Are the Red states favored in the electoral college system?

(regularly updated for typos)

Máté Wierdl

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Contents

0 Executive Summary for those who are busier than they should be

The answer to the question in the title is *yes*. This is one point to the fans of the Blue team, but the game is not over yet. What if a Blue team fan complains *"The electoral college favors the big Red mountain states with small populations at the expense of the poor Blue states"*? Then I think this fan should stop saying this, since it's not true. Instead, start saying *"The electoral college favors the big Red mountain states but the small, North Eastern Blue states are favored more."* Does the Blue fan also complain *"The Blue states with large urban populations suffer under the electoral system."*? I think the fan should stop saying this half truth, too. Instead, the sentence should be completed as *"The Blue states with large urban populations suffer under the electoral system, but the Red states with large populations suffer more."*

Many people want to demolish the electoral system and decide elections by popular vote only. No doubt, a few "smart" people shouldn't be able to overrule the people's choice. On the other hand, big states shouldn't be able to push around small states the way they see fit.

Perhaps the following would work

1. Multiply the vote of each person by a factor (the "voting factor") that depends only on the population size of the state the voter is the resident of. For example, the vote count in the state with the smallest population (Wyoming) would be multiplied by 3 while the Californian votes would be taken as they

are, so the voting factor would be 1. The factor in Michigan would be somewhere between 1 and 3—perhaps 1.8.

2. The voting factor needs to be dynamic, which means it needs to be updated regularly so that all possible biases (like the "Red bias" we currently see) disappear.

1 What background does the reader need to understand these notes?

The reader has to understand the US electoral college system as it is explained in the first four paragraphs of

https://en.wikipedia.org/wiki/Electoral_College_(United_States).

The reader also needs to understand that in the US, the color Blue is associated with the Democratic party and the color Red is associated with the Republican party.

From mathematics, all is needed is to understand what it means to take the ratio of two numbers.

2 Introduction: the electoral system *is* rigged, but not where one would expect

I heard quite a few arguments against the "ancient" electoral college system, but I think two important ones don't hold water. One of them is

"Big, Red mountain states with small populations are favored by the US electoral system at the expense of Blue states."

which is usually accompanied by

"The Blue states with large populations suffer under the US electoral system, while the Red states are having a ball. "

In fact, both of these statements are *certifiably false*, as we will see. Yes, this means that exactly the *opposite* of the above two statements are true—though the drama needs to be toned down.

On the other hand, it does seem that the electoral system is rigged, and the problem seems to occur so consistently that it's difficult for the observer to think, it's accidental, though I am quite sure it *is* accidental.

I am not talking about the well known, crazy practice of giving all the electoral votes of a state to the winning candidate of the state even if the win was ensured only by a few votes. No, this is an almost uniform practice (only Nebraska and Maine are exceptions), and I don't think it can explicitly favor one state over another, or one party over the other. What I am talking about is a problem with the actual distribution of the number of electors among the states: the Red states get a better distribution, and this better distribution seems to occur consistently.

This is bad news, but there is good news. The change needed to make this bias disappear is (mathematically!) simple, namely, create a better, fairer distribution.

Since it really seems reasonable to also make sure, the vote of the states with small populations don't get completely nullified by the votes in large states, the following two-point scheme basically presents itself.

1. Multiply the vote of each person by a factor (the "voting factor") that depends only on the population size of the state the person lives in. For example, the vote count in the state with the smallest population (Wyoming) would be multiplied by 3 while the Californian votes would be taken as they are, so the voting factor would be 1. The factor in Michigan would be somewhere between 1 and 3—perhaps 1.8.

2. The voting factor needs to be dynamic, which means it needs to be updated regularly so that all possible biases (like the "Red bias" we currently see) disappear or get minimized.

3 The main course: the three groups of states

I think any statistics trying to examine the fairness of the electoral system considers, one way or another, the number of people per elector in a given state, in other words, how many people are represented by each elector. I refer to this ratio as the state's *electoral rate* or *electoral quotient*. So to calculate a state's electoral rate, I divide a given state's population P by the number of electors E in that state, so I take P/E. For example, if a state's population is 1 million, so $P = 1,000,000$, and it has 5 people in its electoral college, so $E = 5$, then that state's electoral rate P/E is

$$P/E = \frac{1,000,000}{5} = 1,000,000 \div 5 = 200,000. \tag{1}$$

The meaning of P/E is that each elector in this state represents 200 thousand people.

The smaller the electoral ratio P/E is, the more influence each person in the state has in the elections. We can and do say that in a state with small P/E ratio, people are in a *better* position in the electoral system, since their vote has greater weight during elections than those in a state with larger P/E ratio.

