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26 July 2017

Math 190s

Electoral College Strategy

Introduction:

Conventional wisdom often clouds presidential candidates' strategies. Too often do candidates trap themselves in the triangle of Ohio, North Carolina, and Florida. Misguided political pundits mislead the public by asserting "Ohio and Florida *always* decide the election!". Heuristics like these distract from the deeper math involved with strategizing in a campaign. Do these states truly matter? Yes, they do, but the degree to which they do varies from campaign to campaign and from election to election. Ohio may matter for a candidate like Donald Trump, but it did not matter as much for Hillary Clinton. Conversely, Virginia mattered for Hillary but not as much for Trump. What gives? A candidate can incorporate a number of different outlooks in his calculation of strategy: partisan lean in states, elasticity of states, tipping-point probabilities, and the game theory implications of misleading the opponent. In order to maximize the chance of victory, candidates must abandon the punditry and embrace the statistics.

Section I: Structure of Electoral College

Unlike many other democracies and republics, the United States does not elect its leader – the president – with a popular vote. Instead of having one national election, the fifty states and the District of Columbia have separate elections. Each state gets a number of points equal to the number of members it has in the House and Senate[1].

A state's government has the power to decide how to select the candidate for whom the state's Electors vote. Typically, if a candidate wins the popular vote in a state, then s/he wins *all* the electors in the state[2]. However, Maine and Nebraska split Electors by congressional districts: Maine and Nebraska. Vacationland and the Cornhusker State award one point for each congressional district a candidate wins and the extra two points to whomever wins the statewide popular vote.

These values represent more than just symbolic points. Electors are actual people! The state organizations for each party usually choose the people who will serve as Electors before the election[8], and they typically hold state political positions or have influence in the state party.

A candidate must earn at least 270 electoral votes – a majority – to become president, but with a deadlock, no candidate reaches this threshold. The two major party candidates could have a 269 to 269 split. The Twelfth Amendment – ratified on June 15, 1804 – prescribes a solution to this improbable but problematic possibility: The House would decide the president. Each state delegation in the House gets only one vote, so California – a state with 53 representatives – gets the same number of votes as Wyoming – a state with 3 representatives. The members of these state delegations select from the top three Electoral vote winners.

Section II: The Number of Combinations of Outcomes in the Electoral College

In order to determine the most effective Electoral College strategy for a presidential nominee, first the campaign needs to analyze the sample space for Electoral College outcomes. Forty-eight states and D.C. have winner-take-all methods of awarding votes. It will be assumed only either a Democrat or Republican can win a state thereby making every statewide election a binary outcome. Therefore, the outcomes of the elections in 48 "normal" states and D.C. can shake out in 4,503,599,627,370,496 ways or 2^{49} ways.

What happens when the problem factors in the oddballs of Maine and Nebraska? Nebraska has 4 presidential elections within it: the statewide one that awards 2 electoral votes and the 3 races in each congressional district, which award 1 vote each. The same math holds true for Maine, which has 3 races within it. Let N_{NE} represent the number of outcomes of the 4 elections in Nebraska, and let N_{ME} represent outcomes of the 3 elections in Maine. Calculating 2^3 and 2^4 would be sufficient if the outcomes of each election in Nebraska and Maine were independent, but in an election between Candidate A and Candidate B, the following 4 outcomes *cannot* occur in these states:

1. Candidate A **cannot** win Maine's 2 at-large votes **AND** lose Maine's 2 congressional districts.
2. Candidate A **cannot** lose Maine's 2 at-large votes **AND** win Maine's 2 congressional districts.
3. Candidate A **cannot** win Nebraska's 2 at-large votes **AND** lose Nebraska's 3 congressional districts.
4. Candidate A **cannot** lose Nebraska's 2 at-large votes **AND** win Nebraska's 3 congressional districts.

These 4 events can never occur because if a candidate wins either a majority or plurality in all of a Maine's congressional districts, then he *must* win the at-large votes in Maine. The same logic extends to Nebraska, but a candidate *can* win only one congressional district in one of these states and then proceed to win the entire state if his margins are high enough in the one district.

Due to the symmetry of binary events, the events that cannot occur for Candidate B do not have to be counted. In other words, if Candidate A wins Maine's 2 at-large votes **AND** loses

Maine's 2 congressional districts, the Candidate B will lose Maine's 2 at-large votes **AND** win the two congressional districts. The outcome for Candidate B is *also* impossible. This logic extends to the other three enumerated impossible events.

