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EXHIBIT G

Expert Report on North Carolina's Enacted Congressional Districts

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November 29, 2021

Introduction

My name is Christopher A. Cooper. I have been asked to provide a brief analysis of the partisan characteristics of North Carolina's congressional maps, enacted on November 4, 2021, for purposes of Plaintiffs' motion for preliminary relief in *Harper v. Hall*, No. 21 CVS 500085. I am conducting this analysis as a private citizen and am not speaking for my employer, nor am I conducting this work on university time, or using university resources.

I am the Robert Lee Madison Distinguished Professor of Political Science and Public Affairs at Western Carolina University, where I have been a tenured or tenure-track professor since 2002. I hold a PhD and MA in Political Science from the University of Tennessee, Knoxville and a BA in Political Science and Sociology from Winthrop University. My academic research focuses on state politics and policy, elections, and southern politics—with particular application to North Carolina. To date, I have published over 50 academic journal articles and book chapters, co-edited one book, and co-authored one book (both with the University of North Carolina Press). I teach courses on state and local politics, political parties, campaigns, and elections, southern politics, research methods, and election administration. In 2013, I was named the North Carolina Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and I have received Western Carolina University's highest honors in teaching (Board of Governors Teaching Award) and scholarship (University Scholar).

Much of my academic and applied research relates to North Carolina politics and policy and I am a frequent source for news media seeking comments about politics in the Old North State. My quotes have appeared in national and international outlets including the New York Times, Washington Post, Politico, BBC, and the New Yorker, as well as in North Carolina-based outlets including the News and Observer, Charlotte Observer, Asheville Citizen Times, Carolina Journal, Spectrum News, and National Public Radio affiliates in Chapel Hill, Charlotte, and Asheville. I have written over 100 op-eds on North Carolina, southern and national elections and politics, including pieces in the Atlanta Journal Constitution, NBC.com, the News and Observer, Charlotte Observer, and Asheville Citizen Times, and regularly give talks about North Carolina politics, North Carolina elections, and the redistricting process to groups throughout the state. I previously served as an expert witness in *Common Cause v. Lewis*.

I am being compensated at a rate of $300 per hour.

The bulk of the analysis that follows analyzes the consequences of the choices made district by district. Before proceeding into this analysis, however, a few points of context:

- North Carolina is, by virtually any measure, a "purple state" with healthy two-party competition. The North Carolina Governor is a Democrat, while the US Senators are Republicans. There are more registered Democrats than Republicans in the state, and in the 2020 election, the two-party vote share difference between Trump and Biden was the smallest of any state that Donald Trump won.

- North Carolina does not show as much evidence of "natural clustering" as other states. According to Stanford University political geographer Jonathan Rodden, "Due to the presence of a sprawling knowledge-economy corridor, a series of smaller automobile cities with relative low partisan gradients, and the distribution of rural African Americans, Democrats are relatively efficiently distributed in North Carolina at the scale of congressional districts."[1] In other words, massive partisan disparities in election outcomes in favor of one party or the other cannot be discounted as simply a result of where Democrats and Republicans happen to live.

- Gerrymandering, drawing districts to benefit one party at the expense of the other, is generally accepted as a threat to democracy in North Carolina and across the nation. This statement is true regardless of partisanship. For example, a 2018 Elon Poll found that just 10% of registered voters in North Carolina believe the current redistricting system is "mostly fair." A recent op-ed in the *News and Observer* by Republican Carter Wrenn and Democrat Gary Pearce illustrates bi-partisan agreement on the evils of gerrymandering in clear terms. They explain, "We agree that gerrymandering is a major problem that undermines the foundations of our democracy. We agree that districts shouldn't be drawn to help one political party, no more than college basketball games should be rigged to favor one team."[2] The preference for fair maps is not a partisan one.

[1] Rodden, Jonathan, Why Cities Lose (New York: Basic Books, 2019), 173.

[2] Gary Pearce and Carter Wrenn. "We're usually on opposite sides of political battles. But we agree on NC voting maps." News and Observer. October 21, 2021.

While the district-by-district analysis is key to understanding the ways in which the map will translate into advantage for one party or the other in any given district, the map is best thought of as a single organism, rather than 14 separate congressional districts---when one district moves in one direction, another district must shift in response. As a result, it is worth pausing and considering some of the general characteristics of the map before moving into a district-by-district analysis.

- North Carolina earned an additional congressional seat because of population growth that occurred mostly in urban areas: according to an analysis of U.S. census data by the News and Observer, more than 78% of North Carolina's population growth came from the Triangle area and the Charlotte metro area.[3] Despite that fact, the number of Democratic seats actually *decreases* in the current map, as compared to the last map. The last map produced 5 Democratic winss and 8 Republican wins; this map is expected to produce 3 Democratic wins, 10 Republican wins and 1 competitive seat.

- Democratic strongholds Mecklenburg, Guilford, and Wake Counties are each divided across three districts, despite the fact that there is no population-based reason to divide them this many times. In the previous map, Mecklenburg was divided into two districts, Wake into two districts, and Guilford fell completely in one district. The strategic splits in the enacted map ensure that large numbers of voters will have no chance of being represented by a member of their own party. These splits will also lead to voter confusion and fractured representational linkages. The shaded red-and-blue maps that follow this introductory section provide a graphical representation of each of these county splits.

- The map produces geographic contortions that combine counties in ways that, in some circumstances, have never existed before.

- The double-bunking that occurs in the enacted map advantages the Republican Party. A Republican (Virginia Foxx) and a Democrat (Kathy Manning) are both drawn into in an overwhelmingly Republican district, thus virtually guaranteeing that the Democrat (Manning) will lose her seat. There are no cases where two Republican incumbents seeking re-election are double-bunked. The map also produces at least one district with no incumbents, but that district overwhelmingly favors the Republican Party.

- Neutral, third-party observers have been uniform in their negative assessment of the map. For example, The Princeton Gerrymandering Project gives the map an "F" overall, an "F" in partisan fairness and a "C" in competitiveness. Dave's Redistricting App assess the map as "very bad" in proportionality and "bad" in terms of competitiveness. Both of these groups are nonpartisan and have given similar grades to Democratic gerrymanders in other states.

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[3] David Raynor, Tyler Dukes, and Gavin Off. "From population to diversity, see for yourself how NC changed over 10 years." News and Observer, Oct. 18, 2021, https://www.newsobserver.com/news/local/article253546964.html.

In the text that follows, I refer to the "current" maps as the maps that were used in the 2020 election and the "enacted" maps as the maps that have been approved by the North Carolina General Assembly for use in the 2022 elections. While I conducted all of the analysis that follows and wrote all of the verbiage, the shaded red-and-blue maps were produced by John Holden, a GIS expert, using a composite measure of partisanship that I selected and describe below.

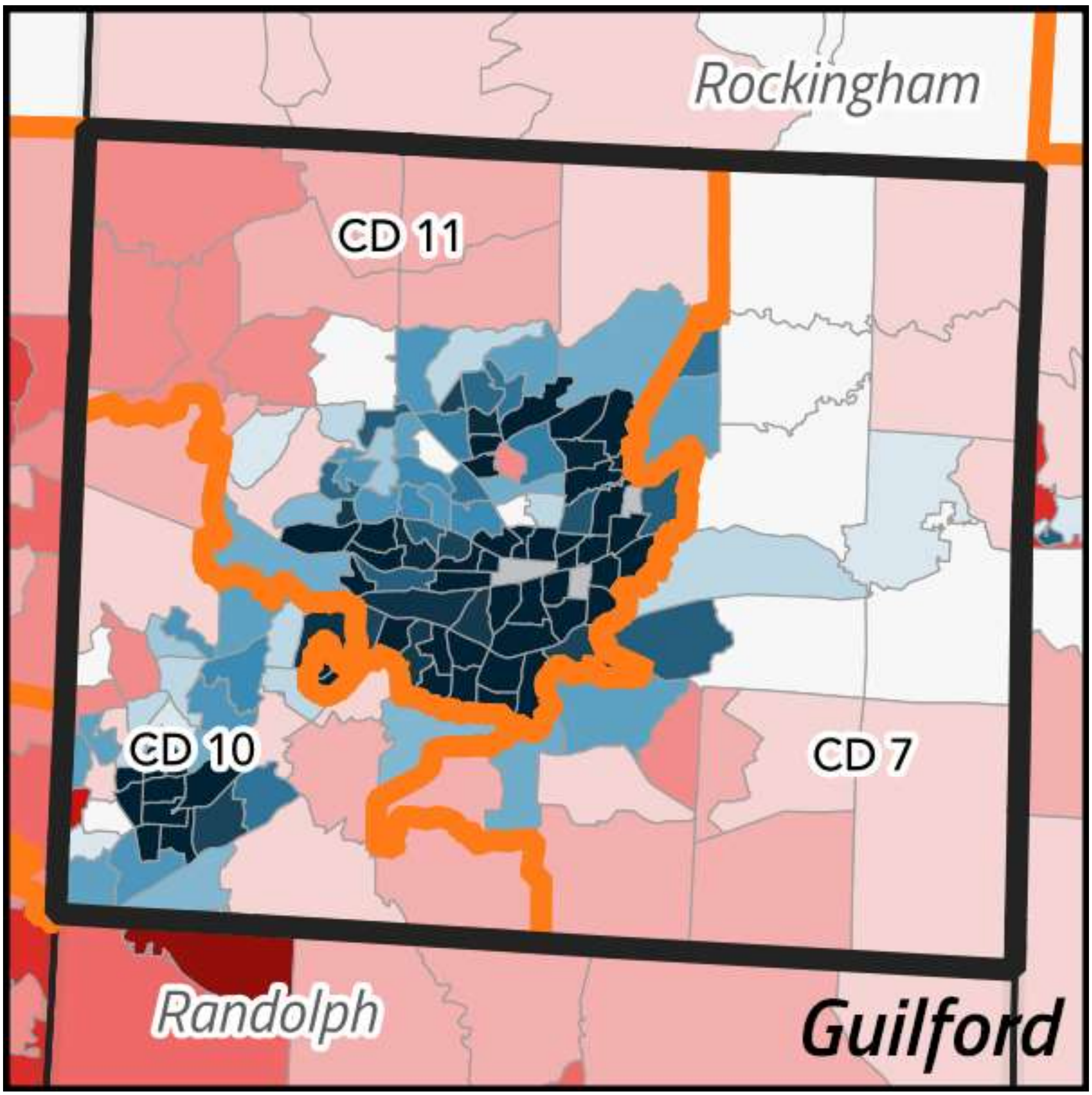
I use three different metrics in the analysis that follows. The first is the Cook Political Report's Partisan Voter Index (PVI), a standard metric of the expected "lean" of a district using a composite of past elections. The second is a metric created for this analysis that combines the results of the Secretary of Labor and Attorney General races, the two closest Council of State races in North Carolina in 2020, into one measure, which I term the Competitive Council of State Composite (CCSC). This measure allows us to use relatively low-profile elections to get a sense of the "true partisanship" of the district. It is presented below as the raw difference in votes and is used in the shaded red-and-blue maps that follow. Finally, I mention the percent of the electorate that voted for Donald Trump in the 2020 election to give yet another sense of the partisan lean of the district. As the table below shows, the metrics all tell a similar story: the enacted map will produce 10 Republican seats, 3 Democratic seats, and one competitive seat. At most, the enacted map could be expected to elect four Democrats to office in 2022—fewer than in the current map and far below Democratic representation statewide, or the results of other recent statewide elections.

Table 1. Summary Data for Each Enacted Congressional District

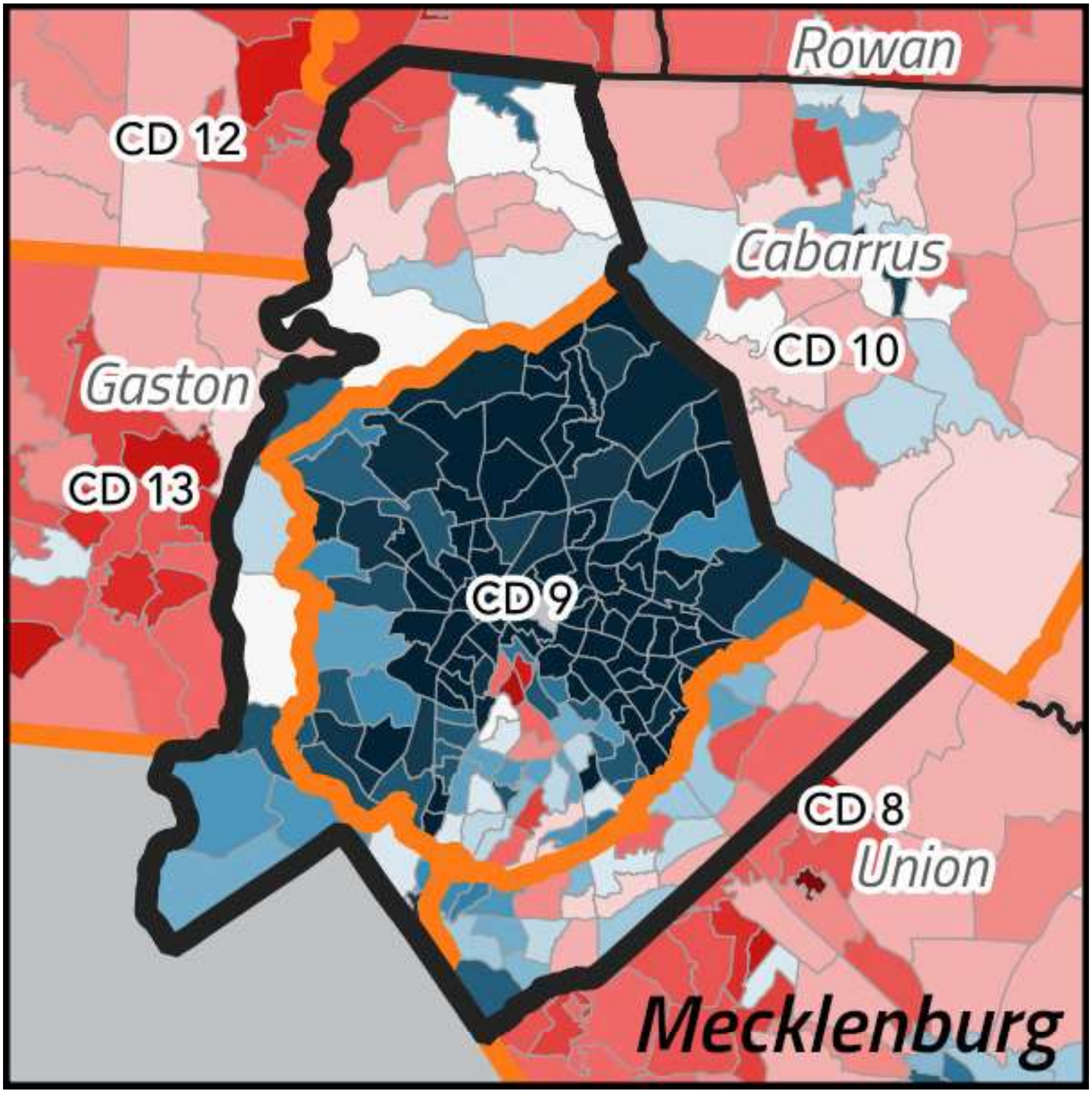
District	PVI	CCSC	Trump Perc
1	R+10	R + 98,969	57%
2	Even	D +40,396	48%
3	R+10	R +111,451	58%
4	R+5	R + 28,045	53%
5	D+12	D +227,327	34%
6	D+22	D + 374,786	25%
7	R+11	R + 115,682	57%
8	R+11	R +125,842	57%
9	D+23	D + 325,717	25%
10	R+14	R + 156,833	60%
11	R+9	R + 94,407	57%
12	R+9	R + 102,404	56%
13	R+13	R + 150,187	60%
14	R+7	R + 58,387	53%

I begin by showing shaded red-and-blue maps demonstrating the trisection of Wake County, Mecklenburg County, and Guilford County. These maps show county lines in black, VTD lines in gray, and district lines in orange. The red and blue shading represents the relative vote margin using my CCSC composite—the composite of the Secretary of Labor and Attorney General races in North Carolina in 2020—in each VTD, with darker blue shading representing larger Democratic vote margins and darker shades of red indicating larger Republican vote margins (both normalized by acreage).

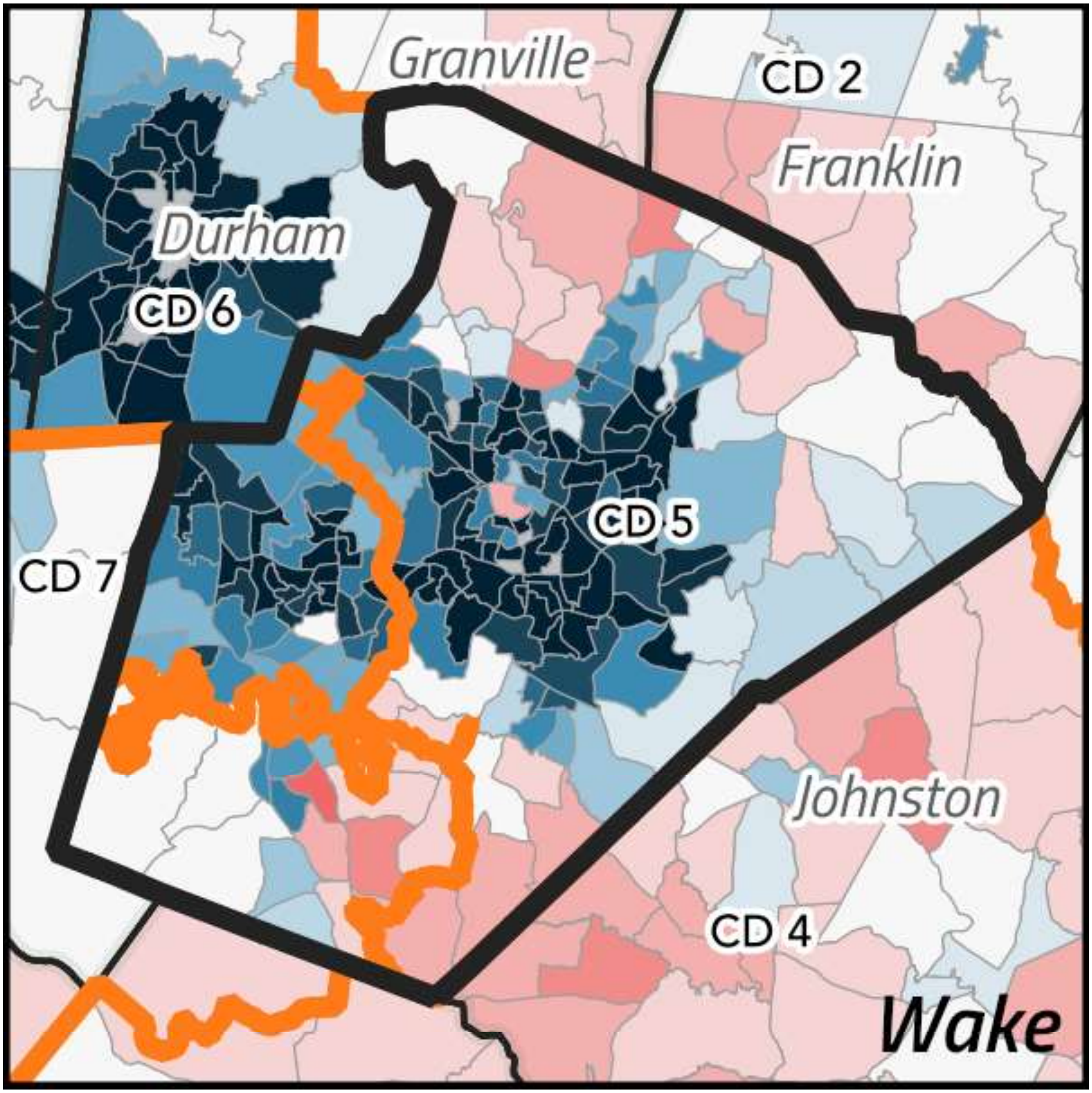
Map 1. Close-Up of Wake County VTD CCSC estimates across three districts



Map 2. Close-Up of Mecklenburg County VTD CCSC estimates across three districts



Map 3. Close-Up of Guilford County VTD CCSC estimates across three districts

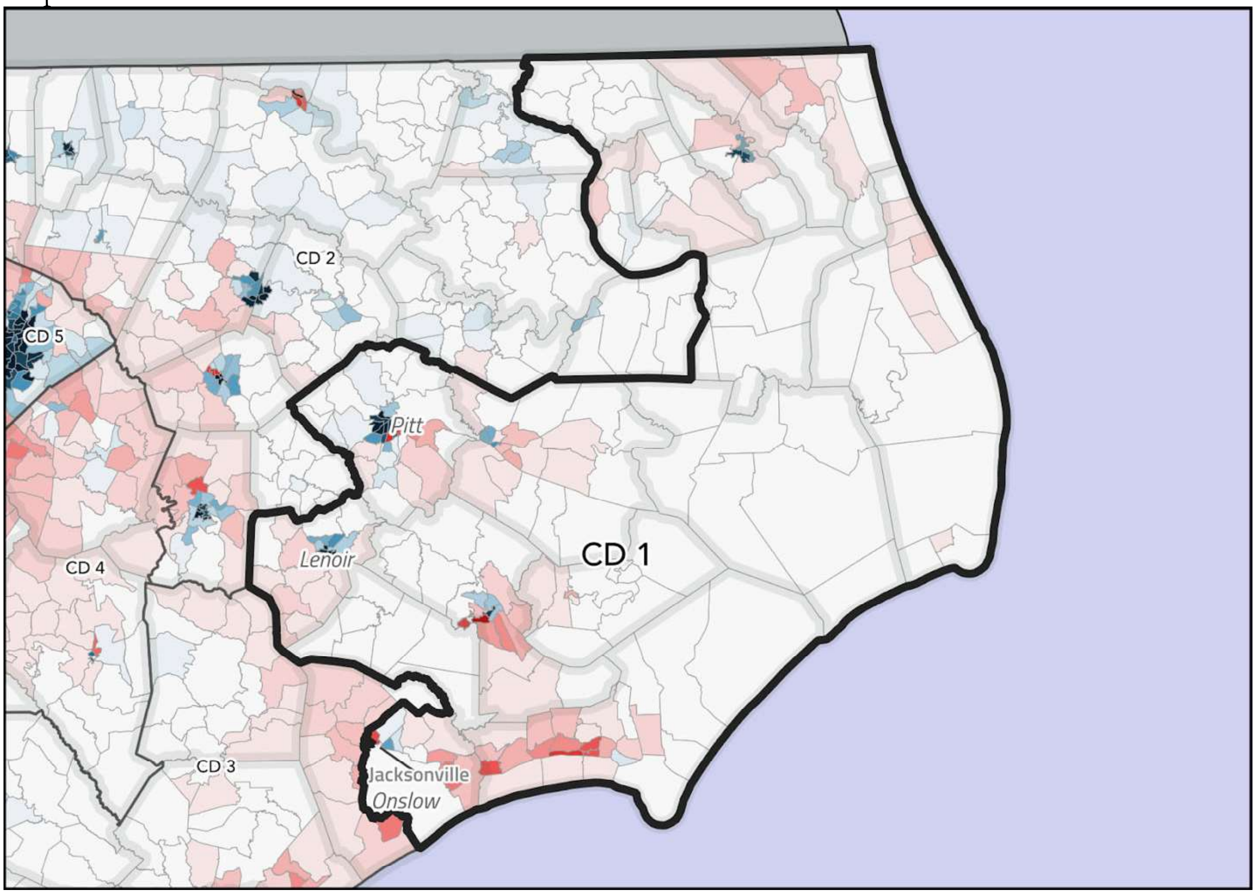


NC-1

The enacted 1st congressional district is mostly comprised of the current NC-3, but also includes part of the current NC-1. Most potential congressional districts in this part of North Carolina would likely lean towards the Republican Party, but to create extra advantage for the Republican Party in other parts of the map, the current map brings the Democratic-leaning areas of Pitt County into District 1, thus removing them from NC-2 and allowing NC-2 to become much more competitive for the Republican Party.

Despite moving the district line westward to include the Democratic portion of Pitt County, the enacted district remains virtually a guaranteed Republican victory with a PVI of R+10 (the current NC-3 is R+14). No Democratic member of Congress in the country represents a district that leans this far towards the Republican Party.

Map 4: VTD CCSC estimates for NC-1



NC-2

The enacted 2nd congressional district includes the core of the current NC-1, along with portions of the current NC-4 and NC-13 districts. The area that largely comprises the new 2nd district is currently represented by Democrat GK Butterfield and is considered a D +12 district by the Cook Political Report, making it a safe Democratic seat. Butterfield has the longest uninterrupted tenure of any member of North Carolina's congressional delegation. Under the enacted map, however, Butterfield's district changes radically, loses many of its Democratic strongholds (including the aforementioned loss of the Democratic areas in Pitt County) and now picks up enough Republican voters to move the district to "even," according to the Cook Political Report. For example, it picks up Caswell County, which does not include a single Democratic-leaning VTD, according to the 2020 Attorney General/Secretary of Labor "CCSC" composite in the map shown below. The 2020 Presidential vote share and composite score reinforce that this is an extremely competitive district. This is an enormous shift for what was formerly a Democratic stronghold.

In addition to producing a clear partisan shift, the district is difficult to understand from a communities of interest perspective. The enacted district no longer includes any of Pitt County nor the campus of East Carolina University, which provided much of the economic engine of the district, and now stretches from the Albemarle Sound to the Raleigh-Durham-Chapel Hill metropolitan area, and eventually terminates in Caswell County, just northeast of Greensboro. Notably, Washington County and Caswell Counties have never been paired together in a congressional map in the history of North Carolina, further illustrating how little these counties have in common.

At a micro-level, the changes will split communities in important ways. For example, the cut-out in Wayne County, just west of Goldsboro, NC, splits the students and families in Westwood Elementary School (which is located in NC-2) into two separate districts (NC-2 and NC-4). At one point, NC-2 passes through a narrow cut-off between the Neuse River to Old Smithfield Road that is less than one-third of a mile wide.

After the maps were enacted, G.K. Butterfield announced that he will not seek re-election,[4] making the district even more likely to shift to the Republican Party. If the Republicans take over this seat, it will be the first time that this part of North Carolina has been represented by a Republican since the late 19th Century.

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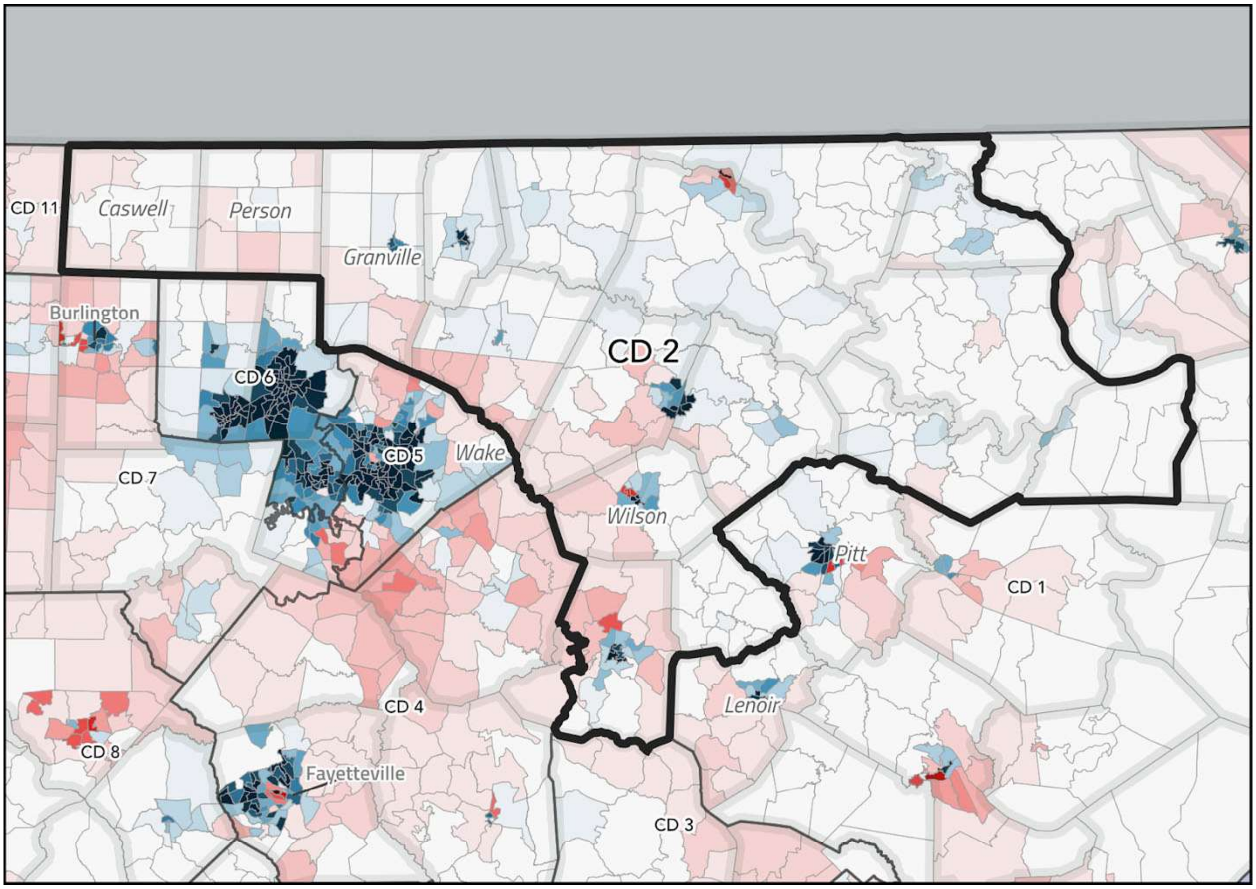
[4] Bryan Anderson, "Democrat Rep. Butterfield to Retire, New District is a Toss-Up." Associate Press News. https://apnews.com/article/elections-voting-north-carolina-voting-rights-redistricting-e221c0732f457b2273f54ef102424eca

Map 5. VTD CCSC estimates for NC-2



NC-3

The enacted third congressional district is mostly carved out of the current 7th congressional district, but also includes portions of the 3rd, and 9th districts. The current 7th district is considered R+11 by the Cook Political Report.

This district once again denies North Carolina's Sandhills a consistent district of their own, despite repeated calls during the redistricting process,[5] and instead places portions of the Sandhills with the coastal enclave in and around Wilmington. The enacted map also creates an odd appendage in Onslow County that, as described in the section on NC-1, makes little sense from a communities of interest perspective.

The enacted district will almost certainly elect a Republican. It is slightly less Republican than the current NC-7 but still is considered R+10 district by the Cook Political Report, favored the Republicans by over 110,000 votes in the 2020 Attorney General/Secretary of Labor "CCSC" composite, and Donald Trump won the district with 58% of the vote. It is currently represented by Republican David Rouzer and is expected to remain in Republican hands.

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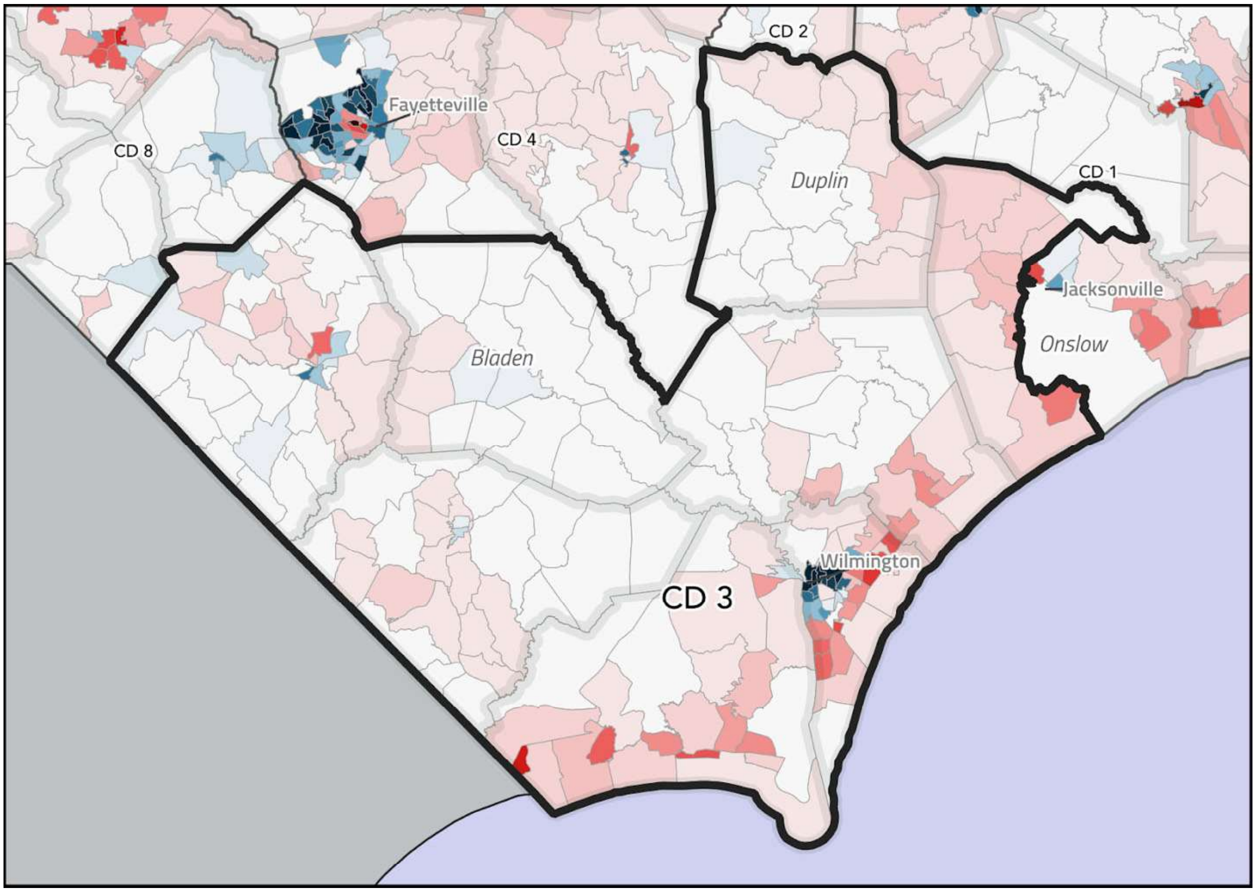
[5] See, for example, Dreilinger, Danielle, "1 woman, 1 North Carolina address, 5 congressional districts. As North Carolina prepares to add a 14th congressional seat, Sandhills residents asked: why can't it be theirs? *Fayetteville Observer*. Nov 5, 2021.

