, and that support the president tend to enjoy more federal expenditures per capita. This is after controlling for demographic, fiscal, and state effects."* Hudak [37] adds, *"Citizens and organizations within swing states receive hundreds of millions of additional grant dollars every year, simply because of their states' electoral competitiveness. As a presidential election draws near, this swing state-focused spending increases dramatically, delivering additional funds to these key constituencies."* Research has also shown that presidents use the power of the office in order to influence voters in swing states in other ways, such as signing statements and

State	Dem.	Rep.	Total
Florida	36	35	71
North Carolina	24	31	55
Pennsylvania	26	28	54
Ohio	18	30	48
Virginia	5	18	23
Michigan	8	14	22
Iowa	7	14	21
New Hampshire	6	15	21
Colorado	3	16	19
Nevada	8	9	17
Wisconsin	5	9	14
Arizona	3	7	10
Georgia	0	3	3
Maine	0	3	3
New Mexico	0	3	3
Indiana	0	2	2
Minnesota	0	2	2
Missouri	0	2	2
Nebraska	1	1	2
California	0	1	1
Connecticut	0	1	1
Illinois	1	0	1
Mississippi	0	1	1
Texas	0	1	1
Utah	0	1	1
Washington	0	1	1

State	Dem.	Rep.	Total
Alabama	0	0	0
Alaska	0	0	0
Arkansas	0	0	0
Delaware	0	0	0
D.C.	0	0	0
Hawaii	0	0	0
Idaho	0	0	0
Kansas	0	0	0
Kentucky	0	0	0
Louisiana	0	0	0
Maryland	0	0	0
Massachusetts	0	0	0
Montana	0	0	0
New Jersey	0	0	0
New York	0	0	0
North Dakota	0	0	0
Oklahoma	0	0	0
Oregon	0	0	0
Rhode Island	0	0	0
South Carolina	0	0	0
South Dakota	0	0	0
Tennessee	0	0	0
Vermont	0	0	0
West Virginia	0	0	0
Wyoming	0	0	0
Total	151	248	399

Table 1.1: The number of general-election campaign events held by the Democratic and Republican candidates per state, 2016 (compiled from [19]).

State	Electoral votes	Total Spending	Spending per vote
Florida	29	173	5.9655
Virginia	13	151	11.615
Ohio	18	150	8.333
North Carolina	15	97	6.4667
Colorado	9	73	8.1111
Iowa	6	57	9.5
Nevada	6	55	9.1667
Wisconsin	10	39	3.9
New Hampshire	4	34	8.4
Michigan	16	33	2.0625
Other states	412	30	0.073
Total	538	892	

Table 1.2: Estimate of total spending on TV ads in April-November 2012, in millions of dollars (compiled from [71]).

constantly campaigning [16, 22], pressuring government agencies to shorten processing time for awards [4, 35], and even strategic trade protection [55]. We do not expand upon these examples, but note that any of them alone should be sufficient argument against the perpetuation of swing states; securing the electoral votes of a handful of states should indisputably not be a driving factor in policies that affect the entire nation.

Some defenders of the Electoral College argue that one of its strengths is that it causes candidates to campaign broadly (e.g., [7]). Another argument for the Electoral College was succinctly stated by John Boehner, Mitch McConnell, and Rick Perry, in a letter sent to the Governors of the Fifty States in 2011 [10]:

> *"The Electoral College . . . embodies the balance [the Founders] aimed to achieve through deference to states with smaller populations and by ensuring that the interests of these states be reflected in national decision-making."*

While these may be true in theory, empirical data shows that this is far from the case: presidential candidates campaign very narrowly, and the interests of states like Rhode Island and Wyoming are almost certainly very far from their minds. Indeed, many strong supporters of the Electoral College argue that they support change in the way the electoral votes are allocated; e.g., [7, 63]. The Founders themselves did not envision the states adopting the winner-take-all method of assigning electoral votes; James Madison wrote in a letter to George Hay [50],

> *"The district mode[3] was mostly, if not exclusively in view when the Constitution was framed and adopted; & was exchanged for the general ticket & the legislative election, as the only expedient for baffling the policy of the particular States which had set the example."*

It is not only defenders of the Electoral College who are (or at the very least should be, by their own arguments) displeased with the effects of swing states. On the other side of the spectrum, critics of the Electoral College say that it is undemocratic: it goes against the 'one person, one vote' doctrine. And while this is true of the Electoral College in general, it is much more pronounced due to the winner-take-all method. While some opponents of the current system level their dissatisfaction at the entire system, some realize that a significant part of their opposition to the current system is in fact an objection to the winner-take-all method, e.g., [48].

Although the battleground states may change in each election, the change is slow; states like Florida, Ohio, Pennsylvania and North Carolina, that were battleground states in the

[3]We describe the district mode and other methods of assigning electoral votes in Section 1.2.

past few elections will almost certainly be battleground states in the 2020 election. Typically, states have a good estimation of their status as safe or battleground, but for the purpose of this proposal, that is somewhat irrelevant. What matters more is whether states *perceive* themselves as battleground states, and thus believe that they will be able to reap the benefits associated with being one. Of course, this is not binary: states and candidates view states as being on a scale between safe and swing. For our purposes, though, we consider each state to be either a swing state or a safe state. We will see that this is without much loss of generality. We henceforth use the term *swing states* to refer to states that perceive themselves as likely to be battleground states in forthcoming elections. We note that when we partition states into swing and safe, in Section 4, we err on the side of caution, and label any state that could conceivably think of itself as a swing state as one.

1.2 Previous attempts at reform and obstacles to change

Public opinion polls have shown that 58%, 81% and 75% of Americans favored abolishing the Electoral college in 1967, 1968, and 1981 respectively [56] (see [59] for more surveys). In 2013, a Gallup poll showed that 66% of Democrats and 61% of Republicans support replacing the Electoral College with Direct Election [26]. Previous plans for reform of the Electoral College can essentially be classified into six categories: the Automatic plan, the National Bonus plan, the Direct Election plan, the National Popular Vote Interstate Compact the District plan and the Proportional plan (see, e.g., [43]).

The plans Under the *Automatic plan*, each state would automatically allocate all of their electoral votes to the winner of the plurality of the popular vote of the state;[4] under the *Direct Election* plan, the Electoral College would be abolished and the winner of the plurality of the popular vote would be appointed president. The *National Bonus plan* adds additional votes to the winner of the national popular vote. All three plans require a constitutional amendment. Over 700 resolutions to reform the Electoral College have been proposed and none have passed, and many scholars agree that a constitutional amendment is unlikely to occur in the near future (e.g., [5,12,30,72]); therefore we do not expand upon these plans. We remind the reader that our goal is to design an implementable system, and a constitutional amendment does not appear to be forthcoming.

The National Popular Vote Interstate Compact, first proposed by Read in 1976 [41] and subsequently by Bennett in 2001 [6], is an agreement in which states commit to pledge all of their electoral votes to the winner of the popular vote, once states with a total of 270 or

[4]That is, all states would be obligated to use the winner-take-all method.

more electoral votes have joined. If implemented, the compact would de-facto convert the Electoral College into a popular vote mechanism, like Direct Election, without the need for constitutional amendment. This plan is controversial; it is not clear whether it is constitutional, due to a clause in the Constitution that forbids states from entering into compacts with one another (scholars have argued both ways e.g., [15, 44]). Regardless of its constitutionality, only 10 states and the District of Columbia have joined the compact since Maryland became the first state to join in 2007; all are safe Democratic states. Many scholars agree that it is highly unlikely to collect a total of 270 electoral votes (it currently has 165), as it is unappealing to both Republican and swing states, e.g., [12, 66]. We discuss the reasons for this in Section 2.1.

Under the *District plan*, the winner of the plurality of the popular vote in each congressional district is allocated the vote of one elector. The winner of the plurality in the state is allocated the two remaining electoral votes. Maine and Nebraska have both adopted this system. Two main criticisms of the District plan are that (i) it is susceptible to gerrymandering, and (ii) it simply shifts the problem of swing states to swing districts: candidates would only campaign in competitive districts (e.g, [7, 51]). This is backed up by empirical data. For example, the Clinton and Trump campaigns both held rallies in Omaha, the heart of Nebraska's 2nd district, while neither candidate visited any other district; Nebraska's 1st and 3rd districts are not competitive, the 2nd is.

Under the *Proportional plan*, each candidate is awarded electoral votes based in proportion to their share of the state's popular vote. This intuitively appears to be a middle-ground between the current system and Direct Election. Scholars agree that the proportional system would lead to more spread out campaigns; for example, Mayer [51] writes, *"A proportional system . . . would give campaigns the incentive to invest resources more widely, since relatively small shifts in statewide vote percentages might enable a candidate to win more electoral votes."* There are two possible ways to implement the Proportional plan. The first is by amending the constitution to allow for fractional votes; as we mentioned, a constitutional amendment is unlikely. The second is by rounding the votes to whole numbers. Typically, the only rounding scheme analyzed is rounding to the nearest whole number (e.g., [45]); we show in Appendix A.1 that varying the rounding method can lead to significantly different results, and it is therefore important to select it carefully. Perhaps due to the difficulty in determining the 'correct' method, some proposed resolutions leave the choice up to the states.[5]

[5]For example: *"Each State shall make computations for purposes of carrying out this section in accordance with such laws as it may adopt, including laws providing for the allocation of Electors among more than two candidates receiving 5 percent or more of the total number of votes cast . . . "* H.J.Res.17 – 107th Congress, introduced by Rep. Eliot L. Engel (D-NY-17), 02/13/2001.

This is ill-advised, as it would lead to undesirable rounding schemes being implemented; a universal rounding scheme is crucial. We expand upon this point in Appendix A.1.

Obstacles to change Political scientists say that one of the reasons that there has been no reform on the congressional front is the "multiplicity of proposals" e.g., [7, 49, 53]: a representative who believes that the Proportional plan is the best solution would vote against a resolution to implement Direct Election. This has been argued to be one of the main reasons the Direct Election bill was filibustered in the Senate in 1970 [13]. Another is that constitutional reform requires that agreement be reached *concurrently*. For example, while both Republicans and Democrats have supported replacing the Electoral College with Direct Election, it is rare to have a synchronous consensus. An example of one such accord was in 1969, when the House voted 338-70 in favor of Direct Election.[6] As mentioned above, the bill did not pass the Senate. Despite many similar bills being proposed since, none has even come close to passing.

On the state side, one can divide the states into safe and swing. Swing states are unlikely to want reform because the current system affords them influence and revenue. Safe states (in particular large ones) are unlikely to deviate unilaterally for partisan reasons: New Jersey will almost certainly allocate all fourteen of its electoral votes to the Democratic candidate in 2020. If it were to deviate to the Proportional or District plans, it would be relinquishing some of those votes to the Republican candidate, increasing the likelihood that the Republican candidate is elected. We expand upon the states' strategic behavior in Section 2.1.

On both the congressional and the state levels, part of the resistance to change is a belief that the Electoral College is central to the U.S. Democracy (e.g., [60]). Some of the main arguments for the Electoral College (which are also typically used as arguments against reform) are (1) it contributes to the cohesiveness of the country by requiring a distribution of popular support to be elected president (2) it enhances the status of minority interests, (3) it contributes to the political stability of the nation by encouraging a two party system, and (4) it maintains a federal system of government and representation (e.g., [7, 42]). Note that Direct Election violates all four points,[7] and the Proportional plan is usually argued to violate the third (e.g., [7, 40]).

[6] There were 246 Democratic and 189 Republican Congresspeople at the time [74].