Now, the number of outcomes in Maine and Nebraska can be calculated.

$N_{\mathrm{NE}} = 2^4 - 2 = 16 - 2 =$ **14 possible outcomes in Nebraska**

$N_{\mathrm{ME}} = 2^3 - 2 = 8 - 2 =$ **6 possible outcomes in Maine**

It is time to incorporate these values with the figure for D.C. and the 48 normal states.

$N_{\mathrm{USA}} = (N_{48\,+\,\mathrm{DC}})\, N_{\mathrm{NE}} \times N_{\mathrm{ME}} = 2^{49} \times 14 \times 6 =$

47,287,796,087,390,208 possible combinations in the Electoral College

These calculations determine the number of ways that the Electoral College can apportion its votes, but how many ways can a candidate actually reach the threshold of 270 electoral votes?

Section III: How Many Ways Can a Candidate Reach 270 Electoral Votes?

As stated previously, in a binary election, if Candidate A wins Florida, then Candidate B must *lose* Florida. This notion may seem simple, but this basic axiom leads to important conclusions.

Let $\mathrm{NW_A}$ represent the number of ways Candidate A reaches 270, and $\mathrm{NW_B}$ represent the number of ways Candidate B reaches 270. Because the outcome in a single state is binary and that the outcomes in each state are symmetrical, we can assume $\mathrm{NW_A} = \mathrm{NW_B}$, but how can we assign actual values to $\mathrm{NW_A}$ and $\mathrm{NW_B}$?

Let $\mathrm{N_D}$ represent the numbers of ways a deadlock can occur in the Electoral College. $\mathrm{NW_A} + \mathrm{NW_B}$ accounts for all combinations in the Electoral College whereby one candidate wins 270 votes. The only other way the Electoral College can apportion its votes is in a 269-269 split. Therefore,

$$N_{USA} = NW_A + NW_B + N_D$$

Substitute N_{USA} for 47,287,796,087,390,208. Substitute NW_A for NW_B.

$$47{,}287{,}796{,}087{,}390{,}208 = 2\times NW_A + N_D$$

Due to the astronomical size of the number of elections outcomes, a normal computer cannot iterate through all outcomes in a reasonable amount of time. However, a computer program can run a large number of randomly simulated elections, in which either candidate has a 0.5 chance of winning each state and EV-producing district (the District of Columbia, Nebraska's congressional districts, and Maine's congressional district). One can then construct a confidence interval based upon the proportion of times that a candidate reaches 269 electoral votes.

```
00110011100011101101011101101000111011100100101001111100
7580
998350

01100000111011111110101100010001000111011110011010100100
7581
998525

11010001000010011010010010101110001101111110100001111101
7582
998560

10110000110001000010101110001110111111010110101000000010
7583
998603

10001001001101000111111111111010100000001010001111101100
7584
998672

01101010001001110111001111010001010011000111011011110101
7585
998806

00111101010111110100101011000001001010011100001010100001
7586
998946

10010011000111010100111111100000000101101000111100110110
7587
999086

00010111010111100101111001001111110010000111101101111101
7588
999144

10000101111100100000110011111101101101111000011000000011
7589
999218

01010101101101010011010101011011100100100001110001001011
7590
999604

10011011100110000100011010100100110110001101110000100100
7591
999947

Mean: 269.081788 Stdev: 50.80132154505791
```

Java program was written for this essay that performs such a task, and the image to the left displays the last portion of its output. In the groupings of the three lines of output, the first line contains a 56-character long `String` with only `'0'` or `'1'` at each index. Each of the character of that binary represents symbolizes either a victory – `'1'` – or a loss – `'0'` – in each state. The characters represent the states and EV-producing districts in decreasing order of number of electoral college votes, so the character at index 0 represents California, which has highest number in the nation at 55 electoral votes. Index 49 represents Nebraska's 2 at-large votes. Index 50 represents Maine's 2 at large votes. Indexes 51 to 53 represent Nebraska's congressional districts, and indexes 54 and 55 represent Maine's congressional districts.

The program randomly generates this binary string by generating a pseudorandom `long` value – the primitive type in Java that represents integers of extremely large values[21]. Usually, one would represent an integer in Java with type `int`. However, type `int` only has a maximum value of 2^{31}-1, and the binary number in that `String` represents a maximum value of 2^{56} - 1. The type `long` has a maximum value of 2^{63}-1, so it suffices for the needs of this program.