Map 6. VTD CCSC estimates for NC-3



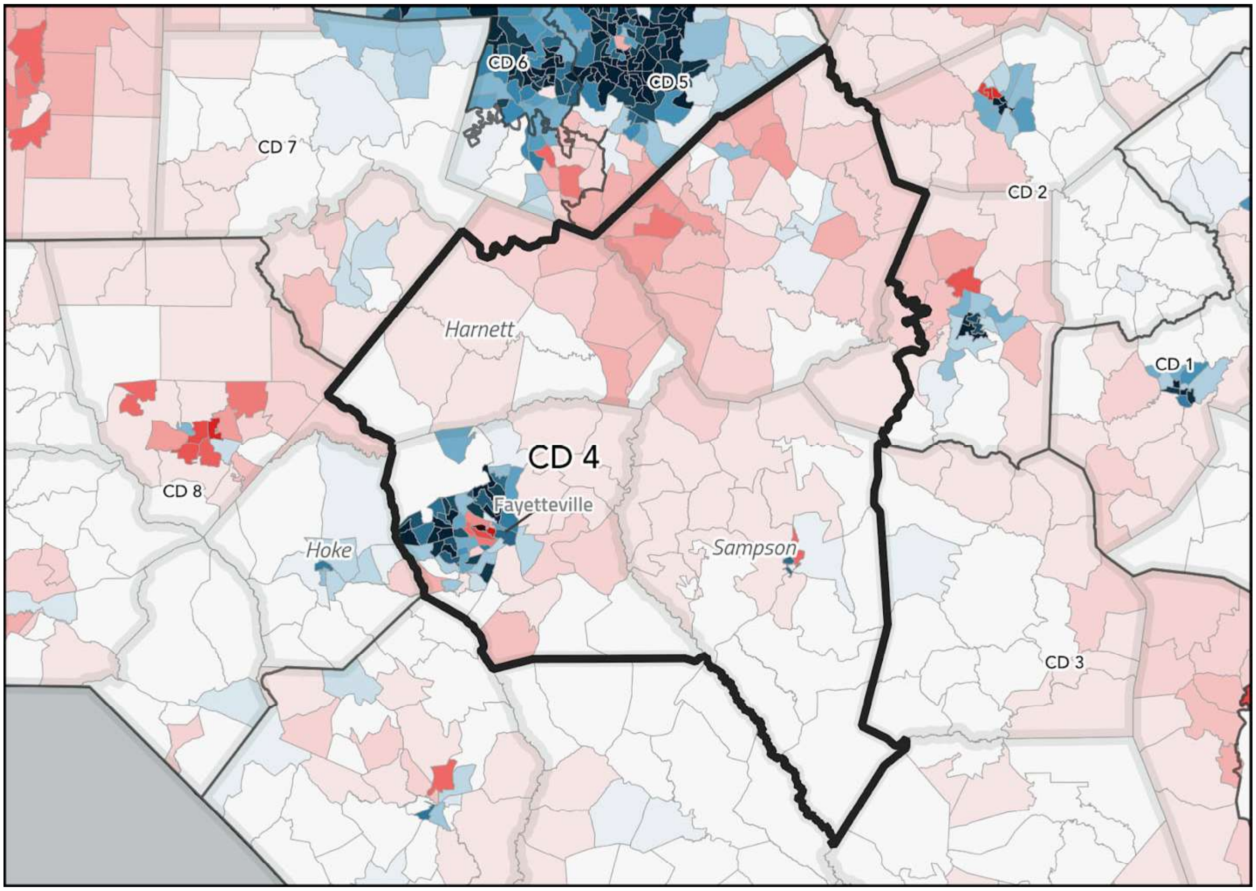
NC-4

The enacted 4th congressional district is carved out of a pocket of North Carolina that includes Johnston County and a portion of Harnett County, both of which are adjacent to Wake County, as well as portions of the Sandhills. The district is carved out of leftover portions from districts 7 and 8 which were R+11 and R+6, respectively. It combines the Democratic-leaning area of Fayetteville with those areas to create a Republican-leaning district.

In addition to the carve out of Republican-leaning VTDs in Wayne County referenced above, this district takes a series of confusing jogs in the Northwest part of Harnett County. A citizen driving Southwest on Cokesbury Road would begin in NC-7, then rest on the line between NC-7 and NC-3, then into NC-4, then back on the line between the two, just before Cokesbury turns into Kipling Road whereupon the driver would move back into NC-7.

This district, which has no incumbent, is considered an R+5 district by the Cook Political Report, gave 53% of its vote share to Donald Trump in 2020, and gave an advantage to Republicans of about 28,000 votes in the 2020 Attorney General/Secretary of Labor "CCSC" composite.

Map 7. VTD CCSC estimates for NC-4

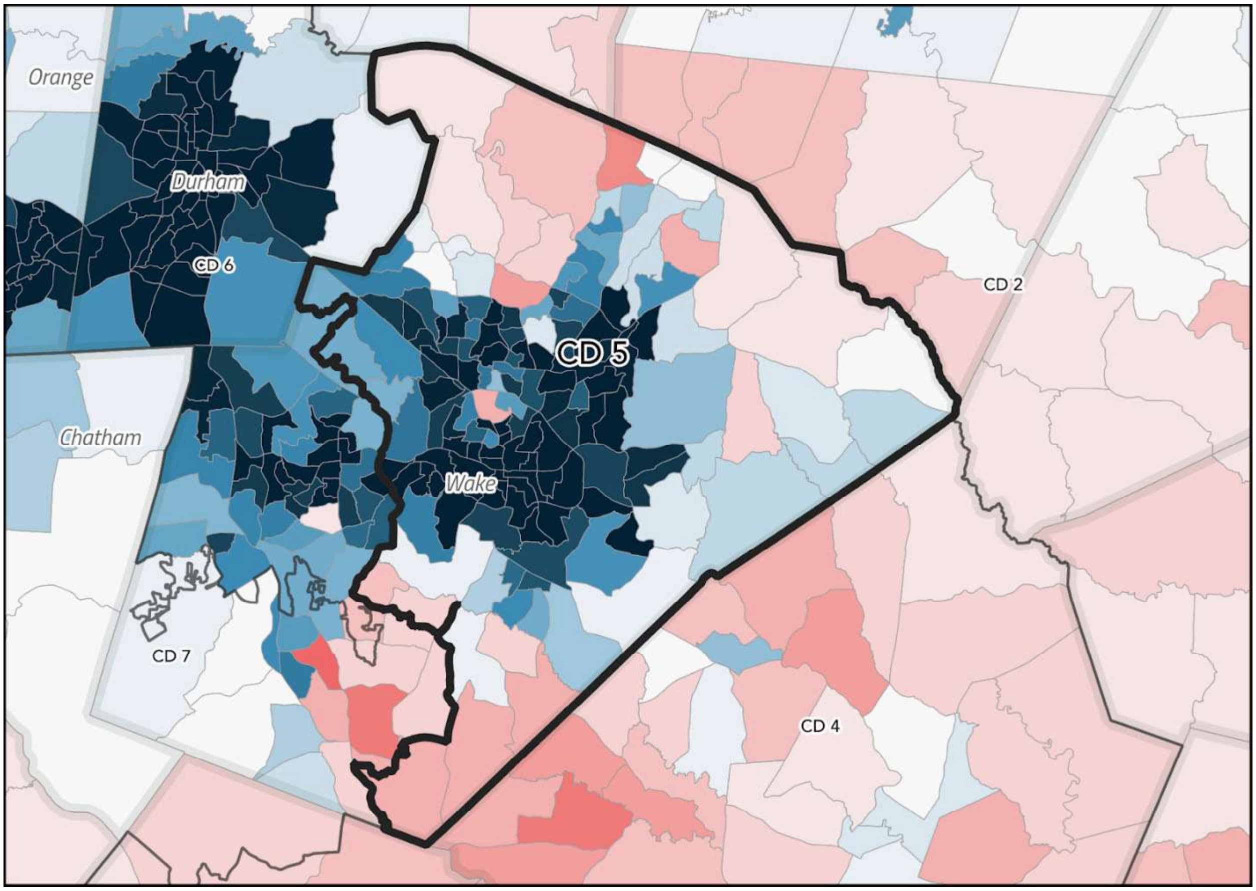


NC-5

The enacted map cracks Democrats in Wake County into three districts. Unlike NC-6 and NC-7, NC-5 is situated completely within Wake County and is made up of portions of current NC-2 and NC-4, districts that were D+12 and D+16. The effects of this are to pack Democratic voters into one district, thus increasing the probability that Republicans can win at least one of the adjacent districts. The enacted district is rated by the Cook Political Report as D+12, the CCSC shows a Democratic advantage of over 227,000 votes and Donald Trump won just 34% of the vote.

This map clearly splits communities of interest. In one particularly egregious example, a small vein runs up Fayetteville Road by McCuller's Crossroads in Fuquay-Varina, where the vein itself is in NC-7 and the areas on either side of it are in NC-5.

Map 8. VTD CCSC estimates for NC-5

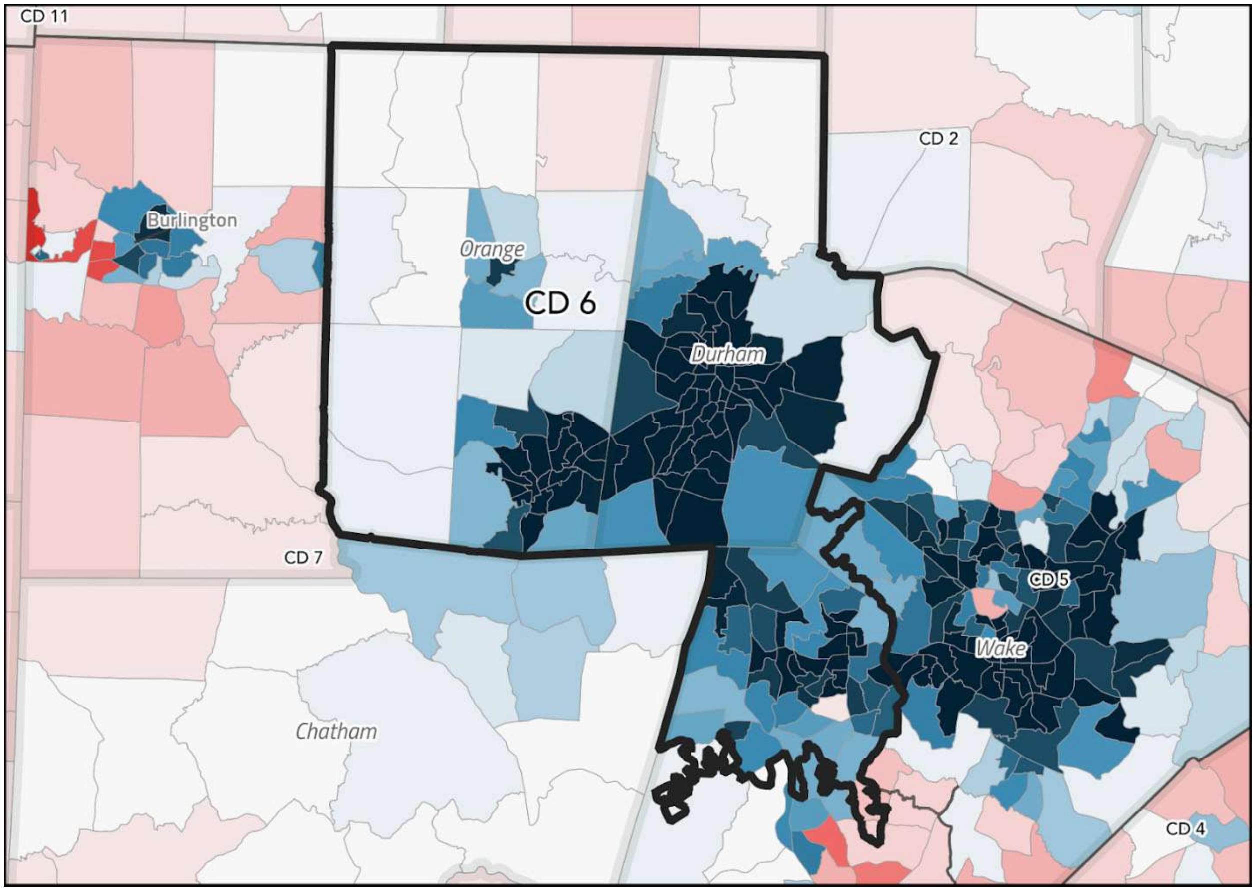


NC-6

The 6th district packs all of Orange, Durham counties and part of Wake County together into one overwhelmingly Democratic district, which is created out of portions of the current Districts 4 and 2 (previously D+16 and D+12, respectively). As the map below demonstrates, the district only includes four marginally Republican VTDs, according to the 2020 Attorney General/Secretary of Labor "CCSC" composite. Cook Political Report estimates this to be a D+22 district, Democrats had more than a 374,000 vote advantage in the CCSC and Donald Trump won only 25% of the vote in 2020. This district packs a greater proportion of Democratic voters in a single district than any district from the previous map. This district, like NC-5, includes Wake County, which is divided across three districts in the enacted map. The packing of Democrats in this district enables adjacent districts, in particular NC-7, to be drawn in ways that make it easier for Republican candidates to win.

The contours of this district border with NC-7 on the southern end splits communities of interest in almost comical ways. In one example, a person traveling south on New Hill Olive Chapel Road would, in a matter of a few miles, move from enacted NC-7 to the line between NC-6 and -7, back into NC-7, through NC-6, back into NC-7, back to the border between the two, back into NC-7, back to the border between the two, then back into NC-7. The contours of these lines are confusing to voters, and, as the map demonstrates, serve to pack as many Democratic precincts as possible into NC-6.

Map 9. VTD CCSC estimates for NC-6

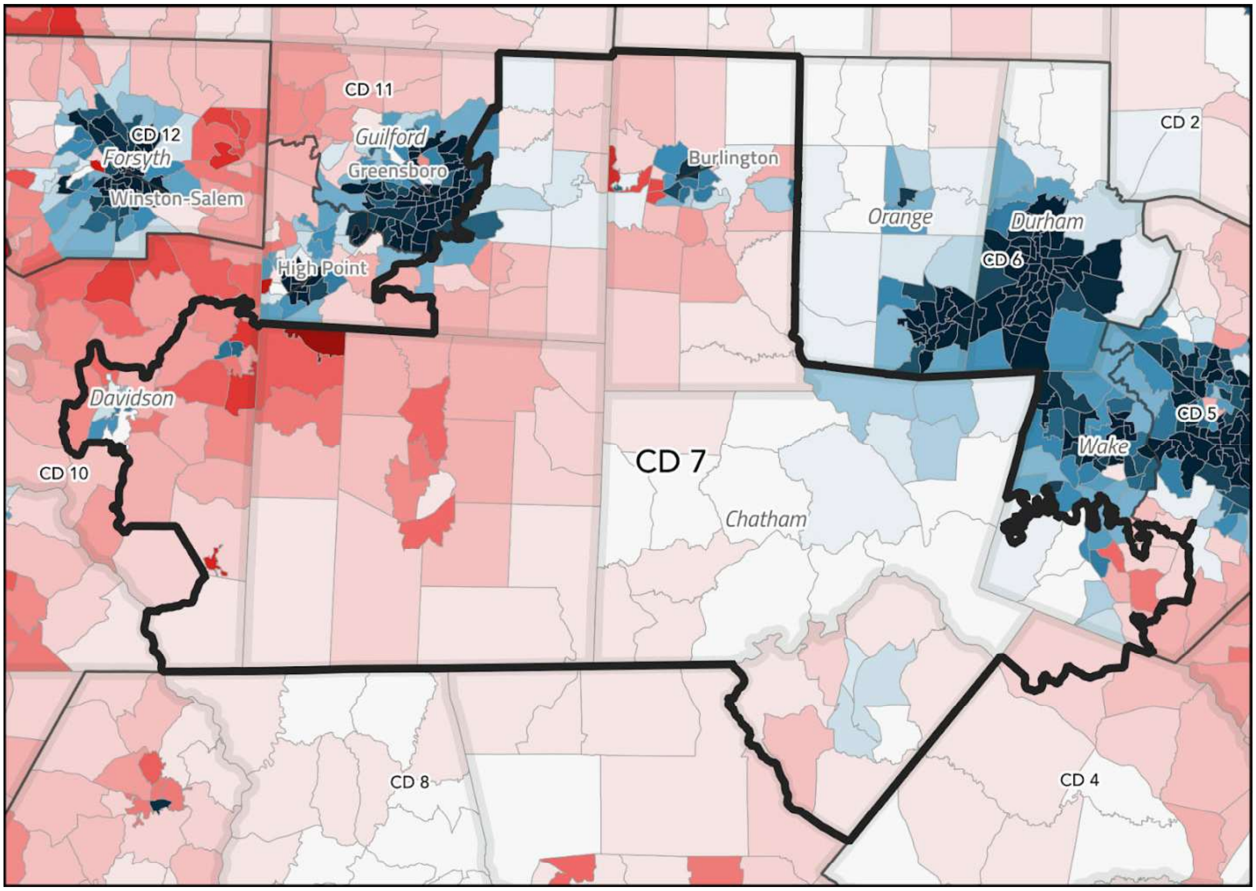


NC-7

The enacted 7th district includes the Republican-leaning Randolph, Alamance, Chatham and Lee Counties as well as portions of Guilford, Wake, and Davidson Counties. It is carved out of districts 13, 6, 4 and 2 from the current map. This district as it is drawn splits both Guilford and Wake Counties (each of which of is divided three times in the map as a whole). Despite including portions of two of the most Democratic counties in North Carolina, the district studiously avoids the Democratic-leaning areas of both counties. The eastern portion of the district in Wake County, near Apex, takes the unusual and confusing contours described in the description of NC-6 above.

The enacted NC-7 is considered R + 11 by the Cook Political Report, it gave Republicans a 115,682 vote advantage in the CCSC, and Donald Trump won 57% of the vote in this district. A Democratic candidate has virtually no chance of victory in the enacted 7th.

Map 10: VTD CCSC estimates for NC-7

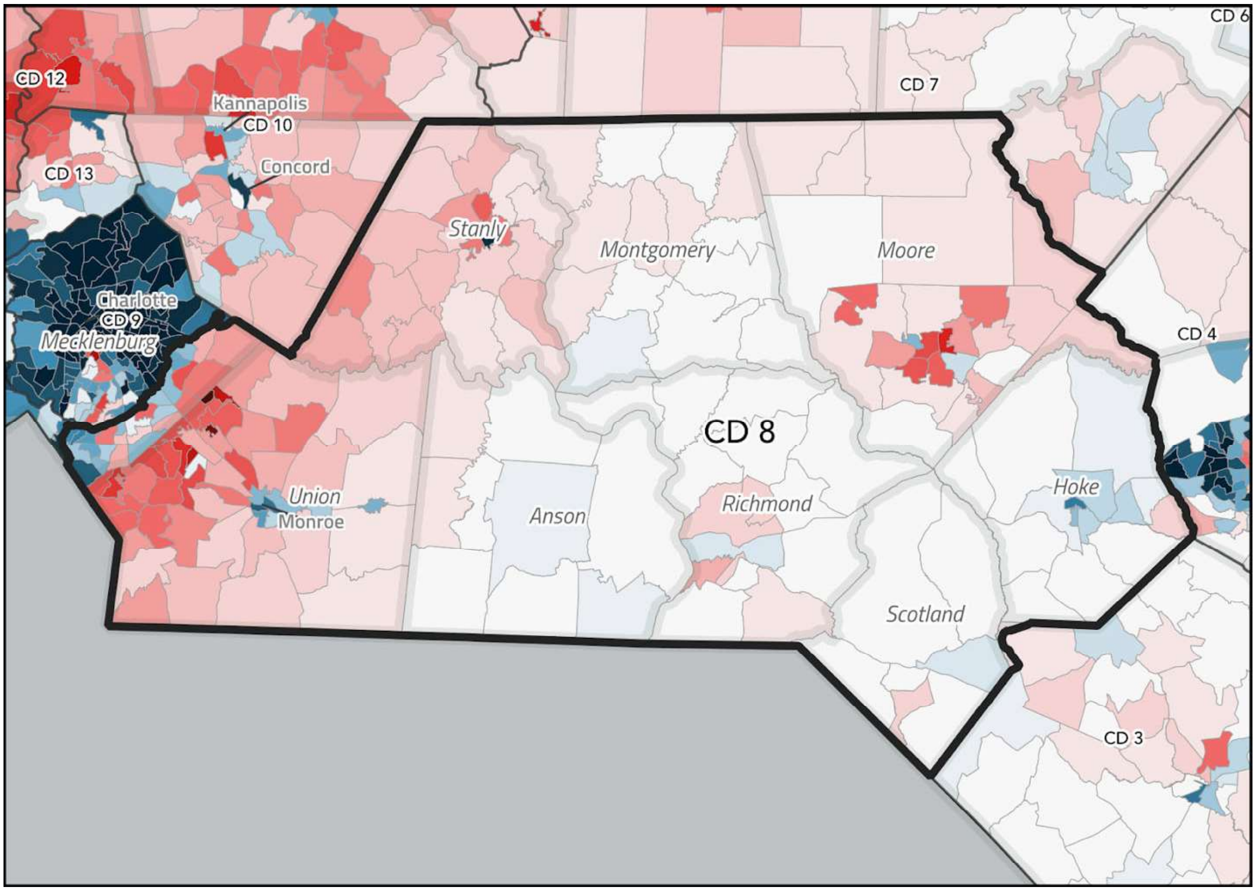


NC-8

The 8th congressional district stretches from the Sandhills into Mecklenburg County and includes portions of the current 9th, 12th, and 8th districts. The core of the district comes from NC-9, currently R+6. The enacted NC-8 includes the entirety of Scotland, Hoke, Moore, Montgomery, Anson, Union, and Stanley counties as well as the southern and eastern edge of Mecklenburg County. Although it includes portions of Mecklenburg County, one of the most Democratic-leaning areas in the state, as well as Democratic municipalities of Union, Anson, and Hoke, the 8th district is unlikely to elect a Democrat under any reasonable scenario. The enacted map stops just shy of the some of the darkest blue VTDs in Mecklenburg County.

The Cook Political Report calls the enacted NC-8 an R+11 district, the CCSC shows that the Republican candidate garnered over 115,000 more votes than the Democratic candidates for the two closest Council of State races, and Donald Trump won approximately 57% of the vote in the 2020 election.

Map 11: VTD CCSC estimates for NC-8



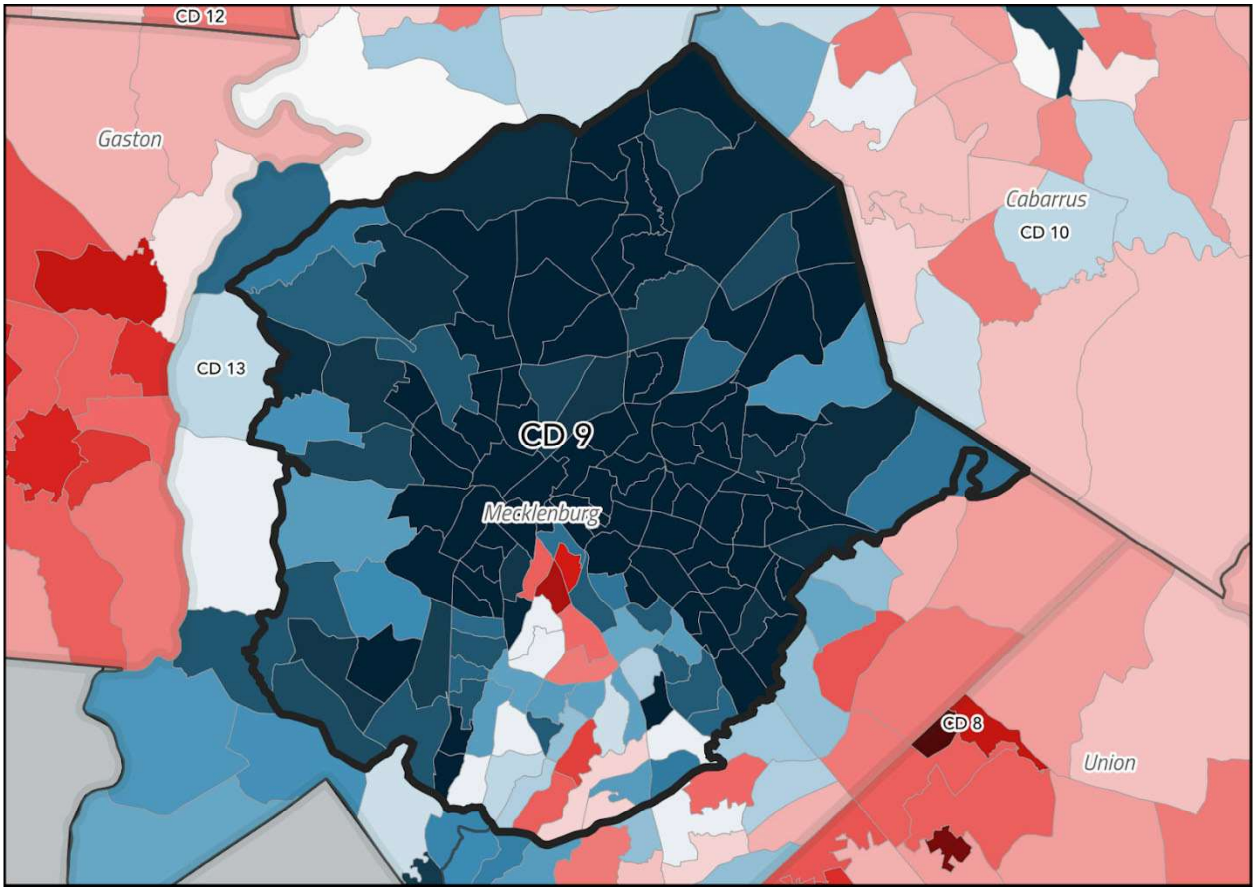
NC-9

The core of the enacted 9th congressional district come from NC-12, but it also includes portions of the current NC-9. The result is the most packed district in the enacted map. The Cook Political Report rates the enacted NC-9 as a D+23 district, meaning that it leans more heavily towards the Democratic Party than any district in the last map. Donald Trump won just 25% of the vote in this district in the 2020 Presidential election and the CCSC indicates that the Democrats won over 325,000 more votes than the Republicans in the two closest Council of State races in 2020.

As with all examples of packing, the key to understanding this district is its effects on the surrounding districts. By ensuing that the Democratic candidate in NC-9 wins by an overwhelming margin, Republican voters will be more efficiently distributed across other districts, where they can affect the outcome. This ensures that neighboring district 8, for example, will not be competitive. This also has the effect of ensuring that Republican voters in NC-9 have no chance of securing representation from a member of their own party.

The geographic contortions of this district are most apparent on its western edge, where a mere 8 miles separates the western edge of district 9 and the Mecklenburg County line.

Map 12. VTD CCSC estimates for NC-9

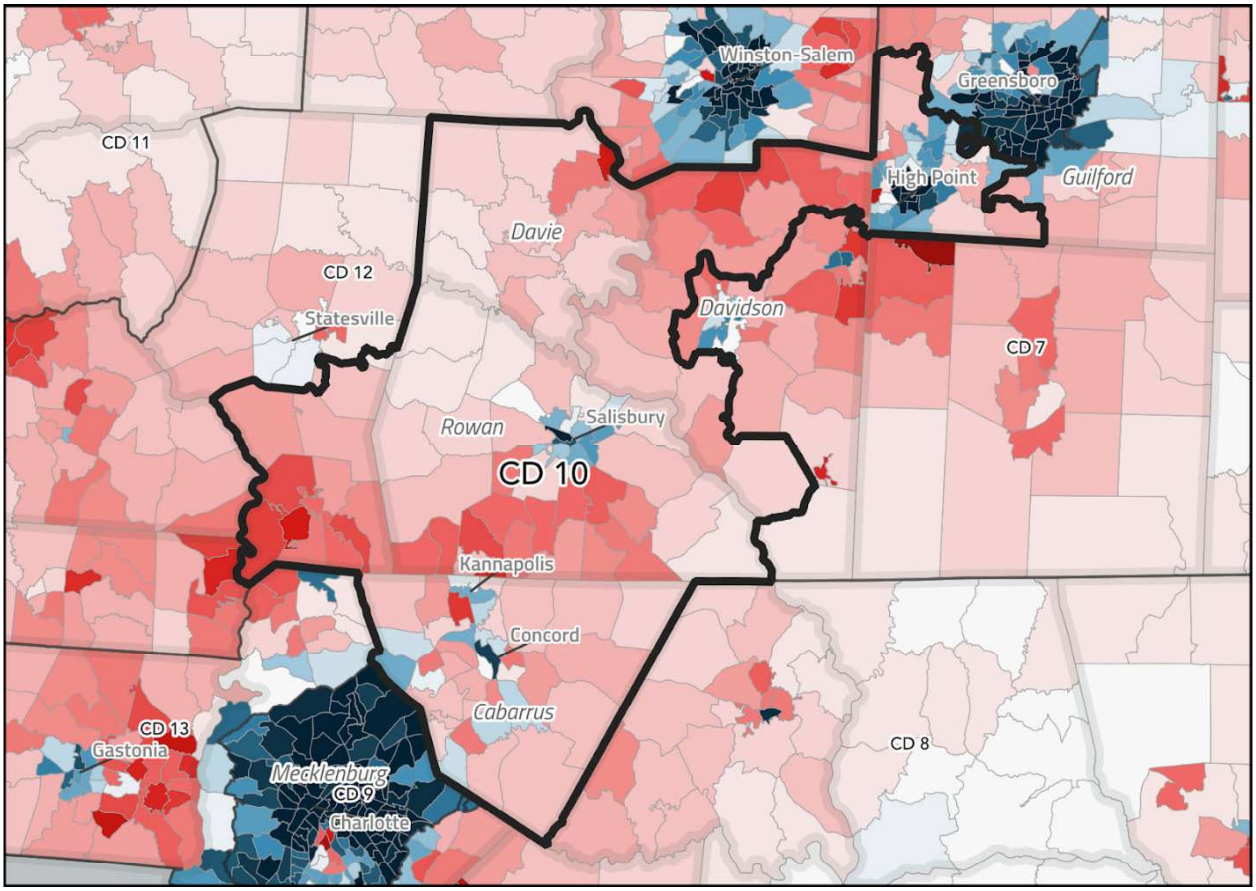


NC-10

The enacted NC-10 includes all of Rowan, Cabarrus and David County and parts of Iredell, Davidson and Guilford Counties. It is drawn out of portions of the current 10th, 9th, 6th, and 13th districts. Despite the inclusion of carefully curated portions of Democratic Guilford County, this district is a safe Republican seat and effectively removes any possibility that Democratic voters in High Point, Salisbury, Kannapolis, Concord, and Cabarrus can elect a member of their own political party. The Cook Political Report rates this district as R+14, the CCSC indicates that Republicans won more than 156,000 additional votes in the two key council of state races, and Donald Trump won over 60% of the Presidential vote in the enacted district.

The enacted NC-10 includes High Point, while NC-11 includes most of Greensboro and NC-12 contains Winston-Salem, meaning that the enacted map splits all three points of North Carolina's Piedmont Triad into separate congressional districts that favor Republicans. In the current map, this community of interest is together in NC-6, represented by Democrat Kathy Manning.

Map 13: VTD CCSC estimates for NC-10



NC-11

The enacted 11th congressional district is carved out of the 5th, 10th, and 6th districts. This map places a portion of Guilford County, including the City of Greensboro in a district with Rockingham, Stokes, Surrey, Alleghany, Ashe, Wilkes, Caldwell, and Alexander counties as well as a tiny boot-shaped sliver of Watauga County.