[7] It could possibly be argued that it actually does encourage a two-party system (though we pose that most scholars would disagree with such an argument); even if that is true, it still violates three out of the four.

Path to reform There are two main aspects to reforming the current election system: the first is to design a new one. It is clear that we cannot hope for a system that everyone agrees is the best, because there is no consensus on what the 'best' is; this disagreement goes back to the drafting of the constitution, and it is safe to say it will not be resolved soon. Given this, one can only hope to design a system that (almost) everyone agrees is better than the current one. In particular, one that keeps most—if not all—of the good features of the Electoral College, does not favor either party, offers better representation than the winner-takes-all system and eliminates or at least greatly reduces the effects of swing states. We will argue in Section 3.1 that our proposed plan indeed meets these requirements. The second aspect is to motivate the nation to transition to the new system. As we have mentioned, this does not appear to be currently possible via congressional reform; therefore, we aim for change at the state level.

1.3 Our proposal: the Biased Proportional plan

The main criticism of the Proportional plan is that it makes it easier for third party candidates to win votes (see e.g., [7, 63]). This has two main effects: (i) it weakens the two-party system and (ii) it results in elections being more likely to go the house for a decision, as it is more difficult to win a majority of electoral votes when some votes go to third parties. We address this problem by setting a high threshold to obtain any electoral votes. We call this the Biased Proportional plan (BPP).[8]

The Biased Proportional plan

Each state assigns electoral votes in proportion to the statewide popular vote; votes of candidates who do not pass a threshold go to the winner of the plurality of the statewide popular vote.

We give a more complete description of the BPP in Section 3. In particular, we specify the threshold and rounding rule—one is necessary as the electoral votes need to be whole numbers. We explain how the BPP overcomes virtually all of the critiques of the other systems, and argue that it is in the interest of all of the safe states (both Republican and Democratic) that the system be adopted. The main gain for safe states from transitioning to the BPP is that they become competitive, and therefore reap the benefits currently restricted to swing states. Even though the safe states should prefer this system, it is not clear how to transition to it. If a safe state transitions, it is essentially giving away votes to the candidate

[8] The name stems from the fact that the plan biases the results in favor of the winner of the plurality. We expand upon the reasons for this in Section 3 and Appendix A.1.

of the opposite party. We overcome this obstacle by coupling states to counterbalance each other: if there is a Democratic state whose transition would most likely give the Republican candidate two extra electoral votes, and a Republican state whose transition would probably give the Democratic candidate two extra electoral votes, they should be willing to transition together, as there is no net partisan effect to the joint transition, and they both gain from becoming competitive. We argue that once sufficiently many safe states have transitioned, the swing states will also be incentivized to transition.

2 Strategic behavior

Looking at the presidential elections through a game-theoretic lens, there are two types of agents: states and candidates. We consider them separately.

2.1 The states

The Constitution gives states the right to decide how to allocate their electoral votes.[9] Currently, almost all states use winner-take-all. In order to incentivize states to change their allocation method, we need to understand the motivations driving them. We view the states as strategic agents, with several (possibly contradicting) objectives. We focus on the following five motivations and argue that they play a large part in the states' choice of allocating the electoral votes, although we do not attempt to (and indeed, can not) quantify the proportions in which they do: political influence, partisanship, economic and social implications for the state and its citizens, the good of the country, and pressure from the populace. We note also that while we have partitioned the motivations into distinct categories for clarity, the categories have significant overlap.

Political influence In the first years of the nation, states 'experimented' with different methods of allocating their electoral votes, but quickly converged to the winner-take-all method: in 1789 three states used the winner-take-all method; in 1816, five did; by 1824, twelve states had adopted this method [3]. The rest of the states soon followed, as their relative influence had diminished. As Kimberling writes in *The Electoral College* [42]: *"This winner-take-all system was really the logical consequence of the direct statewide vote for Electors owing to the influence of political parties."*

It is only natural for presidential candidates to give more attention to states that use the winner-take-all system. If a state uses the Proportional plan, a candidate could only change

[9] The U.S. Constitution, Article II, Section 1.

the number of votes allocated to them by a handful, even with vigorous campaigning. Under winner-take-all, a single vote could conceivably flip the allocation of all of the state's electoral votes. In the 1820s and 30s the states all came to this conclusion. For example, in 1831 the Governor of Tennessee recommended to converting to the winner-take-all mode of electing electors so that the State of Tennessee might have its *"full weight in the election of President and Vice President hereafter"* [9].

Best [7] says, *"Most large states will not consider [the Proportional plan] because they recognize they get more attention because of their huge pools of electoral votes under the unit rule. Unless the large states switch, it is foolish for the small states to do so."* While this is true in theory, in practice we see that it is simply incorrect—large safe states such as California and Texas receive virtually no attention from the candidates. In fact, as we argue, the *opposite* is true: switching to the BPP would earn safe states *more* attention. While we agree with Best that attaining more attention from the candidates is doubtlessly a factor in the states' behavior, and may have contributed to them transitioning to the winner-take-all system, it seems unlikely to be the reason that safe states keep the winner-take-all method. A more plausible explanation is *partisanship*.

Partisanship For safe Republican and Democratic states, using the winner-take-all method maximizes the number of electoral votes the state allocates to the Republican and Democratic candidate respectively. This is one of the main reasons that safe states keep the winner-take-all system (e.g., [2, 23, 66]): a state legislature with a Republican majority would prefer that a Republican president is elected, and hence would like to allocate the Republican candidate as many electoral votes as possible. Safe states would not want to deviate unilaterally as this deviation could potentially be the deciding factor in the election of the other party's candidate: the deviation of any large or medium safe Republican state prior to the 2000 election would have caused Gore to win (assuming the voting had been the same).[10] While there is no Democratic state whose unilateral deviation would have changed the results of any election in recent history, the reasoning is the same: it *could* potentially affect future results, and no safe Democratic state wants to be the reason a Republican president was elected.

Consider the following hypothetical question: "If Kansas transitions from winner-take-all to the BPP, what is the probability that this move will result in a different election outcome in 2020?" As Kansas will most likely allocate all electoral votes to the Republican candidate in 2020 under the winner-take-all method, the question amounts to what is the probability that the Republican candidate will be elected if Kansas does not transition unilaterally, while

[10] We expand upon this speculative reasoning in more detail in Section 3.1 and Appendix A.4.

the Democratic candidate will be if it does. We label the probability that such a transition would change the outcome of some election by PARTISANSHIP. We do not explicitly define the time this probability is over; in any case this probability a completely hypothetical one, and we could not determine PARTISANSHIP even if it was perfectly defined. We will, however, quantify it in a meaningful fashion in Section 4.1.

Economic and social implications Given the many arguments in Section 1.1, it would not be surprising if swing states oppose Electoral College reform. Scholars agree that swing states will resist change, e.g., [12,66]. For example, Silver [66] says, *"Michigan and Minnesota ... receive an influx of media dollars and political pandering every four years, and probably have little incentive to bite the hand that feeds them."*

The benefit of swing states is also difficult to quantify. As it is positively correlated with political influence, we bundle them together, and denote the overall influence and economic and social gains by REVENUE. The units of REVENUE are left unspecified, as they include a plethora of different profits, but the essence of REVENUE is the following: how much influence and social and economic advantage does the state gain from transitioning from winner-take-all to the BPP? Once again, we do not explicitly define the time over which this is measured, but it is the same time period as PARTISANSHIP.

The good of the country In 1960, the Twenty-third Amendment to the United States Constitution, which gives Washington D.C. electoral votes, was passed by the House and the Senate and within a year, it was ratified by 39 states. Only one state (Arkansas) has rejected the Amendment, and 9 states have not taken any action. States voted for the amendment despite realizing that it would diminish their influence.

In 1969, President Richard Nixon supported a push to replace the Electoral College by Direct Election. His opponent in the 1968 election, Hubert Humphrey, also supported the effort, and it passed the House 338-70. Part of he reason for the effort was that a third candidate—former Alabama Governor George Wallace—won 46 electoral votes, generating concern over the possibilities of contingent elections and vote-trading [20, 53]. Once again, states that arguably benefit from the Electoral College put aside their own motives and voted for the greater good. While the bill did not pass the Senate due to a filibuster, these two examples show that states are willing to put the good of the country above their own self-interests, at least when the state's loss is outweighed by the nation's gain. We denote by GREATERGOOD the ideological advantage of a state allocating the electoral votes using the BPP relative to winner-take-all. Of course, this is also not possible to quantify, and it may

mean different things to different states; we do however contend that it is strictly positive for all states (including swing states). We expand upon this in Section 3.1.

Political pressure The premise of elected officials is that they should carry out the will of the people, although what this means exactly is open to debate. On the federal level, discord between the popular will and the law is quite prevalent: 63 percent of Americans would like to replace the Electoral College with Direct Election [26], yet this has not happened, nor does it appear to be even a remote possibility; 64 percent of Americans say that Marijuana should be legalized [27], yet it is still a Schedule I controlled substance. Nevertheless, there is arguably less dissonance between public will and lawmakers' will on the state level; recreational marijuana use is now legal in nine states and the District of Columbia. Public support is rapidly increasing, and it is now less of a question of whether other states will legalize it than when (e.g., [57]). We argue that a similar effect will occur with election reform; in fact, a much stronger effect should occur, as voting equality is far less disputable than whether the negative effects of marijuana outweigh its benefits. As more and more states transition to the BPP, we argue that more and more of the public will support it, and do so more vocally, putting more pressure or legislators in states that have not yet transitioned to do so. We denote by Pressure the effect that public pressure has on state legislators.

Interplay of the motivating factors Naturally, it is not possible to quantify the four motivators Partisanship, Revenue, GreaterGood and Pressure; their units of measurements are different—and not even well-defined—and it is likely that there are other factors that we have not considered. Nonetheless, we are not looking for mathematical precision, and only require that the model is a reasonable proxy for the states' true motivations. We define the utility of the state for transitioning from winner-take-all to the BPP, denoted u, as

$$u = -\text{Partisanship} + \text{Revenue} + \text{GreaterGood} + \text{Pressure}.$$[11]

Without loss of generality, we assume that if u is positive then the state will want to transition to the BPP and if u is negative then it will not. It is easy to see why the signs are as they are: a state wants economic gains, the good of the country (according to its own definition), and will be incentivized to transition by popular pressure, hence Revenue, GreaterGood and Pressure have positive correlation with u; states will not want the transition to affect the outcome of elections in the partisan fashion described above, hence Partisanship has a

[11] We use the simplest possible function. It is easy to see that this is not restrictive, and the results are robust to the choice of function, as long as some minor assumptions, such as monotonicity, are met.

negative correlation. Note that GreaterGood does not change based on actions of other states, while Partisanship, Revenue and Pressure do; we expand upon this in Section 4.

Safe sates vs. swing states The main difference between safe and swing states is that Revenue is positive for safe states and negative for swing states. In addition, Partisanship is harder to quantify for swing states, as it is not clear ex-ante which way they will vote. These differences prompt us to treat safe and swing states differently:

For safe states, we have already argued—and do so in more detail in Section 3.1—that GreaterGood and Pressure are strictly positive. It is easy to see that Revenue is also strictly positive; we discuss this further in Section 4.3. Our goal is to make Partisanship small, thereby ensuring that u is positive. While Partisanship is relatively large for unilateral transitions, we overcome this by coupling the states so that their joint probability of affecting the outcome of an election is small.

