

Analysis of Geographic Distribution on the Advantage of the Dominant Party in Congressional Elections

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I. Introduction and Premise

Some critics argue that the lack of proportionality and competitiveness in congressional districts must be primarily due to the undue influence of dominant parties, mistakenly claiming that proportionality is a necessary goal of democracy. However, this argument overlooks a fundamental constitutional premise: the U.S. system was deliberately designed to **reject** proportional representation in favor of local, geographic accountability.

The Founding Fathers established that congressional representatives would be elected based on small geographic areas, consciously rejecting the parliamentary model and the concept of "virtual representation." Recalling the tyranny of both King **and** Parliament, they prioritized actual representation, ensuring that representatives were tied to a local constituency within the **single-member district system**, over a proportional system. This structure dictates that each of the 50 states be apportioned a fixed number of representatives that are then elected from distinct geographic districts based on population.

The following analysis demonstrates that the natural geographic distribution of voters creates outcomes that critics often mistake for purposeful manipulation. I conduct this simple analysis using a model state with one dominant and one nondominant party —Purple (70% statewide support) and Pink (30% statewide support)—to show how the structural effect of indivisible geographic seats dictates outcomes, even in the absence of partisan intentionality in map design.¹ Once we understand how much geography actually matters, it is easily shown that achieving proportional outcomes and increased numbers of competitive districts would actually require maps to be drawn to purposefully benefit the non-dominant party.²

II. Analysis of a Generic 10-Seat State

¹ Of course, a similar analysis could be done with an evenly divided state, and while that may be of interest, it is left for the reader.

² It is generally accepted that the Constitution and federal law allow states to draw maps to purposefully benefit a particular party or achieve other political goals. This analysis assumes that no such intentionality exists and explores the consequences of geography alone, although in a few cases, I point to areas where intentionality could matter further.

For mathematical simplicity and to demonstrate some basic principles,³ I began the analysis with a hypothetical state allocated 10 seats, using a generic 70% Purple - 30% Pink statewide voter split. The analysis is built upon three distinct geographic models: two extremes and a more realistic intermediate case along with some nuances.

II.A. Extreme Geographic Models: Natural Cracking and Packing

The two extreme models illustrate how simple geographic distribution alone can dictate outcomes:

- **Extreme 1 (Uniform / Natural Cracking):** First, let's assume that the voters are distributed perfectly evenly (70% Purple - 30% Pink) across every possible area of the state. In the single-member district system, this uniformity leads to a natural cracking of the minority vote. No matter how the maps are drawn, each district will have a 70%-30% mix of voters, resulting in a 10 Purple - 0 Pink outcome.
- **Extreme 2 (Concentrated / Natural Packing):** This model assumes the voters are perfectly divided geographically, such as east and west (e.g., Pink voters all live in an isolated and distinct area, and all Purple voters live elsewhere). This distribution creates a natural packing of both parties. If the maps are drawn to honor those natural communities and constituencies, there will be three districts with 100% Pink voters and seven districts with 100% Purple voters. The result is 7 Purple - 3 Pink, where all districts are extremely safe for one party with the winning candidate vote share likely to be near 100% in their respective areas.

Table 1. Summary of the core findings (70% Purple, 30% Pink, Ten Seat State)

Geographic Model	Voter Distribution	Expected Outcome	Winning Candidate Vote Share
Extreme 1 (Uniform)	Voters are distributed perfectly evenly throughout the state.	10 P - 0 K	Every winning candidate will get 70% of the votes.
Extreme 2 (Concentrated)	Voters are perfectly divided	7 P - 3 K	Every winning candidate gets the maximum share in their area.

³ The number ten was chosen primarily for mathematical simplicity, but 41 of the 50 states have 10 or fewer congressional seats, and only three states have more than 20, so the learning from this analysis applies very broadly. In reality, in the vast majority of cases, the geographic indivisibility of the seats becomes an important feature when analyzing the natural advantage vs. partisan intentionality.

geographically (e.g., East-West).

Intermediate Case

Mixed geography, not uniform but also not perfectly packed.

Highly likely to result in **8 P - 2 K** or **9 P - 1 K**.

The competitive outcome in the competitive area is fragile and easily could "tip" to give the dominant party an advantage.

II.B. Detailed Case Study: The Intermediate 10-Seat Scenario

Now that we understand the potential of natural geographic dispersion to influence outcomes in an important way, I will turn to a more realistic and interesting intermediate scenario where part of the state is naturally packed and part is naturally cracked. This scenario examines a combination of the two extremes: a substantial portion of the state is evenly balanced, and the rest of the state is made up of heavily Purple-leaning areas.⁴

Specifically, suppose that 20% of the state lives in a "Middle Area" with even proportions of Pink and Purple voters. The remaining 80% of the population (20% Pink and 60% Purple) is evenly spread throughout the rest of the state, as in the first model.