Firstly, the program randomly generates a `long` from the interval $[0, 2^{56})$. It then converts this value to base 2 and converts that value to a `String`. A `for` loop then adds leading zeros if necessary in order to make the length of the `String` 56 digits long. If the randomly generated 56-digit long binary number contains one of the aforementioned prohibited, impossible outcomes in Maine or Nebraska, then the program randomly reselects another number until it attains a possible outcome.

Once the program has generated this 56-digit binary representation of the outcome of an election, a function iterates through each digit. If the digit is 1, then it adds the number of electoral votes in that state or EV-producing district to the candidate's running total number of the electoral votes from that simulation.

The previously shown screenshot of the program's output has groupings of three lines. Every time a simulation yields a deadlock, it increments a running total of the number of deadlocks during the 1,000,000 election simulations. Additionally, the program then prints:

1. The binary representation of the election simulation that yielded that deadlock
2. The total number of deadlocks thus far
3. The number of simulations that have occurred

At the end of the one million simulations, the program prints out the number of deadlocks in the simulation. This specific simulation reached 7591 deadlocks. The program prints out the mean of all the number of electoral votes the candidate won in each of the million simulations, and it prints out the standard deviation of those totals. In the simulation show, the sample had a μ value of 269.082 votes and a σ value of 50.801 votes.

From this point, one can construct a 99% confidence interval[11] (this footnote can direct somebody who does not know about confidence intervals to a Penn State website that explains the basics of them.) Let $\hat{p}$ represent the sample statistic. The sample statistic equals the proportion of deadlocks in the sample of the 1,000,000 simulations. Therefore,

$$\hat{p} = \frac{7951}{1000000} = 0.007951$$

One cannot accurately find the number of deadlocks in the Electoral College by multiplying $\hat{p}$ by the 47.3 quadrillion figure. Because this proportion was achieved by analyzing a sample of 1,000,000 from a population of 47.3 quadrillion, due to sampling error, it may not actually be the true proportion of combinations in the Electoral College that are deadlocks.

A confidence interval allows one to construct an interval of proportions in which the true population proportion is. A 99% confidence interval means that with 99% certainty, one can deduce that the interval contains true proportion. The following equation constructs a confidence interval where n is the size of the sample and z^* is the multiplier. Each level of confidence has a different z^* value. For 99%, z^* equals 2.576.

$$\hat{p} \pm z^{*}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

Substitute for *z** for 2.576, $\hat{p}$ for 0.007951, and *n* for 1,000,000

$$0.007951 \pm 2.576\sqrt{\frac{0.007951(1-0.007951)}{1{,}000{,}000}} = [0.007722, 0.008180]$$

With 99% certainty, one can deduce that the true population proportion of Electoral College combinations that are deadlocks is on the interval from 0.007722 to 0.008180.

In order to find the number of deadlocks in the population, one can multiply the bounds of that interval by 47.3 quadrillion.

Lower bound of number of deadlocks = 0.007722 • 47,287,796,087,390,208 =

365,166,634,130,326 or 365.2 trillion

Upper bound of number of deadlocks = 0.008180 • 47,287,796,087,390,208

386,803,899,251,352 or 386.8 trillion

Therefore, with 99% certainty, one can conclude the true number of deadlocks is between 365.2 trillion and 386.8 trillion. These two values can now be substituted into the following equation:

$$47{,}287{,}796{,}087{,}390{,}208 = 2\times NW_{A} + N_{D}$$

Let NW_{ALB} represent the lower bound of number of wins for Candidate A and NW_{AUB} represent the lower bound of number of wins for Candidate A. To find NW_{ALB}, one would substitute N_D for the upper bound of the number of deadlocks.

$$47{,}287{,}796{,}087{,}390{,}208 = 2\times NW_{ALB} + 386{,}803{,}899{,}251{,}352$$

$$NW_{ALB} = 23{,}450{,}496{,}094{,}069{,}428$$

To solve for NW_{AUB}, substitute N_D for the lower bound of deadlocks.

$$47{,}287{,}796{,}087{,}390{,}208 = 2\times NW_{AUB} + 365{,}166{,}634{,}130{,}326$$