At the end of these notes, in chart 1, we can find a ranking of the 51 states based on their P/E ratio: states with small P/E are close to the top of the list, and states with large P/E are closer to the bottom of the list. For states around the top of the list, P/E is about 200,000 people (Wyoming 1st, Vermont 2nd) while close to the bottom, the ratio P/E is about 700,000 people (Florida worst, Texas 2nd worst). This is roughly a $1:3$ ratio between those states which are best and worst in the list.

What we do is we look at the ranking of the 51 states based on their P/E ratio, and we examine the states in the bottom third, the top third and middle third. We'll see that in the top or the bottom, the Blue states have clear advantage—contrary to the conventional wisdom. In the middle, the Red states completely compensate for what they lose in the bottom and top.

What we will also notice, quite surprisingly, that in every one of the groups the "group electoral rate" is lower for the Red states. More precisely, when we take the ratio of the total Red state population TP in a group and divide it by the total Red state electors TE in the group, the ratio TP/TE is less than the same ratio for the Blue states in that group. What we find is that that this TP/TE ratio is smaller for the Red states than for the Blue states in *all three groups*.

Incidentally, the *nationwide* electoral ratio is also favorable to the Reds. So if we divide the total US population who lived in Red states in 2016 by the total number of electors of the Red states then we get a smaller number than if we calculate the same ratio for the Blue states.

3.1 Populous Red states have it worse than the Blue ones

Let's see first that, in fact, the populous Red states have it worse than the populous Blue states. To this end, let us look at the bottom third—so the bottom 17 states—of the ranking according to the P/E ratio, so we look at the states with the 17 *highest* P/E ratio. I marked these states on a map which can be viewed here

http://wd369.csi.hu/apu/pic_elector_bottom.png

Here is the electoral rate P/E chart for this bottom group, with Indiana in the best position and Florida in the worst.

State	P/E
Indiana	601,789
Colorado	606,286
Missouri	608,367
Massachusetts	617,675
Michigan	620,161
Arizona	620,733
Georgia	638,429
New Jersey	639,858
Pennsylvania	640,125
Illinois	643,000
Virginia	644,846
Ohio	645,190
North Carolina	669,520
New York	682,613
California	711,724
Texas	722,871
Florida	723,974

So there are 7 Blue and 10 Red states in this group. Their total populations, as can be seen in chart 1, are as follows.

Total population of 10 Red states in the bottom third	122 million
Total population of 7 Blue states in the bottom third:	101 million
Difference (more in Red states):	21 million
Difference as a percentage of Blue population:	20%.

In other words, 101 million people live in Blue states that are in the bottom third of the electoral rate ranking versus 122 million people who live in Red states belonging to this group. The Reds have it worse, since 20 million more Red-state people have low weight in the elections than Blue-state people. We can also say that "the Reds have it 20% worse than the Blues in this bottom group".

We see that population-wise, the Red states are at a 20% a disadvantage in this group. How about elector-wise? What happens if we compare the total number of electors in this group?

Total number of electors in 10 Red states in the bottom third	183
Total number of electors in 7 Blue states in the bottom third:	151
Difference (more in Red states):	32
Difference as a percentage of Blue electors:	21%.

So, the number of electors shows similar differences to the population differences. What is notable here is that elector-wise, the Reds have 21% more electors than the Blues, while population-wise the Reds have only 20% greater population than the Blues.

In other words, the Red states in this group are slightly favored by the Electoral college. To quantify this, let us calculate the *group* electoral ratio for the Blue and Red states in this bottom group. We get this group ratio by dividing the total population by the total number of electors. For example, we calculate the average rate for the 10 Red states in this group by taking their total population $TP = 122$ million and divide it by the total number of electors $TE = 183$. Using more precise numbers from the chart 1, we get

Group electoral rate of 10 Red states in the bottom third:	665,945
Group electoral rate of 7 Blue states in the bottom third:	671,474
Difference (more for Blue):	5,529
Difference as a percentage of Red electoral rate:	0.8%.

Compared to what we are going to see in the other two groups, this 0.8% difference is small—but it's here, nevertheless.

3.2 Blue states with low population have it better than the Red ones

Let us now look at the top third, so the top 17 states, in the ranking according to their P/E ratio. We can view these states on the map here

http://wd369.csi.hu/apu/pic_elector_top.png

The actual P/E numbers are in this chart

State	P/E
Wyoming	195,369
Vermont	208,681
District of Columbia	224,076
Alaska	246,144
North Dakota	252,309
Rhode Island	264,075
South Dakota	286,156
Delaware	315,311
Maine	332,332
New Hampshire	332,652
Montana	344,316
Hawaii	357,901
West Virginia	368,826
Nebraska	379,238
Idaho	413,733
New Mexico	417,022
Nevada	481,808

So there are 9 Blue and 8 Red states in the top third of the elector rate list. Their total population is

Total population of 8 Red states in the top third	9 million
Total population of 9 Blue states in the top third:	12 million
Difference (more in Blue states):	3 million
Difference as a percentage of Red population:	32%.