If the map is drawn such that the Middle Area is represented by two representatives, we know for sure that the other eight seats will be Purple, and those winning candidates should all get 75% of the vote.

The question then becomes: *What happens to the two seats in the Middle Area?*

We can analyze this as a "state within a state" where the maps for those two seats are wholly contained within the Middle Area. The answer will depend on how the voters are geographically distributed within the Middle Area.

1. **Scenario 1: Uniform Middle Area (50-50 Split)** If the 20% that lives in the middle are evenly spread out, then both of those districts will be 50-50 Pink and Purple. While we cannot predict outcomes easily in that case, if we are strict about it, both races would be determined by a coin toss. As a practical matter, they are highly competitive races that could go either way depending on other factors, such as voter turnout or candidate quality.

⁴ In the real world, geographic dispersion of political adherents is much more complicated than this analysis considers, but we can learn a lot from the two extreme cases and the intermediate scenarios. What is generalizable is that disproportionality (e.g., 9 P - 1 K or 10 P - 0 K outcomes) is the highly likely default condition of the single-member district system, while proportional outcomes (7 P - 3 K) require specific, unusually high concentration of the minority party's voters.

- **Overall Outcome Range:** The state would have 8 very safe Purple districts and 2 toss up districts, with an outcome somewhere in the range of 10 Purple - 0 Pink to 8 Purple - 2 Pink.
- 2. **Scenario 2: Geographically Packed Middle Area** Alternatively, if you assume that within the Middle Area itself, the voters are divided by geography, you could easily get maps that are even less competitive than the rest of the state, resulting in 1 Pink and 1 Purple seat, with winning candidates getting nearly 100% of the vote in their respective areas.
 - **Overall Outcome:** The outcome here would be 9 Purple - 1 Pink.
- 3. **Scenario 3: Tipping the Middle Area** Finally, if we relax the assumption that the Middle Area maps are self-contained, it is easy enough to imagine situations where other considerations will cause the maps to pull voters from the rest of the state into the two predominantly Middle Area districts. In Scenario 1, incorporating even just a few voters from the nearby 75% - 25% Outer Area would easily tip the maps to be in favor of Purple. This highlights that even when it appears that there should be a safe district for Pink, the result is fragile and heavily impacted by even small required changes due to considerations besides geographic location. In this case, what could be an 8-2 outcome, tips easily to a 10-0 outcome without any partisan intentionality.
 - **Overall Outcome:** The 8 Purple - 2 Pink outcome is unlikely to hold and could easily turn into 10 Purple - 0 Pink.

This exercise illustrates how the majority party's significant statewide advantage makes it fairly likely that they naturally secure a 10-0 or 9-1 result. An 8-2 or 7-3 outcome requires some very specific requirements on the geographic location and concentration of the Pink voters. It is important to note that a favorable result for Purple could happen due to a variety of neutral map requirements (such as compactness, contiguity, equal populations, or minimized transportation distances), and not just through the application of intentionality in drawing the final borders.

Conclusion on the 10-Seat State (70% - 30%):

The analysis clearly shows that with a broad range of assumptions about population distribution, a 10-0, 9-1, or 8-2 outcome is highly likely even without undue or purposeful drawing of the maps to favor the dominant Purple party.

Furthermore, to achieve proportional results of 7-3 (which is a misguided objective as previously explained), it would require very special assumptions that the population is naturally packed by party in a very specific way or that the maps are purposefully drawn to favor the Pink party in certain areas of the state. Any result that is 6-2 or less for the Purple party could *only* happen with intentionally drawn maps to provide advantage to the Pink party.⁵

III. Analysis of a 4-Seat State

⁵ While this analysis ignores intentionality, or assumes it doesn't exist, intentionality could make the disproportionality even more likely. However, since in this case, most of the outcomes are naturally favorable to the dominant party, intentionality isn't really needed, because the system already gives a substantial structural advantage to the dominant party.

While the understanding from a 10-seat state is very informative and the math is quite simple, it is even more interesting to look at smaller states with fewer seats. In these cases, the strength of the natural advantage of the dominant party becomes more apparent because the structural effect of indivisible seats is magnified.

Of course, in the trivial case of a 1-seat state (like Alaska, Delaware, North Dakota, South Dakota, or Vermont), the result is a winner-take-all outcome. The single representative is predicted to be allocated to whichever party can muster 50% +1 in a statewide election.

Let's now look at the case of a 4-seat state. If we use the same party make-up assumption as in the previous section, namely a 70%-30% Purple-Pink mix, what outcomes are possible? What does it take to get the 3-1 split that proportionality advocates desire? How much does the structural effect of indivisible seats change the outcome?

