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Estimating Partisan Bias of the Electoral College Under Proposed Changes in Elector Apportionment

Abstract: In the election for President of the United States, the Electoral College is the body whose members vote to elect the President directly. Each state sends a number of delegates equal to its total number of representatives and senators in Congress; all but two states (Nebraska and Maine) assign electors pledged to the candidate that wins the state's plurality vote. We investigate the effect on presidential elections if states were to assign their electoral votes according to results in each congressional district, and conclude that the direct popular vote and the current electoral college are both substantially fairer compared to those alternatives where states would have divided their electoral votes by congressional district.

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1 Introduction

Every election seems to rekindle interest in possible reform of the unique Electoral College system used to elect the U.S. President. Under the Electoral College each state receives an electoral vote for each member in its Congressional delegation: one for each member in the House of Representatives and one each for its two Senators. There are a total of 538 electoral votes and a candidate needs a majority

of at least 270 electoral votes to win the election.[1] Most states allocate their electoral votes on a winner-take-all basis.

Proposals to change this arrangement within individual states are not uncommon. For example, in California prior to the 2008 presidential election a group advanced the "Presidential Election Reform Act" (Petition 2007), a proposed referendum for the state to change the mechanism by which its electoral votes are awarded. Following the method of Maine and Nebraska, rather than awarding all electoral votes to the winner of the plurality vote, only the two at-large electors in the state would be determined in this way, while the remaining electors (53) would be awarded to the winner in each of California's congressional districts. While ultimately the referendum did not qualify for the ballot, it is interesting to ask how this change would affect the presidential election.

What has clouded this specific initiative in controversy is the petitioner's connection to the Republican Party.[2] As California has voted for the Democratic candidate for President in every election since 1992, the likelihood of Democratic victories in near-future presidential elections has appeared large enough that the initiative can be viewed as a partisan effort to remove a Democratic advantage in the short-term.

What makes this more interesting is that other states might also be a target for this kind of electoral change. For example, a similar change was recently proposed for Pennsylvania by various Republican politicians, most notably State Senate Majority Leader Dominic Pileggi[3]; despite there being a Republican governor, and a Republican majority in both houses, the change was ultimately not approved. Among the reasons cited for its failure was the simple chance that the state could once again trend Republican in the near future, removing a gained advantage; another was the simple possibility that the state would lose attention and clout if fewer of its electoral votes were in play. Finally, there was the possibility that the change of focus to the Congressional district level for president would similarly affect other elections down the ticket, putting once-safe state-level seats into play again.

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1 Although there are total of 535 members of Congress, the District of Columbia gets three electoral votes under the 23rd Amendment of the U.S. Constitution even though it has no members of Congress.
2 Petitioner Thomas W. Hiltachk, the signed author of the proposal and representative of Californians for Equal Representation, is a partner of law firm Bell, McAndrews and Hiltachk, LLP, which has represented the California Republican Party.
3 See http://www.post-gazette.com/stories/local/state/change-proposed-for-states-electoral-vote-process-314523/ and http://fivethirtyeight.blogs.nytimes.com/2011/09/15/pennsylvania-electoral-college-plan-could-backfire-on-g-o-p/ for more background.

Recognizing that these sorts of factors would be present in many states, we wish to systematically examine how changes in the allocation of electoral votes would alter presidential elections. We do so by using historical elections to construct appropriate counterfactuals.

We begin by discussing several potential sources of bias in the Electoral College and defining several useful measures to quantify the partisan bias in the electoral system. We then examine the impact if California had adopted the Maine-Nebraska method, first on California itself, then on the entire presidential election process. We also examine a possible situation with reciprocity: whether Texas, a state that has consistently favored the Republican candidate for President, had also apportioned its votes similarly. What is most interesting, however, is to consider what would happen if the entire country were to allocate its electoral vote by Congressional district.