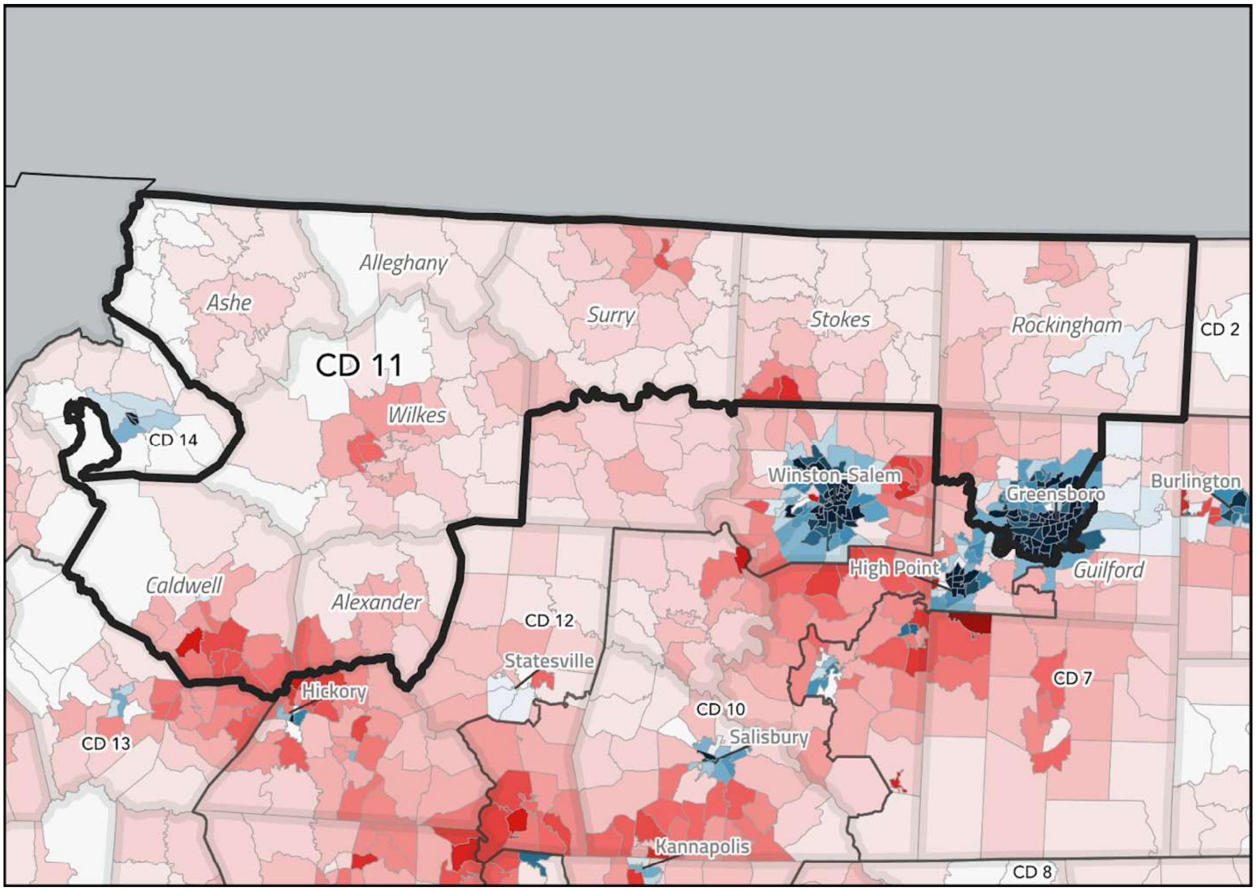
As discussed elsewhere, the enacted map splits Guilford County across three districts (the 10th, 11th, and 7th) and puts all three points of the Piedmont triad in separate districts. By placing most of Greensboro in this overwhelmingly Republican district, this ensures that the City of Greensboro, among the most Democratic and racially diverse cities in the state of North Carolina, will not be represented by a Democrat.

The enacted district is rated by Cook as R+9, 57% of the district voted for Donald Trump in the 2020 election, and Republicans held a 94,000 vote lead in the two closest Council of State elections. No Democrat in the current Congress represents a district that leans this heavily Republican.

It is difficult to imagine any sense in which this district has shared interests. Geographically, it spans radically different parts of the state. Greensboro is firmly in the Piedmont, resting at under 900 feet elevation. Watauga and Ashe counties, by comparison, reside in the high country, with elevations that consistently run above 5500 feet. The corners of the district have different area codes, are served by different media markets, and share virtually no characteristics in common other than the fact that they are both within North Carolina. In the history of North Carolina, Caldwell and Rockingham Counties have never shared a congressional representative.

In addition to its geographic span, the enacted district stands out for its double-bunking of Republican Virginia Foxx and Democrat Kathy Manning. To shoe-horn Virginia Foxx into the new district, the mapmakers carved out a tiny sliver of Watauga County to allow her house to fall into the redrawn district. This passage is so narrow, in fact, that is connected by a stretch of land that is roughly 3 miles wide and requires a traverse of the Daniel Boone Scout Trail.

Map 14: VTD CCSC estimates for NC-11

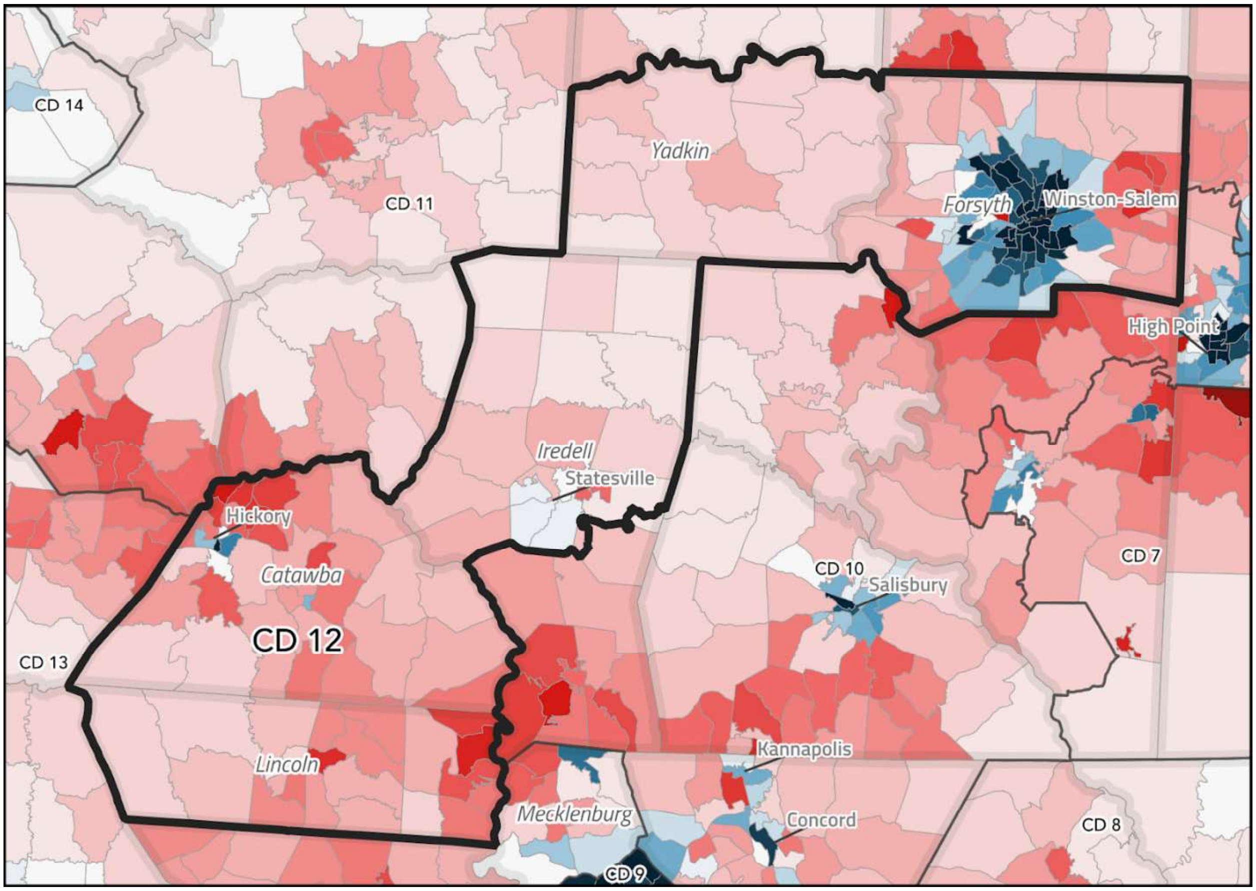


NC-12

The 12th congressional district stretches from Lincoln County at the southwestern corner through Catawba, the Northern part of Iredell, Yadkin, and Forsyth Counties. As the map below makes clear, by including Winston-Salem with this overwhelmingly red swath of geography and walling it off from Democratic voters in High Point, the enacted map ensures that Republican member of Congress Patrick McHenry, who lives at the southeast corner of this district, will maintain his seat and the Democratic voters in Winston-Salem will have virtually no chance to elect a member of their own party.

The Cook Political Report rates this district as R+9, Republicans had over a 100,000 vote margin in the two closest Council of State races, and Donald Trump won over 56% of the vote in this district.

Map 15: VTD CCSC estimates for NC-12



NC-13

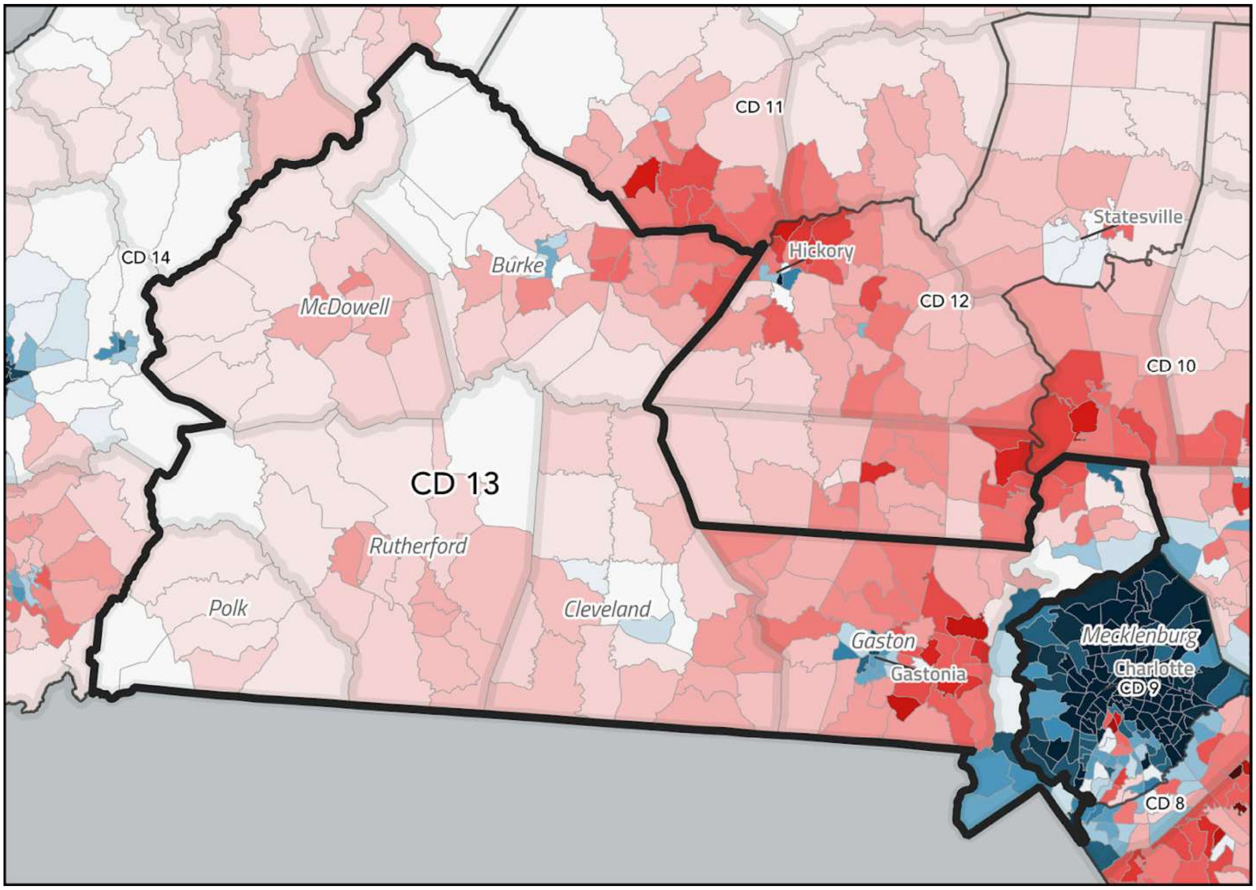
The 13th congressional district is carved out of portions of the old 11th, 5th, and 12th, and 10th districts. As the map that follows demonstrates, the district includes Polk, Rutherford, McDowell, Burke, Cleveland, Gaston, and part of Mecklenburg County.

The district was generally understood to be created for Republican Speaker of the House Tim Moore who lives in Cleveland County—the *Charlotte Observer*'s editorial board even referred to it as "Moore's designer district."[6] Republican Madison Cawthorn recently announced that he will run in the 13th, and Moore soon noted that he would stay in the General Assembly. While the specifics of the candidates have changed, the fact that this is a Republican district that will elected a Republican candidate has not. This district was rated by the Cook Political Report as R+13, has a CCSC of R+150,187 votes, and gave 60% of its votes to Donald Trump in 2020.

As mentioned in the discussion of NC-9, the narrow passageway that is necessary to squeeze NC-13 into Mecklenburg County only consists of a few miles at one point--stretching from a Food Lion to the Mecklenburg County line. The enacted district also creates unusual pairings of counties that share little in common. For example, Polk and Mecklenburg Counties have never resided in the same district.

[6] https://www.charlotteobserver.com/opinion/article255769626.html

Map 16. VTD CCSC estimates for NC-13

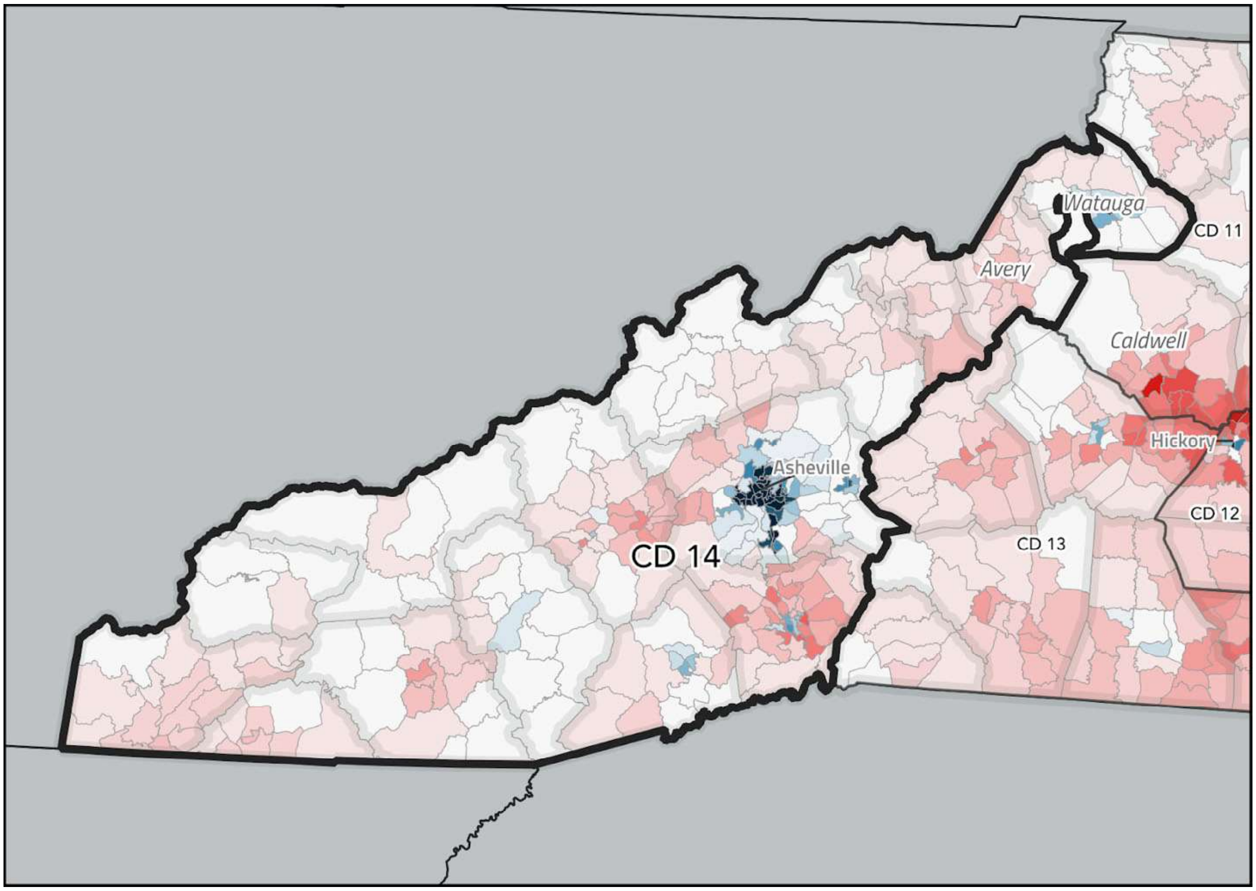


NC-14

The enacted 14th district includes most of the 11th congressional district and includes part of Watauga County, which previously sat in the 5th congressional district. The former 11th congressional district also lost the Republican strongholds of Polk and McDowell counties, as well as part of Rutherford County. These changes shifted the district slightly in the Democratic direction (from a PVI of R+9 to R+7), although not enough to give a Democratic candidate a reasonable chance of victory. No Democrat in Congress represents a district that has a PVI score that leans this heavily towards the Republican Party. As a result, the 14th is expected to stay squarely in Republican hands.

Geographically, the 14th is a sprawling district that includes three media markets. Traversing the district from its western end in Murphy to its northeastern corner in Stony Fork would take approximately four hours. Perhaps because of the geographic incompatibility, Watauga has not been in a district with the western end of the state since 1871—before Graham and Swain Counties were even in existence. Adequately representing this massive swath of geography would be difficult for any member of Congress—Republican or Democrat.

Map 17. VTD CCSC estimates for NC-14



Conclusion

After analyzing the characteristics of the map as a whole as well as the characteristics of each district in isolation, it is clear that the enacted map will increase the number of Republican members of Congress and decrease the number of Democratic members of Congress in North Carolina's congressional delegation. Democratic voters in the vast majority of the districts will have no chance at representation from a member of their own party and Republican voters in the districts that pack Democrats will have no chance of representation from a member of their own party. This is not a result of natural packing, or geographic clustering, but rather because the congressional district lines shifted in ways that, taken together, benefit the Republican Party. Not only does the enacted map create a substantial partisan advantage for which there is no apparent explanation other than gerrymandering, but it unnecessarily splits communities of interest and will alters representational linkages in ways that, in some cases, have never been seen in North Carolina's history.

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Christopher A. Cooper

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EXHIBIT H

STATE OF NORTH CAROLINA | **IN THE GENERAL COURT OF JUSTICE**

COUNTY OF WAKE | **SUPERIOR COURT DIVISION**

No.21 CVS 500085

REBECCA HARPER; AMY CLARE OSEROFF; DONALD RUMPH; JOHN ANTHONY BALLA; RICHARD R. CREWS; LILY NICOLE QUICK; GETTYS COHEN JR.; SHAWN RUSH; JACKSON THOMAS DUNN, JR.; MARK S. PETERS; KATHLEEN BARNES; VIRGINIA WALTERS BRIEN; DAVID DWIGHT BROWN,

Plaintiffs,

v.

REPRESENTATIVE DESTIN HALL, IN HIS OFFICIAL CAPACITY AS CHAIR OF THE HOUSE STANDING COMMITTEE ON REDISTRICTING; SENATOR WARREN DANIEL, IN HIS OFFICIAL CAPACITY AS CO-CHAIR OF THE SENATE STANDING COMMITTEE ON REDISTRICTING AND ELECTIONS; SENATOR RALPH HISE, IN HIS OFFICIAL CAPACITY AS CO-CHAIR OF THE SENATE STANDING COMMITTEE ON REDISTRICTING AND ELECTIONS; SENATOR PAUL NEWTON, IN HIS OFFICIAL CAPACITY AS CO-CHAIR OF THE SENATE STANDING COMMITTEE ON REDISTRICTING AND ELECTIONS; SPEAKER OF THE NORTH CAROLINA HOUSE OF REPRESENTATIVES TIMOTHY K. MOORE; PRESIDENT PRO TEMPORE OF THE NORTH CAROLINA SENATE PHILIP E. BERGER; THE NORTH CAROLINA STATE BOARD OF ELECTIONS; DAMON CIRCOSTA, IN HIS OFFICIAL CAPACITY AS CHAIRMAN OF THE NORTH

EXPERT REPORT OF DR. JOWEI CHEN

CAROLINA STATE BOARD OF ELECTIONS; STELLA ANDERSON, IN HER OFFICIAL CAPACITY AS SECRETARY OF THE NORTH CAROLINA STATE BOARD OF ELECTIONS; JEFF CARMON III, IN HIS OFFICIAL CAPACITY AS MEMBER OF THE NORTH CAROLINA STATE BOARD OF ELECTIONS; STACY EGGERS IV, IN HIS OFFICIAL CAPACITY AS MEMBER OF THE NORTH CAROLINA STATE BOARD OF ELECTIONS; TOMMY TUCKER, IN HIS OFFICIAL CAPACITY AS MEMBER OF THE NORTH CAROLINA STATE BOARD OF ELECTIONS,

Defendants.

I, Dr. Jowei Chen, upon my oath, declare and say as follows:

1. I am over the age of eighteen (18) and competent to testify as to the matters set forth herein.

2. I am an Associate Professor in the Department of Political Science at the University of Michigan, Ann Arbor. I am also a Research Associate Professor at the Center for Political Studies of the Institute for Social Research at the University of Michigan and a Research Associate at the Spatial Social Science Laboratory at Stanford University. In 2007, I received a M.S. in Statistics from Stanford University, and in 2009, I received a Ph.D. in Political Science from Stanford University.

3. I have published academic papers on legislative districting and political geography in several political science journals, including The American Journal of Political Science and The American Political Science Review, and Election Law Journal. My academic areas of expertise include legislative elections, spatial statistics, geographic information systems

(GIS) data, redistricting, racial politics, legislatures, and political geography. I have expertise in the use of computer simulations of legislative districting and in analyzing political geography, elections, and redistricting.

4. I have authored expert reports in the following redistricting court cases: *The League of Women Voters of Florida v. Detzner* (Fla. 2d Judicial Cir. Leon Cnty. 2012); *Romo v. Detzner* (Fla. 2d Judicial Cir. Leon Cnty. 2013); *Missouri National Association for the Advancement of Colored People v. Ferguson-Florissant School District & St. Louis County Board of Election Commissioners* (E.D. Mo. 2014); *Raleigh Wake Citizens Association v. Wake County Board of Elections* (E.D.N.C. 2015); Brown v. Detzner (N.D. Fla. 2015); *City of Greensboro v. Guilford County Board of Elections* (M.D.N.C. 2015); *Common Cause v. Rucho* (M.D.N.C 2016); *The League of Women Voters of Pennsylvania v. Commonwealth of Pennsylvania* (No. 261 M.D. 2017); *Georgia State Conference of the NAACP v. The State of Georgia* (N.D. Ga. 2017); *The League of Women Voters of Michigan v. Johnson* (E.D. Mich. 2017); *Whitford v. Gill* (W.D. Wis. 2018); *Common Cause v. Lewis* (N.C. Super. 2018); *Harper v. Lewis* (N.C. Super. 2019); *Baroody v. City of Quincy, Florida* (N.D. Fla. 2020); *McConchie v. Illinois State Board of Elections* (N.D. Ill. 2021). I have testified either at deposition or at trial in the following cases: *Romo v. Detzner* (Fla. 2d Judicial Cir. Leon Cnty. 2013*); Missouri National Association for the Advancement of Colored People v. Ferguson-Florissant School District & St. Louis County Board of Election Commissioners* (E.D. Mo. 2014); *Raleigh Wake Citizens Association v. Wake County Board of Elections* (E.D.N.C. 2015); *City of Greensboro v. Guilford County Board of Elections* (M.D.N.C. 2015); *Common Cause v. Rucho* (M.D.N.C. 2016); *The League of Women Voters of Pennsylvania v. Commonwealth of Pennsylvania* (No. 261 M.D. 2017); *Georgia State Conference of the NAACP* v. *The State of Georgia* (N.D. Ga. 2017); *The*

League of Women Voters of Michigan v. Johnson (E.D. Mich. 2017); *Whitford v. Gill* (W.D. Wis. 2018); *Common Cause v. Lewis* (N.C. Super. 2018); *Baroody v. City of Quincy, Florida* (N.D. Fla. 2020).

5. I have been retained by Plaintiffs in the above-captioned matter. I am being compensated $550 per hour for my work in this case.

6. Plaintiffs' counsel asked me to analyze the SB 740 districting plan for North Carolina's congressional districts (the "Enacted Plan"), as passed on November 4, 2021. Plaintiffs' counsel asked me to produce a set of computer-simulated plans for North Carolina's congressional districts by following the criteria adopted by the North Carolina General Assembly's Joint Redistricting Committee on August 12, 2021 (the "Adopted Criteria"). Plaintiffs' counsel asked me to compare the district-level partisan attributes of the Enacted Plan to those of the computer-simulated plans and to identify any districts in the Enacted Plan that are partisan outliers. Plaintiffs' counsel also asked me to compare the partisan composition of the individual Plaintiffs' congressional districts under the Enacted Plan to the partisan composition of Plaintiffs' districts under the computer-simulated plans and to identify any Plaintiffs whose Enacted Plan districts are partisan outliers.

7. ***The Use of Computer-Simulated Districting Plans:*** In conducting my academic research on legislative districting, partisan and racial gerrymandering, and electoral bias, I have developed various computer simulation programming techniques that allow me to produce a large number of nonpartisan districting plans that adhere to traditional districting criteria using US Census geographies as building blocks. This simulation process ignores all partisan and racial considerations when drawing districts. Instead, the computer simulations are programmed to draw districting plans following various traditional districting goals, such as equalizing

population, avoiding county and Voting Tabulation District (VTD) splits, and pursuing geographic compactness. By randomly generating a large number of districting plans that closely adhere to these traditional districting criteria, I am able to assess an enacted plan drawn by a state legislature and determine whether partisan goals motivated the legislature to deviate from these traditional districting criteria. More specifically, by holding constant the application of nonpartisan, traditional districting criteria through the simulations, I am able to determine whether the enacted plan could have been the product of something other than partisan considerations. With respect to North Carolina's 2021 Congressional Enacted Plan, I determined that it could not.

8. I produced a set of 1,000 valid computer-simulated plans for North Carolina's congressional districts using a computer algorithm programmed to strictly follow the required districting criteria enumerated in the August 12, 2021 Adopted Criteria of the General Assembly's Joint Redistricting Committee. In following these Adopted Criteria, the computer algorithm uses the same general approach that I employed in creating the simulated state House and state Senate plans that I analyzed in *Common Cause v. Lewis* (2019) and the simulated congressional plans that I used in *Harper v. Lewis* (2019).

9. By randomly drawing districting plans with a process designed to strictly follow nonpartisan districting criteria, the computer simulation process gives us an indication of the range of districting plans that plausibly and likely emerge when map-drawers are not motivated primarily by partisan goals. By comparing the Enacted Plan against the distribution of simulated plans with respect to partisan measurements, I am able to determine the extent to which a map-drawer's subordination of nonpartisan districting criteria, such as geographic compactness and preserving precinct boundaries, was motivated by partisan goals.

10. These computer simulation methods are widely used by academic scholars to analyze districting maps. For over a decade, political scientists have used such computer-simulated districting techniques to analyze the racial and partisan intent of legislative map-drawers.[1] In recent years, several courts have also relied upon computer simulations to assess partisan bias in enacted districting plans.[2]

11. ***Redistricting Criteria:*** I programmed the computer algorithm to create 1,000 independent simulated plans adhering to the following the seven districting criteria, as specified in the Adopted Criteria:

a) Population Equality: Because North Carolina's 2020 Census population was 10,439,388, districts in every 14-member congressional plan have an ideal population of 745,670.6. Accordingly, the computer simulation algorithm populated each districting plan such that precisely six districts have a population of 745,670, while the remaining eight districts have a population of 745,671.

b) Contiguity: The simulation algorithm required districts to be geographically contiguous. Water contiguity is permissible. I also programmed the simulation algorithm to avoid double-traversals within a single county. In other words, for every simulated district, the portion of that district within any given county will be geographically contiguous.

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[1] E.g., Carmen Cirincione, Thomas A. Darling, Timothy G. O'Rourke. "Assessing South Carolina's 1990s Congressional Districting," Political Geography 19 (2000) 189–211; Jowei Chen, "The Impact of Political Geography on Wisconsin Redistricting: An Analysis of Wisconsin's Act 43 Assembly Districting Plan." Election Law Journal

[2] *See, e.g.*, *League of Women Voters of Pa. v. Commonwealth*, 178 A. 3d 737, 818-21 (Pa. 2018); *Raleigh Wake Citizens Association v. Wake County Board of Elections*, 827 F.3d 333, 344-45 (4th Cir. 2016); *City of Greensboro v. Guilford County Board of Elections*, No. 1:15-CV-599, 2017 WL 1229736 (M.D.N.C. Apr 3, 2017); *Common Cause v. Rucho*, No. 1:16-CV-1164 (M.D.N.C. Jan 11, 2018*); The League of Women Voters of Michigan v. Johnson* (E.D. Mich. 2017); *Common Cause v. David Lewis* (N.C. Super. 2018).

c) Minimizing County Splits: The simulation algorithm avoided splitting any of North Carolina's 100 counties, except when doing so is necessary to avoid violating one of the aforementioned criteria. When a county is divided into two districts, the county is considered to have one split. A county divided into three districts is considered to have two splits. A county divided into four districts is considered to have three splits, and so on. For the purpose of creating equally populated districts, each newly drawn congressional district requires only one county split. But the fourteenth and final district drawn in North Carolina does need not create an additional county split, since this final district should simply be the remaining area unassigned to the first thirteen districts. Therefore, an entire plan of 14 congressional districts requires only 13 county splits. Accordingly, I require that every simulated plan contain only 13 county splits. The 2021 Adopted Criteria do not prohibit splitting a county more than once, so I allow some of these 13 county splits to occur within the same county. As a result, the total number of counties containing one or more splits may be fewer than 13.

d) Minimizing VTD Splits: North Carolina is divided into 2,666 VTDs. The computer simulation algorithm attempted to keep these VTDs intact and not split them into multiple districts, except when doing so is necessary for creating equally populated districts. For the purpose of creating equally populated districts, each newly drawn congressional district requires one VTD split. But the fourteenth and final district drawn in North Carolina does need not create an additional VTD split, since this final district should simply be the remaining area unassigned to the first thirteen districts. Therefore, an entire plan of 14 congressional districts requires only 13 VTD splits. I therefore require that every simulated plan split only 13 VTDs in total.

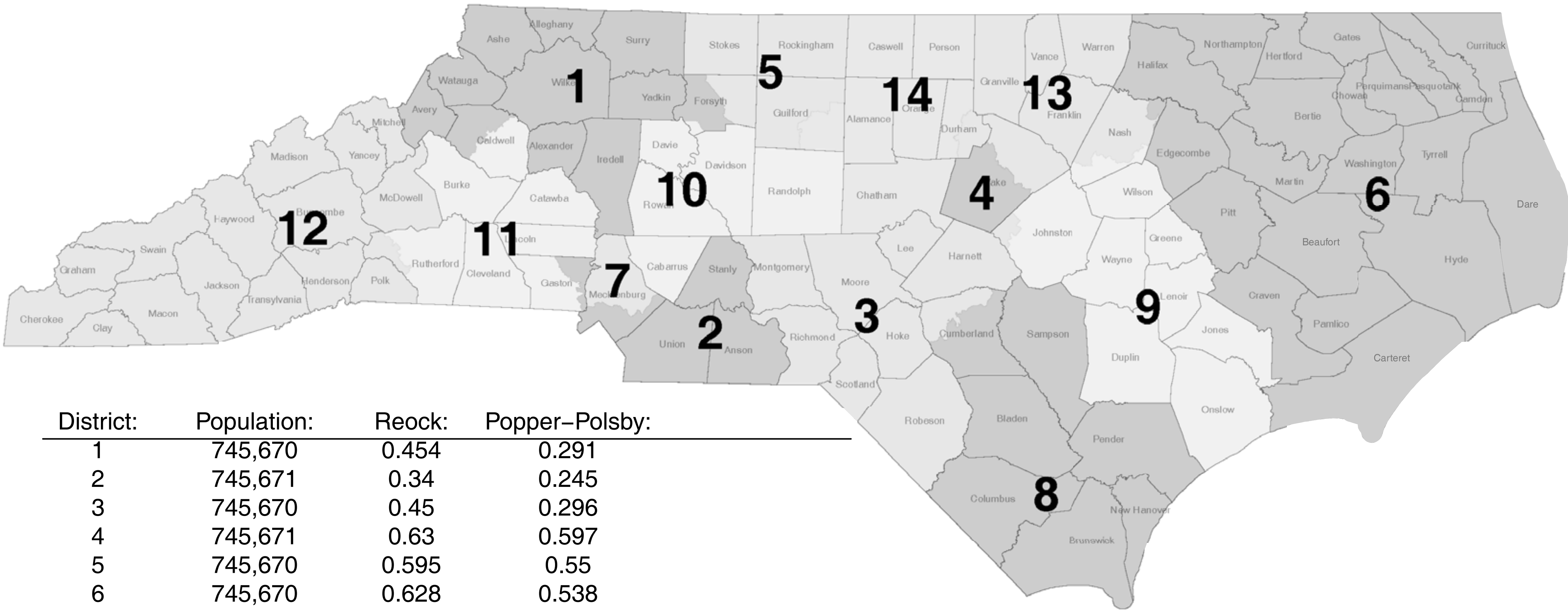
e) Geographic Compactness: The simulation algorithm prioritized the drawing of geographically compact districts whenever doing so does not violate any of the aforementioned criteria.

f) Avoiding Incumbent Pairings: North Carolina's current congressional delegation includes two incumbents, Representatives Ted Budd and David Price, who announced before the Enacted Plan was adopted that they will not run for reelection in 2022. For the remaining eleven congressional incumbents, the simulation algorithm intentionally avoids pairing multiple incumbents in the same district. Hence, in every computer-simulated plan, each district contains no more than one incumbent's residence.

g) Municipal Boundaries: The simulation algorithm generally favors not splitting municipalities, but this consideration is given lower priority than all of the aforementioned criteria. For example, the algorithm would not intentionally split a VTD in order to preserve a municipality, as the Adopted Criteria clearly prioritizes VTD preservation over municipal boundaries.