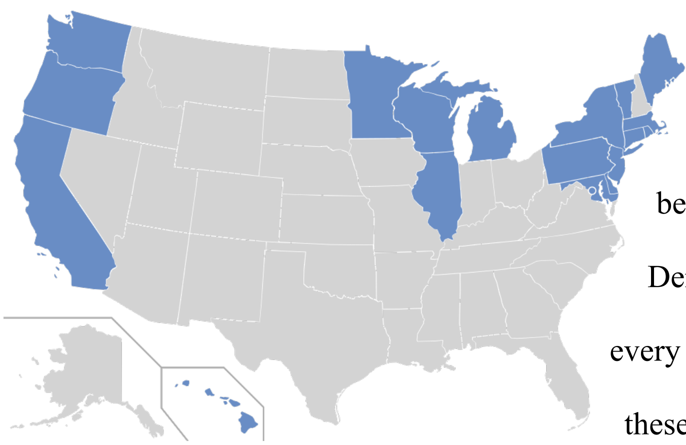
$$NW_{AUB} = 23{,}461{,}314{,}726{,}629{,}941$$

Therefore, with 99% certainty, one can deduce that the true number of ways for a candidate to win 270 votes lies on the interval [23.450.496.094.069.428, 23.461.314.726.629.941].

Section IV: How to Mathematically Define a Swing State

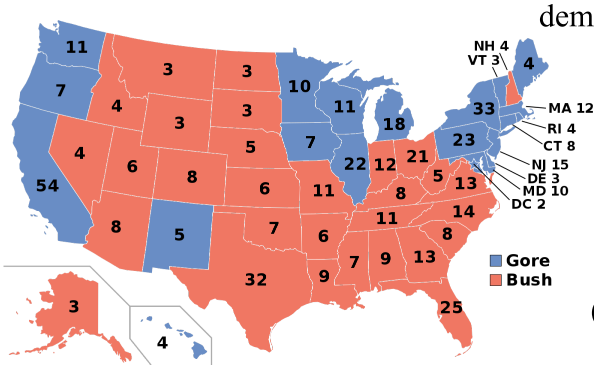
As a candidate, it does not make sense to analyze the campaign's approximately 23.5 quadrillion possibilities to win 270 votes. The vast majority of these outcomes have a near zero probability of occurring. Maryland has an extremely low chance of voting for a Republican nominee, and Oklahoma has an extremely low chance of voting for a Democratic nominee. Only a few states have a decent chance of voting for either candidate. Political analysts typically call these states "swing states". Usually, candidates spend most of their resources and time campaigning in these states.

Different experts and metrics disagree on how to define swing states. Until Election Day



2016, the conventional wisdom has agreed on a "Blue Wall" (displayed below[12]) – a group of states that the Democratic presidential nominee had won in every election[13] between 1992 to 2012. Winning these states awards the Democratic nominee a solid cushion of at least 242 electoral votes. Just winning Florida would put the Democratic nominee over the 270-vote threshold – consequently creating an obvious Electoral College advantage for the Democrats.

However, such a heuristic does not hold up mathematically. It wrongly assumes that the demographics and political opinions of the populations of these states stay static throughout history. This logic leads to candidates to ignore states that they take for granted. During the 2000 election (Electoral map shown to the left[28], Vice President Al Gore ignored his home state of Tennessee[14], and Governor George W. Bush of Texas won the state's 11 electoral votes. If Gore had won his home state, he would have become president, and Clinton's vice president would not have had to conduct a recount in Florida.



In 2016, Hillary Clinton did not visit Michigan until the day before the election[26], and she did not visit Wisconsin at all during the general election[27]. For the first time since 1984, Trump made these "Blue Wall" states red. Even if Clinton campaigned and spend money in these two states, she may have still not won them, but spending more effort in them definitely would not have hurt.

After each election, *The Cook Political Report* calculates the partisan lean for every state and U.S. House district with a value called the "Cook Partisan Voter Index"[18] or "Cook PVI". It takes into account the past two presidential elections. To calculate the Cook PVI for a specific state, one performs the following steps:

1. **Find each major party candidates' share of the major party national popular vote for the past two elections.** For example, in 2016, Clinton received 48.2% of the popular vote, and Trump received 46.1%. When one converts these percentages to just national popular vote for only two parties, Clinton received 51.1%, and Trump received 48.9%.