We recognize that many factors would change under such an occurrence – for example, rather than travel to states where the vote would be close, candidates would likely focus their efforts on highly competitive districts, perhaps in states where the total vote is seen to be solidly toward one candidate (see Katz, Gelman and King 2004). As this is a historical evaluation of a hypothetical system, we leave the debate of future changes in campaign strategies to others, and examine only the direct effects on the mapping of popular to electoral votes, ignoring any vote changes that would occur. We believe this is a reasonable first approximation given that any changes in strategies by the two sides should tend to cancel out and have little net effect on relative vote shares within districts or states.

1.1 Sources of Bias in the Electoral College

The choice of the Electoral College, as opposed to other proposed schemes to elect a chief executive, was made in 1787 at the Constitutional convention, primarily due to its two distinct characteristics: it allowed smaller states to wield additional electoral power, allaying fears that larger states would ignore federally significant interests; and it permitted slave states to add their non-free population to the total reckoning (giving each slave an electoral value of three-fifths that of a free person). While the latter of these adjustments disappeared with the prohibition of slavery, the former remains a concern.

The makeup of the Electoral College is proportional to the total number of representatives a state has in Congress. As each state has two senators regardless of population, smaller states have more power per capita in the Senate. This imbalance is diminished in the Electoral College, due to the addition of counting

proportionally elected representatives, but its presence is still a potential source of asymmetry.[4]

Each state is free to determine how to allocate its electoral votes, and alternative schemes have been used at different times. Until 1832, several states awarded electors on the basis of the plurality vote in each of a map of "electoral districts" drawn differently from congressional districts.[5]

Whether or not electors are assigned on a winner-take-all basis by each state, there is still the possibility of "wasted vote" bias, where voters for one candidate are disproportionately located in a small number of districts. If the vote were split evenly in this circumstance, the remaining districts would lean toward the other candidate, giving them an advantage: more of their candidate's voters would have influence in districts where the outcome is less certain. The implementation of the Maine-Nebraska plan would reduce this bias between states, but expose a new one within each state instead, as votes can now be wasted by district.

Implementing the Maine-Nebraska method in each state would have an effect dependent on the overall vote. A state whose voters are evenly split might not see a large change in the expected number of electors – just in the variance of the outcome, since now electors would be closer to evenly split rather than an equal chance that either candidate would win the whole slate. And a state with a high probability of voting for one candidate may see only minor changes if only a small fraction of congressional districts would give a plurality vote for the losing candidate. We expect that the greatest shift in votes would then be somewhere in between – a state leaning moderately towards one candidate but with great variation in its congressional districts.

2 Measures of Fairness: Symmetry and Partisan Bias

In elections between two dominant parties (where third-party votes may safely be disregarded), we consider as our most important measure the notion of partisan symmetry, as specified in (King and Browning 1987; Gelman and King 1990). In a two-party electoral system, suppose one party receives a particular share

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4 Another way to define the influence of states in the Electoral College is by comparing the empirical voting power, or the probability that an individual vote is decisive, in different states. Voting power varies greatly from state to state – for example, Utah is so far from the national median that voters there have almost zero chance of determining the national electoral vote winner – but, overall, voters in small states have slightly higher voting power; see (Gelman, King and Boscardin 1998).
5 Michigan enacted this system for the 1892 election, but removed it for the subsequent election in 1896.

of the total vote (V) and correspondingly receives a particular share of the total electors or seats in the body (S). If instead, in the same election, the other party had received a vote share V, then they must receive the same share of seats S that their opponents would have received.[6]

In essence, this definition suggests that in a symmetric system, the party labels would have no impact on the nature of the outcome. Partisan bias, therefore, is the property of an electoral system where symmetry is broken.

Since we can only observe one outcome of an election, this definition requires a framework that allows us to investigate hypothetical election scenarios for previous elections.