12. On the following page of this report, Map 1 displays an example of one of the computer-simulated plans produced by the computer algorithm. The lower half of this Map also reports the population of each district, the compactness scores for each district, and the county splits and VTD splits created by the plan. As with every simulated plan, this plan contains exactly 13 VTD splits and 13 county splits, with 11 counties split into two or more districts.

Map 1:
Example of a Computer−Simulated Congressional Plan Protecting all 11 Incumbents



District:	Population:	Reock:	Popper−Polsby:
1	745,670	0.454	0.291
2	745,671	0.34	0.245
3	745,670	0.45	0.296
4	745,671	0.63	0.597
5	745,670	0.595	0.55
6	745,670	0.628	0.538
7	745,671	0.555	0.44
8	745,671	0.555	0.402
9	745,671	0.494	0.345
10	745,671	0.527	0.535
11	745,670	0.592	0.295
12	745,671	0.354	0.313
13	745,671	0.629	0.396
14	745,670	0.513	0.439
Plan Average:	745,670.6	0.523	0.406

11 Split Counties:
Caldwell (Districts 1, 11)
Cumberland (Districts 3, 8)
Durham (Districts 13, 14)
Forsyth (Districts 1, 10, 5)
Gaston (Districts 11, 2)
Guilford (Districts 14, 5)
Johnston (Districts 3, 9)
Mecklenburg (Districts 2, 7)
Nash (Districts 13, 6, 9)
Rutherford (Districts 11, 12)
Wake (Districts 13, 4)

13 Split VTD's:
VTD 00PR32 in Caldwell County (Districts 1 and 11)
VTD 00CC17 in Cumberland County (Districts 3 and 8)
VTD 055−11 in Durham County (Districts 13 and 14)
VTD 000051 in Forsyth County (Districts 1 and 10)
VTD 000301 in Forsyth County (Districts 1 and 5)
VTD 000025 in Gaston County (Districts 11 and 2)
VTD 000PG1 in Guilford County (Districts 14 and 5)
VTD 00PR33 in Johnston County (Districts 3 and 9)
VTD 000216 in Mecklenburg County (Districts 2 and 7)
VTD 00P16A in Nash County (Districts 13 and 6)
VTD 00P22A in Nash County (Districts 13 and 9)
VTD 000018 in Rutherford County (Districts 11 and 12)
VTD 001−36 in Wake County (Districts 13 and 4)

The Enacted Plan's Compliance with the Adopted Criteria:

13. Although all seven of the criteria listed above are part of the General Assembly's Adopted Criteria, five of these criteria are ones that the Joint Redistricting Committee "shall" or "should" follow in the process of drawing its Congressional districting plan. These five mandated criteria are: equal population; contiguity, minimizing county splits, minimizing VTD splits, and geographic compactness.[3]

14. I assessed whether the 2021 Enacted Plan complies with these five mandated criteria, and I describe my findings in this section. I found that the Enacted Plan does not violate the equal population requirement, nor do any of its districts violate contiguity.

15. However, by comparing the Enacted Plan to the 1,000 computer-simulated plans, I found that the Enacted Plan fails to minimize county splits, fails to minimize VTD splits, and is significantly less geographically compact than is reasonably possible. I describe these findings below in detail.

16. ***Minimizing County Splits:*** In comparing the total number of county splits in the Enacted Plan and in the computer-simulated plans, I counted the total number of times a county is split into more than one district. Specifically, a county fully contained within a single district counts as zero splits. A county split into two full or partial districts counts as one split. And a county split into three full or partial districts counts as two splits. And so on.

17. Using this standard method of accounting for total county splits, I found that the Enacted Plan contains 14 total county splits, which are detailed in Table 1. These 14 total county splits are spread across 11 counties. Eight of these 11 counties are split only once, but Guilford,

[3] In listing these five mandated criteria, I am not including the Adopted Criteria's prohibitions on the use of racial data, partisan considerations, and election results data. I did not assess whether the Enacted Plan complies with the prohibition on racial considerations.

Mecklenburg, and Wake Counties are each split into three districts, thus accounting for two splits each. Thus, the Enacted Plan has 14 total county splits, as listed in Table 1.

Table 1: Total Number of County Splits in the 2021 Enacted Plan

	County:	Congressional Districts:	Total County Splits:
1	Davidson	7 and 10	1
2	Guilford	7, 10, and 11	2
3	Harnett	4 and 7	1
4	Iredell	10 and 12	1
5	Mecklenburg	8, 9, and 13	2
6	Onslow	1 and 3	1
7	Pitt	1 and 2	1
8	Robeson	3 and 8	1
9	Wake	5, 6, and 7	2
10	Watauga	11 and 14	1
11	Wayne	2 and 4	1
Total County Splits:			14

18. As explained in the previous section, a congressional plan in North Carolina needs to contain only 13 county splits if the map-drawer is attempting to minimize the splitting of counties. The Enacted Plan's 14 county splits is therefore one more split than is necessary. This "extra" split is specifically found at the border between District 7 and District 10. In general, the border between any two congressional districts in North Carolina needs to split only one county, at most. But in the Enacted Plan, the border between Districts 7 and 10 creates two county splits: One split of Davidson County and one split of Guilford County. Creating two county splits of Davidson and Guilford Counties was not necessary for equalizing district populations. Nor was it necessary for protecting incumbents, as no incumbents reside in the

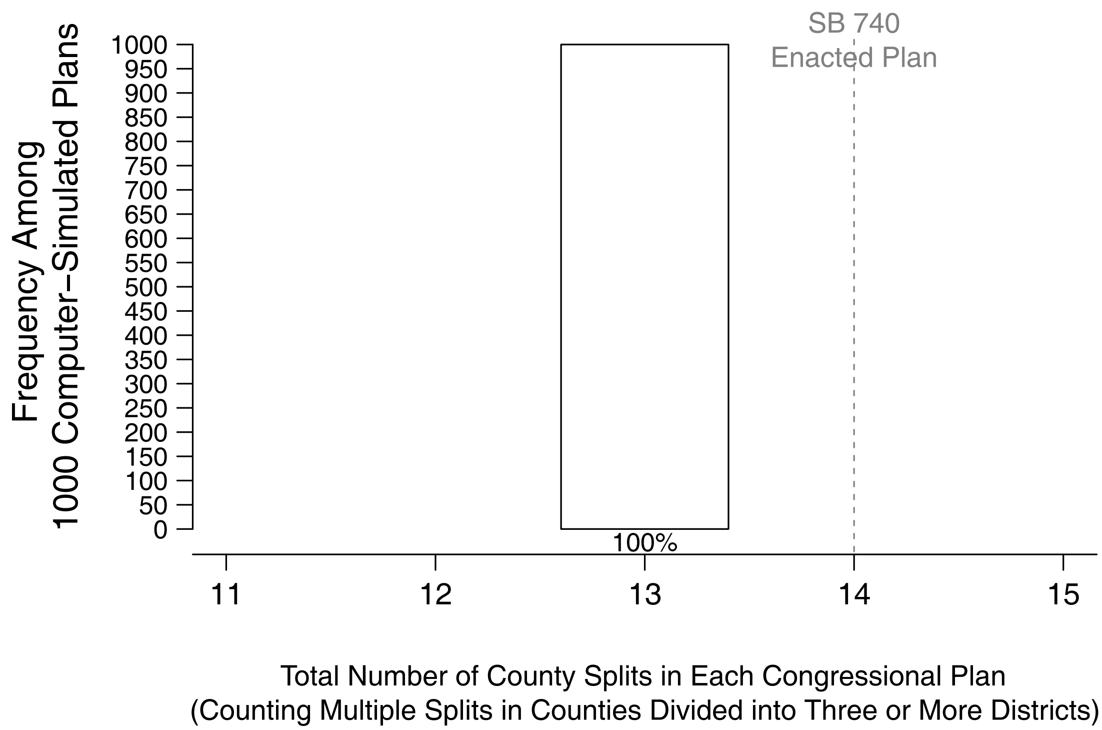
portions of Davidson and Guilford Counties within District 7 and District 10. Hence, the "extra" county split in Davidson and Guilford Counties does not appear to be consistent with the 2021 Adopted Criteria, which mandate that "Division of counties in the 2021 Congressional plan shall only be made for reasons of equalizing population and consideration of double bunking."

19. Indeed, I found that the computer simulation algorithm was always able to draw districts complying with the Adopted Criteria without using an "extra" 14th county split. As the upper half of Figure 1 illustrates, all 1,000 computer-simulated plans contain exactly 13 county splits. The Enacted Plan clearly contains more county splits than one would expect from a map-drawing process complying with the Adopted Criteria. Therefore, I conclude that the Enacted Plan does not comply with the Adopted Criteria's rule against unnecessary division of counties.

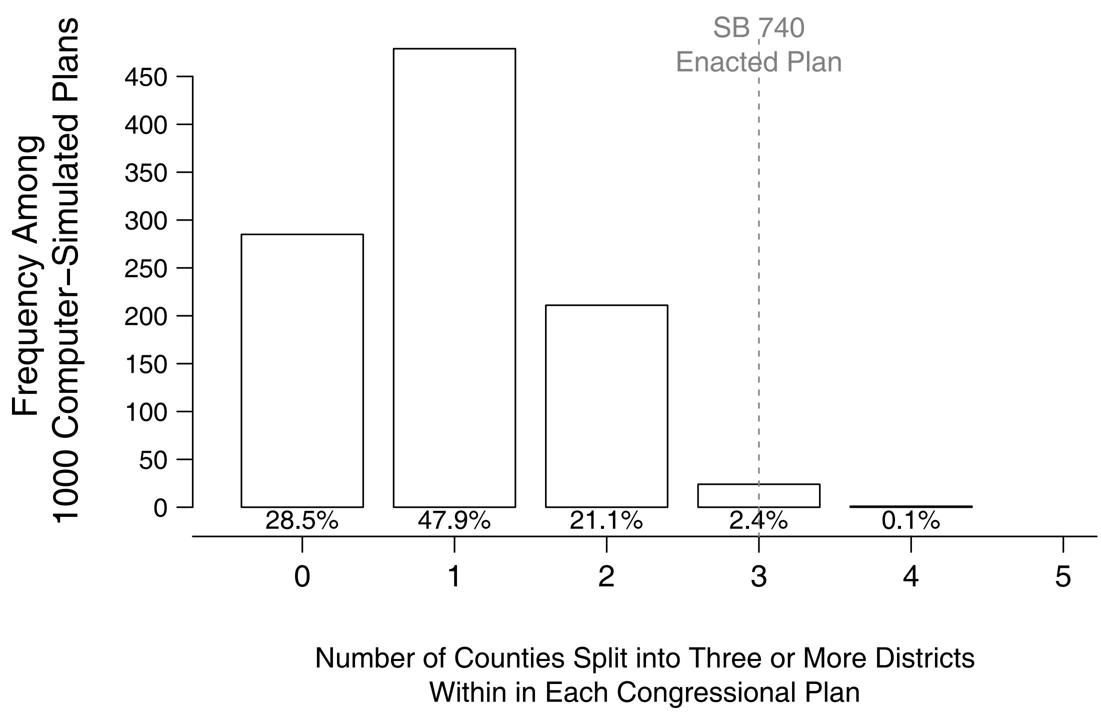
20. The Adopted Criteria do not explicitly limit the number of county splits within any single county. Nevertheless, it is notable that under the Enacted Plan, three different counties (Guilford, Mecklenburg, and Wake) are split multiple times. These three counties are each split into three districts under the Enacted Plan. This is an outcome that rarely occurs under the computer-simulated plans. As the lower half of Figure 1 illustrates, only 2.5% of the computer-simulated plans similarly split three or more counties multiple times. Thus, it is clear that the Enacted Plan's level of concentrating multiple county splits within a single county is an outcome that generally does not occur in a vast majority of the simulated plans drawn according to the Adopted Criteria.

Figure 1:

Comparison of Total County Splits in Enacted SB 740 Plan and 1,000 Computer–Simulated Plans



Number of Counties Split Multiple Times
in Enacted SB 740 Plan and 1,000 Computer–Simulated Plans



21. Minimizing VTD Splits: The Adopted Criteria mandates that "Voting districts ("VTDs") should be split only when necessary." As explained earlier in this report, each newly drawn congressional district needs to create only one VTD split for the purpose of equalizing the district's population. But the fourteenth and final district drawn in North Carolina does need not create an additional VTD split, since this final district should simply be the remaining area unassigned to the first thirteen districts. Therefore, an entire plan of 14 congressional districts needs to create only 13 VTD splits.

22. However, the Enacted Plan creates far more VTD splits than is necessary. As the General Assembly's "StatPack" Report[4] for the Enacted SB 740 Plan details, the Enacted plan splits 24 VTDs into multiple districts. Among these 24 split VTDs, 23 VTDs are split into two districts, while one VTD (Wake County VTD 18-02) is split into three districts. Thus, using the same method of accounting for splits described earlier, the Enacted Plan contains 25 total VTD splits, and 24 VTDs are split into two or more districts.

23. The Enacted Plan's 25 total VTD splits is far more than is necessary to comply with the Adopted Criteria' equal population requirement. As explained earlier, only 13 VTD splits are necessary in order to produce an equally-populated congressional plan in North Carolina. Thus, as Figure 2 illustrates, every one of the 1,000 computer-simulated plans contains exactly 13 VTD splits, and the Enacted Plan's 25 total VTD splits is clearly not consistent with the Adopted Criteria's requirement that "Voting districts ('VTDs') should be split only when necessary."

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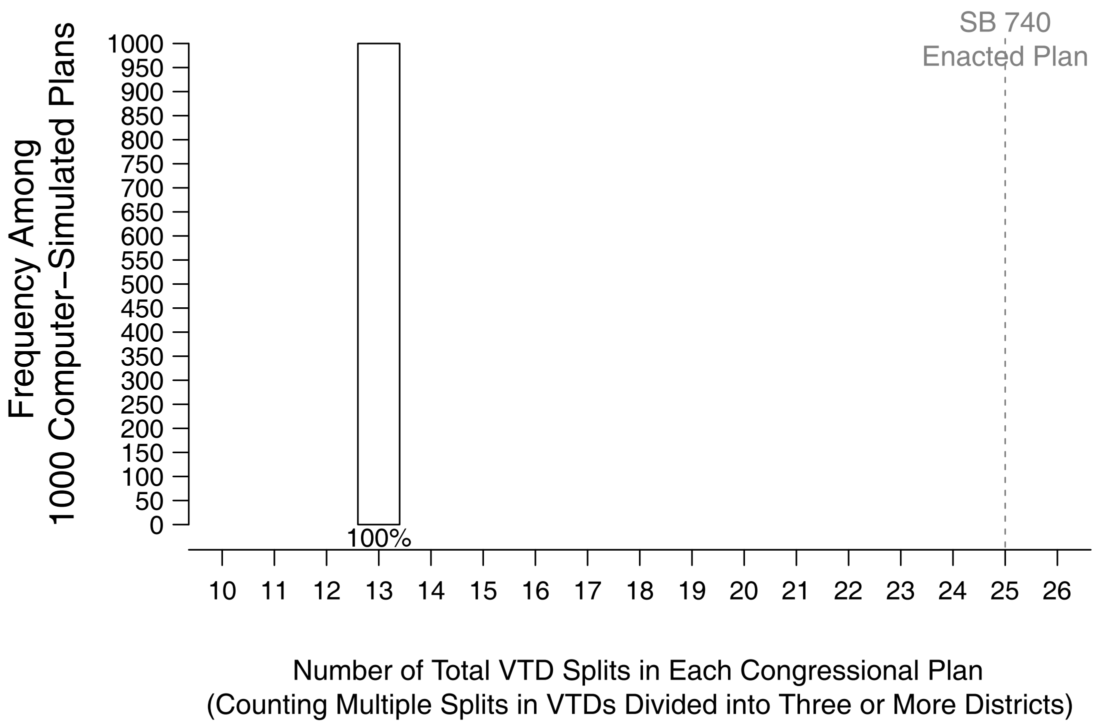
[4] Available at:
https://webservices.ncleg.gov/ViewBillDocument/2021/53447/0/SL%202021-174%20-%20StatPack%20Report.

Figure 2:

Comparison of Total VTD Splits in Enacted SB 740 Plan and 1,000 Computer–Simulated Plans



24. ***Measuring Geographic Compactness***: The August 12, 2021 Adopted Criteria mandates that the Joint Redistricting Committee "shall" attempt to draw geographically compact congressional districts. The Adopted Criteria also specify two commonly used measures of district compactness: the Reock score and the Polsby-Popper score.

25. In evaluating whether the Enacted Plan follows the compactness requirement of the Adopted Criteria, it is useful to compare the compactness of the Enacted Plan and the 1,000 computer-simulated plans. The computer-simulated plans were produced by a computer algorithm adhering strictly to the traditional districting criteria mandated by the Adopted Criteria and ignoring any partisan or racial considerations. Thus, the compactness scores of these computer-simulated plans illustrate the statistical range of compactness scores that could be

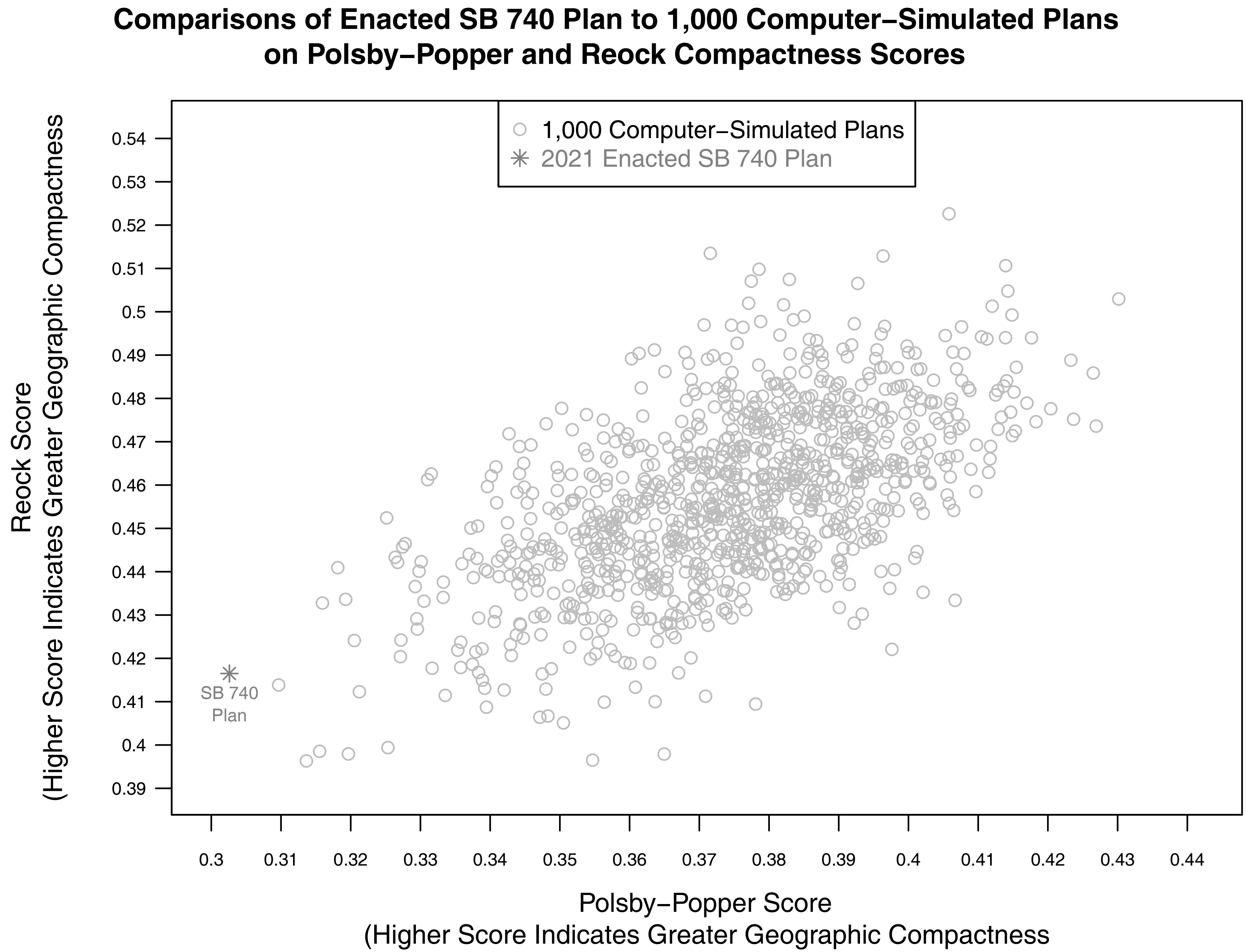
reasonably expected to emerge from a districting process that solely seeks to follow the Adopted Criteria while ignoring partisan and racial considerations. I therefore compare the compactness of the simulated plans and the Enacted Plan using the two measures of compactness specified by the 2021 Adopted Criteria.

26. First, I calculate the average Polsby-Popper score of each plan's districts. The Polsby-Popper score for each individual district is calculated as the ratio of the district's area to the area of a hypothetical circle whose circumference is identical to the length of the district's perimeter; thus, higher Polsby-Popper scores indicate greater district compactness. The 2021 Enacted Plan has an average Polsby-Popper score of 0.3026 across its 14 congressional districts. As illustrated in Figure 3, every single one of the 1,000 computer-simulated House plans in this report exhibits a higher Polsby-Popper score than the Enacted Plan. In fact, the middle 50% of these 1,000 computer-simulated plans have an average Polsby-Popper score ranging from 0.36 to 0.39, and the most compact computer-simulated plan has a Polsby-Popper score of 0.43. Hence, it is clear that the Enacted Plan is significantly less compact, as measured by its Polsby-Popper score, than what could reasonably have been expected from a districting process adhering to the Adopted Criteria.

27. Second, I calculate the average Reock score of the districts within each plan. The Reock score for each individual district is calculated as the ratio of the district's area to the area of the smallest bounding circle that can be drawn to completely contain the district; thus, higher Reock score indicate more geographically compact districts. The 2021 Enacted Plan has an average Reock score of 0.4165 across its 14 congressional districts. As illustrated in Figure 3, 97.7% of the 1,000 computer-simulated plans exhibit a higher Reock score than the Enacted Plan. In fact, the middle 50% of these 1,000 computer-simulated plans have an average Reock

score ranging from 0.44 to 0.47, and the most compact computer-simulated plan has an average Reock score of 0.52. Hence, it is clear that the Enacted Plan is significantly less compact, as measured by its Reock score, than what could reasonably have been expected from a districting process adhering to the Adopted Criteria.

Figure 3:


Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
on Polsby−Popper and Reock Compactness Scores
1,000 Computer−Simulated Plans
2021 Enacted SB 740 Plan
SB 740
Plan
Reock Score
(Higher Score Indicates Greater Geographic Compactness
0.54
0.53
0.52
0.51
0.5
0.49
0.48
0.47
0.46
0.45
0.44
0.43
0.42
0.41
0.4
0.39
0.3
0.31
0.32
0.33
0.34
0.35
0.36
0.37
0.38
0.39
0.4
0.41
0.42
0.43
0.44
Polsby−Popper Score
(Higher Score Indicates Greater Geographic Compactness

Measuring the Partisanship of Districting Plans

28. In general, I use actual election results from recent, statewide election races in North Carolina to assess the partisan performance of the Enacted Plan and the computer-simulated plans analyzed in this report. Overlaying these past election results onto a districting plan enables me to calculate the Republican (or Democratic) share of the votes cast from within each district in the Enacted Plan and in each simulated plan. I am also able to count the total number of Republican and Democratic-leaning districts within each simulated plan and within the Enacted Plan. All of these calculations thus allow me to directly compare the partisanship of the Enacted Plan and the simulated plans. These partisan comparisons allow me to determine whether or not the partisanship of individual districts and the partisan distribution of seats in the Enacted Plan could reasonably have arisen from a districting process adhering to the Adopted Criteria and its explicit prohibition on partisan considerations. Past voting history in federal and statewide elections is a strong predictor of future voting history. Mapmakers thus can and do use past voting history to identify the class of voters, at a precinct-by-precinct level, who are likely to vote for Republican or Democratic congressional candidates.

29. In the 2011, 2016, and 2017 rounds of state legislative and congressional redistricting last decade, the North Carolina General Assembly publicly disclosed that it was relying solely on recent statewide elections in measuring the partisanship of the districting plans being created. I therefore follow the General Assembly's past practice from last decade by using results from a similar set of recent statewide elections in order to measure the partisanship of districts in the Enacted Plan and in the computer-simulated plans.

30. ***The 2016-2020 Statewide Election Composite:*** During the General Assembly's 2017 legislative redistricting process, Representative David Lewis announced at the Joint

Redistricting Committee's August 10, 2017 meeting that the General Assembly would measure the partisanship of legislative districts using the results from some of the most recent elections held in North Carolina for the following five offices: US President, US Senator, Governor, Lieutenant Governor, and Attorney General.

31. To measure the partisanship of all districts in the computer-simulated plans and the 2021 Enacted Plan, I used the two most-recent election contests held in North Carolina for these same five offices during 2016-2020. In other words, I used the results of the following ten elections: 2016 US President, 2016 US Senator, 2016 Governor, 2016 Lieutenant Governor, 2016 Attorney General, 2020 US President, 2020 US Senator, 2020 Governor, 2020 Lieutenant Governor, and 2020 Attorney General. I use these election results because these are the same state and federal offices whose election results were used by the General Assembly during its 2017 legislative redistricting process, and the 2017 redistricting process was the most recent one in which the leadership of the General Assembly's redistricting committees publicly announced how the General Assembly would evaluate the partisanship of its own districting plans.

32. I obtained precinct-level results for these ten elections, and I disaggregated these election results down to the census block level. I then aggregated these block-level election results to the district level within each computer-simulated plan and the Enacted Plan, and I calculated the number of districts within each plan that cast more votes for Republican than Democratic candidates. I use these calculations to measure the partisan performance of each simulated plan analyzed in this report and of the Enacted Plan. In other words, I look at the census blocks that would comprise a particular district in a given simulation and, using the actual election results from those census blocks, I calculate whether voters in that simulated district collectively cast more votes for Republican or Democratic candidates in the 2016-2020 statewide

election contests. I performed such calculations for each district under each simulated plan to measure the number of districts Democrats or Republicans would win under that particular simulated districting map.

33. I refer to the aggregated election results from these ten statewide elections as the "2016-2020 Statewide Election Composite." For the Enacted Plan districts and for all districts in each of the 1,000 computer-simulated plans, I calculate the percentage of total two-party votes across these ten elections that were cast in favor of Republican candidates in order to measure the average Republican vote share of the district. In the following section, I present district-level comparisons of the Enacted Plan and simulated plan districts in order to identify whether any individual districts in the Enacted Plan are partisan outliers. I also present plan-wide comparisons of the Enacted Plan and the simulated plans in order to identify the extent to which the Enacted Plan is a statistical outlier in terms of common measures of districting plan partisanship.

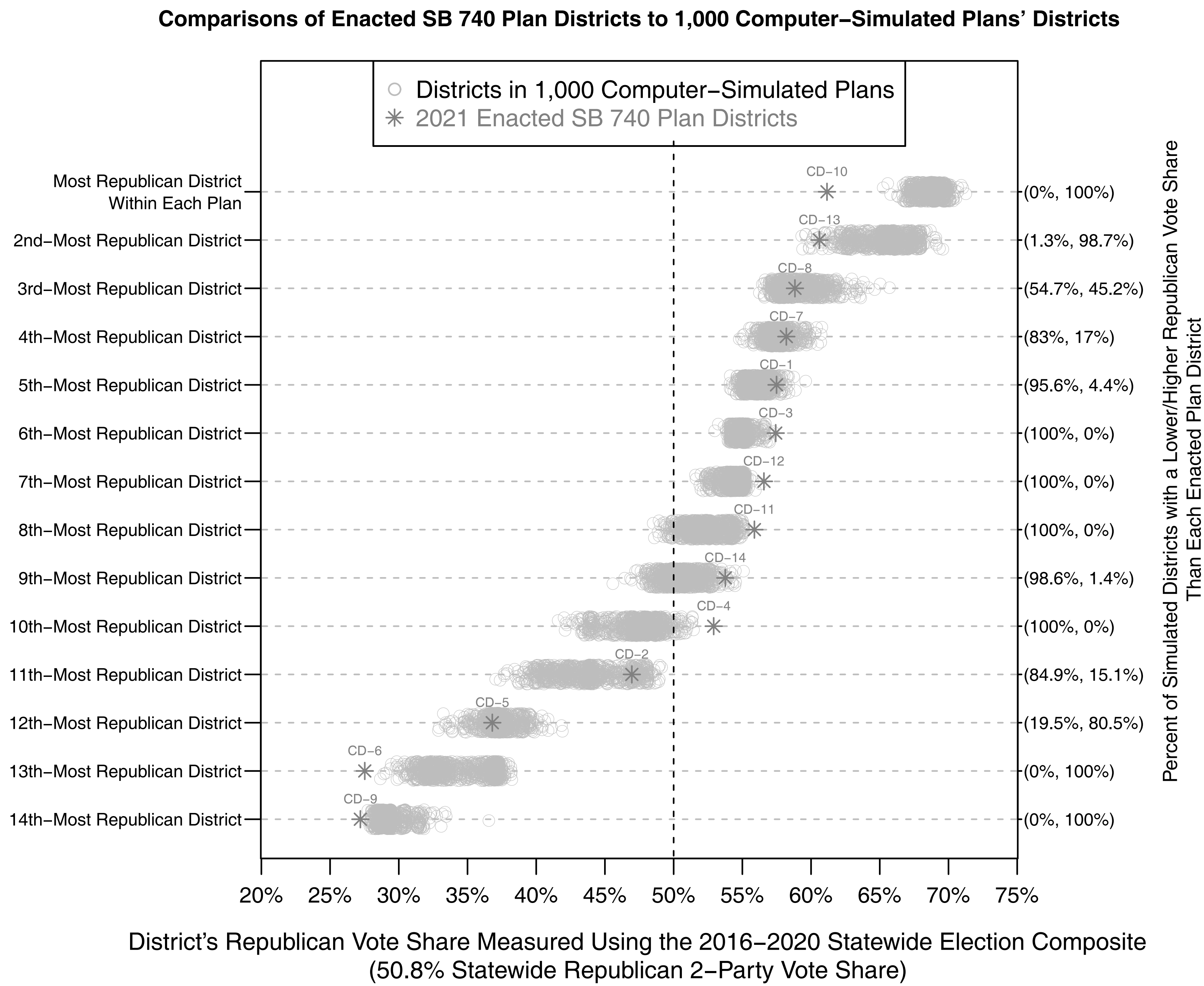
District-Level and Plan-Wide Partisan Comparisons of the Enacted Plan and Simulated Plans

34. In this section, I present partisan comparisons of the Enacted Plan to the computer-simulated plans at both a district-by-district level as well as a plan-wide level using several common measures of districting plan partisanship. First, I compare the district-level Republican vote share of the Enacted Plan's districts and the districts in the computer-simulated plans. Next, I compare the number of Republican-favoring districts in the Enacted Plan and in the computer-simulated plans. Finally, I use several common measures of partisan bias to compare the Enacted Plan to the computer-simulated plans. Overall, I find that the several individual districts in the Enacted Plan are statistical outliers, exhibiting extreme partisan characteristics that are rarely or never observed in the computer-simulated plan districts drawn with strict adherence to the Adopted Criteria. Moreover, I find that at the plan-wide level, the Enacted Plan creates a degree of partisan bias favoring Republicans that is more extreme than the vast majority of the computer-simulated plans. I describe these findings in detail below:

35. ***Partisan Outlier Districts in the Enacted Plan***: In Figure 4, I directly compare the partisan distribution of districts in the Enacted Plan to the partisan distribution of districts in the 1,000 computer-simulated plans. I first order the Enacted Plan's districts from the most to the least-Republican district, as measured by Republican vote share using the 2016-2020 Statewide Election Composite. The most-Republican district appears on the top row, and the least-Republican district appears on the bottom row of Figure 4. Next, I analyze each of the 1,000 computer-simulated plans and similarly order each simulated plan's districts from the most- to the least-Republican district. I then directly compare the most-Republican Enacted Plan district (CD-10) to the most-Republican simulated district from each of the 1,000 computer-simulated plans. In other words, I compare one district from the Enacted Plan to 1,000 computer-simulated

districts, and I compare these districts based on their Republican vote share. I then directly compare the second-most-Republican district in the Enacted Plan to the second-most-Republican district from each of the 1,000 simulated plans. I conduct the same comparison for each district in the Enacted Plan, comparing the Enacted Plan district to its computer-simulated counterparts from each of the 1,000 simulated plans.