In other words, 12 million people live in Blue states that are in the top third of the electoral rate ranking versus 9 million people who live in Red states belonging to this group. The Blues have it better, I'd say, since 3 million more Blue-state people have high weight in the elections than Red-state people. This difference in population is significant: it means 32% more people live in Blue states that are in this highest group than in Red states.

Elector-wise, we get

Total number of electors in 8 Red states in the top third	29
Total number of electors in 7 Blue states in the top third:	36
Difference (more in Blue states):	7
Difference as a percentage of Red electors:	24%.

What we see is that while the Blues have 32% greater population than the Reds, they only have 24% more electors. This suggests that the electoral college again favors the Reds, and this time we expect a greater Red bias than what we saw in the bottom group.

How much does the electoral system favor the Red states in this top group? Let us calculate the group elector rate TP/TE for this group as well

Group electoral rate of 8 Red states in the top third:	323,039
Group electoral rate of 9 Blue states in the top third:	343,555
Difference (more for Blue):	20,516
Difference as a percentage of Red electoral rate:	6.4%.

So the Reds' elector rate is 6% better than the Blues' in the top group.

3.3 Middle third: Red states have it much better than the Blue ones

Let us look at the final 17 states in the ranking of the states according to their elector rate P/E. We call this group the middle group. We can view these states on the map here

http://wd369.csi.hu/apu/pic_elector_middle.png

The actual P/E numbers are in this chart

State	P/E
Kansas	485,274
Arkansas	496,367
Mississippi	498,722
Utah	499,320
Connecticut	512,984
Iowa	520,650
Alabama	539,887
South Carolina	544,016
Minnesota	548,959
Kentucky	553,137
Oklahoma	558,763
Oregon	575,568
Wisconsin	577,134
Louisiana	583,841
Washington	597,529
Tennessee	600,027
Maryland	600,640

So there are 5 Blue and 12 Red states in the middle third of the state elector rate ranking. Their total population is

Total population of 12 Red states in the middle third	50 million
Total population of 5 Blue states in the middle third:	26 million
Difference (more in Red states):	24 million
Difference as a percentage of Blue population:	92%.

In other words, 26 million people live in Blue states that are in the middle third of the electoral rate ranking versus 50 million people who live in Red states belonging to this group. The Reds have it much better since 24 million more people in Red states have "middle" weight in the elections than people in Blue states.

We see that this 50 million is close to being *double* that of 26 million: 50 million is 92% more than 26 million.

Also, notable is the fact that this 24 million difference in this middle group is *basically equal* to the *combined* differences between the two colors in the top third and bottom third groups.

Elector-wise, we get

Total number of electors in 12 Red states in the top third	92
Total number of electors in 5 Blue states in the top third:	46
Difference (more for Red states):	46
Difference as a percentage of Blue electors:	100%.

What we see is that while the Reds have 92% greater population than the Blues, they have 100% more electors. This yet again suggests that the electoral college favors the Reds in this middle group as well.

How much does the electoral system favor the Red states in this middle group? Let us calculate the group elector rate TP/TE for this group as well

Group electoral rate of 12 Red states in the bottom third:	544,956
Group electoral rate of 5 Blue states in the bottom third:	571,439
Difference (more for Blue):	26,483
Difference as a percentage of Red electoral rate:	5%.

So the Reds' elector rate is 5% better than the Blues' in this middle group.

4 Summary and a bonus observation

4.1 What have we learned about the elector rate?

We have seen three quite surprising statistics just by looking at the simple idea of ranking the US states based on their elector rate and dividing the states into three groups based on this ranking.

1. While it is certainly true that the US electoral system favors states with small population, we cannot say anymore that the "Big" Red states with small populations have a clear advantage over the Blue states. We have seen in section 3.2, that the mostly North Eastern Blue states with small population, in fact, outnumber those living in the Big Red states by 3 million.

2. While it is certainly true that the US electoral system is unfavorable to states with big populations, we cannot say anymore that "Big Urban" Blue states suffer more in the electoral system than the Red states. We have seen in section 3.1 that during these 2016 elections, 21 million more people lived in Red states with big populations than in Blue ones.

3. The last observation we have made is that in each of the three groups we have considered, the Red states have a more favorable elector rate P/T. In the bottom group, this ratio is only 0.8% better for the Red states, but in the other two groups, the Red states are favored more significantly: over 6% in the top group and 5% in the middle group.