2.1 Evaluating Elections Using a Model for District-level Votes

As postulated in (Gelman and King 1994), we model one party's share of the two-party vote v_i in district i (of N total districts), as dependent on predictor variables and two sources of error: a systematic component, those variations that are characteristic of the system itself (typically, factors that deal with the true level of support, that do not include the election itself), and a random component, those variations that cannot be attributed to the system (such as those pertaining to the process of the election itself). We assume that the share of total error in each year attributed to systematic factors is constant. All together, this suggests that one election can be modeled as

$$v_i = X'_i \beta + \gamma_i + \varepsilon_i,$$

where X_i is a vector of predictors with coefficients β, γ_i is normal with mean 0 and variance $\lambda \sigma^2$, and ε_i is normal with mean 0 and variance $(1-\lambda)\sigma^2$. This implies that the total unexplained variance is σ^2, where λ is the systematic fraction of the total vote.

We use least squares estimates of β and σ^2. To estimate λ, the fraction of the vote attributed to systematic factors, we model several consecutive elections simultaneously. If two consecutive elections use the same electoral map (that is, a redistricting has not occurred), we model the later election using the earlier election as a predictor variable and save the coefficient value. That is, if there are elections at time $t-1$ and t, respectively, then the election outcome model is

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6 Proportional representation, a system in which S equals V by design, is a special case of partisan symmetry, but one that has no role in American elections.

$$v_{it} = v_{i,t-1}\alpha_t + X'_{it}\beta_t + \gamma_{it} + \varepsilon_{it},$$

and the mean of the α_t terms is our estimate for λ.

To investigate symmetry and partisan bias, we must estimate the results of the election when the mean vote is set at specified values. To accomplish this, we make the *generalized uniform partisan swing* assumption: For small deviations, a shift in the mean vote δ can be applied equally to each district in the system. Our simulation equation therefore takes the form

$$\bar{v}_i = X'_i\beta + \delta + \gamma_i + \widetilde{\varepsilon}_i$$

where $\widetilde{\varepsilon}_i$ are newly simulated errors and the y_i are the estimated systematic errors, given the observed vote v_i. [see Gelman and King (1994) and Gelman, King and Thomas (2008) for more information on this process]. To choose δ, the shift in the mean vote, we first calculate the observed mean vote (in this analysis, the average vote across all the congressional districts), then subtract it from the desired mean vote.

With these tools, we now have the means of calculating our useful quantities, which are functions of district votes and their results – whether individual districts and whole states give more votes to one of each major party candidate. Confidence intervals for quantities of interest are derived directly from simulations of the election using these estimates. Intervals are slightly conservative due to the use of fixed estimates of λ and σ^2, but minimally so given the large number of data points, 435 congressional districts in 14 consecutive presidential elections.

2.2 Measurements of Partisan Bias

We have several methods of determining whether symmetry in a system is violated. The choice depends on which quantity we choose to set as known. For this analysis, we fix the mean vote at 50%, and determine *partisan seat bias,* the difference in the share of seats between the two candidates' parties. If this is zero, symmetry is obeyed; if not, we have a measure of the bonus one party gets due to the configuration of the electoral map.

Alternatively, we can determine *electoral win bias* by setting a shift in votes so that each candidate has an equal chance of winning, as well as circumstances in which one candidate has a very high probability of winning. If the mean vote required for an equal probability of winning is far from equal for each candidate, symmetry is broken; this effect is especially noticeable if one candidate has a very high probability of victory while obtaining <50% of the mean vote.

For example, Figure 1 shows the measurements of each quantity for the 2004 presidential election between George W. Bush and John Kerry. Using generalized
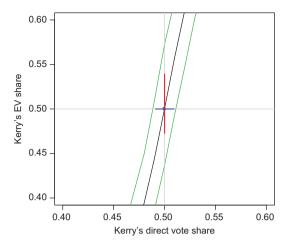
Figure 1: The electoral votes vs. direct vote curve for the 2004 presidential election. The black line is the mean fraction of electoral votes as a function of average district vote; green lines are the 95% interval for electoral votes. The red and blue bars are estimates of the mean partisan seat bias and mean electoral vote bias with respect to a symmetric outcome at (0.5, 0.5). In this election, neither of these bias estimates is statistically or practically significant, so that we judge the 2004 Electoral College to be symmetric for the two parties.

uniform partisan swing we can project the election results from their observed value over a narrow range including the 50% mark. The vertical bar at $\overline{V}$=0.5 represents the central 95% probability interval for the mean expected seats; as this bar clearly contains the 50% seat point, we conclude that the system does not have a statistically significant partisan seat bias. Given that the center of this interval is nearly at 0.5, our estimate of the partisan seat bias is practically negligible.