2. **Calculate the partisan lean in percentage points for the last two elections.** In 2012, Obama received 52.0% of the major party popular vote, so the national vote leaned to the Democrats by 2.0 percentage points. In 2016, the national electorate leaned to the Democrat Hillary Clinton by 1.1% percentage point.
3. **Average these partisan leans.**
4. **Repeat steps 1-3 for each state and District of Columbia.**

A PVI is represented as first by the “R” or “D”, which represents which party has dominance in the state, and then a plus sign with the number of points the state has leaned in that direction on average (rounded to the nearest whole number). For example, Arizona has a Cook PVI of R+5. If a state’s lean is on the interval (D+0.5, R+0.5), then its PVI is “EVEN”.

The Cook Political Report defines a “competitive” House district as one that has a PVI on the interval [D+5, R+5], so one can reasonably extend this interval to entire states. Using the Cook and Silver PVIs, the following states have PVIs on this interval:

1. Oregon (Cook = D+5; Silver = D+5)
2. New Mexico (Cook = D+4; Silver = D+4)
3. Maine (Cook = D+3; Silver = D+2)
4. Colorado (Cook = D+1; Silver = D+1)
5. Nevada (Cook = D+1; Silver = D+1)
6. Virginia (Cook = D+1; Silver = D+1)
7. Minnesota (Cook = D+1; Silver = EVEN)
8. Michigan (Cook = D+1; Silver = EVEN)
9. New Hampshire (Cook = EVEN; Silver = EVEN)
10. Wisconsin (Cook = EVEN; Silver = R+1)
11. Pennsylvania (Cook = EVEN; Silver = R+1)
12. Florida (Cook = R+2; Silver = R+2)
13. Ohio (Cook = R+2; Silver = R+4)
14. Iowa (Cook = R+2; Silver = R+4)
15. North Carolina (Cook = R+3; Silver = R+3)
16. Georgia (Cook = R+5; Silver = R+4)
17. Arizona (Cook = R+5; Silver = R+4)

In the 2020 election, either party's nominee could conceivably win one of these 16 states based on the measures of PVI. Georgia has not voted for a Democratic nominee since Governor Bill Clinton of Arkansas in 1992, and Arizona has not voted for one since President Clinton in 1996. However, an aggressive Democratic candidate would spend resources in Arizona and Georgia in 2020. Conversely, a Republican nominee would not take the Grand Canyon and Peach States for granted.

As for the Republicans, Oregon has not voted for a Republican nominee since President Ronald Reagan in 1984, and Maine has not given *all* of its electoral votes to one since Vice President George H.W. Bush in 1988. However, an aggressive Republican nominee would at least spend *some* resources in Vacationland and the Beaver State. Conversely, a Democratic nominee should not take these two states for granted.

Unfortunately, a presidential candidate only has so much money to spend on advertising and surrogates in a state, and s/he can only go to one or two cities in a day. How do nominees effectively and efficiently allocate their limited resources to maximize their electoral vote reward?

Section V: State Elasticity

Not all swing states are equal. Some are “swingier” than others. During the 2012 election, Nate Silver introduced a new metric for the ease with which the presidential popular vote in a state swings: state elasticity[21]. This concept draws similarity from the economic concept of the elasticity of a good in the marketplace. An inelastic state has an elasticity less than 1, and an elastic state has an elasticity greater than 1. An elasticity score of 1.24 – as Hawaii does -- means that a candidate would need to increase his popular vote of by 1 percentage point in order to expect an increase in the popular vote in Hawaii by 1.24 percentage points. Therefore:

State	Elasticity	State	Elasticity
Rhode Island	1.29	Michigan	1.03
New Hampshire	1.28	Wyoming	1.03
Maine	1.27	California	1.02
Hawaii	1.24	Nebraska	1.02
Vermont	1.22	Kentucky	1.01
Alaska	1.19	Arkansas	1.01
Massachusetts	1.19	Minnesota	1.01
Iowa	1.17	Missouri	1.01
North Dakota	1.17	Tennessee	1.01
Colorado	1.16	Utah	1.01
Oregon	1.16	Illinois	1.00
West Virginia	1.15	Texas	1.00
New Mexico	1.15	Indiana	0.99
Washington	1.13	Delaware	0.98
Arizona	1.13	Virginia	0.95
Montana	1.12	Oklahoma	0.93
Wisconsin	1.10	Pennsylvania	0.93
South Dakota	1.10	North Carolina	0.92
Nevada	1.08	New York	0.90
Ohio	1.07	Maryland	0.90
Kansas	1.07	Georgia	0.85
New Jersey	1.06	Louisiana	0.79
Idaho	1.06	South Carolina	0.72
Connecticut	1.06	Alabama	0.67
Florida	1.05	Mississippi	0.63
		District of Columbia	0.45

$$\boldsymbol{state\ elasticity} = \frac{\Delta\,\%\ in\ popular\ vote\ in\ state}{\Delta\,\%\ in\ national\ popular\ vote}$$