For swing states, Revenue is always negative, but we show that it decreases in absolute value (i.e., becomes less negative) as more and more safe states transition. Combined with the fact that GreaterGood is positive and Pressure is increasing in the number of states that have transitioned, there is (hopefully) a critical mass of safe states whose transition will be sufficient to convert swing states' utility to positive. We expand upon this in Sections 4.4 and 4.5.

2.2 The candidates

As we mentioned in Section 1.1, there has been much work studying how candidates should allocate their resources in an election, and empirically testing how they do (e.g., [11, 14]). Several hypotheses have been suggested, but for our purposes, we only need a natural property: that the resources allocated by candidates a state is *monotonically increasing in its proportion of contested votes*; i.e., those that are 'up for grabs'. This means that if, for example, Ohio has 18 contested votes and there are a total of 100 nationally contested votes, it will be allocated less resources than if it had the same number of contested votes but there were a total of 99 nationally contested votes. In the current system, the safe states' vote allocation is essentially known before the election, and the only contested votes are the swing states'. Under BPP, it is more difficult to say exactly how many votes are decided beforehand and how many are contested, however we argue that only a very rough estimate is actually needed; we explore this in more detail in Section 4.3.

3 The Biased Proportional Plan

We now give a formal description of the BPP. The threshold and rounding parameter are set so that the BPP maintains features that proponents of the Electoral College consider crucial, while giving a voice to populations that are ignored by the winner-take-all method. Hence states whose legislature would like the country to move in a more democratic direction see it do so, and states who believe that the Electoral College has many important features see them maintained while at the same time, disadvantages of the winner-take-all method are removed. We explain the methodologies used to derive the threshold and rounding parameter in Appendix A.1.

How each state computes the allocation of electoral votes under BPP

1. The unrounded electoral vote is computed for each candidate:

$$\text{unrounded electoral votes} = \#\text{of electorates} \times \frac{\text{number of popular votes}}{\text{total popular votes}} .$$

2. For each candidate, if the fractional part of their unrounded electoral vote is at least 0.84, round the number of electoral votes up; otherwise round it down.

3. For each candidate, if they received either (a) less than 1 unrounded electoral vote or (b) at most 20 percent of the popular statewide vote, reduce their electoral votes to 0.

4. The candidate that won the plurality receives all the remaining electoral votes.

Example 1 There are two candidates: A and B. They receive 55.5% and 44.5% of the statewide popular vote respectively in both Maine, which has 4 electoral votes, and Pennsylvania, which has 20. In Maine, candidate B receives $4 \times 0.445 = 1.78$ unrounded electoral votes, below the 1.84 needed to be rounded up, and is therefore rounded down to 1. Candidate A receives the 3 remaining electoral votes. In Pennsylvania, candidate B receives 8.9 unrounded electoral votes, and is rounded up to 9. Candidate A receives the remaining 11 votes.

Example 2 There are three candidates: A, B, and C. They receive 40%, 36% and 24% of the statewide popular vote in Idaho, which has 4 electoral votes. The unrounded electoral votes are 1.6, 1.44 and 0.96 respectively. Candidate C did not obtain a full electoral vote,

and so receives 0 votes; candidate B has $1.44 < 1.84$, and so is rounded down to 1. Candidate A receives the 3 remaining electoral votes.

Example 3 There are three candidates: A, B, and C. They receive 49%, 33% and 18% of the statewide popular vote in Texas, which has 38 electoral votes. The unrounded electoral votes are 18.62, 12.54 and 6.84 respectively. Candidate C did not win 20% of the popular vote, and so receives 0 votes; candidate B is rounded down to 12. Candidate A receives the 26 remaining electoral votes.

Note There are extremely unlikely hypothetical cases in which the BPP would result in more electoral votes being allocated than there are available (for example, if in a state with 19 electors, 10 candidates each receive 1.9 unrounded electoral votes, the BPP would suggest that each candidate receive 2 electoral votes, for a total of 20). In order for the BPP to be applicable to *any* voting results, we suggest the following for such improbable scenarios: If there are x more electoral votes allocated than available, reduce by 1 the number electoral votes from each of the x candidates that received the smallest number of votes.

3.1 Features and advantages of the BPP

We contend that the BPP should be an appealing alternative to the winner-take-all system for all safe states, regardless of partisan leaning or views on the Electoral College, for the following reasons.

The "same winners" As mentioned in Section 2.1, one of the main challenges in presidential election reform lies in designing a system that does not favor either party. There is no scientific way to formally show this; nevertheless we argue that analyzing the outcome of the new system on the actual votes cast may be sufficient. Of course, this is a purely hypothetical exercise. It is impossible to know what the voter turnout would have been if the voting system was different; not only could the individual voter strategies have shifted, but the candidate strategies could have too, affecting the campaigns—candidates may have held different rallies, advertised differently, and so on. It is even possible that different candidates would have been chosen in the primaries.[12]

Despite the speculative nature of the computing the results of a new voting system on the actual votes, many political scientists argue that such results are a major factor in determining people's feelings about the new system (e.g, [23, 25, 40, 45, 52, 54, 66]). It is

[12]Similar arguments have been given in, e.g., [11], as criticism of this type of analysis.

arguably the only objective measure we can have to determine how similar two systems are in terms of partisan favor, and this is perhaps part of the reason that it is used so often (e.g., [8, 40, 44, 45]). For example, the Direct Election (and hence the Interstate Compact) appears to be advantageous to Democrats with respect to this measure: whenever there was a discrepancy between the winner of the Electoral College and the popular vote, the Republican candidate won the Electoral College.[13] It would make sense, therefore, for Republicans to object to Direct Election, and hence to the Interstate Compact. This is indeed the reason usually attributed to the fact that no Republican states have joined the Compact, e.g., [23, 52, 66].

Our empirical analysis shows that if the voting had been the same, the outcome of all thirty elections between 1900 and 2016 would had been identical, with the exception of 1968, when the decision would have gone to the House. As Nixon won the plurality vote in many more states and received many more electoral votes than Humphrey, it seems highly probable that the House would have elected him president, and so the result would have also been the same; the 1968 election was highly contentious as it was, sparking an outcry for electoral reform. We contrast this with Direct Election, in which the outcome would have changed twice in the last thirty elections[14] and with the District plan, in which the outcome would have been different twice out of the ten elections (1960–1996) analyzed in [40]. Table 3.1 shows the actual electoral votes and the BPP votes given to the candidates in the thirty elections since 1900. To ensure a fair comparison, we compute the actual votes without deviations of faithless electors. Table 3.2 shows the results of the 2016 election by state, comparing the popular vote, electoral votes and BPP votes.

Close elections The 2000 election is arguably the most controversial in U.S. history. Before Florida's 25 electoral votes were finally allocated, the tally was 246 to Bush and 266 to Gore (one Democratic elector abstained). A month of recounts and legal battles ensued, which were finally ended by a Supreme Court decision. Bush won Florida's electoral votes by a margin of only 537 votes out of almost six million cast and as a result claimed all of Florida's electoral votes. Note that the same situation could have occurred if the electoral votes excepting Florida's had tallied up to anywhere between 268-245 and 245-268, quite a large range. In contrast, under the BPP, Bush would have won by six electoral votes (seven if the elector had still abstained) and not four (respectively five), and the controversial

[13] This happened five times. In 1876, 1888, 2000 and 2016, the Republican candidate won the presidency and the Democrat won the popular vote. The first time this happened, 1824, was before the formation of the two major parties.

[14] We note, though, that only nine of these saw a five percent difference or less in the nationwide popular vote.

Year	Candidate	Actual*	BPP
2016	Clinton	232	268
	Trump	306	270
	Johnson	0	0
2012	Obama	332	279
	Romney	206	259
2008	Obama	365	289
	McCain	173	249
2004	Kerry	252	256
	Bush	286	282
2000	Gore	267	266
	Bush	271	272
	Nader	0	0
1996	Clinton	379	312
	Dole	159	226
	Perot	0	0
1992	Clinton	370	277
	Bush	168	215
	Perot	0	46
1988	Dukakis	112	233
	Bush	426	305
1984	Mondale	13	199
	Reagan	525	339
1980	Carter	49	213
	Reagan	489	325
	Anderson	0	0
1976	Carter	297	276
	Ford	241	262
1972	McGovern	17	179
	Nixon	521	359
1968	Humphrey	191	230
	Nixon	302	261
	Wallace	45	47
1964	Johnson	486	337
	Goldwater	52	201
1960†	Kennedy	303	271
	Nixon	219	267
	Byrd	15	0
1956	Stevenson	74	214
	Eisenhower	457	315
	Other	0	2

Year	Candidate	Actual*	BPP
1952	Stevenson	89	227
	Eisenhower	442	304
1948	Truman	304	282
	Dewey	189	214
	Thurmond	38	35
	Wallace	0	0
1944	Roosevelt	432	323
	Dewey	99	208
1940	Roosevelt	449	334
	Wilkie	82	197
1936	Roosevelt	523	377
	Landon	8	154
1932	Roosevelt	472	358
	Hoover	59	173
	Thomas	0	0
1928	Smith	87	225
	Hoover	444	306
1924	Davis	136	182
	Coolidge	382	316
	LaFollette	13	33
1920	Cox	127	197
	Harding	404	334
	Debs	0	0
1916	Wilson	276	305
	Hughes	255	226
	Benson	0	0
1912	Wilson	433	321
	Taft	8	95
	Roosevelt	90	115
	Debs	0	0
1908	Bryan	156	230
	Taft	327	253
	Debs	0	0
1904	Parker	133	201
	Roosevelt	343	275
	Debs	0	0
1900	Bryan	155	217
	McKinley	292	230

Table 3.1: Electoral votes according to the current system and according to the proposed BPP system. * To discount the effect of faithless electors, the "Actual" votes are computed if there were none, with the exception of 1960†: The results of the 1960s election are ambiguous; the actual votes reflect the actual votes cast, and we chose the widely accepted method of White [73] to determine the outcome of the BPP vote.

		Percent of votes			Actual votes*		BPP votes	
State	*Elec.*	*Clinton*	*Trump*	*Johnson*	*Clinton*	*Trump*	*Clinton*	*Trump*
Alabama	9	34.4	62.1	2.1		9	3	6
Alaska	3	36.6	51.3	5.9		3	1	2
Arizona	11	44.6	48.1	4.1		11	5	6
Arkansas	6	33.7	60.6	2.6		6	2	4
California	55	61.5	31.5	3.4	55		38	17
Colorado	9	48.2	43.3	5.2	9		5	4
Connecticut	7	54.6	40.9	3.0	7		4	3
Delaware	3	53.1	41.7	3.3	3		2	1
Florida	29	47.4	48.6	2.2		29	13	16
Georgia	16	45.3	50.4	3.0		16	7	9
Hawaii	4	62.2	30.0	3.7	4		3	1
Idaho	4	27.5	59.2	4.1		4	1	3
Illinois	20	55.2	38.4	3.7	20		13	7
Indiana	11	37.5	56.5	4.9		11	4	7
Iowa	6	41.7	51.1	3.8		6	2	4
Kansas	6	35.7	56.2	4.6		6	2	4
Kentucky	8	32.7	62.5	2.8		8	2	6
Louisiana	8	38.4	58.1	1.9		8	3	5
Maine	4	47.8	44.9	5.1	3	1	3	1
Maryland	10	60.3	33.9	2.9	10		7	3
Massachusetts	11	60.0	32.8	4.2	11		8	3
Michigan	16	47.0	47.3	3.6		16	7	9
Minnesota	10	46.4	44.9	3.8	10		6	4
Mississippi	6	40.1	57.9	1.2		6	2	4
Missouri	10	37.9	56.4	3.4		10	3	7
Montana	3	35.4	55.6	5.6		3	1	2
Nebraska	5	33.7	58.7	4.6		5	1	4
Nevada	6	47.9	45.5	3.3	6		4	2
New Hampshire	4	46.8	46.5	4.1	4		2	2
New Jersey	14	55.0	41.0	1.9	14		9	5
New Mexico	5	48.3	40.0	9.3	5		3	2
New York	29	59.0	36.5	2.3	29		19	10
North Carolina	15	46.2	49.8	2.7		15	7	8
North Dakota	3	27.2	63.0	6.2		3		3
Ohio	18	43.2	51.3	3.2		18	7	11
Oklahoma	7	28.9	65.3	5.7		7	2	5
Oregon	7	50.1	39.1	4.7	7		5	2
Pennsylvania	20	47.5	48.2	2.4		20	9	11
Rhode Island	4	54.4	38.9	3.2	4		3	1
South Carolina	9	40.7	54.9	2.3		9	3	6
South Dakota	3	31.7	61.5	5.6		3		3
Tennessee	11	34.7	60.7	2.8		11	3	8
Texas	38	43.2	52.2	3.2		38	16	22
Utah	6	27.2	45.1	3.5		6	1	5
Vermont	3	56.7	30.3	3.2	3		3	
Virginia	13	49.8	44.4	3.0	13		8	5
Washington	12	52.5	36.8	4.9	12		8	4
West Virginia	5	26.2	67.9	3.2		5	1	4
Wisconsin	10	46.5	47.2	3.6		10	4	6
Wyoming	3	21.9	68.2	5.2		3		3
Washington DC	3	90.9	4.1	1.6	3		3	
Total	338				233	305	268	270