The horizontal bar at $\overline{S}$=0.5 represents the probability interval for Kerry having a 50% chance of winning the election with respect to the average vote. Since the 50% bar covers the point where the vote is split equally, we conclude that this system does not have an statistically significant electoral win bias. Similarly, the center of this interval is so close to 0.5 that the magnitude of any electoral win bias is negligible.

3 Evaluating California and the Country under the Maine-Nebraska Method

Before demonstrating what would happen if all states assigned its voters by the Maine-Nebraska method, we first look at California alone to reveal the magnitude

of the change conditioned on the state's (hypothetical) average vote. In this case, we are looking from a strategist's point of view: we do not know the exact mean vote of the outcome, but we do have an estimate of the population's underlying support. This allows us to set a single value of δ, though elections produced with this value will have slightly different mean votes from each other (which is a consequence of the random variation in each district).

Figure 2 indicates the consequences of this change for the 2000 election. The change in expected electoral votes is greatest between 1 and 3 percentage points on each side of an evenly split vote, diminishing slowly as a party's advantage increases. The maximum of effect is almost identical in each election year studied, suggesting that the distribution of voter preference is quite similar over time. At the observed level of support for the Democratic candidate over the past two decades, this corresponds to a gain of roughly 20 electoral votes for the Republican candidate in each election.

We have suggested that since California has recently been a reliably Democratic state, it should only adopt the Maine-Nebraska system if other large, reliably Republican states were to follow suit, in order to balance the outcome. However, it is evident from the non-linear nature of the effect that the notion of
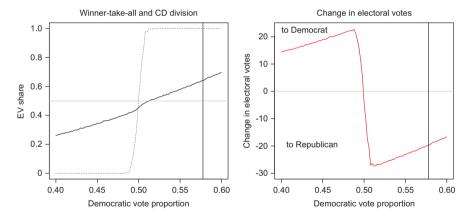

Figure 2: The change in electors if California had shifted to the Maine-Nebraska system in 2000 (other years are similar). Left figure: the fraction of California's electoral votes received by Democratic candidate Al Gore. The dotted line is under winner-take-all, solid is under the Maine-Nebraska system; the vertical line is the share of the of the direct vote actually received by Gore in the election, over 57%. Right, the difference between these two systems in total electoral votes, in red. The maximum gain for Republican candidate George W. Bush would be if Gore's true support was 51%, resulting in a gain of roughly 28 electoral votes; at the observed level of support for Gore, this is roughly an additional 20 electoral votes that would have been won by Bush.

"balance" would be difficult to accomplish, both politically and mathematically. Swing states whose results pivot about 50% each year would likely be unwilling to adopt the Maine-Nebraska system for fear of losing their influence; states that vote solidly for one party would have little to gain by the move for their party, despite the increased attention in their swing districts; and states who consistently vote for President opposite to their state legislatures are rare.

Under these conditions, the only large, single state that has voted the opposite way of California and had state legislatures opposite to their presidential vote is Texas (before the elections in 2002 and redistricting in 2003). We therefore measure the impact on the election for President in past years where California alone, as well as California and Texas, would have adopted the Maine-Nebraska system. We also consider what would happen if the entire country decided to switch over.

3.1 Examining the Entire Country

We model the outcomes of the Electoral College for each presidential election between 1956 and 2004.[7]

For this analysis, we assume that the popular vote total is known exactly at each point, though with as many congressional districts as are present in the United States (compared to California), the difference is negligible.

We measure both partisan seat bias and electoral win bias in four separate scenarios:
–   As they were originally held;
–   California adopting the Maine-Nebraska method;
–   California and Texas adopting the Maine-Nebraska method, and
–   Every state in the union adopting this method.