If one looks at the chart above with each state’s elasticity score, one might find it surprising that North Carolina has a low elasticity score. Does the media not incessantly talk about the Tar Heel State serving as a crucial swing state every election? Why does Rhode Island have highest elasticity score? Does the Ocean State not reliably vote for the Democratic nominee in presidential elections?

Elasticity does not necessarily mean that a state historically oscillates between the Democratic and Republican nominees in presidential elections. It means that a high proportion of swing voters in the state. Nate Silver identified several demographic factors that influence whether a voter is a swing voter or not. A swing voter tends to not have African-American heritage. The African-American population has reliably voted for Democrats[22] since President Franklin Roosevelt implement the New Deal between 1933 and 1937, which gave resources to many black areas in the United States. No Democratic presidential nominee has received below 82% of the African American vote since President John F. Kennedy received 68% in 1960. A white swing voter tends to not have strong devotion to an Evangelical Christian faith as this demographic has historically supported Republican nominees[23]. A swing voter also likely does not have registration with the Democratic Party or Republican Party as 90% registered members of the two major parties typically vote for the nominee of their parties in presidential elections.

These indicators explain why Rhode Island has the highest elasticity. Rhode Island has a large share of non-party-affiliated voters, but of the party-affiliated voters, Rhode Island has many more registered Democrats than registered Republicans. As of January 27, 2016, registered Democrats comprise 38.97% of the Rhode Islander electorate. Registered Republicans represent 10.34%[24].

The idea of elasticity does not change the states a campaign should campaign, but it can identify which demographics a candidate should target in a state. Highly elastic competitive states include Maine, Oregon, Colorado, Iowa, New Mexico, Wisconsin, and Arizona. In these states, a candidate should mostly target the "swing voters", which typically includes non-party-affiliated, non-black, non-Evangelical voters. More specific target areas could include rural, northern Maine, eastern Oregon, and suburbs in Denver, Phoenix, and Milwaukee. Targeted rhetoric is crucial in these states. Trump delivered a nativist economic message, so he performed well and won Maine's rural 2nd congressional district and Wisconsin – two areas where globalism has hurt the industrial economy. However, Trump paid a price for this rhetoric that promoted a border wall between the U.S. and Mexico. Clinton could impugn Trump and perform well with moderate Latinos in Colorado and New Mexico.

		Partisan Lean				
		Strong Dem	Lean Dem	Swing	Lean GOP	Strong GOP
Elasticity	Elastic	HI, MA, RI, VT	ME, OR, WA	CO, IA, NH, NM, WI	AZ, MT	AK, ND, SD, WV
	Average	CA, CT, IL	NJ	FL, MI, MN, NV, OH	MO	AR, ID, KS, KY, NE, TN, TX, UT, WY
	Inelastic	DC, DE, MD, NY		NC, PA, VA	IN, GA	AL, LA, MS, OK, SC

Highly inelastic competitive states include North Carolina, Pennsylvania, Virginia, and Georgia. In these states, candidates need to get their base to turn out to vote. Republican nominees should focus on conservative Evangelical whites or wealthy whites in these states in the affluent suburbs of Charlotte, Philadelphia, northern Virginia, and Atlanta and Evangelical voters in the rural parts of these states. Democrats should focus on African-American voters in these states and the liberal white voters in the Research Triangle – a triangular region of North Carolina bounded by Duke University, University of North Carolina at Chapel Hill, and North Carolina State University[60].

In moderately elastic or inelastic competitive states of Florida, Michigan, Minnesota, Nevada, and Ohio. A candidate needs to do a medley of the persuasion strategy and promoting strategies. Of course, in every state, a candidate should a bit of both strategies.

High elasticity scores also mean highly ambitious Republicans could try to make inroads in highly elastic liberal states, such as Hawaii, Massachusetts, Rhode Island, Vermont, and Washington, and highly ambitious Democrats could try to make inroads in Montana, Alaska, North Dakota, South Dakota, and West Virginia. Statistics and past victories say that the parties could campaign in these states, but the conventional wisdom of the prototypical swing states of Ohio and Florida often preclude a candidate from pushing the boundaries.