Table 3.2: Popular statewide vote, electoral votes and BPP votes for the 2016 election.

election results would most likely have been avoided. Even if he had won by just four votes, the Florida recount could have only reduced the margin of victory to 270-268, and again, the entire situation would have been avoided. We note that under Direct Election, a national recount would probably be less likely [44], but if one was required, its effects would be catastrophic. It is almost impossible to say what would happen if a recount would be required under the Interstate Compact; see e.g., [15, 44] for some arguments.

This advantage of the BPP over the current system (and Direct Election) can be illustrated by the following hypothetical question: say a couple's car breaks down on their way to the election booth in Florida and they don't manage to vote for their candidate. What effect can this have on the election? Under winner-take-all, if the other candidate was leading 268-241[15] in the other states, this event could be the difference between their candidate winning 270-268, and and losing 297-241, seemingly a landslide. Under Direct Election, once again, this could be the difference between winning and losing (although the probability of this happening appears smaller). Under BPP, however, this event could not directly change the winner; at worst it could change 270-268 to 269-269 or vice-versa. In the first case, there is a winner; in the second, a tie, and the House would decide.

Concordance with arguments for the Electoral College Unlike Direct Election and the Proportional plan, the BPP upholds all four arguments for the Electoral College given in Section 1.2 (requiring a distribution of popular support to be elected president; enhancing the status of minority interests; encouraging a two party system; maintaining a federal system of government and representation). The first, second and fourth points are straightforward and follow from arguments already presented. With regards to the third, the high threshold is likely to provide a sufficient buffer against third-party candidates, in particular considering that the votes for third party candidates that do not pass the threshold are essentially awarded to the winner. A voter would probably be more likely to vote for a third-party candidate if they knew their vote would be distributed among the other candidates or discarded than if they knew that it would be given to the winner. Empirically, the BPP appears to reduce the effect of third-party candidates, relative to the Proportional plan: in 1992, Ross Perot won 18.9% of the popular vote. Under BPP, he would have only won 14.6% of the electoral votes. As many scholars have pointed out, there is no system that would completely eliminate the threat of a strong third-party candidate; even with all states using the winner-take-all rule, Wallace received 46 electoral votes in 1968.

We wish to address a specific argument of Koza et al., [45], who claim that the Proportional plan would leave many small states ignored. This is due to their lack of threshold and

[15] In 2000, Florida had 25 electors; in 2016, 29.

rounding the votes to the nearest whole number. For a state with 3 electoral votes, their cutoff for obtaining one electoral vote is 16.7%, while in the BPP it is 33.3%. The cutoffs for obtaining 2 electoral votes are the same in both systems: 50%. Koza et al. say that many states, e.g., Alaska (in which Clinton received 36.6% of the votes), Montana (35.4%), and South Dakota (31.7%), would remain uncompetitive under their system, as the distance from both 16.6% and 50% is large. It is easy to see that all three are very competitive under BPP. In fact, we show in Section 4.3 that under BPP, no state would be uncompetitive.

Implementability One of advantages of the proposed implementation of the BPP is its incremental nature. There is no need to convince all of the states of its merits simultaneously. Even though we show that it is very much in the States' own interest to transition, convincing the legislators that this is the case will probably not be trivial. The only temporal constraints are that two states need to transition concurrently. This may at first glance appear to be a problem, but it is not: one does not need to convince the legislators at the same time, nor does the bill need to pass the state legislatures/assemblies at the same time. The only requirement is that the laws be signed into effect by the governors at approximately the same time, which is easy to coordinate.

4 Stepwise Implementation of the BPP

As we previously showed, we need to treat safe and swing states differently. Recall that for our purposes, the definition a swing state is one that perceives itself as a battleground state. In order to make sure we do not treat any swing state as safe, we define the swing states to be the union of the swing states as currently defined by Politico [61], FiveThirtyEight [67] and the book "Only Ten Matter" [36], as well as all states that received visits from both Republican and Democratic candidates in the months leading up to the 2016 election (with the exception of Nebraska).[16] We feel that it is safe to say that any state that is not included in any of these lists probably does not consider itself a battleground state. The following states are therefore classified as swing states: Arizona, Colorado, Florida, Iowa, Michigan, Minnesota, Nevada, New Hampshire, North Carolina, Ohio, Pennsylvania, Virginia, and Wisconsin.

There are two naïve ways by which the states could transition to the BPP. The first is for all of the states to transition at once. It is highly unlikely that this would happen, as the swing states would probably not comply. Even if we only consider safe states, convincing more than 30 states to change their election laws at the same time seems like a Sisyphean

[16] Table 1.1

task. The other obvious choice is unilateral transition. This is not unheard of—Maine and Nebraska both converted to the District plan. Nevertheless, such unilateral transitions are a rare occurrence. As we have contended, swing states would not want to transition unilaterally as they would be giving up on REVENUE. Safe states would not want to due to PARTISANSHIP.

Our solution is to couple states to counterbalance their partisan effect, and to defer swing states to the end. Once enough states have transitioned to the BPP, the swing states' REVENUE will have decreased and the PRESSURE will have increased sufficiently—we believe—for them to transition as well. We describe several contingency plans in case swing (or even safe) states refuse to transition in Section 4.5.

Coupling states Consider a hypothetical situation in which states X and Y, each with four electors, are certain that in the next 100 elections—under the current system—they will allocate all four of their electoral votes to the Republican and Democratic candidates respectively. Furthermore, under the BPP, both would always end up giving exactly one electoral vote to the opposite party's candidate (only the states are clairvoyant in this hypothetical situation; the candidates are not, and hence have incentive to campaign in these states). In this case, transition to the BPP is clearly beneficial to both states. The transition will not have a net effect on the outcome of any future election, but they will both increase their REVENUE, as candidates will now be incentivized to campaign there. Furthermore, they would be giving a voice to all of their citizens, not just the ones aligned with the state's dominant party. Of course, this is a purely hypothetical situation, but it serves to illustrate the reasoning behind the coupling. While we cannot predict the future, we can analyze past voting patterns to estimate how likely it is that a coupled transition would affect the results of future elections.

4.1 Impact of transitions

We define the IMPACT of a unilateral move as follows. Let SYS be a voting system (for example the current system), and assume that some state s transitions to the BPP. Let DemVotes(SYS, s, y) (respectively RepVotes(SYS, s, y)) denote the number of electoral votes given to the Democratic (respectively Republican) candidate in state s in year y under the system SYS, and DemVotes(SYS, ALL, y) (respectively RepVotes(SYS, ALL, y)) denote the total electoral votes received by the Democratic (Republican) candidate nationwide in year y under system SYS. The impact of the transition of s from SYS to the BPP in year y is defined as follows.

Impact(Sys, s, y)

If the Democratic candidate won the plurality in s,

$$\textsc{Impact}(\textsc{Sys}, s, y) = 2 \times \frac{\text{DemVotes}(\textsc{Sys}, s, y) - \text{DemVotes}(BPP, s, y)}{\text{DemVotes}(\textsc{Sys}, \textsc{all}, y) - \text{RepVotes}(\textsc{Sys}, \textsc{all}, y)} .$$

If the Republican candidate won the plurality in s,

$$\textsc{Impact}(\textsc{Sys}, s, y) = 2 \times \frac{\text{RepVotes}(\textsc{Sys}, s, y) - \text{RepVotes}(BPP, s, y)}{\text{RepVotes}(\textsc{Sys}, \textsc{all}, y) - \text{DemVotes}(\textsc{Sys}, \textsc{all}, y)} .$$

Simply put, the impact of a state s in year y relative to the system Sys, denoted Impact(Sys, s, y), is the decrease in the number of votes the winning party in s receives due to transitioning to the BPP, scaled by the total gap between the winner and loser in that year (under Sys). Note that if the move decreases the gap or changes the winner, then it is a positive number, otherwise it is negative. We scale the value by a factor of two so that an impact of 1 or more means that the winner of the plurality of electoral votes (probably) changed—this happens when the change in number of votes, x, is greater than half of the difference between the votes allocated to the Republican and Democratic candidate; if the Republican candidate was leading, they now receive x fewer Republican votes and the Democratic candidate (probably)[17] receives x more. An impact of strictly less than 1 means that the winner did not change. We define impact only in terms of Republican and Democratic votes, as no other party in modern history has ever received enough votes to even come close to claim the presidency.

As an example, consider the impact in 2016 of Florida unilaterally transitioning from the current system. Without faithless electors, Trump would have won by 74 electoral votes (306–232) under the current system.[18] Under the BPP, Florida would have given Clinton 13 electoral votes (she received 47.4% of the votes, giving 13.75 electoral votes, which is rounded down to 13); therefore Florida's impact is $\frac{13}{74} \approx 0.176$. Rhode Island's impact for 2016 is $-\frac{1}{74}$, as it would have allocated Trump one extra electoral vote.

We use the above definition to define the (overall) impact of a state s's transition from Sys to the BPP, and the joint transition of two states, over a period of z elections. The definitions are straightforward: the z-Impact of a state is the maximal impact over the previous z elections; the impact of two (or any subset) of states is their maximal joint impact over the previous z elections. We only consider 5-Impact and 30-Impact, the impact over

[17] Some votes could go to a third candidate.

[18] The actual tally was 304–227.

	Hawaii		S. Dakota	
Year	*Act.*	*BPP*	*Act.*	*BPP*
2016	4	3	0	0
	0	1	3	3
2012	4	3	0	1
	0	1	3	2
2008	4	3	0	1
	0	1	3	2
2004	4	3	0	1
	0	1	3	2
2000	4	3	0	1
	0	1	3	2
1996	4	3	0	1
	0	1	3	2
1992	4	3	0	1
	0	1	3	2
1988	4	3	0	1
	0	1	3	2

	Hawaii		S. Dakota	
Year	*Act.*	*BPP*	*Act.*	*BPP*
1984	0	1	0	1
	4	3	3	2
1980	4	3	0	1
	0	1	4	3
1976	4	2	0	2
	0	2	4	2
1972	0	1	0	1
	4	3	4	3
1968	4	3	0	1
	0	1	4	3
1964	4	4	4	3
	0	0	0	1
1960	3	2	0	1
	0	1	4	3
1956	-	-	0	1
	-	-	4	3

Table 4.1: Actual and BPP electoral votes in Hawaii and South Dakota. The blue and red shaded rows represent votes for Democratic and Republican candidates respectively. Hawaii has voted since 1960.

the previous 5 and 30 elections respectively; we give a detailed explanation of the reasoning behind these choices in Appendix A.4. We define 5-IMPACT precisely below; the definition of 30-IMPACT is analogous, with the years spanning 1900-2016.