We demonstrate the overall trend in partisan bias only, in Figure 3; those for electoral win bias are comparable in their interpretation. Historically, neither

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7 The year 1968 is the only recent presidential contest where a major third-party candidate appears after the fact to have made a major impact on the properties of the election. We ought to consider the impact of shifting votes to and from George Wallace, who won five southern states and 46 electoral votes, but we do not have the model framework to do so; as a result, votes are only shifted between Hubert Humphrey and Richard Nixon. Results for this year are therefore more speculative than in all others. We also note that for Florida's electoral votes in 2000, third-party candidates Nader and Buchanan each had vote counts that were far more than the ultimate vote difference between candidates Bush and Gore, but far less than the effective uncertainty of this difference, so that their presence can be safely ignored for our purposes.

quantity has been noticeably different from zero since 1976. Before this year, three of the preceding four elections show a strong Democratic bias, but all in blowout years – 1956, 1964, and 1972 – where one party won the election decisively. Since the mean vote in all these cases is far from evenly split, we must question the validity of uniform partisan swing as an assumption in these cases, as well as in 1984, a landslide win for Ronald Reagan.

This is abundantly clear with the result in 1972, where the implementation of the Maine-Nebraska system in California would cause the Democrats to lose a partisan bias in their favor, despite losing California. In this year, Richard Nixon handily won the election, but won his home state of California by a smaller margin than the nation as a whole. Since partisan bias is measured at the point of equality, raising the mean vote to equality under uniform partisan swing would put California in the Democratic column, meaning that Democratic candidate George McGovern would expect to *lose* his hypothetical advantage there. However, the probability that the electorate in 1972 would split the vote evenly is so remote that this hypothetical situation is not worth seriously considering, confining us to deal with closer elections – in particular, each election starting in 1976 with the exception of President Reagan's blowout reelection in 1984 – so that uniform partisan swing is appropriate.

When we examine the system with California's adoption of the Maine-Nebraska method, we see several interesting features, first and foremost being the increasing bias towards the Republican candidates beginning in 1984, which has a high probability of being non-zero. Converting California would have a noticeable impact on the election; the Democratic candidate would need to exceed his Republican opponent by at least a full percentage point (50.5% to 49.5%) to have an equal chance of winning the election.

As the third panel of Figure 3 shows, adjusting for the introduced partisan swing by adding a Republican-trending state such as Texas mitigates the effect, though it is not eliminated. Converting all states to the Maine-Nebraska method, as shown in the fourth panel, does not make the system fairer; if anything, it entrenches a bias toward the Republicans and ensures the statistical significance of this bias. This is because each state assigns two electoral votes to the overall state winner in any event, and less populous states tend to vote for the Republican candidate.

4 Conclusions: Potential Reforms and their Effects

The preceding analysis suggests that under the concept of partisan symmetry, given the current positions of the states with respect to each other, if left
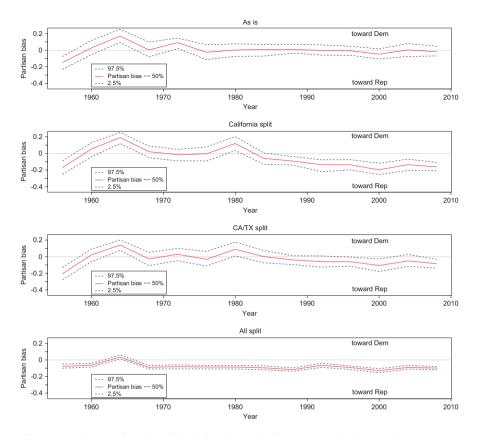
Figure 3: Estimates of partisan bias in the Electoral College over 14 elections as it was, as well as if electoral votes had been assigned by congressional district under several scenarios. The solid red line is the median estimate of partisan bias; dotted black lines denote the 95% confidence interval. Positive values indicate bias toward the Democratic candidate. Top: as the system currently is, partisan bias of the electoral college is statistically indistinguishable from zero since 1976. Second: if California was the only additional state to adopt elector assignment by congressional district. Third: if both California and Texas adopted this method. Bottom: if all states adopted this method. In each case in which California's electoral votes are divided by congressional district, there is a substantial partisan bias in favor of the Republican candidate.

untouched the Electoral College would continue to elect a candidate fairly – that is, with negligible partisan bias. Reforming the system by allocating electors on a per-district basis, while retaining the two at-large electoral votes in each state, would only reduce between-state wasted-vote bias. As long as the states retain their relative positions in terms of partisan support, the at-large elector bias remains, which has remained steadily Republican for at least the past twenty years and five presidential elections.