I will now re-analyze the same three geographic models in this 4-seat context:

- **Extreme 1 (Uniform / Natural Cracking):** This model assumes the 70%-30% Purple/Pink split is perfectly uniform across all areas. Just as in the 10-seat case, this leads to the minority vote being naturally cracked. Each of the four districts will be 70% Purple - 30% Pink, resulting in a 4 Purple - 0 Pink outcome.
- **Extreme 2 (Concentrated / Natural Packing):** This model assumes the Pink voters are perfectly concentrated geographically. The results here are slightly different than in the ten-seat case. Because 30% of the population is too much to put into a single district and not anywhere near enough to have two districts, we have to consider whether the allocation of the extra voters matters. Following the logic employed previously and assuming that there are no external requirements preventing the creation of maps that keep the large blocks of Pink voters together, we have the following results.
 - **District 1 (All Pink):** This district has 100% Pink voters (25 of the 30 percent available). The Pink candidate would win this seat with nearly 100% of the vote.
 - **Remaining Districts (Purple Dominant):** While it turns out that it doesn't really matter much to the result, we have to consider what happens to the remaining 5% of the vote that is Pink. For simplicity and without loss of generality, let's assume that they are all allocated to a nearby district. In that case, there will be two districts that are 100% Purple and one that is 80% Purple. Even if the Pink voters are allocated some other way, the result is the same – 3 overwhelming wins for Purple.
 - **Side note:** It should be obvious that drawing the map this way essentially guarantees a 3-1 result with all districts having blowout 80-100% wins. This highlights that in this scenario you can have proportionality or a competitive race, but not both.
- **Intermediate Case:** The default outcome under most intermediate conditions (including mixed geography) is the 4 Purple - 0 Pink outcome. Let's apply the logic from our 10-seat example. If 20% of the population lives in a Middle Area that is evenly divided between Pink and Purple, there aren't enough people there to have their own district. Pulling in another 5% from any evenly distributed area yields an arguably competitive

district that leans heavily Purple. In fact, combining the 20% 50-50 area with enough 75-25 voters to get you to equal population results in a 55% Purple district, which essentially secures the 4-0 outcome.⁶

This demonstrates the fragility of the 3-1 result; small deviations from the perfect minority concentration causes the structural advantage of the majority party to secure a 4-0 outcome in most cases. This is due to the fact that a broad range of natural geographic distribution of the voters gives this outcome, without any intentionality by the dominant party. In fact, in most real world scenarios, the only way to get a 3-1 outcome is to intentionally draw a map that packs as many Pink voters as possible into a single district in order to get close to a competitive outcome.

IV. Overall Conclusion of the Analysis

My analysis leads to the following conclusion regarding the necessary conditions required to achieve the specific 3-1 split demanded by proportionality advocates in a 70%-30% state with 4 seats.

A 3-1 outcome requires either a very special assumption about natural distribution where you have extremely naturally packed pink voters OR you have to intentionally and carefully draw the maps to artificially pack those voters.

Therefore, to achieve this statistically proportional result (3-1), you must actively overcome the natural, structural advantage the majority party holds, either through highly unusual geographic luck or through the intentional design of the maps.

In essence, structural disproportionality and non-competitive districts are the default conditions imposed by the single-member district system when the parties are widely, even if not uniformly, dispersed and the only way to avoid those outcomes is to intentionally draw maps that favor the non-dominant party.

V. Post-Script: Distinguishing Structural Advantage from Intentionality: A Nearly Impossible Task

Political scientists have spent a lot of time and energy developing metrics that try to identify intentional partisan manipulation. It is crucial to acknowledge how difficult it is to differentiate between the naturally occurring structural advantage demonstrated here and intentional partisan manipulation. Here are the three main reasons:

1. **Intertwined Outcomes:** Both natural geographic concentration and intentional drawing produce the same observable result: disproportionate representation and a high number of non-competitive districts. The political effect is identical, making it nearly impossible to distinguish cause based on the final map outcomes alone.

⁶ While a 55-45 district might not be technically considered safe, it is at a minimum comfortable or very likely. Of course, the final outcome depends on other factors, such as candidate quality, national wave, and voter turnout.

2. **Limitations of Quantitative Metrics:** Measures of partisan bias, such as the Efficiency Gap or Mean-Median difference, often perform poorly in the specific circumstances analyzed in this report (e.g., states with a highly dominant party or a very small number of districts). In the context of a 70%-30% statewide split, a proportional result is structurally fragile, meaning metrics may fail to separate a naturally disproportionate outcome from a deliberately rigged one, or worse, assume that there is intentionality when the outcomes are driven by natural advantages.
3. **The Proof of Intent:** Ultimately, confirming that a map constitutes intentional partisan bias often requires establishing clear intent (e.g., through review of internal communications or map-drawing logs), since the presence of a strong structural advantage means that many disproportionate results can be plausibly attributed to natural population distribution.