5-Impact(Sys, s)

$$5\text{-IMPACT}(\text{SYS}, s) = \max_{y=2000,2004,\ldots,2016} \text{IMPACT}(\text{SYS}, s, y).$$

5-Impact(Sys, s_1, s_2)

$$5\text{-IMPACT}(\text{SYS}, s_1, s_2) = \max_{y=2000,2004,\ldots,2016} \left[\text{IMPACT}(\text{SYS}, s_1, y) + \text{IMPACT}(\text{SYS}, s_2, y)\right].$$

4.2 Computing the transition order

As the gain in REVENUE of safe states is strictly positive, and GREATERGOOD and PRESSURE are also positive, pairs of safe states with a low joint 5-IMPACT are incentivized to transition together. Despite the fact that we showed (Table 3.1) that BPP would have produced the

#	States		5-Impact	Year	30-Impact	Year
1	Hawaii	South Dakota	0	2000	0.01626	1924
2	Vermont	Wyoming	0	2008	0.036036	1968
3	Connecticut	Oklahoma	0.015873	2012	0.043321	1920
4	Delaware	Montana	0	2000	0.037037	1968
5	Alaska	Rhode Island	0	2004	0.016807	1948
6	Mississippi	Oregon	0.016129	2012	0.038462	1968
7	New Mexico	Utah	0.15	2004	0.15	2004
8	Indiana	Washington	0.094737	2008	0.130081	1900
9	Maryland	South Carolina	0	2008	0.162162	1916
10	Massachusetts	Tennessee	0.166667	2000	0.209302	1976
11	Idaho	Maine	0.025	2016	0.044444	1908
12	Georgia	New Jersey	0.051282	2016	0.226415	1960
13	Kentucky	North Dakota	0.5	2000	0.5	2000
14	Illinois	West Virginia	0.106061	2012	0.347826	1960
15	Louisiana	Nebraska	0.7	2000	0.7	2000
16	California	Texas	0.078125	2012	0.347826	1948
17	Arkansas	Kansas	0.266667	2000	0.266667	2000
18	Alabama	New York	0.111111	2012	0.757576	1960
19	Iowa	Nevada	0.142857	2004	0.150943	1900
20	Arizona	Colorado	0.285714	2000	0.285714	2000
21	New Hampshire	Wisconsin	0.113208	2012	0.212766	1900
22	Michigan	Virginia	0.276596	2012	0.276596	2012
23	Minnesota	North Carolina	0.192982	2008	0.647059	1960
24	Missouri	Ohio	0.736842	2000	0.736842	2000
25	Florida	Pennsylvania	0.956522	2016	0.956522	2016

Table 4.2: The proposed transition order, with the 5-Impact and 30-Impact of every transition and years when they are maximized.

same winners in the past 30 elections,[19] it would appear unreasonable to assume that the 30-Impact of a set of transitions produced using the 5-Impact would be good. This is especially true as all states have voted both for both Republican and Democratic candidates over this time period; in fact, in the early part of the 20th century, the Southern states were considered safe for Democrats, while the Northeastern states were considered safe for Republicans—the opposite of the current political landscape. In light of this, if it turns out that the 30-Impact *is* good for every pair (in particular, always less than 1), it would suggest considerable robustness of the transition order.

We generate transition orders by choosing pairs randomly out of all pairs that have a low 5-Impact; we describe the precise algorithm in more detail in Appendix A.3. A large percentage of orders generated by this method lead to a good (less than 0.9) 5-Impact for all transitions, and of those, a large proportion also have the 30-Impact of every transition at less than 1. The implication of this is that whenever it is a pair of states' turn to transition, they can do so knowing that it is unlikely (in the sense we have described) to affect the results of an election: it would have had no effect on the outcomes of any of the previous 30 elections. Note that this holds even if the process were to halt at some point. For example, in the transition order of Table 4.2, Vermont and Wyoming should transition even if they predict that the process will stop after Idaho and Maine. In game-theoretic terms, it is a *dominant strategy* for pairs of states to transition at the recommended time.[20]

To offer more support for the robustness of the method, we give some statistics: a total of 25 pairs have a 5-Impact of less than 0.01 at the beginning (i.e., before any state transitions). Out of those, a pairing of any of {Alaska, Montana, South Dakota, Wyoming} with any of {Delaware, Vermont} gives a 30-Impact of less than 0.02, as do Hawaii–South Dakota and Alaska–Rhode Island (a total of 10 pairs). In all of our trials, regardless of which pairs we selected (out of the 'reasonable' pairs), there were always many options for continuing, at least near the beginning of the order. For example, if we consider the transition order as in Table 4.2, and look for pairs with 5-Impact of at most 0.05, there are 68 such pairs before first transition, 58 pairs after the first transition, and 50, 38 and 32 pairs after the second, third and fourth transitions. This implies that if some states refuse to transition at the suggested time, refuse to pair with a specific state, or decide to transition earlier than suggested, it is usually possible to find an alternative order.

We executed our algorithm several times and—in order to be unbiased—selected a transition order at random to be our proposed order. It is given in Table 4.2. Another possible

[19] With the same caveats as above, namely that the voting had been the same, and that congress had acted sensibly in 1968.

[20] Assuming that the possible actions for states are to either transition or not at the recommended times.

order (also selected at random) is given in Table B.1. We note that we do not include the District of Columbia in the order; since the ratification of the Twenty-third Amendment, it has always given all three of its electoral votes to the Democratic candidate, hence its 30-Impact is always 0, and it can transition at any time without affecting the other states.

4.3 Appeal to candidates

If a pair of states have small joint 5-Impact (and ideally also a small joint 30-Impact), we conclude that their Partisanship factor is small. We need to verify that Revenue is sufficiently large, so that coupled with GreaterGood (and possibly Pressure), it incentivizes the states to transition.

We quantify the Revenue of a state using its Appeal and RelativeAppeal. The Appeal of a state is an estimate of the number of contestable votes it has. We set the Appeal of safe and swing states under winner-take-all to be zero and the number of electors it has, respectively. The methodology used to compute the states' Appeal under the BPP is described in Appendix A.2. Table 4.3 shows the Appeal of the states under the BPP; it is easy to see that these values are positively correlated with the number of electors of each state. The RelativeAppeal of a state is simply its Appeal normalized by the sum of the Appeals of all states. As shown in e.g., [11, 14], the candidates investment in a state is roughly proportional to its RelativeAppeal. There is disagreement about the precise correlation, but all agree that the candidates' investment in states is increasing in the states' RelativeAppeal.

For safe states, transition to the BPP clearly increases their Revenue, regardless of the other states' Appeal, as their RelativeAppeal under BPP is strictly positive, while under winner-take-all it is zero. The same reasoning shows that once a state has transitioned, it is not incentivized to transition back to winner-take-all. There is a caveat to this, as a state might value its partisan influence more that the benefits it reaps from the candidates' attention, and hence be incentivized to transition back. This is easily addressed, however, as the other states offer a *credible threat* of reverting as well. If some state reverts, it loses its Revenue, and other states (at the very least its partner in the order, but most likely all states) will also revert; hence reverting will not give the state the partisan advantage it would reap if it could revert alone. To illustrate this, we plot the RelativeAppeal of Oklahoma and Wisconsin as a function of the transitions of Table 4.2, with the swing states as in the 2012 election[21] in Figures 4.1 and 4.2 respectively.[22]

[21] Colorado, Florida, Iowa, Michigan, Ohio, Nevada, New Hampshire, North Carolina, Virginia and Wisconsin.

[22] For clarity, the RelativeAppeal of Wisconsin is only shown until its transition.

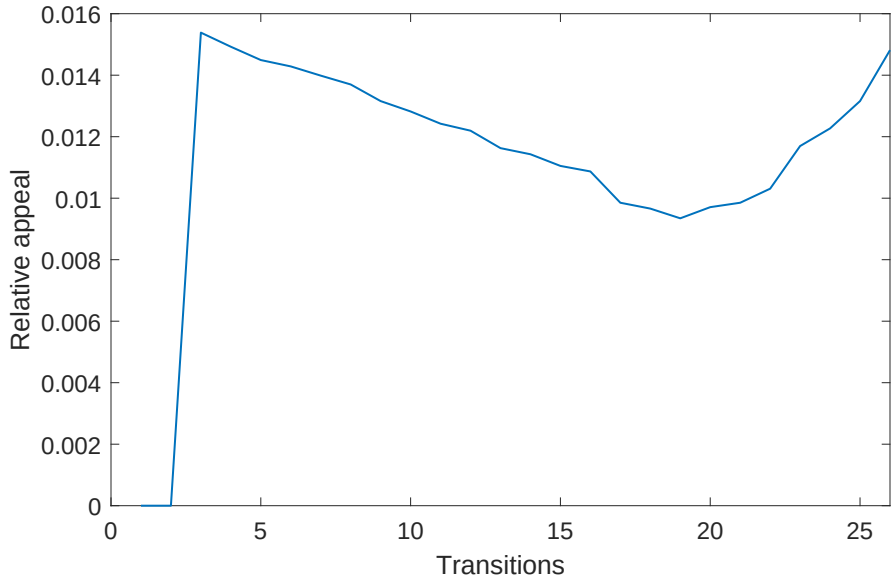

Figure 4.1: The RelativeAppeal of Oklahoma to the candidates using the transition order of Table 4.2, with the swing states as in the 2012 election. It is easy to see that once Oklahoma transitions, it has no incentive to go back to the winner-take-all rule as its RelativeAppeal would go back down to 0.

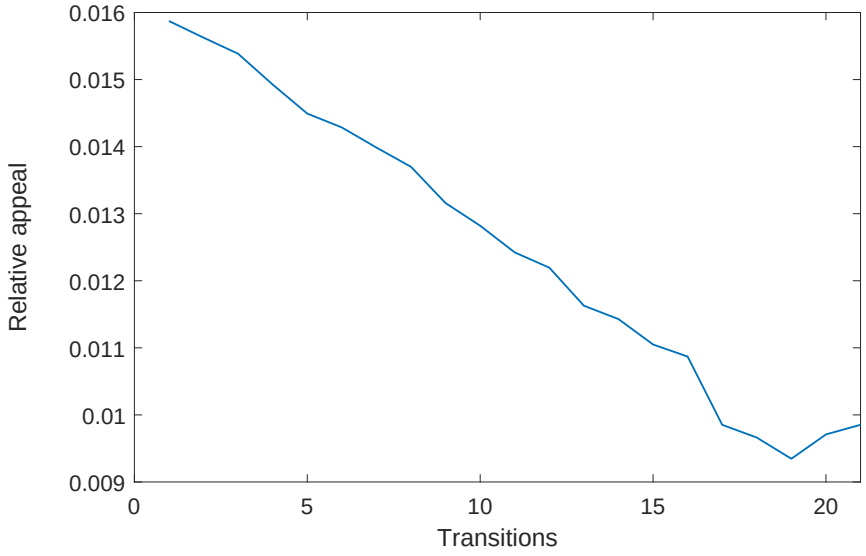

Figure 4.2: The RelativeAppeal of Wisconsin to the candidates until its transition using the transition order of Table 4.2, with the swing states as in the 2012 election.