4.2 The nationwide electoral rate also favors the Red states

In connection with the last observation, I felt like calculating the *nationwide* Red and Blue elector rates. What I got was not surprising anymore: the Red states have a better overall ratio than the Blue ones by $4,441$. This $4,441$ is 0.7% of the Red elector rate P/T. To put this insignificant looking 0.7% into perspective: in this 2016 election year, Clinton won the popular vote by a smaller margin: by less than 0.6%.

4.3 Bonus calculation: the electoral system meant 8 million extra Red votes

As a farewell bonus task, I thought it would be interesting to add some numbers to the claim that says something like

"The electoral vote was significantly different from the popular vote this year."

What we know is that though Clinton won the popular vote, the vote counts of the two candidates were roughly the same—less than 1% difference. On the other hand, the total number of Red electors is 304 while the total number of Blue ones is 233. The difference is 71 which is 30% of the number of Blue state electors. That's quite an astonishing percent, isn't it?

What does this 30% mean if we translate it to voting population? Well, this year, the total number of voters was 120 million. If we divided up this 120 million the same way the 535 electoral votes got divided, Trump would get 68 million votes and Clinton would get 52 million votes. Instead, each candidate got about 60-60 million votes. We can say, the electoral system added an extra 8 million votes to Trump and took away 8 million votes from Clinton.

To appreciate this 8 million votes, note that only 3 states turned out more than 8 million voters: California (8.5 million), Florida (9 million), Texas (8.4 million).

5 Possible and existing problems with my claims

1. Instead of full state populations, I probably should have done the calculations with the number of people in a state with the right to vote. My feeling is, those numbers are not easy to produce, but perhaps their good approximations exist. Would I have gotten similar conclusions?

2. I didn't consider the effects of the two states that actually tried to do the right thing by splitting the electoral votes between the two candidates. I just wanted to see the big picture simply. I doubt the conclusions would have changed with taking this into consideration.

State	P/E	P	E	P. Total	E. Total	TP/TE
Wyoming	195,369	586,107	3			
Vermont	208,681	626,042	3			
District of Columbia	224,076	672,228	3			
Alaska	246,144	738,432	3			
North Dakota	252,309	756,927	3			
Rhode Island	264,075	1,056,298	4			
South Dakota	286,156	858,469	3			
Delaware	315,311	945,934	3			
Maine	332,332	1,329,328	4			
New Hampshire	332,652	1,330,608	4			
Montana	344,316	1,032,949	3			
Hawaii	357,901	1,431,603	4			
West Virginia	368,826	1,844,128	5			
Nebraska	379,238	1,896,190	5			
Idaho	413,733	1,654,930	4	9,368,132	29	323,039
New Mexico	417,022	2,085,109	5			
Nevada	481,808	2,890,845	6	12,367,995	36	343,555
Kansas	485,274	2,911,641	6			
Arkansas	496,367	2,978,204	6			
Mississippi	498,722	2,992,333	6			
Utah	499,320	2,995,919	6			
Connecticut	512,984	3,590,886	7			
Iowa	520,650	3,123,899	6			
Alabama	539,887	4,858,979	9			
South Carolina	544,016	4,896,146	9			
Minnesota	548,959	5,489,594	10			
Kentucky	553,137	4,425,092	8			
Oklahoma	558,763	3,911,338	7			
Oregon	575,568	4,028,977	7			
Wisconsin	577,134	5,771,337	10			
Louisiana	583,841	4,670,724	8			
Washington	597,529	7,170,351	12			
Tennessee	600,027	6,600,299	11	50,135,911	92	544,956
Maryland	600,640	6,006,401	10	26,286,209	46	571,439
Indiana	601,789	6,619,680	11			
Colorado	606,286	5,456,574	9			
Missouri	608,367	6,083,672	10			
Massachusetts	617,675	6,794,422	11			
Michigan	620,161	9,922,576	16			
Arizona	620,733	6,828,065	11			
Georgia	638,429	10,214,860	16			
New Jersey	639,858	8,958,013	14			
Pennsylvania	640,125	12,802,503	20			
Illinois	643,000	12,859,995	20			
Virginia	644,846	8,382,993	13			
Ohio	645,190	11,613,423	18			
North Carolina	669,520	10,042,802	15			
New York	682,613	19,795,791	29			
California	711,724	39,144,818	55	101,392,606	151	671,474
Texas	722,871	27,469,114	38			
Florida	723,974	20,271,272	28	121,867,967	183	665,945

Table 1: The full ranking based on the electoral rate P/E

6 Printable version, original calculations

Here is a weblink to the PDF version of this document

http://wd369.csi.hu/apu/electoral.pdf

Here is the Excel file containing the data and my calculations, including the formulas.

http://wd369.csi.hu/apu/vote2016.xlsx

Note that the voting data is approximate and correspond to those avaiable on Nov 9, 2016. But I didn't use the actual vote counts anywhere except when I said that about 60-60 million people voted for each candidate.