Figure 4:



Comparisons of Enacted SB 740 Plan Districts to 1,000 Computer−Simulated Plans' Districts
Districts in 1,000 Computer−Simulated Plans
2021 Enacted SB 740 Plan Districts
Most Republican District Within Each Plan
2nd−Most Republican District
3rd−Most Republican District
4th−Most Republican District
5th−Most Republican District
6th−Most Republican District
7th−Most Republican District
8th−Most Republican District
9th−Most Republican District
10th−Most Republican District
11th−Most Republican District
12th−Most Republican District
13th−Most Republican District
14th−Most Republican District
CD−10
CD−13
CD−8
CD−7
CD−1
CD−3
CD−12
CD−11
CD−14
CD−4
CD−2
CD−5
CD−6
CD−9
(0%, 100%)
(1.3%, 98.7%)
(54.7%, 45.2%)
(83%, 17%)
(95.6%, 4.4%)
(100%, 0%)
(100%, 0%)
(100%, 0%)
(98.6%, 1.4%)
(100%, 0%)
(84.9%, 15.1%)
(19.5%, 80.5%)
(0%, 100%)
(0%, 100%)
20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75%
District's Republican Vote Share Measured Using the 2016−2020 Statewide Election Composite
(50.8% Statewide Republican 2−Party Vote Share)
Percent of Simulated Districts with a Lower/Higher Republican Vote Share Than Each Enacted Plan District

36. Thus, the top row of Figure 4 directly compares the partisanship of the most-Republican Enacted Plan district (CD-10) to the partisanship of the most-Republican district from each of the 1,000 simulated plans. The two percentages (in parentheses) in the right margin of this Figure report the percentage of these 1,000 simulated districts that are less Republican than, and more Republican than, the Enacted plan district. Similarly, the second row of this Figure compares the second-most-Republican district from each plan, the third row compares the third-most-Republican district from each plan, and so on. In each row of this Figure, the Enacted Plan's district is depicted with a red star and labeled in red with its district number; meanwhile, the 1,000 computer-simulated districts are depicted with 1,000 gray circles on each row.

37. As the bottom row of Figure 4 illustrates, the most-Democratic district in the Enacted Plan (CD-9) is more heavily Democratic than 100% of the most-Democratic districts in each of the 1,000 computer-simulated plans. This calculation is numerically reported in the right margin of the Figure. Every single one of the computer-simulated counterpart districts would have been more politically moderate than CD-9 in terms of partisanship: CD-9 exhibits a Republican vote share of 27.2%, while all 1,000 of the most-Democratic districts in the computer-simulated plans would have exhibited a higher Republican vote share and would therefore have been more politically moderate. It is thus clear that CD-9 packs together Democratic voters to a more extreme extent than the most-Democratic district in 100% of the computer-simulated plans. I therefore identify CD-9 as an extreme partisan outlier when compared to its 1,000 computer-simulated counterparts, using a standard threshold test of 95% for statistical significance.

38. The next-to-bottom row of Figure 4 reveals a similar finding regarding CD-6 in the Enacted Plan. This row illustrates that the second-most-Democratic district in the Enacted

Plan (CD-6) is more heavily Democratic than 100% of the second-most-Democratic districts in each of the 1,000 computer-simulated plans. Every single one of its computer-simulated counterpart districts would have been more politically moderate than CD-6 in terms of partisanship: CD-6 exhibits a Republican vote share of 27.5%, while 100% of the second-most-Democratic districts in the computer-simulated plans would have exhibited a higher Republican vote share and would therefore have been more politically moderate. In other words, CD-6 packs together Democratic voters to a more extreme extent than the second-most-Democratic district in 100% of the computer-simulated plans. I therefore identify CD-6 as an extreme partisan outlier when compared to its 1,000 computer-simulated counterparts, using a standard threshold test of 95% for statistical significance.

39. Meanwhile, the top two rows of Figure 4 reveal a similar finding: As the top row illustrates, the most-Republican district in the Enacted Plan (CD-10) is less heavily Republican than 100% of the most-Republican districts in each of the 1,000 computer-simulated plans. A similar pattern appears in the second-to-top row of Figure 4, which illustrates that the second-most-Republican district in the Enacted Plan (CD-13) is less heavily Republican than 98.7% of the second-most-Republican districts in each of the 1,000 computer-simulated plans.

40. It is especially notable that these four aforementioned Enacted Plan districts – the two most Republican districts (CD-10 and CD-13) and the two most Democratic districts (CD-9 and CD-6) in the Enacted Plan – were drawn to include more Democratic voters than virtually all of their counterpart districts in the 1,000 computer-simulated plans. These "extra" Democratic voters in the four most partisan-extreme districts in the Enacted Plan had to come from the remaining ten more moderate districts in the Enacted Plan. Having fewer Democratic voters in these more moderate districts enhances Republican candidate performance in these districts.

41. Indeed, the middle six rows in Figure 4 (i.e., rows 5 through 10) confirm this precise effect. The middle six rows in Figure 4 compare the partisanship of districts in the fifth, sixth, seventh, eighth, ninth, and tenth-most Republican districts within the Enacted Plan and the 1,000 computer-simulated plans. In all six of these rows, the Enacted Plan district is a partisan outlier. In each of these six rows, the Enacted Plan's district is more heavily Republican than over 95% of its counterpart districts in the 1,000 computer-simulated plans. Four of these six rows illustrate Enacted Plan districts that are more heavily Republican than 100% of their counterpart districts in the computer-simulated plans. The six Enacted Plan districts in these six middle rows (CD-1, 3, 4, 11, 12, and 14) are more heavily Republican than nearly all of their counterpart computer-simulated plan districts because the four most partisan-extreme districts in the Enacted Plan (CD-6, 9, 10, and 13) are more heavily Democratic than nearly all of their counterpart districts in the computer-simulated plans.

42. I therefore identify the six Enacted Plan districts in the six middle rows (CD-1, 3, 4, 11, 12, and 14) of Figure 4 as partisan statistical outliers. Each of these six districts has a Republican vote share that is higher than over 95% of the computer-simulated districts in its respective row in Figure 4. I also identify the four Enacted Plan districts in the top rows and the bottom two rows (CD-6, 9, 10, and 13) of Figure 4 as partisan statistical outliers. Each of these four districts has a Republican vote share that is lower than over 98% of the computer-simulated districts in its respective row in Figure 4.

43. In summary, Figure 4 illustrates that 10 of the 14 districts in the Enacted Plan are partisan outliers: Six districts (CD-1, 3, 4, 11, 12, and 14) in the Enacted Plan are more heavily Republican than over 95% of their counterpart computer-simulated plan districts, while four

districts (CD-6, 9, 10, and 13) are more heavily Democratic than over 98% of their counterpart districts in the computer-simulated plans.

44. The Appendix of this report contains ten additional Figures (Figures A1 through A10) that each contain a similar analysis of the Enacted Plan districts and the computer-simulated plan districts. Each of these ten Figures in the Appendix measures the partisanship of districts using one of the individual ten elections included in the 2016-2020 Statewide Election Composite. These ten Figures generally demonstrate that the same extreme partisan outlier patterns observed in Figure 4 are also present when district partisanship is measured using any one of the ten statewide elections held in North Carolina during 2016-2020.

45. ***"Mid-Range" Republican Districts:*** Collectively, the upper ten rows in Figure 4 illustrate that the Enacted Plan's ten most-Republican districts exhibit a significantly narrower range of partisanship than is exhibited by the ten most-Republican districts in each of the computer-simulated plans. Specifically, the Enacted Plan's ten most-Republican districts all have Republican vote shares within the narrow range of 52.9% to 61.2%. As explained earlier, this narrow range is the product of two distinct dynamics: In the top two rows of Figure 4, the Enacted Plan's districts are significantly less Republican than nearly all of the simulated plans' districts in these rows. But in the fifth to tenth rows of Figure 4, the Enacted Plan's districts are more safely Republican-leaning than over 95% of the computer-simulated districts within each of these six rows. The overall result of these two distinct dynamics is that the Enacted Plan contains ten districts that all have Republican vote shares within the narrow range of 52.9% to 61.2%. I label any districts within this narrow range of partisanship as "mid-range" Republican-leaning districts, reflecting the fact that these districts have generally favored Republican candidates, but not by overwhelmingly large margins.

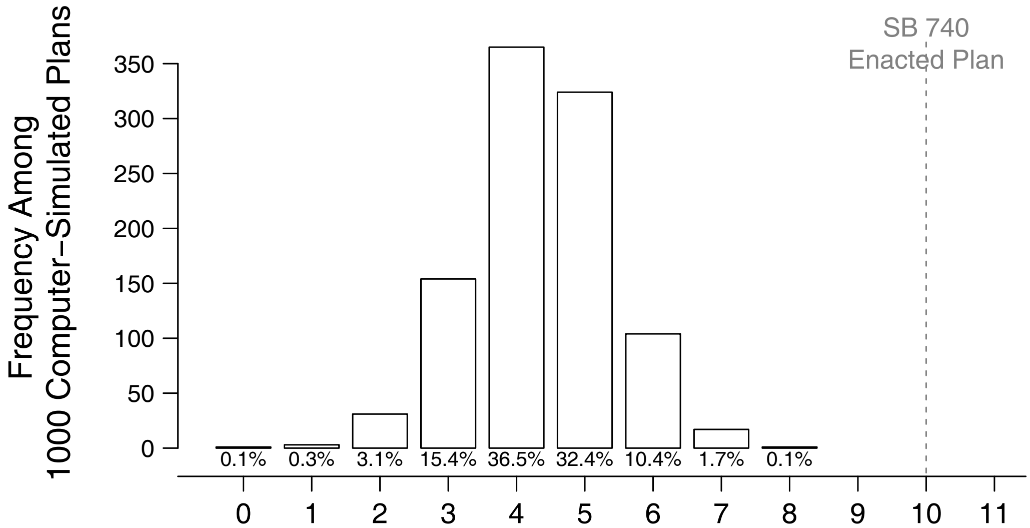
46. Is the Enacted Plan's creation of ten such "mid-range" Republican-leaning districts an outcome that ever occurs in the 1,000 computer-simulated plans? I analyzed the simulated plans and counted the number of districts within each plan that are similarly "mid-range" with a Republican vote share between 52.9% and 61.2%. As Figure 5 illustrates, the Enacted Plan's creation of ten "mid-range" Republican districts is an extreme statistical outlier. None of the 1,000 simulated plans comes close to creating ten such districts. Virtually all of the simulated plans contain from two to six "mid-range" Republican districts, and the most common outcome among the simulations is four such districts. Hence, the Enacted Plan is clearly an extreme partisan outlier in terms of its peculiar focus on maximizing the number of "mid-range" Republican districts, and the Enacted Plan did so to an extreme degree far beyond any of the 1,000 simulated plans created using a partisan-blind computer algorithm that follows the Adopted Criteria.

47. ***Competitive Districts:*** The Enacted Plan's maximization of "mid-range" Republican districts necessarily comes at the expense of creating more competitive districts. As Figure 4 illustrates, the Enacted Plan contains zero districts whose Republican vote share is higher than 47.0% and lower than 52.9%, as measured using the 2016-2020 Statewide Election Composite. In other words, there are zero districts in which the Republican vote share is within 5% of the Democratic vote share.

48. I label districts with a Republican vote share from 47.5% to 52.5% as "competitive" districts to reflect the fact that such districts have a nearly even share of Republican and Democratic voters, and election outcomes in the district could therefore swing in favor of either party. The Enacted Plan contains zero "competitive" districts, as measured using the 2016-2020 Statewide Election Composite.

Figure 5:

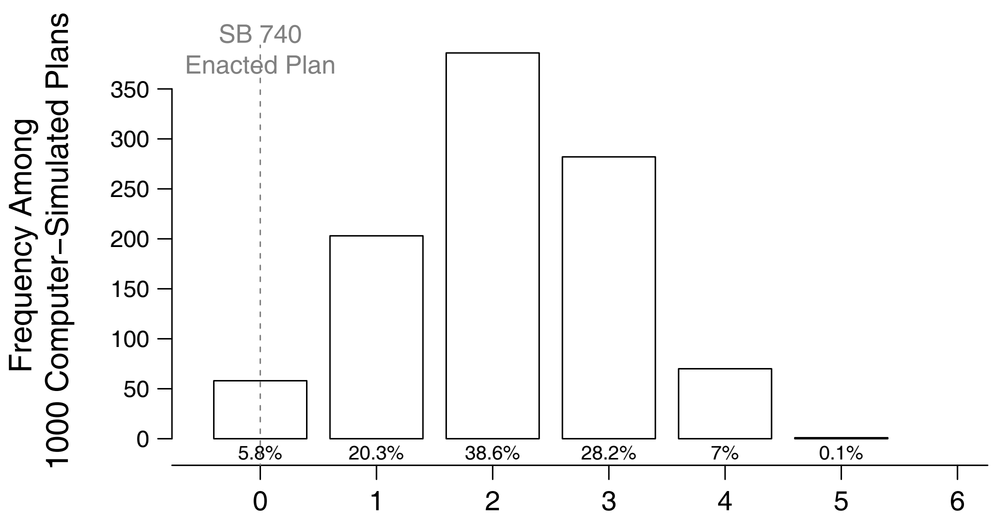
Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
On Number of Mid−Range Republican Districts



Number of Mid−Range Republican Districts with 52.9% to 61.2% Republican Vote Share Within Each Plan
Using the 2016−2020 Statewide Election Composite
(50.8% Statewide Republican 2−Party Vote Share)

Figure 6:

Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
On Number of Competitive Districts



Number of Competitive Districts with 47.5% to 52.5% Republican Vote Share Within Each Plan
Using the 2016−2020 Statewide Election Composite
(50.8% Statewide Republican 2−Party Vote Share)

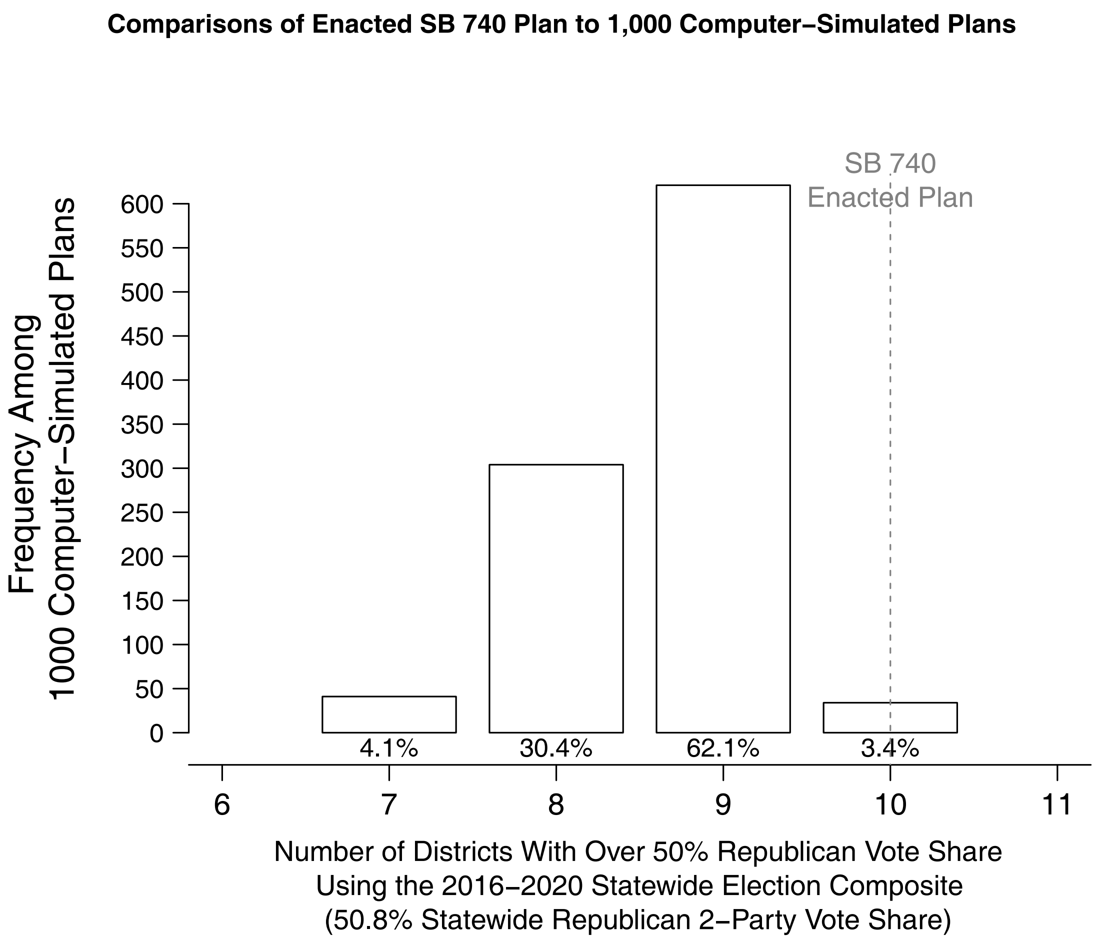
49. Is the Enacted Plan's failure to create any "competitive" districts an outcome that ever occurs in the 1,000 computer-simulated plans? I analyzed the simulated plans and counted the number of districts within each plan that are "competitive" districts with a Republican vote share between 47.5% and 52.5%. As Figure 6 illustrates, the Enacted Plan's creation of zero "competitive" districts is almost a statistical outlier: Only 5.8% of the 1,000 simulated plans similarly fail to have a single "competitive" district. The vast majority of the computer-simulated plans contain two or more "competitive" districts. Over 94% of the computer-simulated plans create more "competitive" districts than the Enacted Plan does.

50. ***Number of Democratic and Republican Districts:*** Figure 7 compares the partisan breakdown of the computer-simulated plans to the partisanship of the Enacted Plan. Specifically, Figure 7 uses the 2016-2020 Statewide Election Composite to measure the number of Republican-favoring districts created in each of the 1,000 simulated plans. Across the entire state, Republican candidates collectively won a 50.8% share of the votes in the ten elections in the 2016-2020 Statewide Election Composite. But within the 14 districts in the Enacted Plan, Republicans have over a 50% vote share in 10 out of 14 districts. In other words, the Enacted Plan created 10 Republican-favoring districts, as measured using the 2016-2020 Statewide Election Composite.. By contrast, only 3.4% of the computer-simulated plans create 10 Republican-favoring districts, and no computer-simulated plan ever creates more than 10 Republican districts.

51. Hence, in terms of the total number of Republican-favoring districts created by the plan, the 2021 Enacted Plan is a statistical outlier when compared to the 1,000 computer-simulated plans. The Enacted Plan creates the maximum number of Republican districts that ever occurs in any computer-simulated plan, and the Enacted Plan creates more Republican districts

than 96.6% of the computer-simulated plans, which were drawn using a non-partisan districting process adhering to the General Assembly's 2021 Adopted Criteria. I characterize the Enacted Plan's creation of 10 Republican districts as a statistical outlier among the computer-simulated plans because the Enacted Plan exhibits an outcome that is more favorable to Republicans than over 95% of the simulated plans.

Figure 7:



52. Notably, the ten elections included in the Statewide Election Composite all occurred in two election years and in electoral environments that were relatively favorable to Republicans across the country (November 2016 and November 2020). North Carolina did not hold any statewide elections for non-judicial offices in November 2018, which was an electoral environment more favorable to Democrats across the country.

53. Hence, the projected number of Republican seats would be even lower in the computer-simulated plans if one measured district partisanship using a statewide election whose outcome was more partisan-balanced or even favorable to Democrats. In the Appendix, I present ten histograms (labeled as Figures B1 to B10), each presenting the projected number of Republican seats across all of the simulated plans and the Enacted Plan using only one of the ten elections in the Statewide Election Composite.

54. The ten histograms in Figures B1 to B10 illustrate how the partisanship of the Enacted Plan compares to the partisanship of the 1,000 computer-simulated plans under a range of different electoral environments, as reflected by the ten elections in the Statewide Election Composite. Most notably, under all ten of these elections, the Enacted Plan always contains exactly 10 Republican-favoring districts and 4 Democrat-favoring districts. Hence, it is clear that the Enacted Plan creates a 10-to-4 distribution of seats in favor of Republican candidates that is durable across a range of different electoral conditions.

55. Moreover, the histograms in Figures B1 to B10 demonstrate that the Enacted Plan becomes a more extreme partisan outlier relative to the computer-simulated plans under electoral conditions that are slightly to moderately favorable to the Democratic candidate. For example, Figure B1 compares the Enacted Plan to the computer-simulated plan using the results of the 2016 Attorney General election, which was a near-tied statewide contest in which Democrat Josh

Stein defeated Republican Buck Newton by a very slim margin. Using the 2016 Attorney General election to measure district partisanship, the 2021 Enacted Plan contains 10 Republican-favoring districts out of 14. The Enacted Plan's creation of 10 districts favoring Republican Buck Newton over Democrat Josh Stein is an outcome that occurs in only 0.2% of the 1,000 computer-simulated plans, indicating that the Enacted Plan is a partisan statistical outlier under electoral conditions that are more favorable for Democrats (and thus relatively more unfavorable for Republicans) than is normal in North Carolina.

56. An even more favorable election for the Democratic candidate was the 2020 gubernatorial contest, in which Democrat Roy Cooper defeated Republican Dan Forest by a 4.5% margin. Figure B7 compares the Enacted Plan to the computer-simulated using the results of this 2020 gubernatorial election. Using the results from this election, the 2021 Enacted Plan contains 10 Republican-favoring districts out of 14. None of the 1,000 simulated plans ever contain 10 districts favoring the Republican candidate. The Enacted Plan's creation of 10 Republican-favoring districts is therefore an extreme partisan outlier that is durable even in Democratic-favorable electoral conditions. In fact, the 10-to-4 Republican partisan advantage under the Enacted Plan appears to become even more of an extreme partisan outlier under Democratic-favorable elections.

57. ***The Mean-Median Difference:*** I also calculate each districting plan's mean-median difference, which is another accepted method that redistricting scholars commonly use to compare the relative partisan bias of different districting plans. The mean-median difference for any given plan is calculated as the mean district-level Republican vote share, minus the median district-level Republican vote share. For any congressional districting plan, the mean is calculated as the average of the Republican vote shares in each of the 14 districts. The median, in

turn, is the Republican vote share in the district where Republican performed the middle-best, which is the district that Republican would need to win to secure a majority of the congressional delegation. For a congressional plan containing 14 districts, the median district is calculated as the average of the Republican vote share in the districts where Republican performed the 7th and 8th-best across the state.

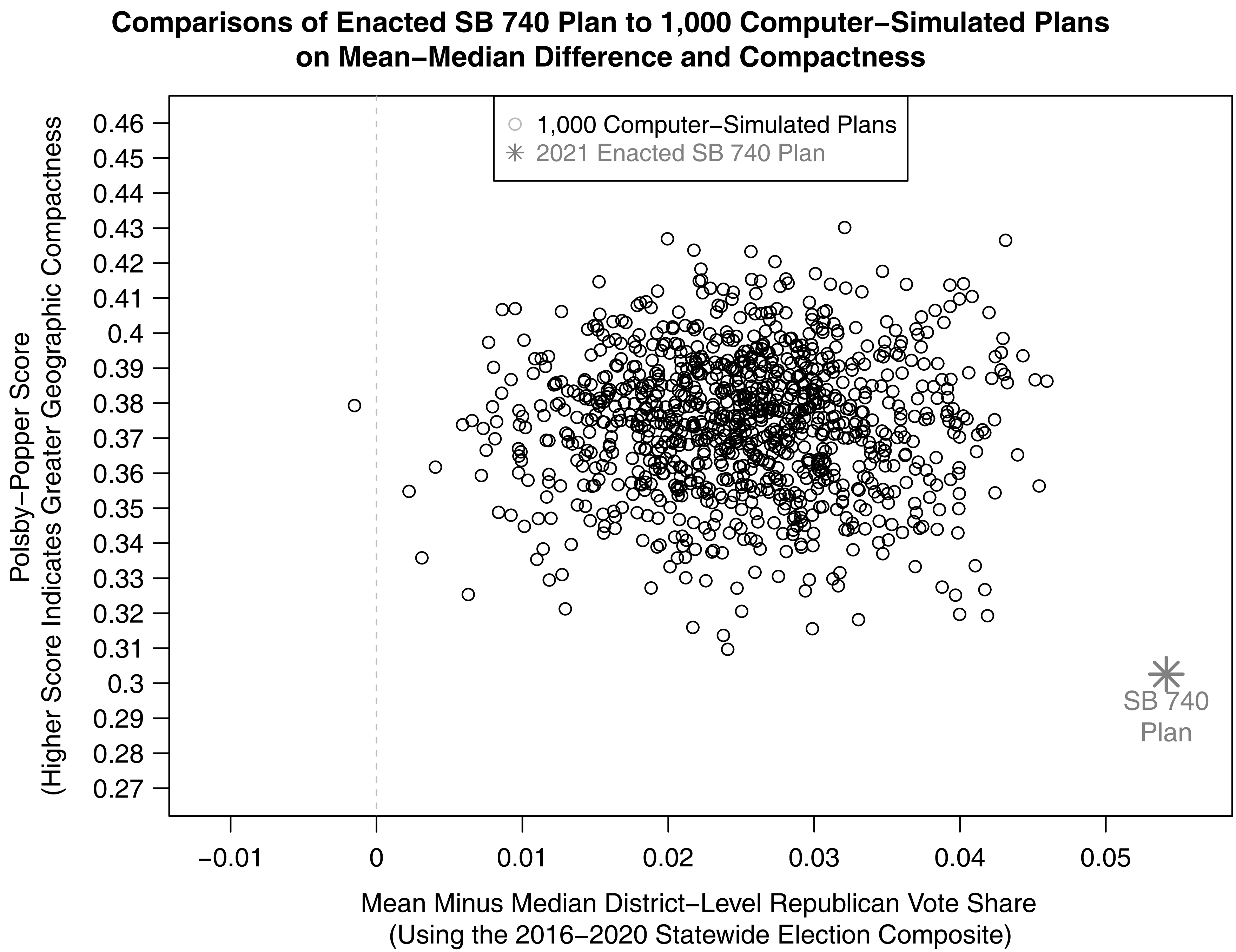
58. Using the 2016-2020 Statewide Election Composite to measure partisanship, the districts in the 2021 Enacted Plan have a mean Republican vote share of 50.8%, while the median district has a Republican vote share of 56.2%. Thus, the Enacted Plan has a mean-median difference of +5.4%, indicating that the median district is skewed significantly more Republican than the plan's average district. The mean-median difference thus indicates that the Enacted Plan distributes voters across districts in such a way that most districts are significantly more Republican-leaning than the average North Carolina congressional district, while Democratic voters are more heavily concentrated in a minority of the Enacted Plan's districts.

59. I perform this same mean-median difference calculation on all computer-simulated plans in order to determine whether this partisan skew in the median congressional districts could have resulted naturally from North Carolina's political geography and the application of the Adopted Criteria. Figure 8 compares the mean-median difference of the Enacted Plan to the mean-median difference for each the 1,000 computer-simulated plans.

60. Figure 8 contains 1,000 gray circles, representing the 1,000 computer-simulated plans, as well as a red star, representing the 2021 Enacted Plan. The horizontal axis in this Figure measures the mean-median difference of the 2021 Enacted Plan and each simulated plan using the 2016-2020 Statewide Election Composite, while the vertical axis measures the average Polsby-Popper compactness score of the districts within each plan, with higher Polsby-Popper

scores indicating more compact districts. Figure 8 illustrates that the Enacted Plan's mean-median difference is +5.4%, indicating that the median district is skewed significantly more Republican than the plan's average district. Figure 8 further indicates that this difference is an extreme statistical outlier compared to the 1,000 computer-simulated plans. Indeed, the Enacted Plan's +5.4% mean-median difference is an outcome never observed across these 1,000 simulated plans. The 1,000 simulated plans all exhibit mean-median differences that range from -0.2% to +4.6%. In fact, the middle 50% of these computer-simulated plans have mean-median differences ranging from +2.0% to +3.0%, indicating a much smaller degree of skew in the median district than occurs under the 2021 Enacted Plan. These results confirm that the Enacted Plan creates an extreme partisan outcome that cannot be explained by North Carolina's voter geography or by strict adherence to the required districting criteria set forth in the General Assembly's Adopted Criteria.

Figure 8:


Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
on Mean−Median Difference and Compactness
1,000 Computer−Simulated Plans
2021 Enacted SB 740 Plan
Polsby−Popper Score
(Higher Score Indicates Greater Geographic Compactness
0.46
0.45
0.44
0.43
0.42
0.41
0.4
0.39
0.38
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.3
0.29
0.28
0.27
−0.01
0
0.01
0.02
0.03
0.04
0.05
SB 740
Plan
Mean Minus Median District−Level Republican Vote Share
(Using the 2016−2020 Statewide Election Composite)

61. Figure 8 illustrates that the Enacted Plan is less geographically compact than every single one of the computer-simulated plans, as measured by each plan's average Polsby-Popper score. The simulated plans have Polsby-Popper scores ranging from 0.31 to 0.43. In fact, the middle 50% of these computer-simulated plans have Polsby-Popper scores ranging from 0.36 to 0.39. Meanwhile, the Enacted Plan exhibits a Polsby-Popper score of only 0.30, which is lower than all 1,000 of the computer-simulated plans. Hence, it is clear that the Enacted Plan did not seek to draw districts that were as geographically compact as reasonably possible. Instead, the Enacted Plan subordinated geographic compactness, which enabled the Enacted Plan to create a partisan skew in North Carolina's congressional districts favoring Republican candidates.

62. ***The Efficiency Gap:*** Another commonly used measure of a districting plan's partisan bias is the efficiency gap.[5] To calculate the efficiency gap of the Enacted Plan and every computer-simulated plan, I first measure the number of Republican and Democratic votes within each Enacted Plan district and each computer-simulated district, as measured using the 2016-2020 Statewide Election Composite. Using this measure of district-level partisanship, I then calculate each districting plan's efficiency gap using the method outlined in *Partisan Gerrymandering and the Efficiency Gap.*[6] Districts are classified as Democratic victories if, using the 2016-2020 Statewide Election Composite, the sum total of Democratic votes in the district during these elections exceeds the sum total of Republican votes; otherwise, the district is classified as Republican. For each party, I then calculate the total sum of surplus votes in districts

[5] Eric McGhee, "Measuring Partisan Bias in Single-Member District Electoral Systems." Legislative Studies Quarterly Vol. 39, No. 1: 55–85 (2014).

[6] Nicholas O. Stephanopoulos & Eric M. McGhee, *Partisan Gerrymandering and the Efficiency Gap,* 82 University of Chicago Law Review 831 (2015).

the party won and lost votes in districts where the party lost. Specifically, in a district lost by a given party, all of the party's votes are considered lost votes; in a district won by a party, only the party's votes exceeding the 50% threshold necessary for victory are considered surplus votes. A party's total wasted votes for an entire districting plan is the sum of its surplus votes in districts won by the party and its lost votes in districts lost by the party. The efficiency gap is then calculated as total wasted Republican votes minus total wasted Democratic votes, divided by the total number of two-party votes cast statewide across all seven elections.