State	Appeal	State	Appeal	State	Appeal
Alabama	2	Louisiana	2	Ohio	4
Alaska	1	Maine	2	Oklahoma	2
Arizona	3	Maryland	2	Oregon	2
Arkansas	2	Massachusetts	2	Pennsylvania	5
California	11	Michigan	3	Rhode Island	1
Colorado	3	Minnesota	3	South Carolina	2
Connecticut	2	Mississippi	1	South Dakota	1
Delaware	2	Missouri	3	Tennessee	3
Florida	7	Montana	2	Texas	8
Georgia	4	Nebraska	1	Utah	1
Hawaii	1	Nevada	2	Vermont	1
Idaho	1	New Hampshire	2	Virginia	3
Illinois	5	New Jersey	4	Washington	3
Indiana	3	New Mexico	2	West Virginia	1
Iowa	2	New York	5	Wisconsin	3
Kansas	2	North Carolina	4	Wyoming	1
Kentucky	2	North Dakota	1	DC	0

Table 4.3: The Appeal of each state under the BPP.

4.4 Swing states

Reasoning about whether swing states will be motivated to transition is more tricky. As can be seen in Tables 4.2 and B.1, they are also guaranteed that their Partisanship effect is small. We claim that for them too, GreaterGood is positive and Pressure is increasing (if we use the data from the Gallup poll [27] as a guideline, we can conjecture that the public pressure will be very strong by the time that most of the safe states have transitioned). In addition, as more safe states transition, the swing states' RelativeAppeal decreases. An example of this is shown in Figure 4.2. We remark that once swing states transition, the RelativeAppeal of all states increases, except for the transitioning state. Thus, swing states at the end of the order have less incentive to transition from this perspective. Still, we contend that once almost all states have transitioned, the public pressure will be extremely strong. It is nevertheless possible that a swing state will refuse to transition despite the public pressure; we discuss such contingencies next.

4.5 Contingencies

We have used game-theoretic reasoning to argue that the BPP with the proposed transition order incentivizes states to transition at the proposed steps. Although we have tried to be general in our assumptions of states' behavior and conservative in choosing our parameters, it is impossible to completely model the states' motivations or accurately predict their behavior. It is useful for the transition order to be robust to states not adhering to the plan. Our simulations show that the transition order is indeed highly resilient to perturbations in states' behavior. In over one thousand simulations, regardless of how the safe or swing states behave (barring them not agreeing to transition even after they have been moved to the end of the queue), it has always been possible to find a transition order that preserves the required qualities. Although it is impossible to try all possibilities, our simulations suggest that if a safe state refuses to transition, it is almost always possible to move that state to the end of the queue and continue from there. Similarly, if one or two safe states transition too early or a swing state agrees to 'join' the safe states (i.e., to be included in the algorithm as a safe state), it is highly likely that we will be able to continue the transition order from that point.

Finally, we note that it is possible that some states will refuse to transition even after all of the others have. We have tried to make the case that public pressure will be sufficient for them to transition by that point, but of course, it is always possible that some states will nevertheless resist change. In this case, we believe there are two main possible courses of action: the first is to accept that some states will not transition, and then the system will be in a somewhat unsatisfactory equilibrium—but an equilibrium nonetheless—and the overall situation will be much better than it is now, with the swing state effects greatly reduced and broader representation. The second (and in our opinion more likely) is that once a large majority—in particular, more than three quarters—of the states will have transitioned, the ground will be set for a constitutional amendment, to force the dissenting states to transition. We do not believe that will be necessary, but argue that even if the BPP is enforced by law, it would not be a large transition (if any) from the Framers' intentions.

5 Conclusion

The Biased Proportional Plan circumvents the weaknesses of previous proposals. Unlike Direct Election, the Interstate Compact and the District Plan, the results of the previous thirty elections would have been identical if the BPP was used to determine the winner

(and the voting had been the same); unlike the Proportional Plan, it discourages third-party candidates.

Our simulations show that the algorithm we used to compute the order is highly resilient to perturbations in states' behavior. In over one thousand randomized simulations, when some states deviate from the suggested behavior (barring them not agreeing to transition even after they have been moved to the end of the queue), our algorithm has always managed to find a transition order that preserves the required qualities. If a safe state refuses to transition, it is possible to move that state to the end of the queue and continue from there. If one or two safe states transition too early or a swing state agrees to 'join' the safe states (i.e., to be included in the algorithm as a safe state), it is possible to compute a continuation of the transition order from that point.

Economists agree that there is no perfect voting system. That is, no voting system can ensure that the winner will be the person who best represents voters wishes, including how intensely they favor or disfavor each candidate [24]. The BPP is not, and indeed cannot be, everyone's ideal system. It should be, however, appealing to both Democrats and Republicans as it is both closer to the 'one person, one vote' doctrine than the current system, and more in concordance with the founding fathers' original intentions,

> *"...to establish him in the esteem and confidence of the whole Union, or of so considerable a portion of it as would be necessary to make him a successful candidate for the distinguished office of President of the United States."*
>
> Alexander Hamilton, *The Mode of Electing the President*, March 14, 1788. [34]

References

[1] David W. Abbott and James P. Levine. *Wrong Winner: The Coming Debacle in the Electoral College*. Praeger, 1991.

[2] Vikram Amar. The So-Called Presidential Election Reform Act A Clear Abuse of California's Initiative Process. `http://supreme.findlaw.com/legal-commentary/the-so-called-presidential-election-reform-act-a-clear-abuse-of-californias-initiative-process.html`, August 2007.

[3] Herman Vandenburg Ames. *The Proposed Amendments to the Constitution of the United States During the First Century of Its History*. American historical association. Annual report, 1896. U.S. Government Printing Office, 1897.

[4] J. Theodore Anagnoson. Federal Grant Agencies and Congressional Election Campaigns. *American Journal of Political Science*, 26(3):547–561, 1982.

[5] Julia Azari. Most People Hate The Electoral College, But Its Not Going Away Soon. `https://fivethirtyeight.com/features/most-people-hate-the-electoral-college-but-its-not-going-away-soon/`, November 2016.

[6] Robert W. Bennett. Popular Election of the President without a Constitutional Amendment, 2001. Green Bag, Spring 2001.

[7] Judith A. Best. Presidential Selection: Complex Problems and Simple Solutions. *Political Science Quarterly*, 119(1):39–59, 2004.

[8] A.M. Bickel. *Reform and Continuity: The Electoral College, the Convention, and the Party System*. Harper & Row, 1971.

[9] Joseph Blunt. *American Annual Register*. W. Jackson, 1835.

[10] John Boehner, Mitch McConnel, and Rick Perry. Letter from John Boehner, House of Rep. Speaker, Mitch McConnell, Senate Republican Leader, and Rick Perry, Governor of Texas, to Governors of the Fifty States. `http://www.flashreport.org/blog/wp-content/uploads/2011/08/Letter-Boehner.McConnell.Perry-1.pdf`, June 2011.

[11] Steven J. Brams and Morton D. Davis. The 3/2's Rule in Presidential Campaigning. *The American Political Science Review*, 68(1):113–134, 1974.

[12] Gary Bugh. *Electoral College Reform: Challenges and Possibilities*. Ashgate Pub., 2010.

[13] Gary Bugh. Representation in Congressional Efforts to Amend the Presidential Election System. In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 1. Ashgate Pub., 2010.

[14] Jonathan Paul Day. *The Strategy of Presidential Campaigns*. PhD thesis, University of Iowa, 2010.

[15] Darin DeWitt and Thomas Schwartz. A Calamitous Compact. *PS: Political Science & Politics*, 49(4):791–796, 2016.

[16] Brendan J. Doherty. Electoral College Incentives and Presidential Actions: A Case for Reform? In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 11. Ashgate Pub., 2010.

[17] Simon Dumenco. The States Where Clinton and Trump Are Advertising Most. http://adage.com/article/campaign-trail/states-where-trump-clinton-spending-most-on-advertising/306377/, October 2016.

[18] George C. Edwards. *Why the Electoral College Is Bad for America*. Yale University Press, 2004.

[19] FairVote. 2016 Presidential Candidate General Election Events Tracker. https://docs.google.com/spreadsheets/d/14Lxw0vc4YBUwQ8cZouyewZvOGg6PyzS2mArWNe3iJcY. (Accessed on 03/13/2018).

[20] FairVote. Past Attempts at Reform. http://archive.fairvote.org/?page=979. (Accessed on 03/23/2018).

[21] FairVote. Who Picks the President? http://archive.fairvote.org/presidential/?page=1677. (Accessed on 03/13/2018).

[22] Brian M. Faughnan and John Hudak. Presidential Pandering: How Elections Determine the Exercise of Executive Power in the U.S. and Colombia. https://www.brookings.edu/wp-content/uploads/2016/06/2-us-colombia-election-hudak.pdf, June 2016.

[23] W.H. Flanigan and N.H. Zingale. *Political Behavior of the American Electorate*. CQ Press, 2009.

[24] IGM Forum. Primary Voting. http://www.igmchicago.org/surveys/primary-voting. (Accessed on 03/13/2018).

[25] Brian J. Gaines. Compact Risk: Some Downsides to Establishing National Plurality Presidential Elections by Contingent Legislation. In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 7. Ashgate Pub., 2010.

[26] Gallup. Americans Call for Term Limits, End to Electoral College. http://news.gallup.com/poll/159881/americans-call-term-limits-end-electoral-college.aspx, January 2013.

[27] Gallup. Record-High Support for Legalizing Marijuana Use in U.S. http://news.gallup.com/poll/221018/record-high-support-legalizing-marijuana.aspx, October 2017.

[28] Curtis Gans. *Voter Turnout in the United States 1788-2009*. CQ Press, Inc., 2011.

[29] James G. Gimpel, Karen M. Kaufmann, and Shanna Pearson-Merkowitz. Battleground States versus Blackout States: The Behavioral Implications of Modern Presidential Campaigns. *The Journal of Politics*, 69(3):786–797, 2007.

[30] Darshan J. Goux and David A. Hopkins. The Empirical Implications of Electoral College Reform. *American Politics Research*, 36(6):857–879, 2008.

[31] Gary Gregg. Electoral College Keeps Elections Fair, howpublished = `https://www.politico.com/story/2012/12/keep-electoral-college-for-fair-presidential-votes-084651`, month = December, year = 2012,.

[32] Gary L. Gregg. *Securing Democracy: Why We Have an Electoral College*. ISI Books, 2008.

[33] Allen Guelzo and James Hulme. In Defense of the Electoral College. `https://www.washingtonpost.com/posteverything/wp/2016/11/15/in-defense-of-the-electoral-college/?utm_term=.73fd5337764c`, November 2016.

[34] Alexander Hamilton. Federalist No. 68. `http://avalon.law.yale.edu/18th_century/fed68.asp`, March 1788.

[35] John A. Hamman. Bureaucratic Accommodation of Congress and the President: Elections and the Distribution of Federal Assistance. *Political Research Quarterly*, 46(4):863–879, 1993.

[36] Stacey H. Hecht and David A. Schultz. *Presidential Swing States: Why Only Ten Matter*. Rowman & Littlefield, 2015.

[37] John Hudak. *The Politics of Federal Grants: Presidential Influence over the Distribution of Federal Funds*. PhD thesis, Vanderbilt University. Nashville, TN, 2012.