Section VII: Tipping Point States

When people look at the number electoral votes for each swing state, they may assume Florida has the most significance *because* of its large prize of 29 electoral votes. The Sunshine State had an argument for the highest importance during the 2016 election but for a different reason.

Election analysts have recently created the concept of "tipping-point states". In order to determine a tipping-point state, one must order each state and D.C. by the president-elect's margin of victory. Then, that person must determine which of those states gave the president-elect his decisive 270th electoral vote. The following states have served as tipping-point states in recent elections: Washington (1964), Ohio (1968), Ohio (1972), Wisconsin (1976), Illinois (1980), Michigan (1984), Ohio (1988), Tennessee (1992), Wisconsin (1996), Florida (2000), Ohio (2004), Iowa (2008), and Colorado (2012).

		SHARE OF PUBLIC APPEARANCES, SEPT. 1 TO NOV. 7	
STATE	TIPPING-POINT PROBABILITY	CLINTON	TRUMP
Florida	17.4%	20.0%	18.1%
Pennsylvania	11.5	11.4	11.4
Michigan	9.0	4.3	5.7
North Carolina	8.6	14.3	11.4
Ohio	8.2	11.4	9.5
Colorado	6.1	1.4	7.6
Wisconsin	6.1	0.0	2.9
Virginia	5.7	0.0	3.8
Minnesota	4.5	0.0	1.0
Nevada	3.2	4.3	4.8
New Hampshire	2.5	4.3	6.7
Arizona	2.5	1.4	1.9
Georgia	2.0	0.0	0.0
Iowa	1.9	4.3	2.9
New Mexico	1.5	0.0	1.0

The 2016 election has some ambiguity with regards to the tipping point state. Before the Electoral College convened, Wisconsin gave Trump his decisive 270th electoral vote, but Texas had 2 faithless electors, who voted for Kasich instead of Trump. Due to these faithless electors, Pennsylvania truly gave Trump his tipping-point vote.

During the 2016 election, FiveThirtyEight provided probabilities that any state would function as the tipping-point state. Florida having the highest probability made it arguably the most important state before Election Day 2016. The chart to the left displays the states with the 15 highest probabilities of serving as the tipping-point state in 2016. The middle column lists the percent of campaign time Clinton spent in that state, and the rightmost column displays the same figures for Trump.

Clinton arguably spent too much time in close states instead of states that had a high tipping-point chance. Over the course of Fall 2016, the 5 closest states as project by FiveThirtyEight included Ohio, Nevada, North Carolina, Iowa, and Florida. Though these states held importance, Clinton spent 54% of her time in these states, yet this group of states had a 39% chance of at least one of them serving as the tipping-point state. Relatively, Clinton ignored states, such as Michigan, Wisconsin, and Georgia.

Why did Clinton not spend more time in Michigan and Wisconsin? After all, if she had won those two states plus Pennsylvania, she would have narrowly won the presidency with 273 electoral votes – assuming the 4 Electors from the State of Washington and one elector from Hawaii still defected from Clinton in that scenario. Nobody except for somebody on the Clinton strategy team can know why the former Secretary of State avoided these states. Perhaps the conventional wisdom that Clinton had that "Blue Wall" made her overconfident in the Badger and Wolverine States, or maybe the Clinton team wrongly assumed closer races should have higher priority than states that have the highest probabilities of deciding the election. Perhaps the prototypical swing states on which the media focuses – North Carolina, Ohio, and Florida – led Clinton to disproportionately spend time in those three states. Regardless of the reason, Clinton ignored the math. Instead, her campaign favored conventional wisdom and typical election heuristics.

Section VIII: Electoral College Game Theory

Step into a time machine to October 2020. On a Saturday morning, the Democratic nominee holds a campaign event in the upper middle class and political moderate suburbs of Austin, Texas, In the afternoon, s/he drives the campaign bus to San Antonio and holds a campaign event in predominantly Latino neighborhoods in San Antonio. However, FiveThirtyEight projects that incumbent President Donald Trump has an 0.83 chance of winning Texas's 38 electoral votes for a second term. Though the Democrat still has a low probability of winning Texas, media outlets will devour the idea that a Democrat presidential candidate is making at least an effort to win Texas.