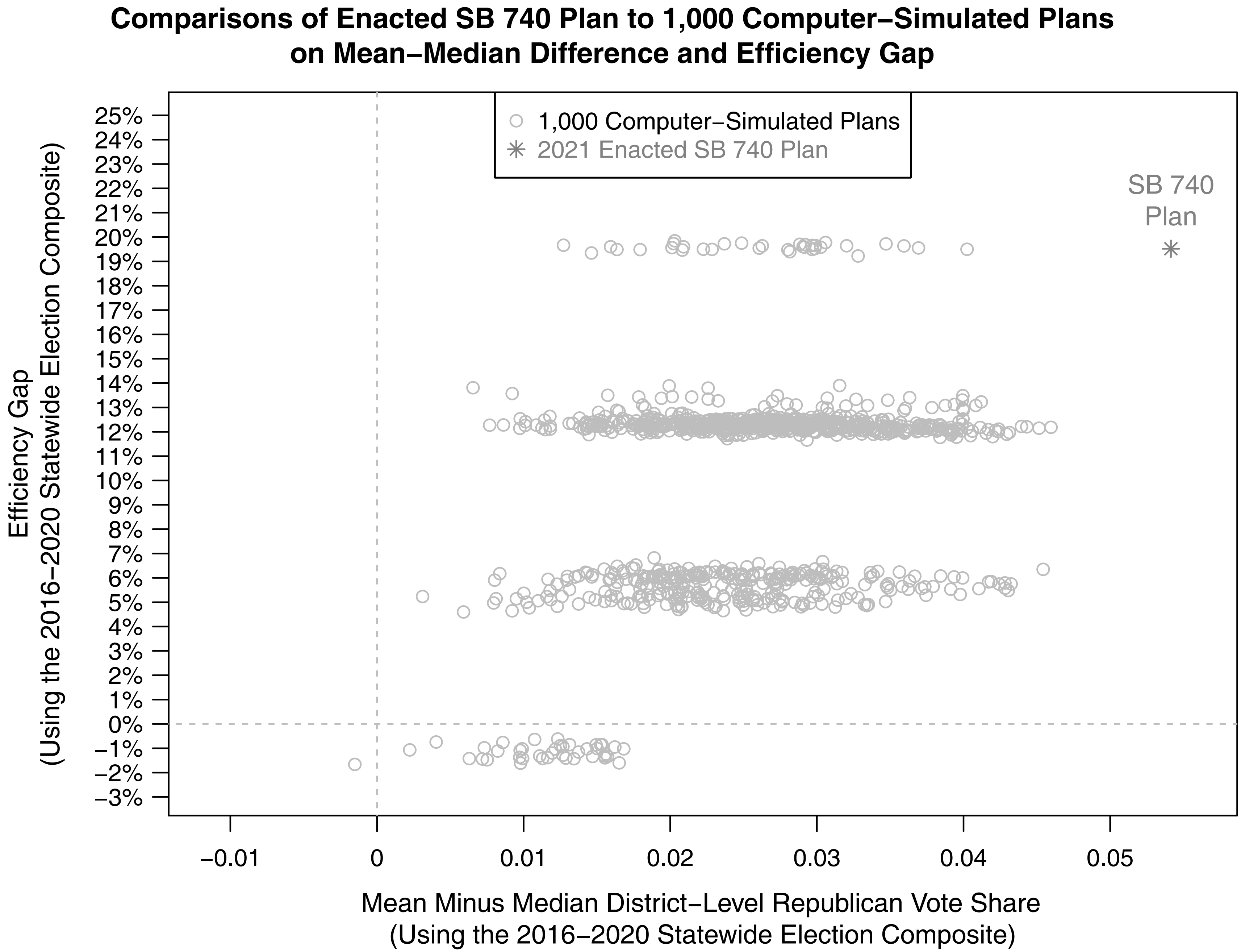
63. Thus, the theoretical importance of the efficiency gap is that it tells us the degree to which more Democratic or Republican votes are wasted across an entire districting plan. A significantly positive efficiency gap indicates far more Republican wasted votes, while a significantly negative efficiency gap indicates far more Democratic wasted votes.

64. I analyze whether the Enacted Plan's efficiency gap arises naturally from a map-drawing process strictly adhering to the mandated criteria in the General Assembly's Adopted Criteria, or rather, whether the skew in the Enacted Plan's efficiency gap is explainable only as the product of a map-drawing process that intentionally favored one party over the other. By comparing the efficiency gap of the Enacted Plan to that of the computer-simulated plans, I am able to evaluate whether or not such the Enacted Plan's efficiency gap could have realistically resulted from adherence to the Adopted Criteria.

65. Figure 9 compares the efficiency paps of the Enacted Plan and of the 1,000 computer-simulated plans. As before, the 1,000 circles in this Figure represent the 1,000 computer-simulated plans, while the red star in the lower right corner represents the Enacted Plan. Each plan is plotted along the vertical axis according to its efficiency gap, while each plan is plotted along the horizontal axis according to its mean-median difference.

66. The results in Figure 9 illustrate that the Enacted Plan exhibits an efficiency gap of +19.5%, indicating that the plan results in far more wasted Democratic votes than wasted Republican votes. Specifically, the difference between the total number of wasted Democratic votes and wasted Republican votes amounts to 19.5% of the total number of votes statewide. The Enacted Plan's efficiency gap is larger than the efficiency gaps exhibited by 97.7% of the computer-simulated plans. This comparison reveals that the significant level of Republican bias exhibited by the Enacted Plan cannot be explained by North Carolina's political geography or the Adopted Criteria alone.

Figure 9:


Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
on Mean−Median Difference and Efficiency Gap
1,000 Computer−Simulated Plans
2021 Enacted SB 740 Plan
SB 740
Plan
25%
24%
23%
22%
21%
20%
19%
18%
17%
16%
15%
14%
13%
12%
11%
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
−1%
−2%
−3%
Efficiency Gap
(Using the 2016−2020 Statewide Election Composite)
−0.01
0
0.01
0.02
0.03
0.04
0.05
Mean Minus Median District−Level Republican Vote Share
(Using the 2016−2020 Statewide Election Composite)

67. ***The Lopsided Margins Measure:*** Another measure of partisan bias in districting plans is the "lopsided margins" test. The basic premise captured by this measure is that a partisan-motivated map-drawer may attempt to pack the opposing party's voters into a small number of extreme districts that are won by a lopsided margin. Thus, for example, a map-drawer attempting to favor Party A may pack Party B's voters into a small number of districts that very heavily favor Party B. This packing would then allow Party A to win all the remaining districts with relatively smaller margins. This sort of partisan manipulation in districting would result in Party B winning its districts by extremely large margins, while Party A would win its districts by relatively small margins.

68. Hence, the lopsided margins test is performed by calculating the difference between the average margin of victory in Republican-favoring districts and the average margin of victory in Democratic-favoring districts. The 2021 Enacted Plan contains four Democratic-favoring districts (CD-2, 5, 6, and 9), and these four districts have an average Democratic vote share of 65.4%, as measured using the 2016-2020 Statewide Election Composite. By contrast, the Enacted Plan contains ten Republican-favoring districts (CD-1, 3, 4, 7, 8, 10, 11, 12, 13, and 14), and these ten districts have an average Republican vote share of 57.3%. Hence, the difference between the average Democratic margin of victory in Democratic-favoring districts and the average Republican margin of victory in Republican-favoring districts is +8.1%, which is calculated as 65.4% - 57.3%. I refer to this calculation of +8.1% as the Enacted Plan's lopsided margins measure.

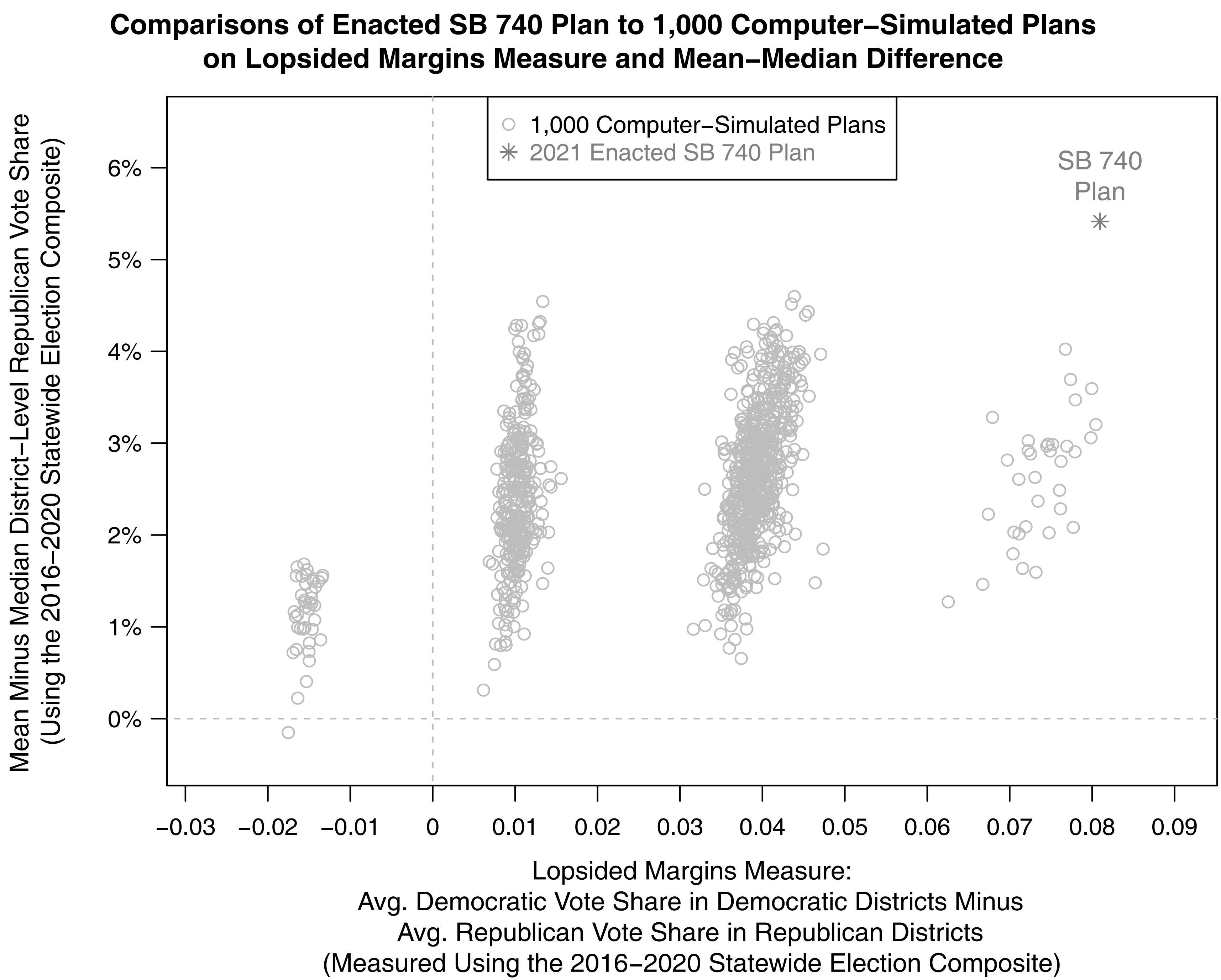
69. How does the 8.1% lopsided margins measure of the Enacted Plan compare to the same calculation for the 1,000 computer-simulated plans? Figure 10 reports the lopsided margins calculations for the Enacted Plan and for the simulated plans. In Figure 10, each plan is plotted

along the horizontal axis according to its lopsided margins measure and along the vertical axis according to its mean-median difference.

70. Figure 10 reveals that the Enacted Plan's +8.1% lopsided margins measure is an extreme outlier compared to the lopsided margins measures of the 1,000 computer-simulated plans. All 1,000 of the simulated plans have a smaller lopsided margins measure than the Enacted Plan. In fact, a significant minority (34.5%) of the 1,000 simulated plans have a lopsided margins measure of between -2% to +2%, indicating a plan in which Democrats and Republicans win their respective districts by similar average margins.

71. By contrast, the Enacted Plan's lopsided margins measure of +8.1% indicates that the Enacted Plan creates districts in which Democrats are extremely packed into their districts, while the margin of victory in Republican districts is significantly smaller. The "lopsidedness" of the two parties' average margin of victory is extreme when compared to the computer-simulated plans. The finding that all 1,000 simulated plans have a smaller lopsided margins measure indicates that the Enacted Plan's extreme packing of Democrats into Democratic-favoring districts was not simply the result of North Carolina's political geography, combined with adherence to the Adopted Criteria.

Figure 10:


Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
on Lopsided Margins Measure and Mean−Median Difference
1,000 Computer−Simulated Plans
2021 Enacted SB 740 Plan
SB 740
Plan
Mean Minus Median District−Level Republican Vote Share
(Using the 2016−2020 Statewide Election Composite)
6%
5%
4%
3%
2%
1%
0%
−0.03
−0.02
−0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Lopsided Margins Measure:
Avg. Democratic Vote Share in Democratic Districts Minus
Avg. Republican Vote Share in Republican Districts
(Measured Using the 2016−2020 Statewide Election Composite)

Conclusions Regarding Partisanship and Traditional Districting Criteria:

72. The analysis described thus far in this report lead me to reach two main findings: First, among the five traditional districting criteria mandated by the General Assembly's 2021 Adopted Criteria, the Enacted Plan fails to minimize county splits, fails to minimize VTD splits, and is significantly less geographically compact than is reasonably possible under a districting process that follows the Adopted Criteria. Second, I found that the Enacted Plan is an extreme partisan outlier when compared to computer-simulated plans produced by a process following the Adopted Criteria. The Enacted Plan contains 10 districts that are partisan outliers when compared to the simulated plans' districts, and using several different common measures of partisan bias, the Enacted Plan creates a level of pro-Republican bias more extreme than in over 95% of the computer-simulated plans. In particular, the Enacted Plan creates more "mid-range" Republican districts than is created in 100% of the computer-simulated plans (Paragraphs 45-46).

73. Based on these two main findings, I conclude that partisanship predominated in the drawing of the 2021 Enacted Plan and subordinated the traditional districting principles of avoiding county splits, avoiding VTD splits, and geographic compactness. Because the Enacted Plan fails to follow three of the Adopted Criteria's mandated districting principles while simultaneously creating an extreme level of partisan bias, I therefore conclude that the partisan bias of the Enacted Plan did not naturally arise by chance from a districting process adhering to the Adopted Criteria. Instead, I conclude that partisan goals predominated in the drawing of the Enacted Plan. By subordinating traditional districting criteria, the General Assembly's Enacted Plan was able to achieve partisan goals that could not otherwise have been achieved under a partisan-neutral districting process that follows the Adopted Criteria.

The Effect of the Enacted Plan Districts on Plaintiffs

74. I evaluated the congressional districts in which each Plaintiff would reside under the 1,000 computer-simulated using a list of geocoded residential addresses for the Plaintiffs that counsel for the Plaintiffs provided me. I used these geocoded addresses to identify the specific district in which each Plaintiff would be located under each computer-simulated plan, as well as under the Enacted Plan. I then compared the partisanship of each individual Plaintiff's Enacted Plan district to the partisanship of the Plaintiff's 1,000 districts from the 1,000 computer-simulated plans. Using this approach, I identify whether each Plaintiff's district is a partisan outlier when compared to the Plaintiff's 1,000 computer-simulated districts.

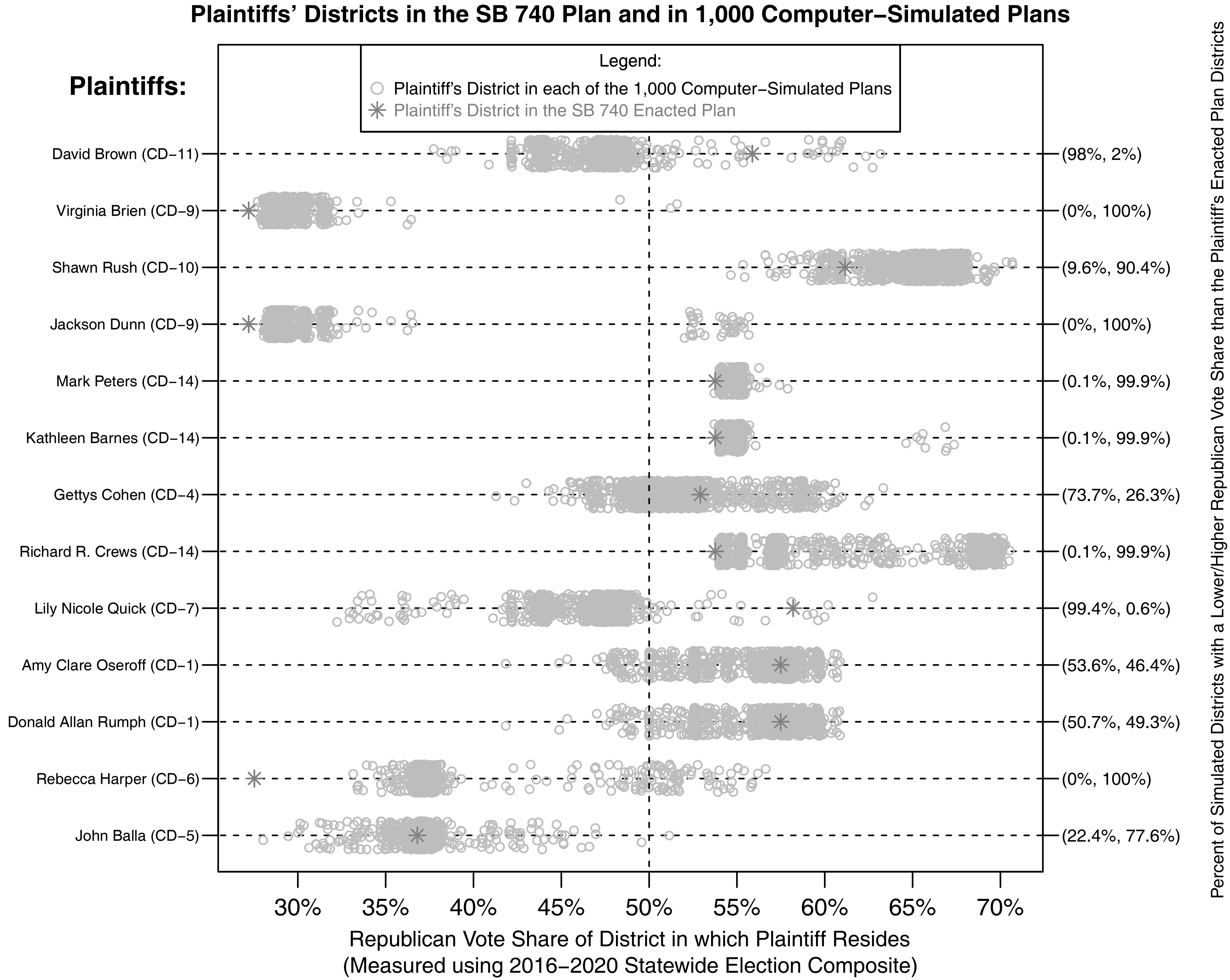
75. Figure 11 present the results of this analysis. This Figure lists the individual Plaintiffs and describes the partisanship of each Plaintiff's district of residence in the Enacted Plan, as well as the partisanship of the district the Plaintiff would have resided in under each of the 1,000 simulated congressional plans.

76. To explain these analyses with an example each row in Figure 11 corresponds to a particular individual Plaintiff. In the first row, describing Plaintiff David Brown, the red star depicts the partisanship of the Plaintiff's Enacted Plan district (CD-11), as measured by Republican vote share using the 2016-2020 Statewide Election Composite. The 1,000 gray circles on this row depict the Republican vote share of each of the 1,000 simulated districts in which the Plaintiff would reside in each of the 1,000 computer-simulated plans, based on that Plaintiff's residential address. In the margin to the right of each row, I list in parentheses how many of the 1,000 simulated plans would place the plaintiff in a more Democratic-leaning district (on the left) and how many of the 1,000 simulations would place the plaintiff in a more Republican-leaning district (on the right) than the Plaintiff's Enacted Plan district. Thus, for

example, the first row of Figure 11 reports that 98% of the 1,000 computer-simulated plans would place Plaintiff David Brown in a more Democratic-leaning district than his actual Enacted Plan district (CD-11). Therefore, I can conclude that Plaintiff David Brown's Enacted Plan district is a partisan statistical outlier when compared to his district under the 1,000 simulated plans.

77. Figure 11 shows that two Plaintiffs residing in Republican-leaning districts under the Enacted Plan would be placed in a more Democratic-leaning district in over 95% of the computer-simulated plans: David Brown (CD-11) and Lily Nicole Quick (CD-7).

Figure 11:


Plaintiffs' Districts in the SB 740 Plan and in 1,000 Computer−Simulated Plans
Plaintiffs:
Legend:
Plaintiff's District in each of the 1,000 Computer−Simulated Plans
Plaintiff's District in the SB 740 Enacted Plan
David Brown (CD−11)
Virginia Brien (CD−9)
Shawn Rush (CD−10)
Jackson Dunn (CD−9)
Mark Peters (CD−14)
Kathleen Barnes (CD−14)
Gettys Cohen (CD−4)
Richard R. Crews (CD−14)
Lily Nicole Quick (CD−7)
Amy Clare Oseroff (CD−1)
Donald Allan Rumph (CD−1)
Rebecca Harper (CD−6)
John Balla (CD−5)
(98%, 2%)
(0%, 100%)
(9.6%, 90.4%)
(0%, 100%)
(0.1%, 99.9%)
(0.1%, 99.9%)
(73.7%, 26.3%)
(0.1%, 99.9%)
(99.4%, 0.6%)
(53.6%, 46.4%)
(50.7%, 49.3%)
(0%, 100%)
(22.4%, 77.6%)
30%
35%
40%
45%
50%
55%
60%
65%
70%
Republican Vote Share of District in which Plaintiff Resides
(Measured using 2016−2020 Statewide Election Composite)
Percent of Simulated Districts with a Lower/Higher Republican Vote Share than the Plaintiff's Enacted Plan Districts

78. Additionally, Figure 11 shows that six Plaintiffs would be placed in a more Republican district in 99.9% or more of the simulated plans relative to their districts under the Enacted Plan: Virginia Brien (CD-9), Jackson Dunn (CD-9), Mark Peters (CD-14), Kathleen Barnes (CD-14), Richard R. Crews (CD-14), and Rebecca Harper (CD-6).

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

This 30th day of November, 2021.

____

Dr. Jowei Chen

Jowei Chen
Curriculum Vitae

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Ann Arbor, MI 48109-1045
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Website: http://www.umich.edu/~jowei

Academic Positions:
Associate Professor (2015-present), Assistant Professor (2009-2015), Department of Political Science, University of Michigan.
Research Associate Professor (2016-present), Faculty Associate (2009-2015), Center for Political Studies, University of Michigan.
W. Glenn Campbell and Rita Ricardo-Campbell National Fellow, Hoover Institution, Stanford University, 2013.
Principal Investigator and Senior Research Fellow, Center for Governance and Public Policy Research, Willamette University, 2013 – Present.

Education:
Ph.D., Political Science, Stanford University (June 2009)
M.S., Statistics, Stanford University (January 2007)
B.A., Ethics, Politics, and Economics, Yale University (May 2004)

Publications:

Chen, Jowei and Neil Malhotra. 2007. "The Law of k/n: The Effect of Chamber Size on Government Spending in Bicameral Legislatures."
__American Political Science Review__. 101(4): 657-676.

Chen, Jowei, 2010. "The Effect of Electoral Geography on Pork Barreling in Bicameral Legislatures."
__American Journal of Political Science.__ 54(2): 301-322.

Chen, Jowei, 2013. "Voter Partisanship and the Effect of Distributive Spending on Political Participation."
__American Journal of Political Science__. 57(1): 200-217.

Chen, Jowei and Jonathan Rodden, 2013. "Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures"
__Quarterly Journal of Political Science__, 8(3): 239-269.

Bradley, Katharine and Jowei Chen, 2014. “Participation Without Representation? Senior Opinion, Legislative Behavior, and Federal Health Reform.”
Journal of Health Politics, Policy and Law. 39(2), 263-293.

Chen, Jowei and Tim Johnson, 2015. “Federal Employee Unionization and Presidential Control of the Bureaucracy: Estimating and Explaining Ideological Change in Executive Agencies.”
Journal of Theoretical Politics, Volume 27, No. 1: 151-174.

Bonica, Adam, Jowei Chen, and Tim Johnson, 2015. “Senate Gate-Keeping, Presidential Staffing of ‘Inferior Offices’ and the Ideological Composition of Appointments to the Public Bureaucracy.”
Quarterly Journal of Political Science. Volume 10, No. 1: 5-40.

Chen, Jowei and Jonathan Rodden, 2015. “Cutting Through the Thicket: Redistricting Simulations and the Detection of Partisan Gerrymanders.”
Election Law Journal. Volume 14, Number 4: 331-345.

Chen, Jowei and David Cottrell, 2016. “Evaluating Partisan Gains from Congressional Gerrymandering: Using Computer Simulations to Estimate the Effect of Gerrymandering in the U.S. House.”
Electoral Studies. Volume 44 (December 2016): 329-340.

Chen, Jowei, 2017. “Analysis of Computer-Simulated Districting Maps for the Wisconsin State Assembly.”
Election Law Journal. Volume 16, Number 4 (December 2017): 417-442.

Chen, Jowei and Nicholas Stephanopoulos, 2020. “The Race-Blind Future of Voting Rights.”
Yale Law Journal, Forthcoming. Volume 130, Number 4: 778-1049.

Kim, Yunsieg and Jowei Chen, 2021. "Gerrymandered by Definition: The Distortion of 'Traditional' Districting Principles and a Proposal for an Empirical Redefinition."
Wisconsin Law Review, Forthcoming, Volume 2021, Number 1.

Chen, Jowei and Nicholas Stephanopoulos, 2021. "Democracy's Denominator."
California Law Review, Accepted for Publication, Volume 109.

Non-Peer-Reviewed Publication:

Chen, Jowei and Tim Johnson. 2017. “Political Ideology in the Bureaucracy.”
Global Encyclopedia of Public Administration, Public Policy, and Governance.

Research Grants:

"How Citizenship-Based Redistricting Systemically Disadvantages Voters of Color". 2020 ($18,225). Combating and Confronting Racism Grant. University of Michigan Center for Social Solutions and Poverty Solutions.

Principal Investigator. National Science Foundation Grant SES-1459459, September 2015 – August 2018 ($165,008). "The Political Control of U.S. Federal Agencies and Bureaucratic Political Behavior."

"Economic Disparity and Federal Investments in Detroit," (with Brian Min) 2011. Graham Institute, University of Michigan ($30,000).

"The Partisan Effect of OSHA Enforcement on Workplace Injuries," (with Connor Raso) 2009. John M. Olin Law and Economics Research Grant ($4,410).

Invited Talks:

September, 2011. University of Virginia, American Politics Workshop.
October 2011. Massachusetts Institute of Technology, American Politics Conference.
January 2012. University of Chicago, Political Economy/American Politics Seminar.
February 2012. Harvard University, Positive Political Economy Seminar.
September 2012. Emory University, Political Institutions and Methodology Colloquium.
November 2012. University of Wisconsin, Madison, American Politics Workshop.
September 2013. Stanford University, Graduate School of Business, Political Economy Workshop.
February 2014. Princeton University, Center for the Study of Democratic Politics Workshop.
November 2014. Yale University, American Politics and Public Policy Workshop.
December 2014. American Constitution Society for Law & Policy Conference: Building the Evidence to Win Voting Rights Cases.
February 2015. University of Rochester, American Politics Working Group.
March 2015. Harvard University, Voting Rights Act Workshop.
May 2015. Harvard University, Conference on Political Geography.
Octoer 2015. George Washington University School of Law, Conference on Redistricting Reform.
September 2016. Harvard University Center for Governmental and International Studies, Voting Rights Institute Conference.
March 2017. Duke University, Sanford School of Public Policy, Redistricting Reform Conference.
October 2017. Willamette University, Center for Governance and Public Policy Research
October 2017, University of Wisconsin, Madison. Geometry of Redistricting Conference.
February 2018: University of Georgia Law School
September 2018. Willamette University.
November 2018. Yale University, Redistricting Workshop.

November 2018. University of Washington, Severyns Ravenholt Seminar in Comparative Politics.
January 2019. Duke University, Reason, Reform & Redistricting Conference.
February 2019. Ohio State University, Department of Political Science. Departmental speaker series.
March 2019. Wayne State University Law School, Gerrymandering Symposium.
November 2019. Big Data Ignite Conference.
November 2019. Calvin College, Department of Mathematics and Statistics.
September 2020 (Virtual). Yale University, Yale Law Journal Scholarship Workshop

Conference Service:

Section Chair, 2017 APSA (San Francisco, CA), Political Methodology Section
Discussant, 2014 Political Methodology Conference (University of Georgia)
Section Chair, 2012 MPSA (Chicago, IL), Political Geography Section.
Discussant, 2011 MPSA (Chicago, IL) "Presidential-Congressional Interaction."
Discussant, 2008 APSA (Boston, MA) "Congressional Appropriations."
Chair and Discussant, 2008 MPSA (Chicago, IL) "Distributive Politics: Parties and Pork."

Conference Presentations and Working Papers:

"Ideological Representation of Geographic Constituencies in the U.S. Bureaucracy," (with Tim Johnson). 2017 APSA.

"Incentives for Political versus Technical Expertise in the Public Bureaucracy," (with Tim Johnson). 2016 APSA.

"Black Electoral Geography and Congressional Districting: The Effect of Racial Redistricting on Partisan Gerrymandering". 2016 Annual Meeting of the Society for Political Methodology (Rice University)

"Racial Gerrymandering and Electoral Geography." Working Paper, 2016.

"Does Deserved Spending Win More Votes? Evidence from Individual-Level Disaster Assistance," (with Andrew Healy). 2014 APSA.

"The Geographic Link Between Votes and Seats: How the Geographic Distribution of Partisans Determines the Electoral Responsiveness and Bias of Legislative Elections," (with David Cottrell). 2014 APSA.

"Gerrymandering for Money: Drawing districts with respect to donors rather than voters." 2014 MPSA.

“Constituent Age and Legislator Responsiveness: The Effect of Constituent Opinion on the Vote for Federal Health Reform.” (with Katharine Bradley) 2012 MPSA.

“Voter Partisanship and the Mobilizing Effect of Presidential Advertising.” (with Kyle Dropp) 2012 MPSA.

“Recency Bias in Retrospective Voting: The Effect of Distributive Benefits on Voting Behavior.” (with Andrew Feher) 2012 MPSA.

“Estimating the Political Ideologies of Appointed Public Bureaucrats,” (with Adam Bonica and Tim Johnson) 2012 Annual Meeting of the Society for Political Methodology (University of North Carolina)

“Tobler’s Law, Urbanization, and Electoral Bias in Florida.” (with Jonathan Rodden) 2010 Annual Meeting of the Society for Political Methodology (University of Iowa)

“Unionization and Presidential Control of the Bureaucracy” (with Tim Johnson) 2011 MPSA.

“Estimating Bureaucratic Ideal Points with Federal Campaign Contributions” 2010 APSA. (Washington, DC).

“The Effect of Electoral Geography on Pork Spending in Bicameral Legislatures,” Vanderbilt University Conference on Bicameralism, 2009.

“When Do Government Benefits Influence Voters’ Behavior? The Effect of FEMA Disaster Awards on US Presidential Votes,” 2009 APSA (Toronto, Canada).

“Are Poor Voters Easier to Buy Off?” 2009 APSA (Toronto, Canada).

“Credit Sharing Among Legislators: Electoral Geography’s Effect on Pork Barreling in Legislatures,” 2008 APSA (Boston, MA).

“Buying Votes with Public Funds in the US Presidential Election,” Poster Presentation at the 2008 Annual Meeting of the Society for Political Methodology (University of Michigan).

“The Effect of Electoral Geography on Pork Spending in Bicameral Legislatures,” 2008 MPSA.

“Legislative Free-Riding and Spending on Pure Public Goods,” 2007 MPSA (Chicago, IL).

“Free Riding in Multi-Member Legislatures,” (with Neil Malhotra) 2007 MPSA (Chicago, IL).

“The Effect of Legislature Size, Bicameralism, and Geography on Government Spending: Evidence from the American States,” (with Neil Malhotra) 2006 APSA (Philadelphia, PA).