[38] Scott C. James and Brian L. Lawson. The Political Economy of Voting Rights Enforcement in America's Gilded Age: Electoral College Competition, Partisan Commitment, and the Federal Election Law. *The American Political Science Review*, 93(1):115–131, 1999.

[39] Thomas Jefferson. Letter to Samuel Kercheval. `http://teachingamericanhistory.org/library/document/letter-to-samuel-kercheval/`, June 1816.

[40] Kenneth Jost and Greg Giroux. Electoral college. *CQ Researcher*, 10:977–1008, December 8, 2000.

[41] Dale Read Jr. Direct Election of the President without a Constitutional Amendment: A Call for State Action. *Washington Law Review*, 51:321–349, 1976.

[42] William C. Kimberling. *The Electoral College*. Essays in elections. National Clearinghouse on Election Administration, Federal Election Commission, 1992.

[43] Michael J. Korzi. "If the Manner of it be Not Perfect" : Thinking Through Electoral College Reform, chapter=3, booktitle=Electoral College Reform: Challenges and Possibilities, editor=Bugh, Gary, isbn=9780754677512, lccn=2010003698, year=2010, publisher=Ashgate Pub.

[44] John R. Koza. A Not-So-Calamitous Compact: A Response to DeWitt and Schwartz. *PS: Political Science & Politics*, 49(4):797–804, 2016.

[45] John R. Koza, Barry Fadem, Mark Grueskin, Michael S. Mandell, Robert Richie, and Joseph F. Zimmerman. *Every Vote Equal: A State-based Plan for Electing the President by National Popular Vote*. National Popular Vote Press, 2013.

[46] Douglas L. Kriner and Andrew Reeves. Presidential Particularism and Divide-the-Dollar Politics. *American Political Science Review*, 109(1):155–171, 2015.

[47] David Leip. US Presidential Results & PVIs by State 1828-2016. `https://docs.google.com/spreadsheets/d/1D-edaVHTnZNhVU840EPUhz3Cgd7m39Urx7HM8Pq6Pus`. (Accessed on 03/16/2018).

[48] Lawrence Lessig. EqualVotes.US: Where We Are, Where Were Going. `https://medium.com/@lessig/equalvotes-us-where-we-are-where-were-going-b421ae6c2e09`, October 2017.

[49] Lawrence D. Longley and Alan G. Braun. *The Politics of Electoral College Reform*. Yale University Press, 1972.

[50] James Madison. *The Writings of James Madison, Vol. 9: Comprising His Public Papers and His Private Correspondence, Including Numerous Letters and Documents; 1819-1836 (Classic Reprint)*. Fb&c Limited, 2016.

[51] William G. Mayer, Emmett H. Buell Jr., James E. Campbell, and Mark Joslyn. The Electoral College and Campaign Strategy. In P. Schumaker and B.A. Loomis, editors, *Choosing a President: The Electoral College and Beyond*, Chapter 7. Chatham House Publishers, 2002.

[52] Mark J. McKenzie. Attitudes toward Electoral College Reform: Understanding Opinion Formation on Complicated Public Policy Issues. *Politics & Policy*, 37(2):265–288, 2009.

[53] Mark J. McKenzie. Systemic Biases Affecting Congressional Voting on Electoral College Reform. In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 6. Ashgate Pub., 2010.

[54] James P. Melcher. Exploring the Difficulties of Electoral College Reform at the State Level: Maine and Nebraska Lead the Way. In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 8. Ashgate Pub., 2010.

[55] Mirabelle Muûls and Dimitra Petropoulou. A Swing State Theory of Trade Protection in the Electoral College. *Canadian Journal of Economics*, 46(2):705–724, 2013.

[56] National Archives and Records Administration. U. S. Electoral College: Frequently Asked Questions. `https://www.archives.gov/federal-register/electoral-college/faq.html`. (Accessed on 03/12/2018).

[57] Newsweek. Marijuana legalization 2018: Which states might consider cannabis laws this year? `http://www.newsweek.com/marijuana-legalization-2018-which-states-will-consider-cannabis-laws-year-755282`, January 2018.

[58] Susan Page. Voter Turnout Higher in Swing States than Elsewhere. `https://www.usatoday.com/story/news/politics/2012/12/23/voter-turnout-swing-states/1787693/`, December 2012.

[59] Costas Panagopoulos. Trends: Electoral Reform. *The Public Opinion Quarterly*, 68(4):623–640, 2004.

[60] Josiah Peterson. *The Electoral College: Critical to our Republic*. The King's College Press, 2016.

[61] Politico. Swing States: Latest News, Top Stories & Analysis. `https://www.politico.com/news/swing-states`. (Accessed on 04/03/2018).

[62] A. Reynolds, B. Reilly, A. Ellis, International Institute for Democracy, and Electoral Assistance. *Electoral System Design: The New International IDEA Handbook*. International Institute for Democracy and Electoral Assistance, 2005.

[63] Sean J. Rosenthal. The Accidental Genius of the Electoral College - Foundation for Economic Education - Working for a Free and Prosperous World. `https://fee.org/articles/the-accidental-genius-of-the-electoral-college/`, November 2016.

[64] Daron R. Shaw. The methods behind the madness: Presidential electoral college strategies, 1988-1996. *The Journal of Politics*, 61(4):893–913, 1999.

[65] Boris Shor. Presidential Power and Distributive Politics: Federal Expenditures in the 50 States, 1983-2001. *University of Chicago. Unpublished manuscript*, January 2006.

[66] Nate Silver. Why a Plan to Circumvent the Electoral College Is Probably Doomed. `https://fivethirtyeight.com/features/why-a-plan-to-circumvent-the-electoral-college-is-probably-doomed/`, April 2014.

[67] Nate Silver. The Odds Of An Electoral College-Popular Vote Split Are Increasing. `https://fivethirtyeight.com/features/the-odds-of-an-electoral-college-popular-vote-split-are-increasing/`, October 2016.

[68] Brian Stelter. Campaign Ad Cash Lures Buyers to Swing-State TV Stations. `http://www.nytimes.com/2013/07/08/business/media/with-political-ad-profits-swing-state-tv-stations-are-hot-properties.html`, July 2013.

[69] Jeffrey M. Stonecash. The Electoral College and Democratic Responsiveness. In Gary Bugh, editor, *Electoral College Reform: Challenges and Possibilities*, Chapter 4. Ashgate Pub., 2010.

[70] David Stromberg. How the electoral college influences campaigns and policy: The probability of being florida. *American Economic Review*, 98(3):769–807, June 2008.

[71] The Washington Post. The Spending Race - TV Ads in the Presidential Campaign. `http://www.washingtonpost.com/wp-srv/special/politics/track-presidential-campaign-ads-2012/`, November 2012.

[72] Hans von Spakovsky. Destroying the Electoral College: The Anti-Federalist National Popular Vote Scheme. `https://www.heritage.org/election-integrity/report/destroying-the-electoral-college-the-anti-federalist-national-popular`, October 2011.

[73] Theodore H. White. *The Making of the President 1960*. HarperCollins, 2009.

[74] Wikipedia. 91st United States Congress. `https://en.wikipedia.org/wiki/91st_United_States_Congress`. (Accessed on 03/29/2018).

[75] Justin Wolfers. *Are Voters Rational?: Evidence from Gubernatorial Elections*. Graduate School of Business, Stanford University, 2002.

Appendix A Methodology

In this section we overview the methodologies used in determining the threshold, rounding parameter, Appeal, and transition order. We conclude with a short discussion on the merits and shortcomings of speculative analysis of historical data, as it plays a non-negligible role in our analysis. The historic voting data used was obtained from Dave Leip's Atlas of U.S. Presidential Elections [47].

A.1 Parameters of the BPP

The BPP has two parameters that need to be set: the threshold and the rounding parameter.

The threshold A feature of many proportional representation voting systems is a *threshold*—votes for candidates or parties that do not accrue a sufficient number of votes are discarded. Our goal in setting a threshold is to strike a balance between discouraging weak third-party candidates, while ensuring that votes for one of the two main parties will rarely be wasted. Of course, no system can completely discourage third party candidates from running, and none should—even proponents of the two-party system typically agree that strong third-party candidates can be important (e.g., [60]). We propose a threshold of 20 percent *and* at least one full electoral vote. We note that this is a very high threshold relative to other thresholds used in elections worldwide. Typical thresholds fall in the range of 0.67% (in the Netherlands) to 10% (in Turkey) [62][23]. The motivation for the proposed threshold comes from the fact that the last time a Republican or Democrat received fewer than 20 percent of the popular vote in any state (excluding the District of Columbia) was in 1972.[24] The combination of both a percentage and a full electoral vote is particularly important given the large variance in number of electors per state—it ensures that in states with many electors, a small percentage of the popular vote will not translate to any electoral votes, and in small states with 3 or 4 electors, a partial electoral vote will not be rounded up. Thus a third-party candidate should only receive electoral votes if they are comparable in popularity to one of the two main parties.

The rounding parameter One major question regarding the Proportional plan is in what proportion to allocate the votes, or more simply—how to *round* the votes (assuming the Electoral College is not changed to allow for fractional votes). To demonstrate the complexity of this issue, assume that two candidates receive 67% and 33% of the vote in a

[23] We note that these are different than the U.S. Presidential elections.

[24] In 1972, McGovern received 19.6 percent of the vote in Mississippi.

state that has 5 electors. Clearly one should receive approximately twice as many votes as the other. This is impossible: the only two reasonable options are $(4, 1)$ and $(3, 2)$, neither of which 'seems right.' Suppose that we decide to use the standard method of rounding (half a fractional vote and above is rounded up), and the two candidates receive 62.3% and 37.7% of the popular votes in a state with four electors. The fractional proportional electoral votes are 2.49 and 1.51 respectively. Standard rounding gives that both candidates receive two electoral votes, which seems far from agreement with the popular vote, as one candidate was clearly favored over the other. Conversely, with aggressive rounding (i.e., rounding up every fraction in favor of the winner), the state could allocate three votes to the majority and one to the minority if the candidates receive 50.01% and 49.99% respectively, also clearly not in line with the popular vote. There is a large middle ground between these two extremes, and there is obviously no single correct way to round. It is is clear, though, is that all states should adhere to the same rule, as illustrated by the following examples. If the states had adopted the BPP (and the voting had been the same), but states in which the Republican candidate won the plurality set the rounding parameter to be 0.9, while the remaining states set it to 0.6, Ford would have won the 1960 election. If the reverse was true, Bryan would have won the 1900 election. It seems logical that states would choose a threshold strategically if it was not decided upon beforehand. Therefore there must be a uniform rule for all states.