Trump's campaign looks at the poll numbers and projections and realizes that the President is still leading in Texas, but the fact that the opponent even stepped *foot* in Texas not for fundraising worries the Trump team. They may double guess themselves: "Does the Democrat Party have data about Texas that we don't have? What if we are taking states for granted as Clinton did in 2016 with Wisconsin and Michigan?" Consequently, Trump strategy team cancels a Monday night event in Allentown, Pennsylvania, and instead schedules a campaign stop in Dallas. Trump has now forfeited resources in Pennsylvania, a state that Trump *must* win to earn a second term, for a state that he will most likely win. Additionally, he high-level personnel on the Trump team now feels insecure in states where they should otherwise feel decently secure.

Unfortunately, this scenario cannot use pure game theory for analysis because campaigns can analyze the actions of the other campaigns, but one can still construct a pseudo-payoff matrix, which has four possible events.

QUADRANT I: The Democrat campaigns in Texas, and Trump follows suit – the aforementioned scenario. With regards to probabilities of victory in the Lone Star State, it may not change much. Trump's efforts in Texas and the Democrat's efforts may just offset each other. However, the benefits to the Democrat transcend Texas itself. The media outlets would most likely give him/her more coverage than they otherwise would if the Democrat campaigned in a typical place like Tampa, Florida, and they also may float the idea that Trump has reason to fear a loss in Texas. The Democrat would also gain because the Trump campaign may take the bait and start to become nervous. Furthermore, both Trump and the Democrat forgo campaigning in more crucial states. Regardless, the Democrat stands to gain the most in this scenario.

QUADRANT II: Trump preemptively campaigns in Texas, and the Democrat follows suit. This scenario presents the reverse of Quadrant I. In this situation, Trump basically does what the Democrat does in Quadrant I. Trump basically baits the Democrat to Texas thereby leading the Democrat to sacrifice time in crucial states. Trump stands to gain in this scenario.

QUADRANT III: The Democrat campaigns in Texas, but Trump does not take the bait. In this scenario, the Democrat still gains media exposure for taking a risk in Texas, but Trump does not waste any of his resources. This quadrant has lower costs for Trump but equal direct benefits for the Democrat.

QUADRANT IV: Nobody goes to Texas. In this scenario, neither candidate loses anything, but the Democrat forgoes possible media exposure.

The matrix below contains the payoff matrix for these scenarios. *TXR* and *TXD* respectively symbolize Trump and the Democrat going to Texas, and *NTXR* and *NTXD* respectively symbolize Trump and the Democrat *not* going to Texas. The left value represents the payoff Trump, and the right value represents the payoff for the Democrat. Unfortunately, these payoffs do not have concrete values, so arbitrary values will be used. The values themselves do not matter, but their relations to each other do.

$$\begin{bmatrix} & TXR & NTXR \\ TXD & (15,-10) & (10,-5) \\ NTXD & (-1,-5) & (0,0) \end{bmatrix}$$

This payoff matrix can apply to states besides Texas. Any other reliable Republican state can substitute. Additionally, a Republican could pull the same trick against a Democrat in reliably blue states. A Republican could campaign in Massachusetts with a pretense that the Massachusetts voters have elected a Republican governor recently.

The solution set (TXD, NTXR) serves as the Nash equilibrium because neither player can unilaterally better his payoff. Assuming both candidates are rational and not swayed by emotional tricks such as the ones proposed, the Democrat should always go to Texas for at least the media exposure, and Trump should fall for the Democratic trap to waste resources in a highly probable Trump state.

In a general sense, parties should try to challenge the electoral expectations for definite media exposure and the possibility of derailing the strategy of the opponent, and perhaps the candidate can win unexpected states as Obama did with Indiana and Trump did with Wisconsin and Michigan.

Conclusion

Going forward, those interested in elections need to ignore punditry based upon "gut feelings". This generalization does not mean people should solely rely on statistical models and game theory to produce election analysis. People can and *should* have individual opinions, but they must base these opinions on objective statistical analysis. Twenty-four-hour cable news has become a staple in modern politics, so it may take some time to abandon this subjective punditry. However, with the rise of independent media on the Internet and the popularization of statistical models of election with sites like FiveThirtyEight and the Princeton Election Consortium, voters have more opportunity than ever to learn about the statistics of the Electoral College and elections in general. As for campaigns, becoming overconfident makes a candidate lazy even when the numbers tell the nominee otherwise. Numbers keep the candidates on their toes and listening to the American electorate while listening to echo chamber of pundits does not.

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