Figure A1: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2016 Attorney General Election Results

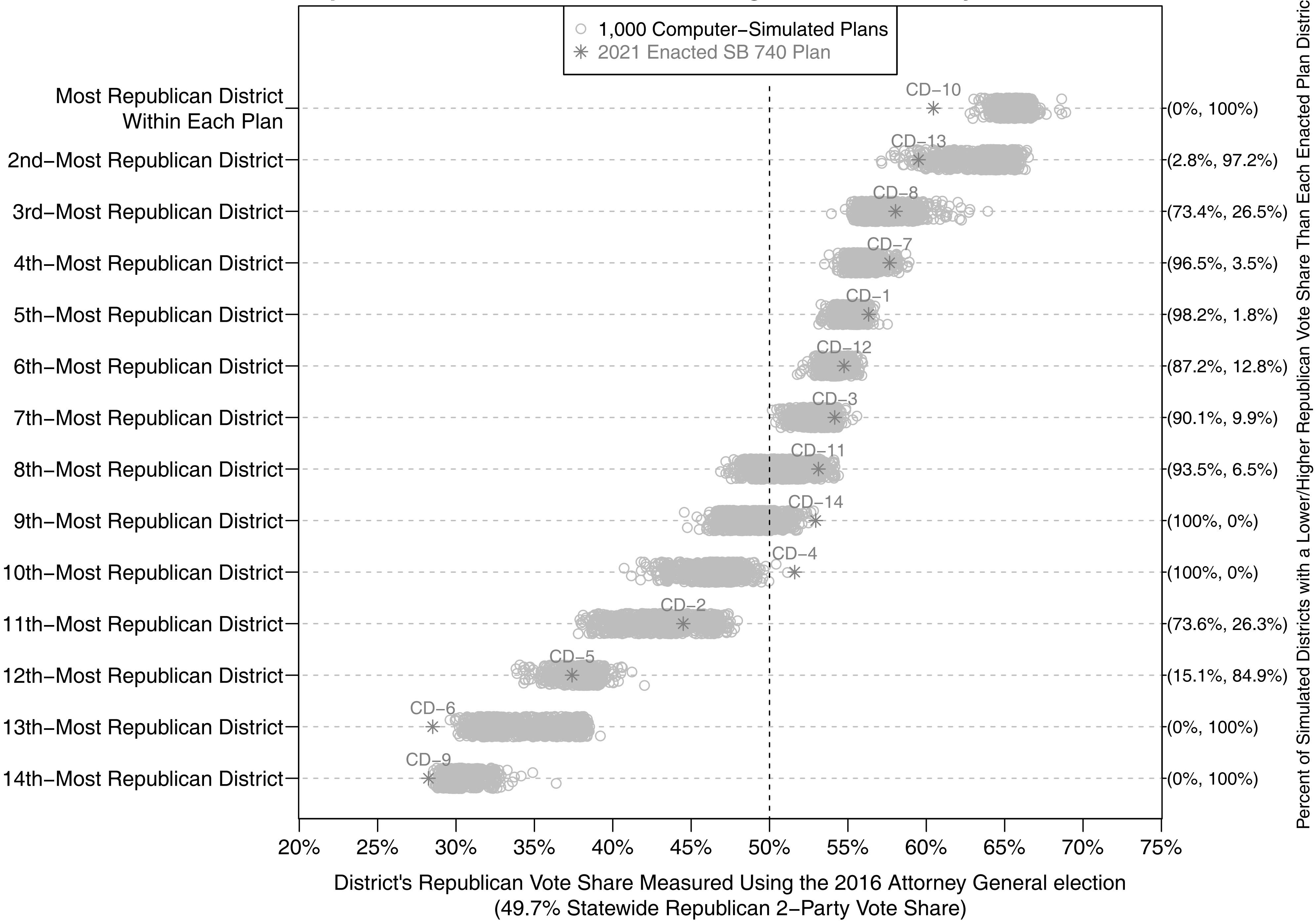

Figure A2: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2016 Governor Election Results

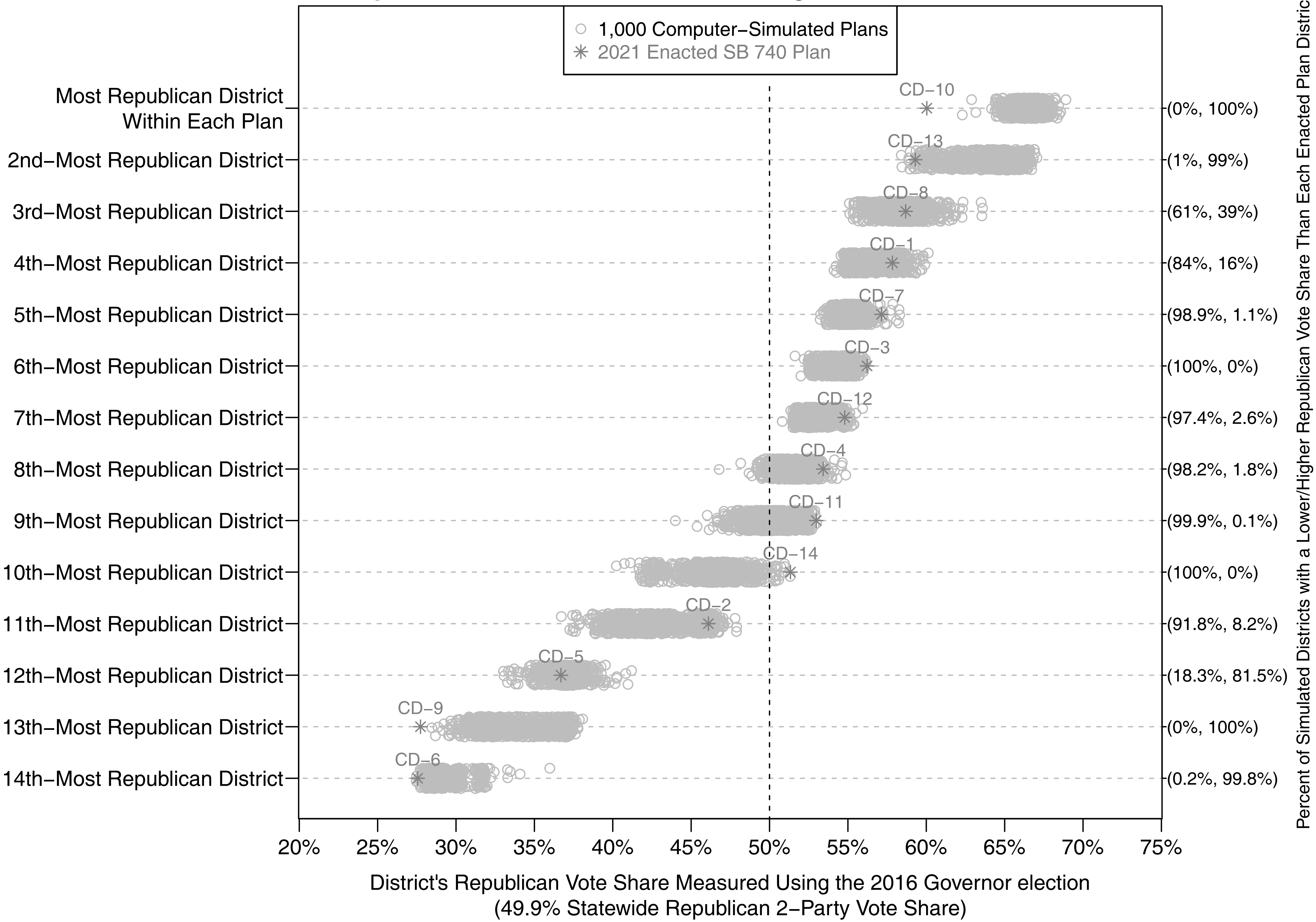

Figure A3: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2016 Lieutenant Governor Election Results

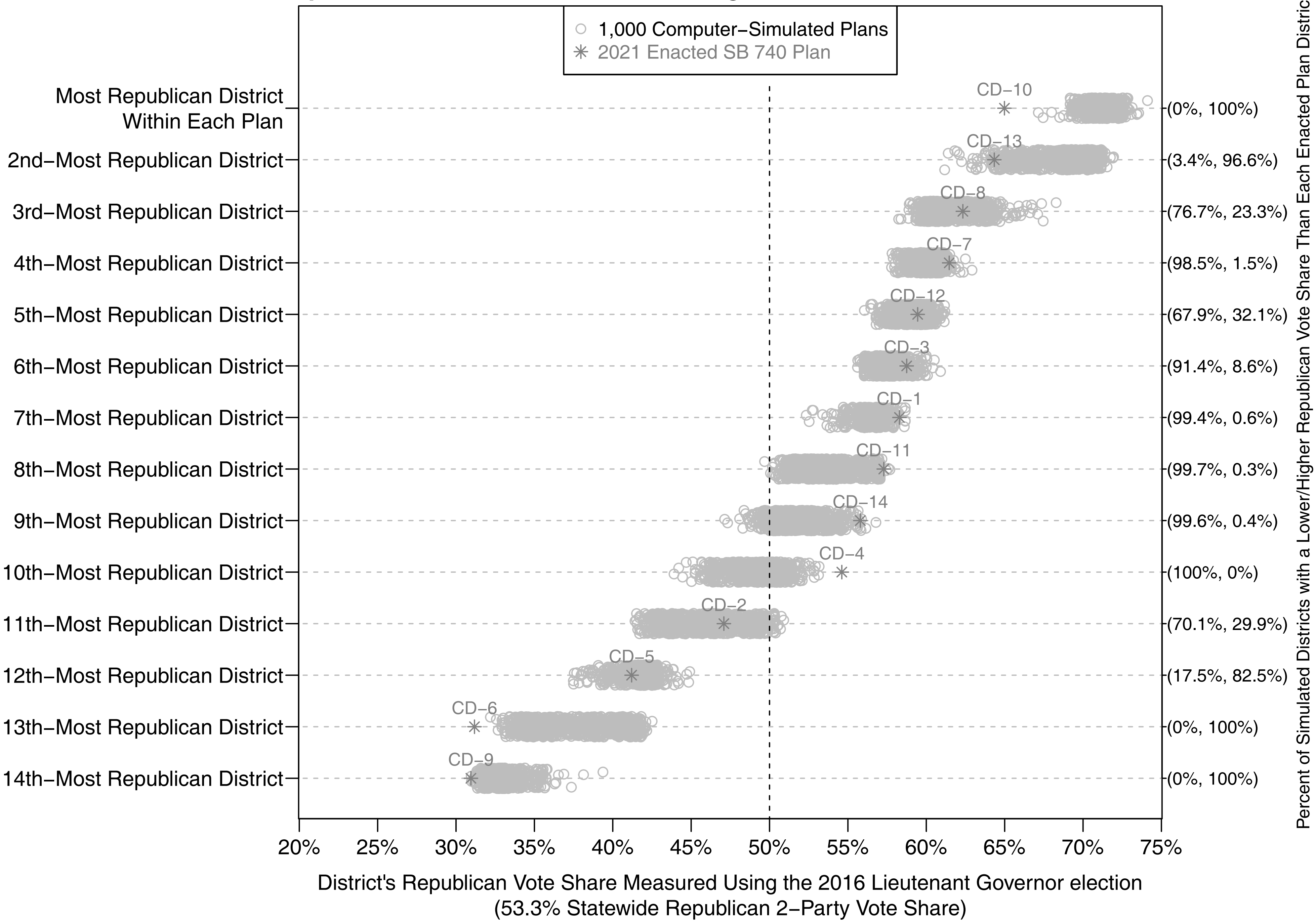

Figure A4: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2016 US President Election Results

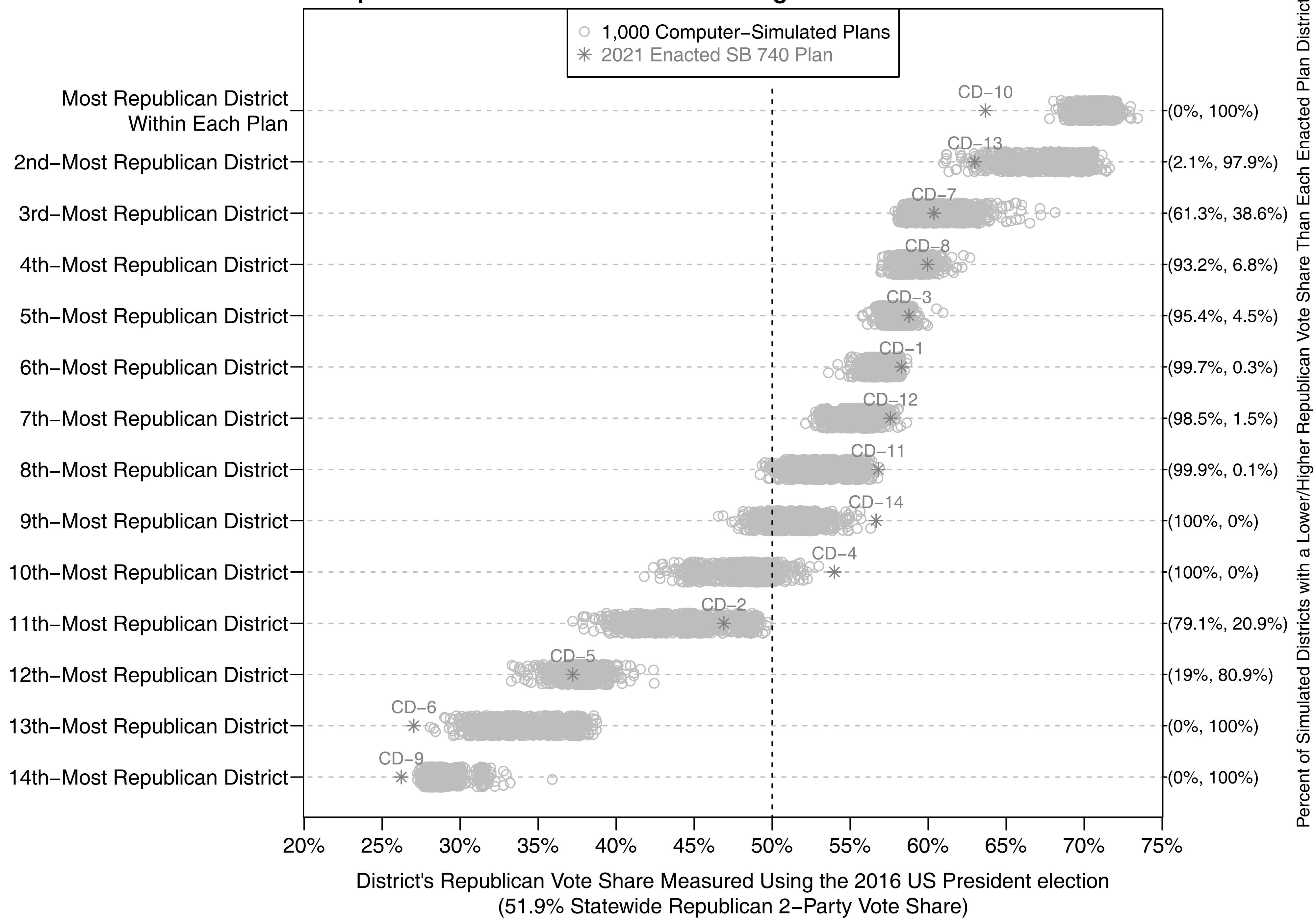

Figure A5: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2016 US Senator Election Results

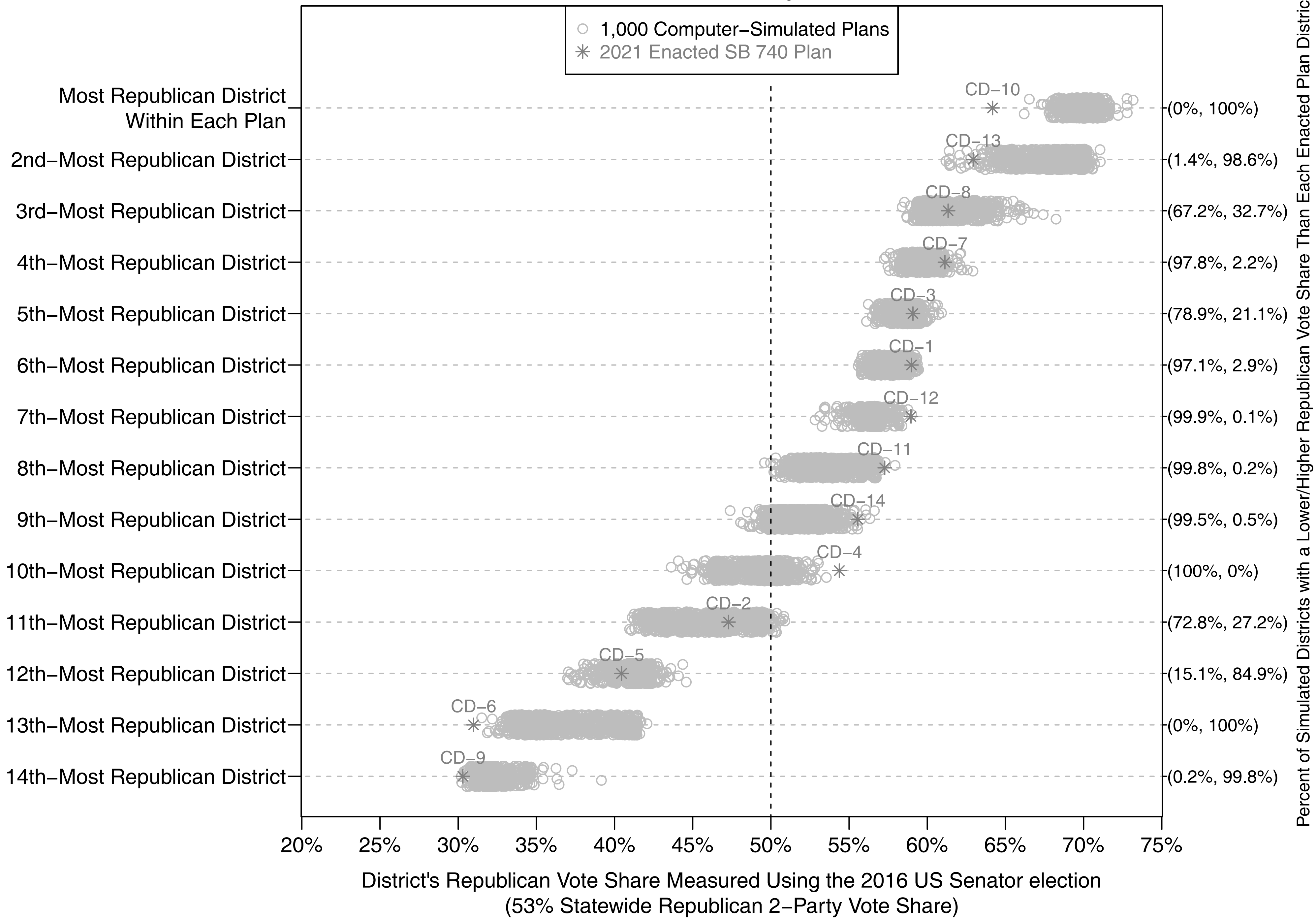

Figure A6: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2020 Attorney General Election Results

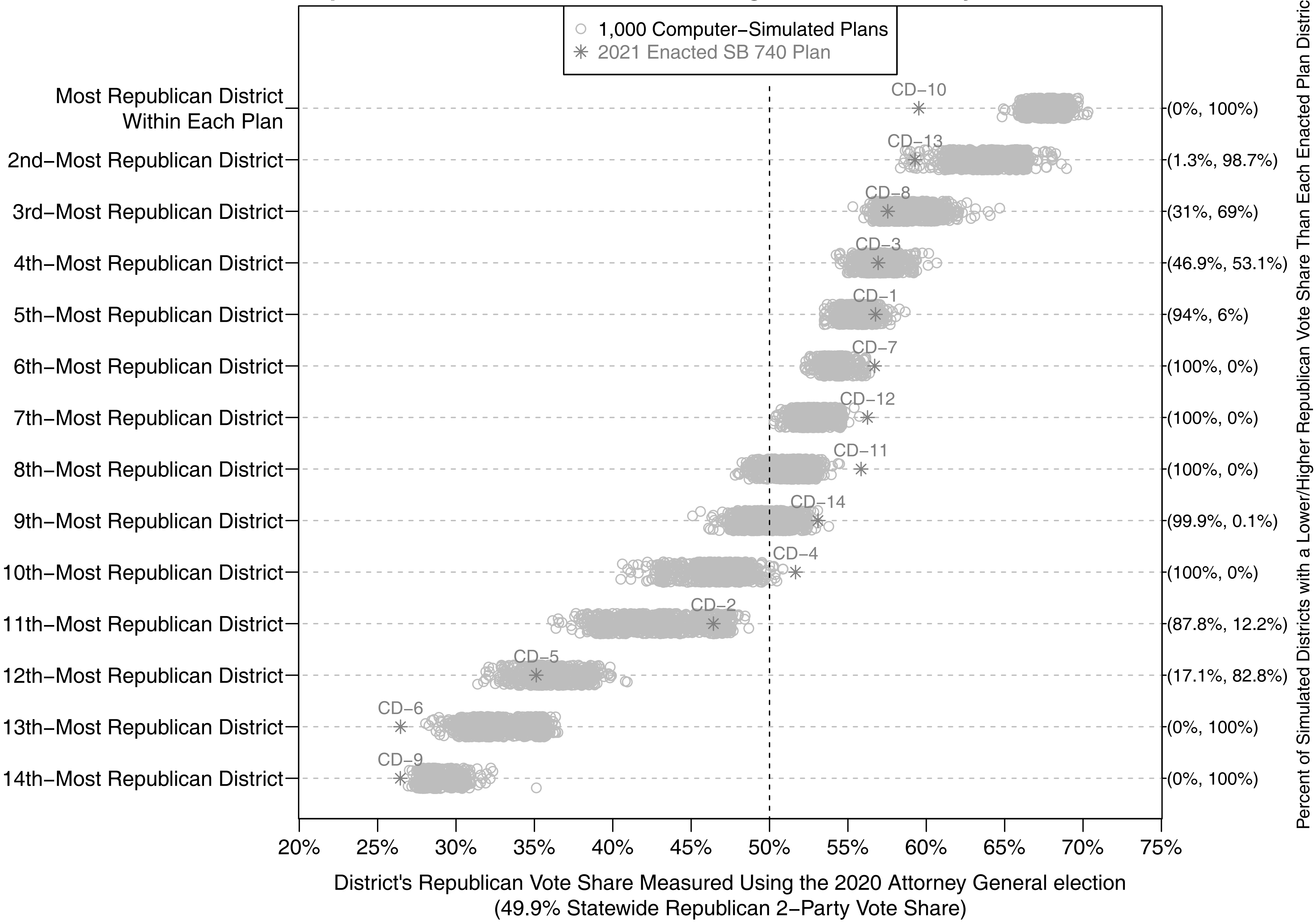

Figure A7: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2020 Governor Election Results

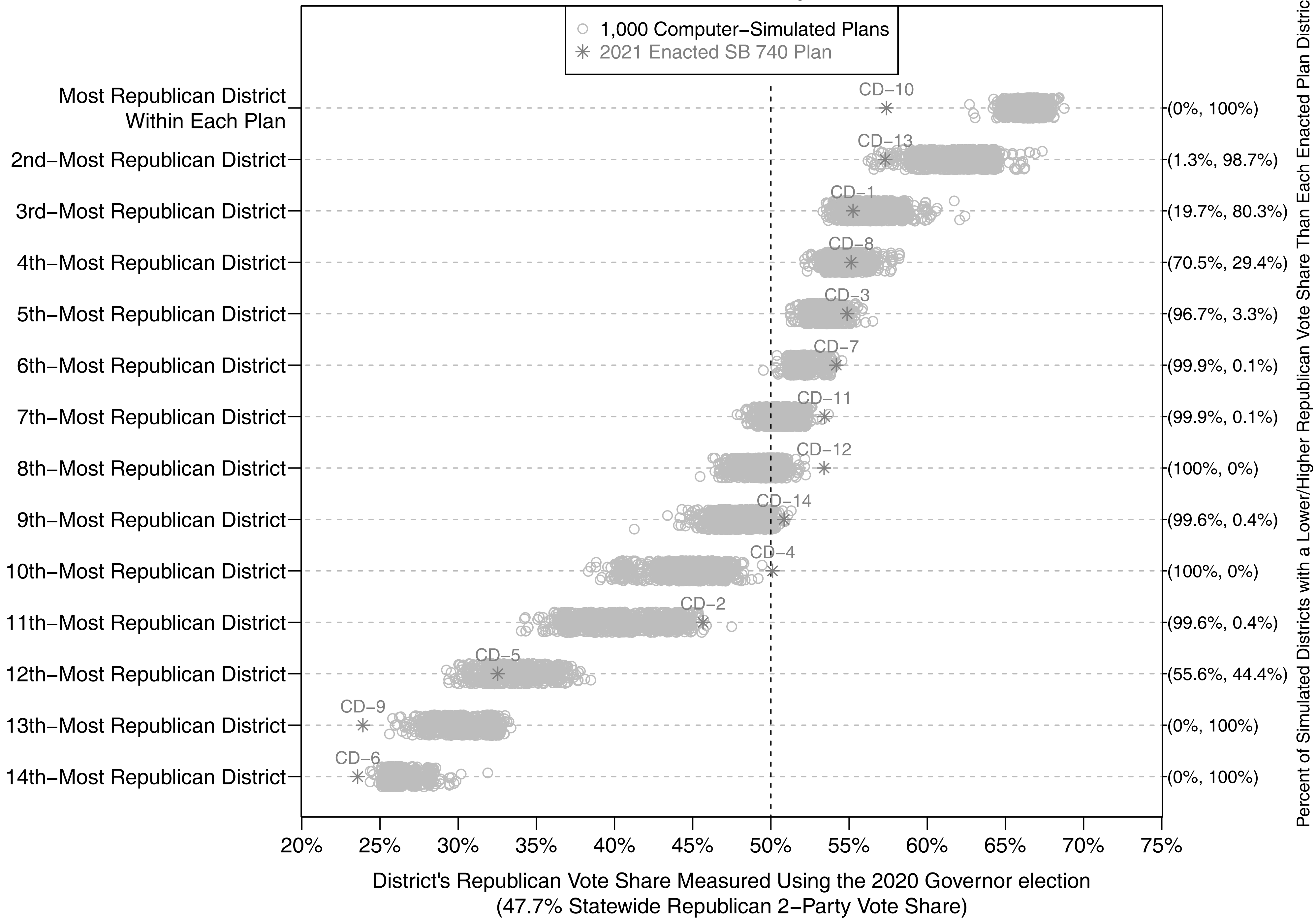

Figure A8: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2020 Lieutenant Governor Election Results

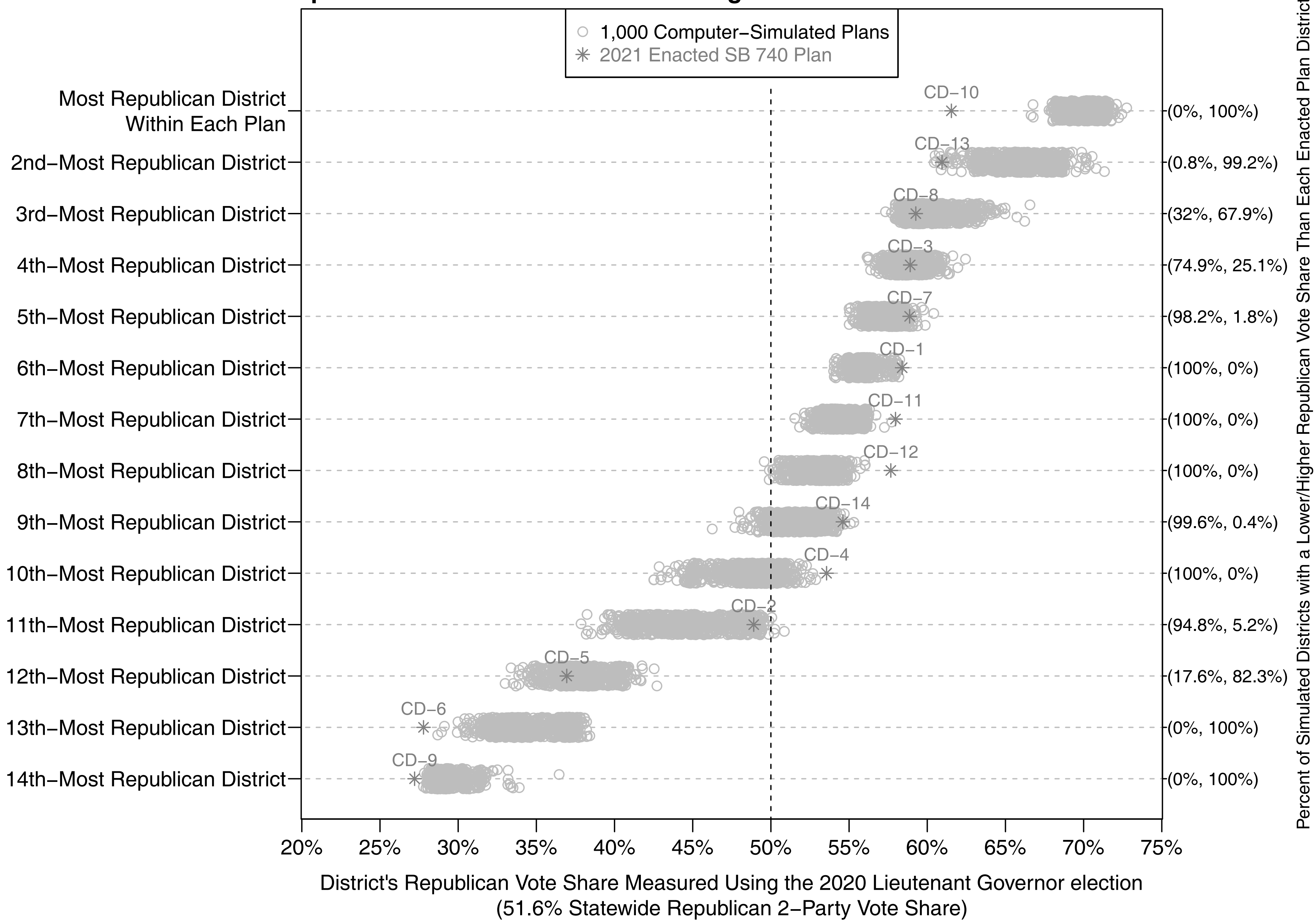

Figure A9: Comparison of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans: Districts' Republican Vote Share Measured Using the 2020 US President Election Results

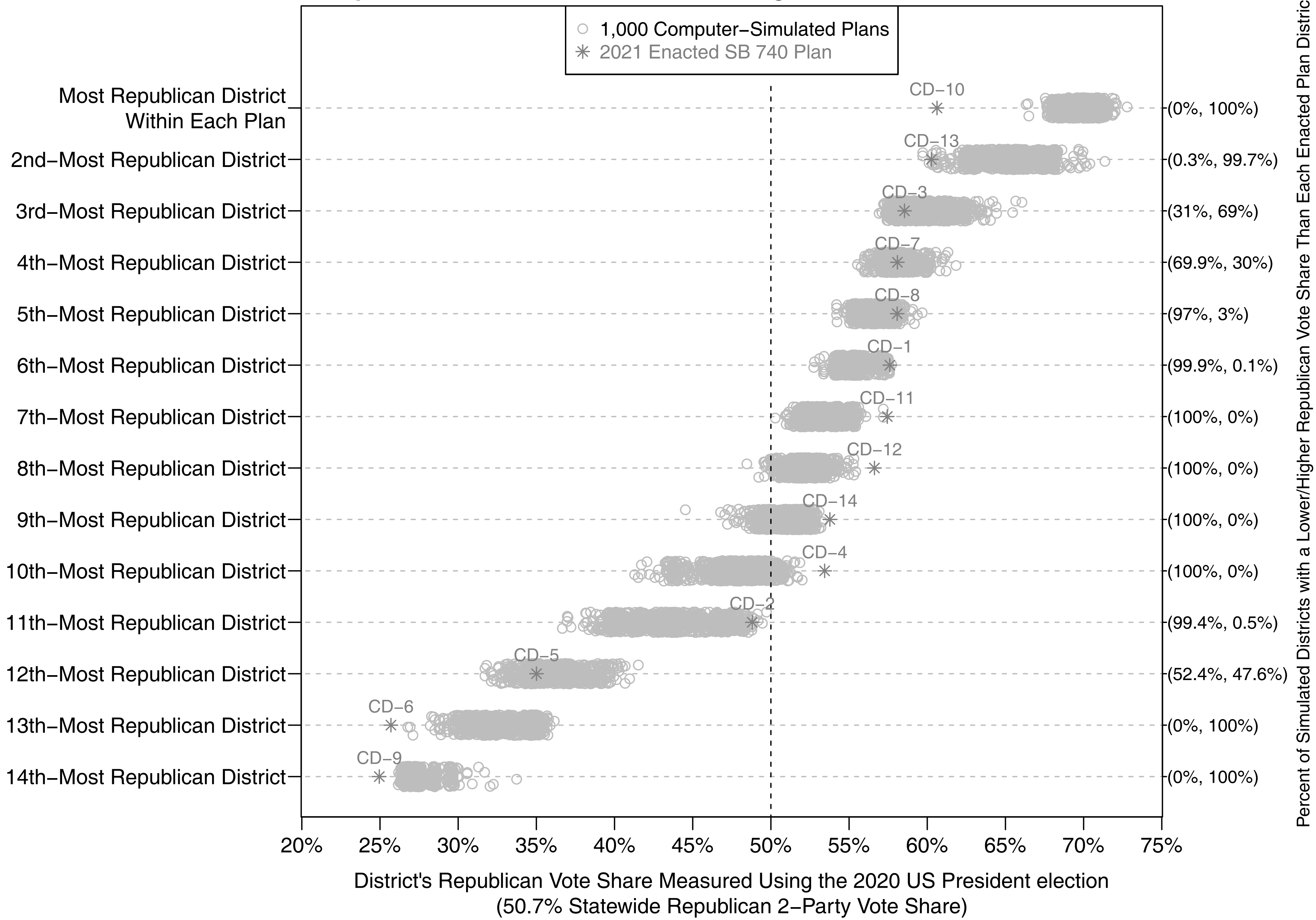

Figure A10: Comparison of Enacted SB 740 Plan to 1,000 Computer–Simulated Plans: Districts' Republican Vote Share Measured Using the 2020 US Senator Election Results