One mechanism for enacting this method, without affecting the overall result, has been proposed by (Lane 2008). Suppose that a number of states have outcomes that are strongly predisposed to one candidate over the others, and each candidate can "claim" an equal share of the electoral votes on this basis; for example, the Democratic candidate for California (55 EVs) and the Republican candidate for Georgia and Texas (16 and 38 EVs, respectively). It would then favor those states to mutually adopt the congressional-district electoral assignment mechanism for the sake of creating "interesting" races; that is, candidates would now be inclined to visit districts within states that would otherwise have been ignored in the national race. Indeed, then-Senator Obama's victory of Nebraska's second congressional district's elector in 2008, compared with Senator McCain's victory in all others including the statewide race, drew considerable media attention to what otherwise would have been unremarkable. This would of course introduce its own issues to contend with; for example, the gerrymandering of congressional districts in states with this mechanism in place would be additionally complicated by the new effect on the Presidential campaign (Thomas 2008).

Other proposals to neutralize the impact of the Electoral College involve the assignment of electors in each state to the national popular vote, to be introduced when a combination of states casting a majority of electoral votes adopt this plan in their legislatures. This approach is more likely to succeed across the country than individual implementations of the Maine-Nebraska plan partly because of its simplicity – whoever has the most votes countrywide wins – and also because the system will not destabilize with the addition of one new state at a time, unlike the piecewise adjustments under the adoption of the Maine-Nebraska system.

Each of these considerations reinforces the notion in our analyses that we are considering the fairness of the electoral system to the candidates from each party, not the fairness of the system to an individual voter. Voters in states that strongly favor one candidate might have plenty to gain by changing to a district-based method, if their districts are suitably competitive, just as voters in competitive states might have far less impact if they live in an uncompetitive district and this change were made. The concern of the power an individual voter has to change an electoral result, and how this power varies across the country, is the subject of future investigations.

References

Gelman, Andrew and Gary King (1990) "Estimating the Electoral Consequences of Legislative Redistricting," *Journal of the American Statistical Association* 85(410):274–82.

Gelman, Andrew and Gary King (1994) "A Unified Method of Evaluating Electoral Systems and Redistricting Plans," *American Journal of Political Science* 38(2):514–54.

Gelman, Andrew, Gary King, and W. John Boscardin (1998) "Estimating the Probability of Events That Have Never Occurred: When Is Your Vote Decisive?" *Journal of the American Statistical Association* 93(441):1–9.

Gelman, Andrew, Gary King, and Andrew C. Thomas (2008) "JudgeIt II: A Program for Evaluating Electoral Systems and Redistricting Plans." R Package. Available on CRAN.

Katz, Jonathan N., Andrew Gelman, and Gary King (2004) "Empirically Evaluating the Electoral College," Chapter 5, pp. 75–88, in *Rethinking the Vote: The Politics and Prospects of American Electoral Reform*. Ann N. Crigler, Marion R. Just, and Edward J. McCaffery, eds. New York: Oxford University Press.

King, Gary and Robert X. Browning (1987) "Democratic Representation and Partisan Bias in Congressional Elections," *American Political Science Research* 81(4):1251–73.

Lane, Randall (2008) "A Ballot Buddy System," *New York Times*, December 15, p. A35.

Petition to the Office of the Attorney General. July 17, 2007. (http://ag.ca.gov/cms_ pdfs/initiatives/2007-07-17_07-0032_Initiative.pdf).

Thomas, Andrew C. (2008) Reply to "A Ballot Buddy System," *New York Times*, December 22.