One attractive artifact of the winner-take-all method is that there are no *tied states*; that is, no state allocates an equal number of votes to both candidates; there is a clear and unambiguous meaning to candidates winning or losing states. We argue that this is an appealing characteristic of the Electoral College. It is easy to see that the number of tied states is monotonically non-increasing in the rounding parameter. Figure A.1 shows the total number of tied states in the past thirty elections as a function of the rounding parameter (assuming the voting had been the same). One option would be to set the parameter to, say, 0.999 and almost never have tied states. As we argued, it is unreasonable for a state with four electors to give three votes to the winner of a 50.01 percent majority. Another reason for setting the rounding parameter lower is that it spreads out the competitive area around the 50 percent mark. For example, in a state with four electors, setting the parameter to 0.99 would mean that (in a two candidate race), a candidate would receive zero electoral votes for $0 - 25\%$ of the popular vote, one for $25 - 49.75\%$, two for $49.75 - 50.25\%$, three for $50.25 - 75\%$ and four otherwise. A state polling at $62.5 : 37.5$ would be unattractive to candidates, requiring a shift of 12.25% relative to the polls to change the outcome. Setting the parameter at 0.7, though, would result in a candidate receiving zero, one, two , three and four votes for $0 - 25\%$, $25 - 43.25\%$, $43.25 - 57.75\%$, $57.75 - 75\%$ and $75 - 100\%$ of

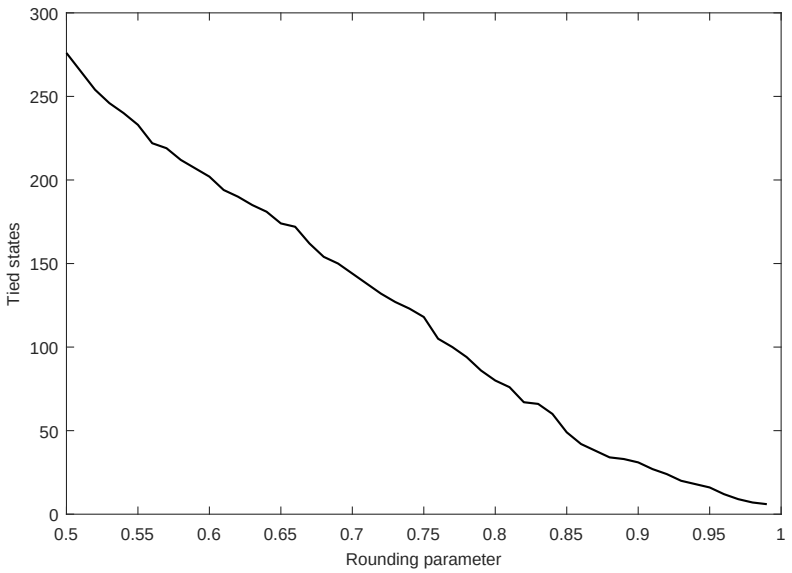

Figure A.1: The total number of tied states in the 30 elections during 1900-2016 as a function of the rounding parameter.

the popular vote respectively, meaning no reasonable poll results[25] could be more than 9 percentage points away from a different outcome.

We feel that allowing the expected number of tied states per year to exceed 5 percent is unattractive as too many states will not have a clear winner or loser; we therefore set the threshold at the number for which exactly two states will be tied in each election cycle on average: 0.84. This appears to be a good compromise in terms of competitiveness as well.

A.2 Appeal and relative appeal

We would like to compute a rough estimate for the 'appeal' of a state to a candidate. Candidates allocate time and resources to states in a strategic manner: they will allocate more resources to states that have more votes that they feel are contestable. Under winner-take-all, we take the number of contestable votes to simply be the number of electoral votes in swing states and zero otherwise. This is a simplification, but not one that significantly affects our results. The appeal of a state also depends on the probabilities that the candidates feel they have has of obtaining the votes (which can be a factor of, for example, the size of the candidate's/opponent's lead in the polls), e.g., [11, 14].

[25] As we mentioned, no state, with the exception of D.C., has given less than 20% of the votes to a major party since 1972.

Typically, $20-40$ percent of the electorate are undecided about their choice of a candidate at the start of a presidential campaign [23]. In order to be conservative, we take the lower bound: 20 percent. In other words we assume that 80 percent of the population in each state have decided which candidate they will vote for before the start of the campaign. We would like to compute the percentage of votes that (generic) Republican and Democratic candidates would expect to receive in an election today, and take a $\pm 10\%$ interval around it. Of course, we would like to compute the results under the BPP, but only have the voting history under the current system. As we are only computing a rough estimate, we argue that the expected votes under the current system are a sufficiently good approximation of the expected votes under the BPP for our purposes.[26] To compute this estimate, we take a weighted average of the voting in the past five elections, giving a weight of $2, 1.5, 1.25, 1.125$ and 1 to the elections from most to least recent respectively. In order to (once again) be conservative, we ignore the effects of third-party candidates, as these provide for greater variance in the votes given to the two main parties; we simply normalize the Democratic and Republican votes (i.e., if the Democratic and Republican candidates received x and y percent of the votes respectively, these are normalized to $\frac{100x}{x+y}$ and $\frac{100y}{x+y}$ to ensure they sum to 100). We then take these values, add and subtract ten percent, and compute the number of electoral votes obtained under the BPP in both cases. The difference in the number of votes between these two extremes are considered the contestable votes, and this is set to be the state's Appeal. We give these values in Table 4.3. Unsurprisingly, states with more electoral votes have a larger Appeal. The RelativeAppeal of a state is simply its Appeal normalized by the sum of the Appeals of all states.

A.3 Computing the transition order

It is not difficult to see that attempting to enumerate all possible transition orders in order to find the 'optimal' one (for any definition of optimal) is infeasible; there are over 10^{50} possibilities. The most natural transition order is the greedy one—at each step, choose the pair with the lowest 5-Impact. Unfortunately, this does not lead to very good results. In particular, the 5-Impact of some transitions is extremely close to 1 (although always below), and the 30-Impact of 16% of the transitions is greater than 2 (meaning that the 'wrong' candidate would have won). Indeed, there is no reason to believe that such an algorithm would be optimal, as greedy decisions early on may lead to only bad options remaining in later stages. We tried several algorithms for computing a good transition order. It turns

[26] A mental exercise should suffice to convince the reader that this is a sufficiently good approximation: If Kentucky were to convert to the BPP (or indeed any other system) in 2019, how surprising would it be if the Democratic candidate won there by a landslide in 2020?

out that there is a simple algorithm that gives consistently good results: a randomized relaxation of the greedy algorithm. Specifically, at every step, we choose a pair of states uniformly at random out of the pairs that have 'close' to the best 5-Impact. We found that the algorithm is quite robust to different (reasonable) interpretations of 'close'. For the specific orders computed, we added 0.8 to the 5-Impact of all pairs that include swing states and 0.1 to pairs that include Maine and Nebraska, to account for their current electoral vote allocation being more competitive than other safe states. We chose a pair at random out of all pairs whose 5-Impact is at most the minimal 5-Impact + 0.15, giving slightly more weight to pairs with a low 30-Impact. Specifically, we gave each pair a weight of $\max\{(1 - \text{30-Impact}), 0\}$. We note that we obtained similar results without the weighting by 30-Impact, at the expense of more trials.

A.4 Analysis of historical voting data

One of our objectives is setting the parameters of the BPP in a way that will ensure that the goals we set (e.g., maintaining a two-party system) are met. Unfortunately, even if our objectives could be perfectly quantified, it would have still been impossible to set the parameters optimally, as it would require us to be able to foresee and compare different possible futures. Even if we only wanted to extrapolate from the past, we would have to use counterfactuals, as the BPP was not used in past elections. As our goal is not to find the perfect system, but to find a better one that a large majority will agree on, we are therefore satisfied with 'reasonable' approximations to the optimal parameters. We argue that analyzing historical data allows us to meet this goal.

As a concrete example of how analyzing historical data can help us set parameters in a useful fashion, consider the following question, the answer to which would have been useful for setting the rounding parameter: "What would be the average number of tied states in the next 30 elections as a function of the rounding parameter, under the BPP?" This is a question that is not answerable in any meaningful sense. An arguably slightly more reasonable one (albeit still hypothetical) is "What would have been the average number of tied states in the previous 30 elections as a function of the rounding parameter, under the BPP?" Once again, there is no way to compute such a function, as the BPP was not used. One question that we *can* answer, however, is "What would have been the average number of tied states in the previous 30 elections as a function of the rounding parameter, under the BPP, *if people had voted the same way*?" The advantage of such a question is that it affords a verifiable (or falsifiable) answer. The disadvantage is that it is less informative than the previous two questions; the important issue is how much less informative. It does not seem

like a huge leap to say that the voting system is unlikely to be the main factor in the margin of victory, as the following thought experiment shows: if the BPP was implemented today (with the proposed parameters), would it be surprising if no state in 2020 were to have a victory margin of less than 10 percent, considering there were 18 such states in 2016 and 17 in 2012? Of course, this is an untestable hypothesis, but it seems natural that the answer is *yes*: the method of voting should not have a particularly strong influence on the vote distribution, in particular considering the multitude of factors involved in voting decisions (e.g., [23]), coupled with the fact that voters are not necessarily rational (e.g., [75]). We therefore contend that there are some parameters for which historical data analysis gives a reasonably good proxy.

We remark that this type of data analysis has been routinely used in determining election policies (e.g., [62]). An example is the '40 percent rule'. Many proposals for U.S. Presidential election reform in which winning a plurality is sufficient to secure the presidency have a 40 percent threshold: if the winner receives less than 40 percent of the vote, there is a runoff election. The reason for this is that there has only been a single president, Lincoln, who won despite receiving less than 40 percent of the vote [7].

In order to approximate current voting trends, we would like to look at the voting spanning (roughly) the current generation. A generation is typically taken to be $20-30$ years; unfortunately the upper bound includes the elections of 1992 and 1996, in which there was an unusually strong third-party candidate, Ross Perot. Including these in the data would inject huge amounts of noise; attempting to accurately account for it would amount to little more than speculation. Therefore, we simply omit it, and concentrate on the five previous elections, $2000-2016$, for an approximation of current voting trends. The other time period we would like to focus on is the largest period where voting patterns would be correlated in some meaningful way with the current voting patterns. There are several milestones which would have hugely affected the voting patterns; arguably the most important is the invention of the radio, as this allowed candidates to address large portions of the population directly. The radio was invented in 1906. For aesthetic reasons, we also include 1900 and 1904, as this makes the number of elections analyzed a round 30. We note that this is without loss of precision: similar results are obtained when the number of elections analyzed is in the vicinity of $25-30$.

Appendix B Alternative transition order

#	States		5-Impact	Year	30-Impact	Year
1	Alaska	Delaware	0	2004	0.036036	1968
2	Connecticut	Oklahoma	0.015873	2012	0.043636	1920
3	Vermont	Wyoming	0	2008	0.037037	1968
4	Hawaii	South Dakota	0	2000	0.016129	1924
5	Montana	Rhode Island	0	2000	0.033058	1948
6	Mississippi	Oregon	0.016129	2012	0.038462	1968
7	Indiana	Washington	0.09375	2008	0.128	1900
8	Idaho	New Mexico	0.142857	2004	0.142857	2004
9	Louisiana	Maryland	0	2000	0.162162	1916
10	Alabama	Massachussetts	0.016949	2012	0.196078	1960
11	Kentucky	New Jersey	0.035294	2008	0.183486	1968
12	Maine	Utah	0.223256	2016	0.256075	1900
13	Georgia	Illinois	0.017857	2012	0.425	1960
14	North Dakota	West Virginia	0.153846	2000	0.153846	2000
15	California	Texas	0.087719	2012	0.340426	1948
16	Kansas	South Carolina	0.238095	2000	0.238095	1968
17	Arkansas	Missouri	0.4375	2000	0.4375	1916
18	Nebraska	Tennessee	0.866667	2000	0.866667	1916
19	Arizona	Minnesota	0.035714	2016	0.2	1948
20	Iowa	New Hampshire	0.056338	2012	0.258065	1968
21	Michigan	Virginia	0.19403	2012	0.19697	1988
22	Ohio	Pennsylvania	0.64	2016	0.64	1900
23	Colorado	Wisconsin	0.216216	2012	0.451613	1968
24	Nevada	North Carolina	0.636364	2000	0.941176	1968
25	Florida	New York	0.75	2016	0.941176	1960

Table B.1: An alternative transition order.