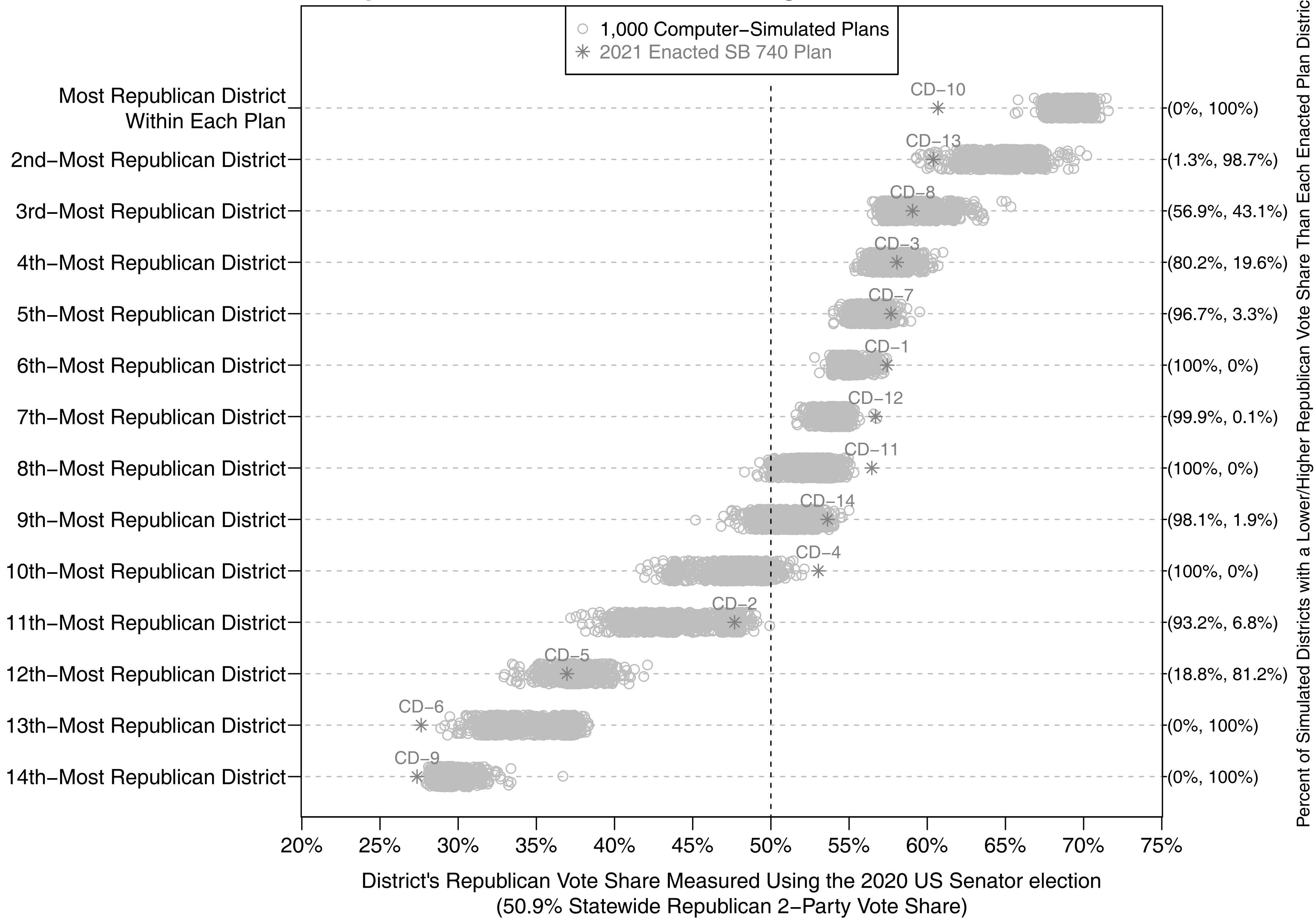

Figure B1: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans Number of Districts With Over 50% Republican Vote Share in the 2016 Attorney General election (49.7% Statewide Republican 2−Party Vote Share)

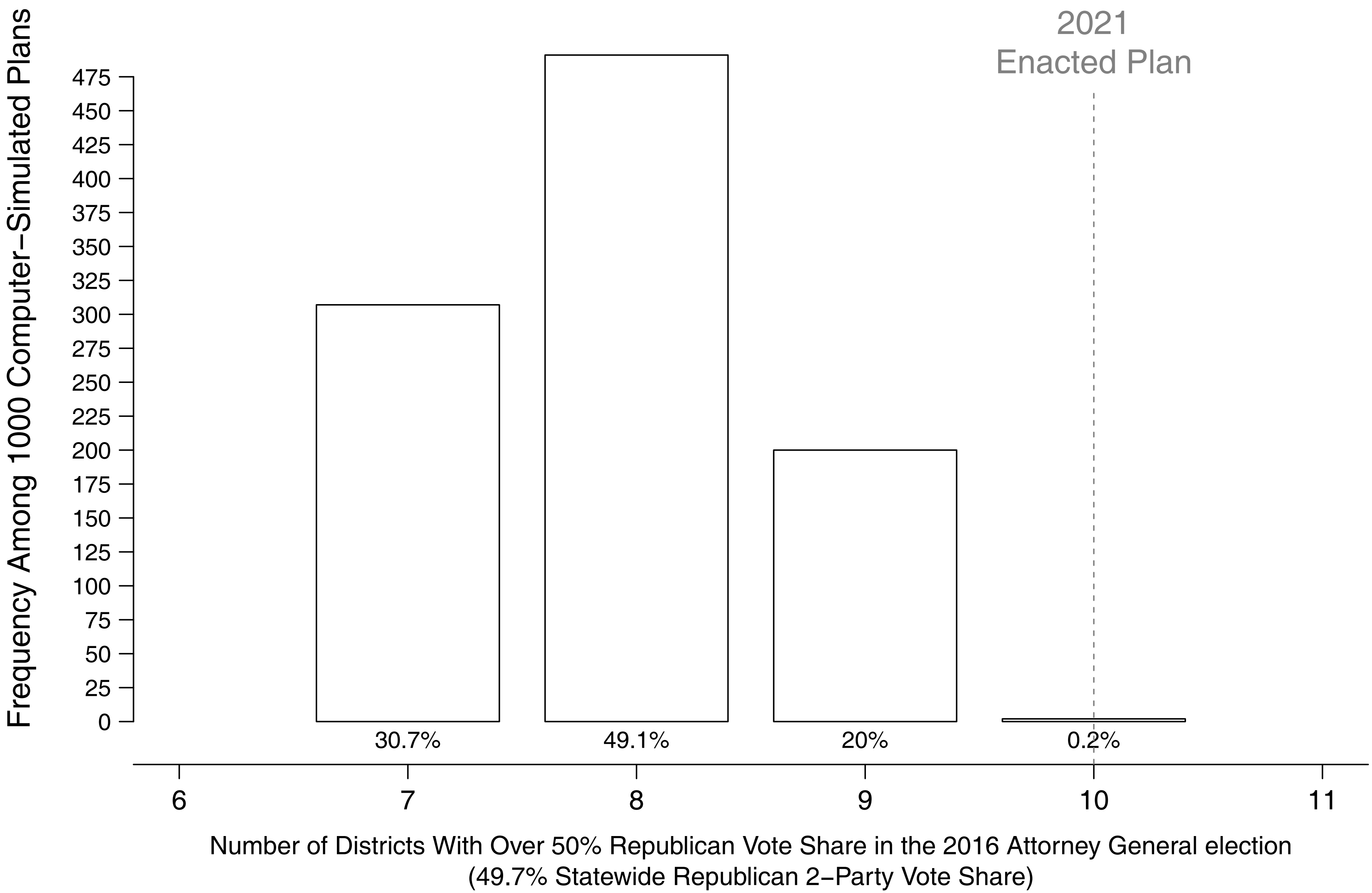

Figure B2: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2016 Governor election
(49.9% Statewide Republican 2−Party Vote Share)

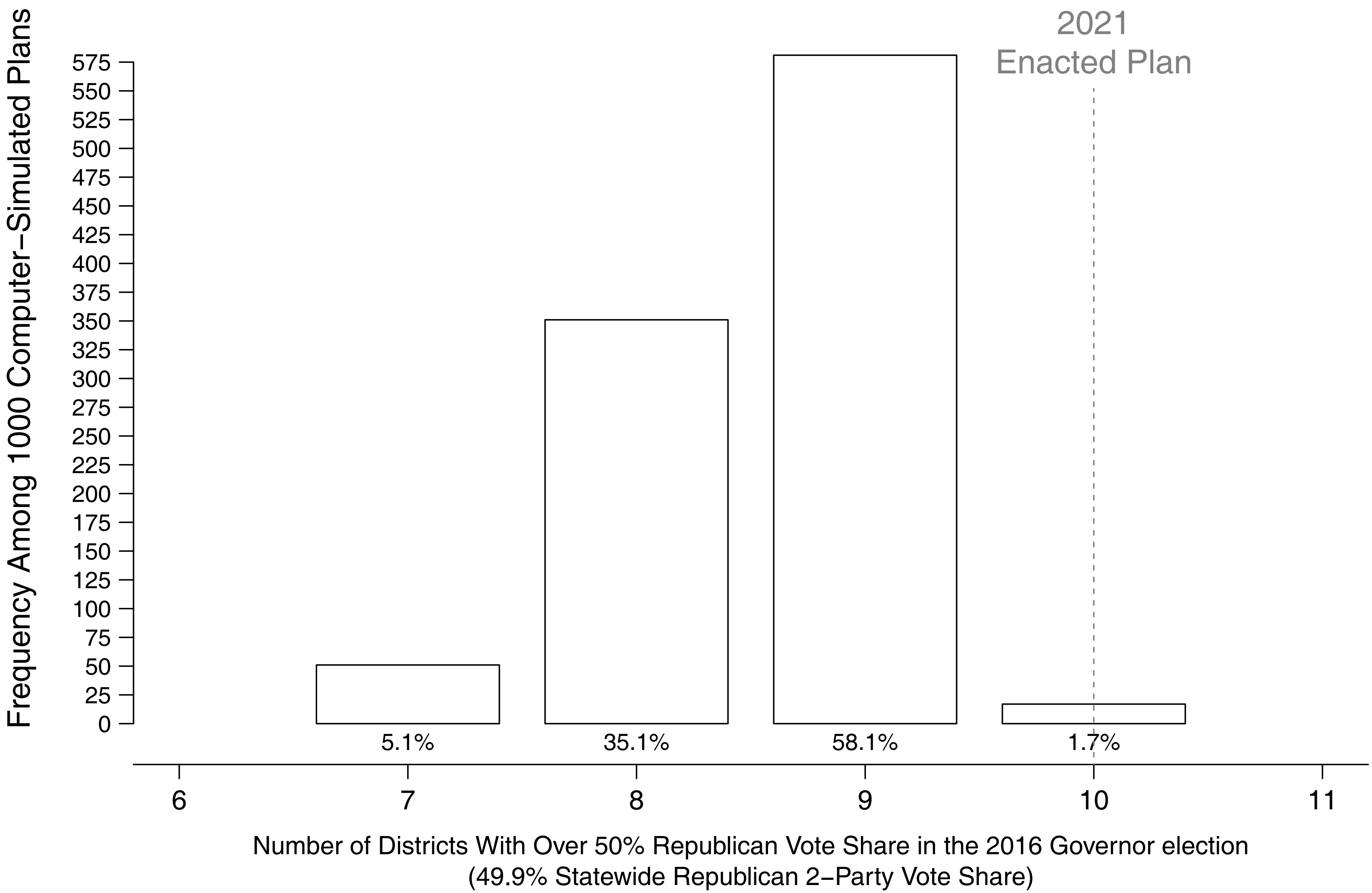

**Figure B3: Comparisons of Enacted SB 740 Plan to 1,000 Computer–Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2016 Lieutenant Governor election
(53.3% Statewide Republican 2–Party Vote Share)**

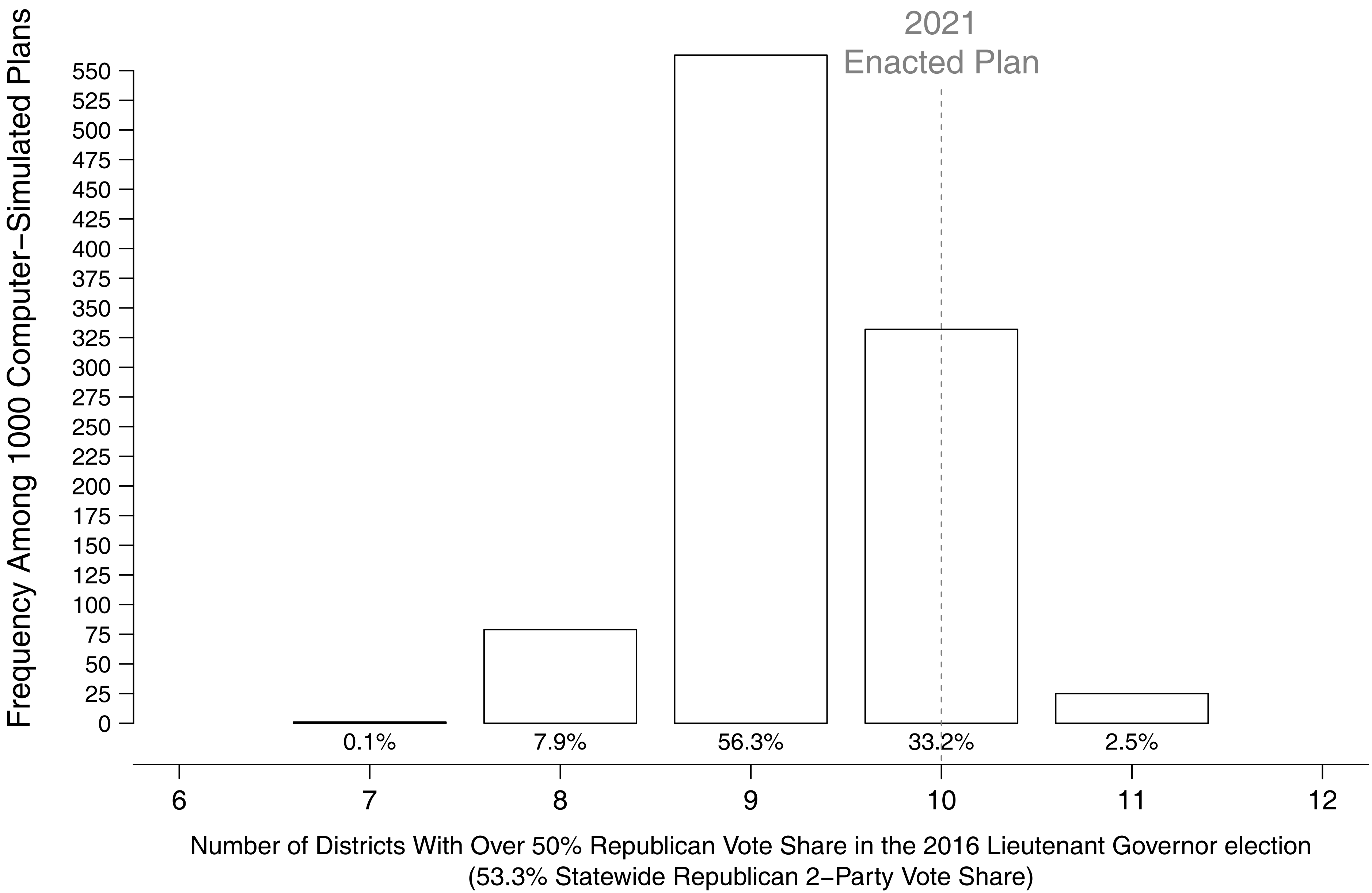

Figure B4: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2016 US President election
(51.9% Statewide Republican 2−Party Vote Share)

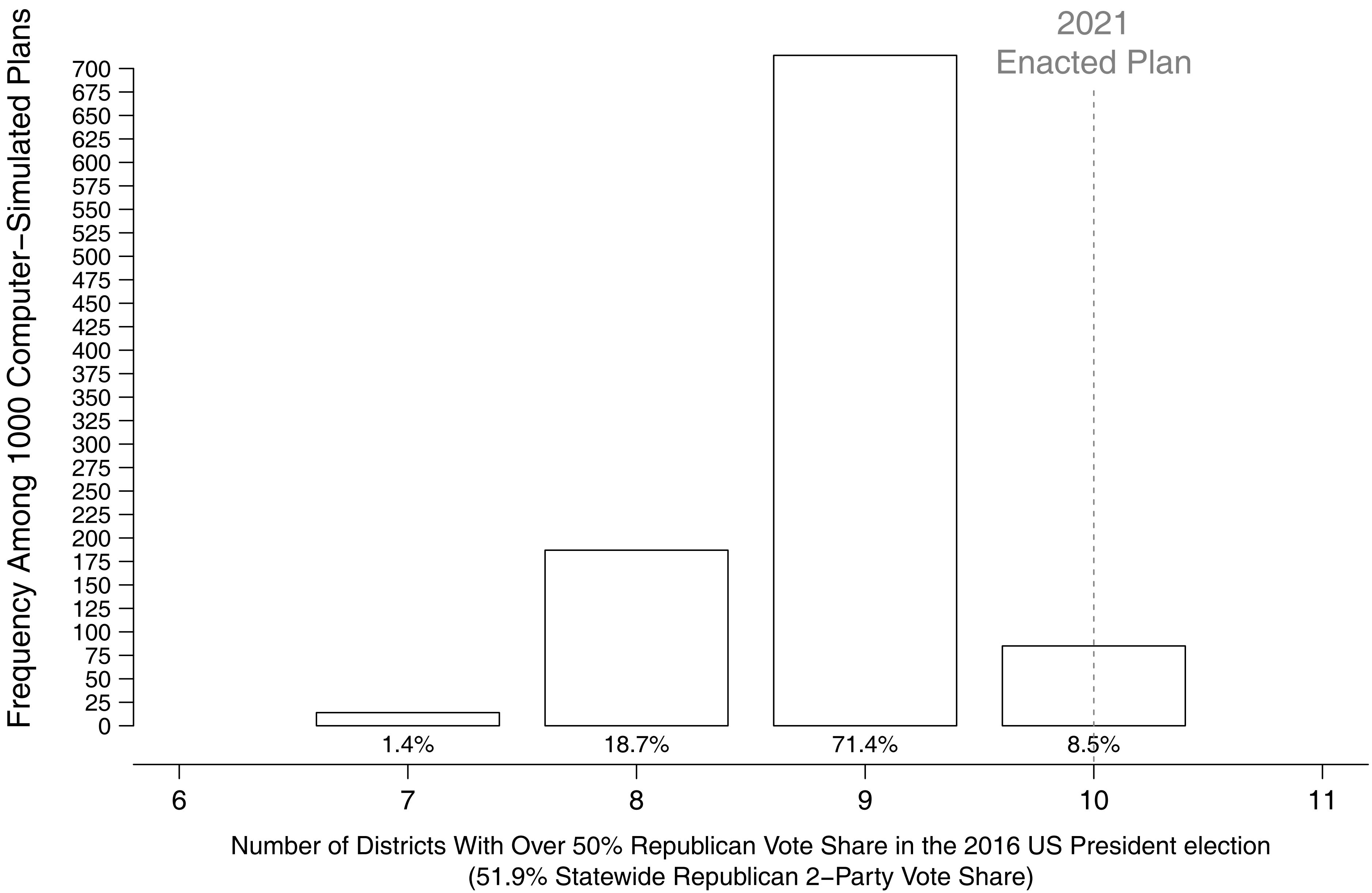

Figure B5: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2016 US Senator election
(53% Statewide Republican 2−Party Vote Share)

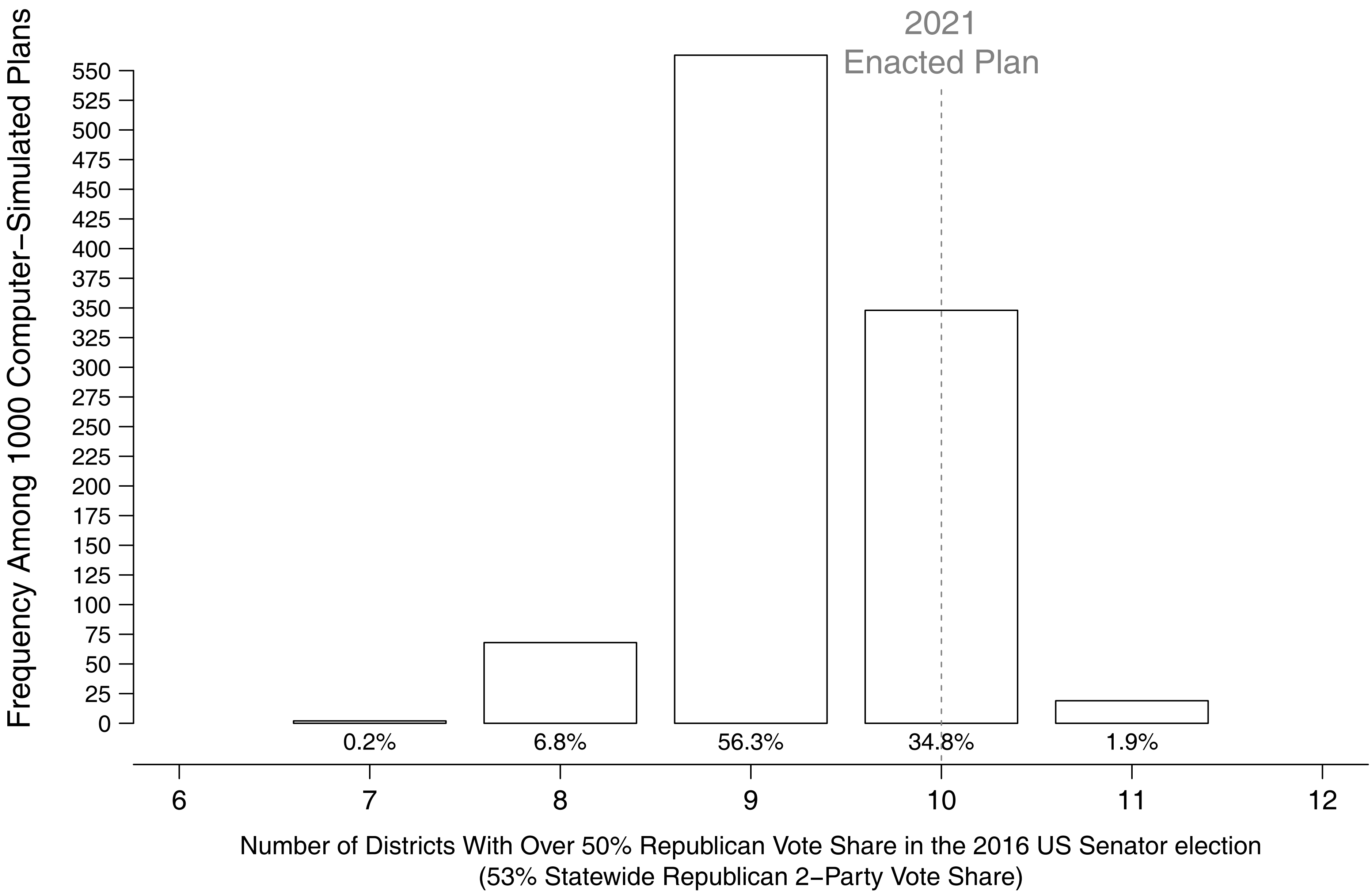

Figure B6: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans Number of Districts With Over 50% Republican Vote Share in the 2020 Attorney General election (49.9% Statewide Republican 2−Party Vote Share)

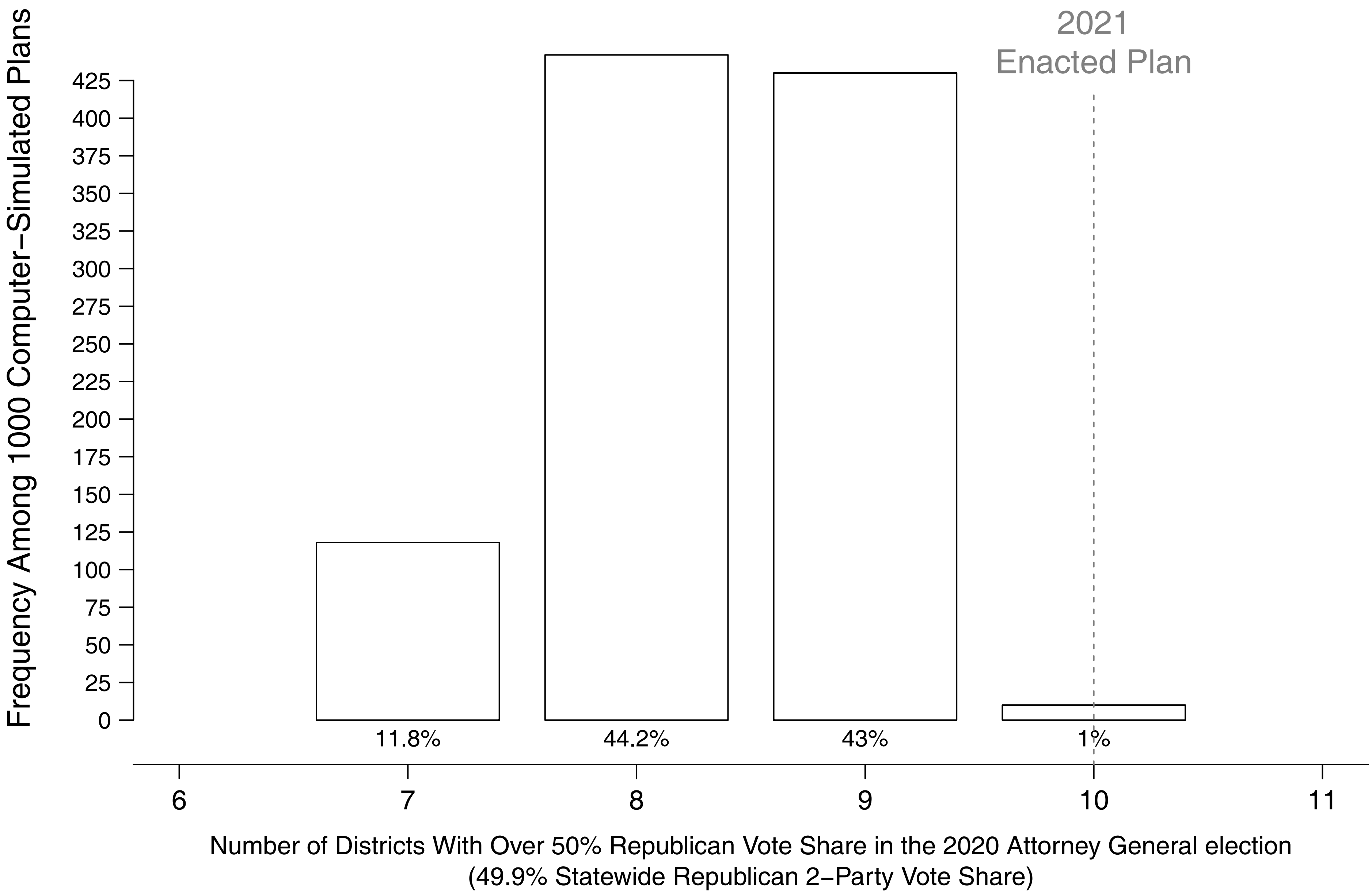

Figure B7: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2020 Governor election
(47.7% Statewide Republican 2−Party Vote Share)

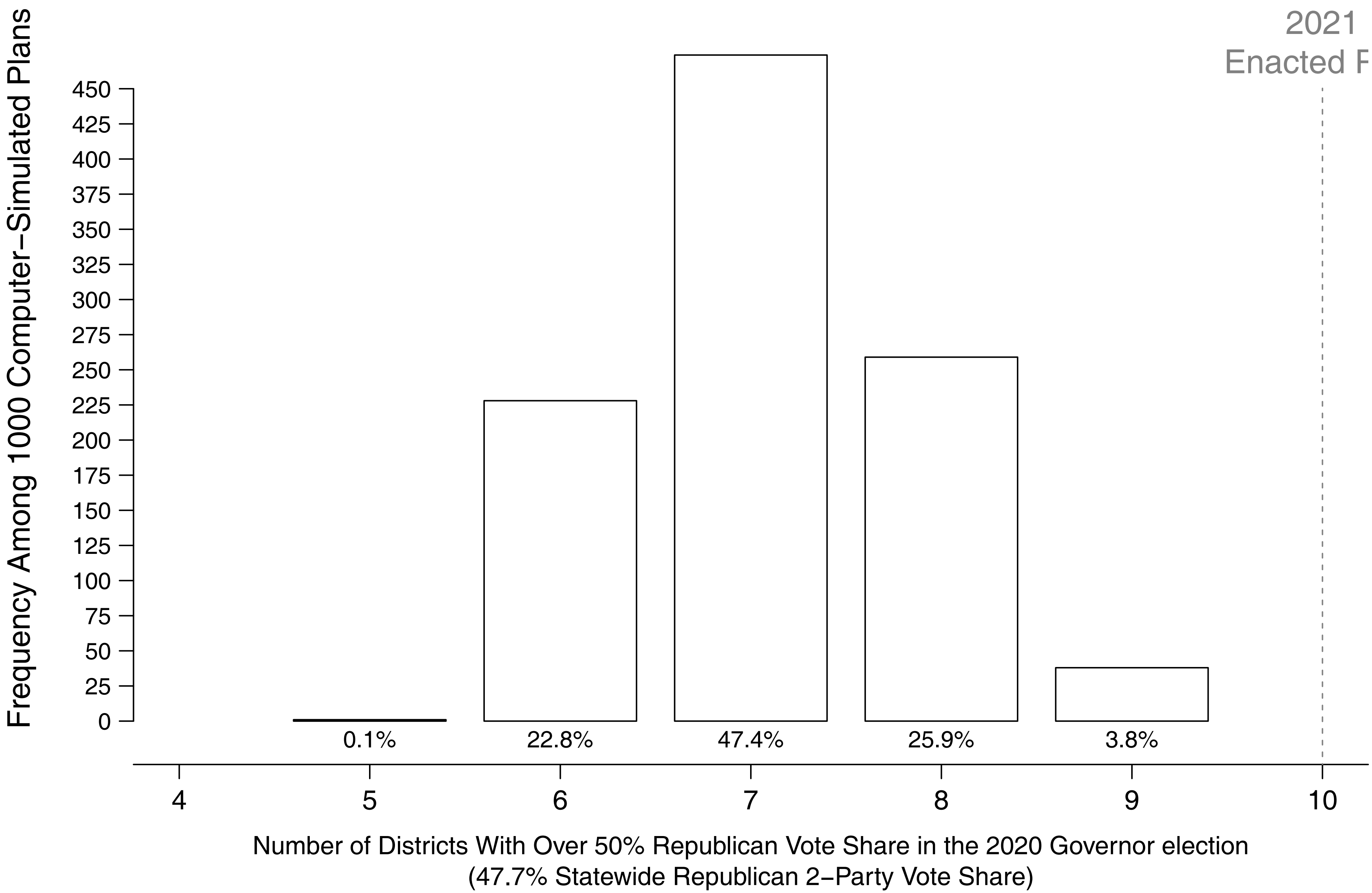

Figure B8: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2020 Lieutenant Governor election
(51.6% Statewide Republican 2−Party Vote Share)

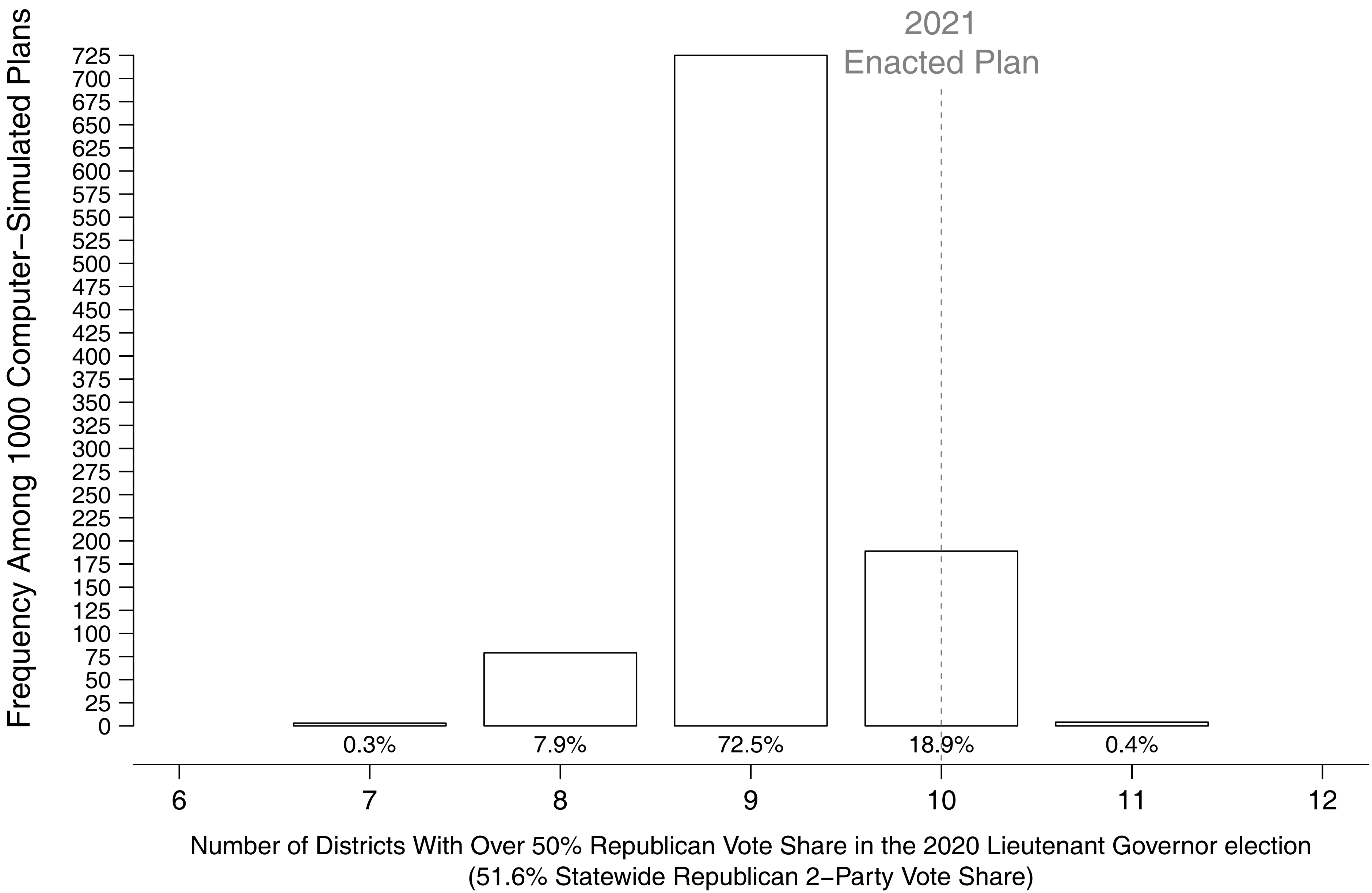

Figure B9: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2020 US President election
(50.7% Statewide Republican 2−Party Vote Share)

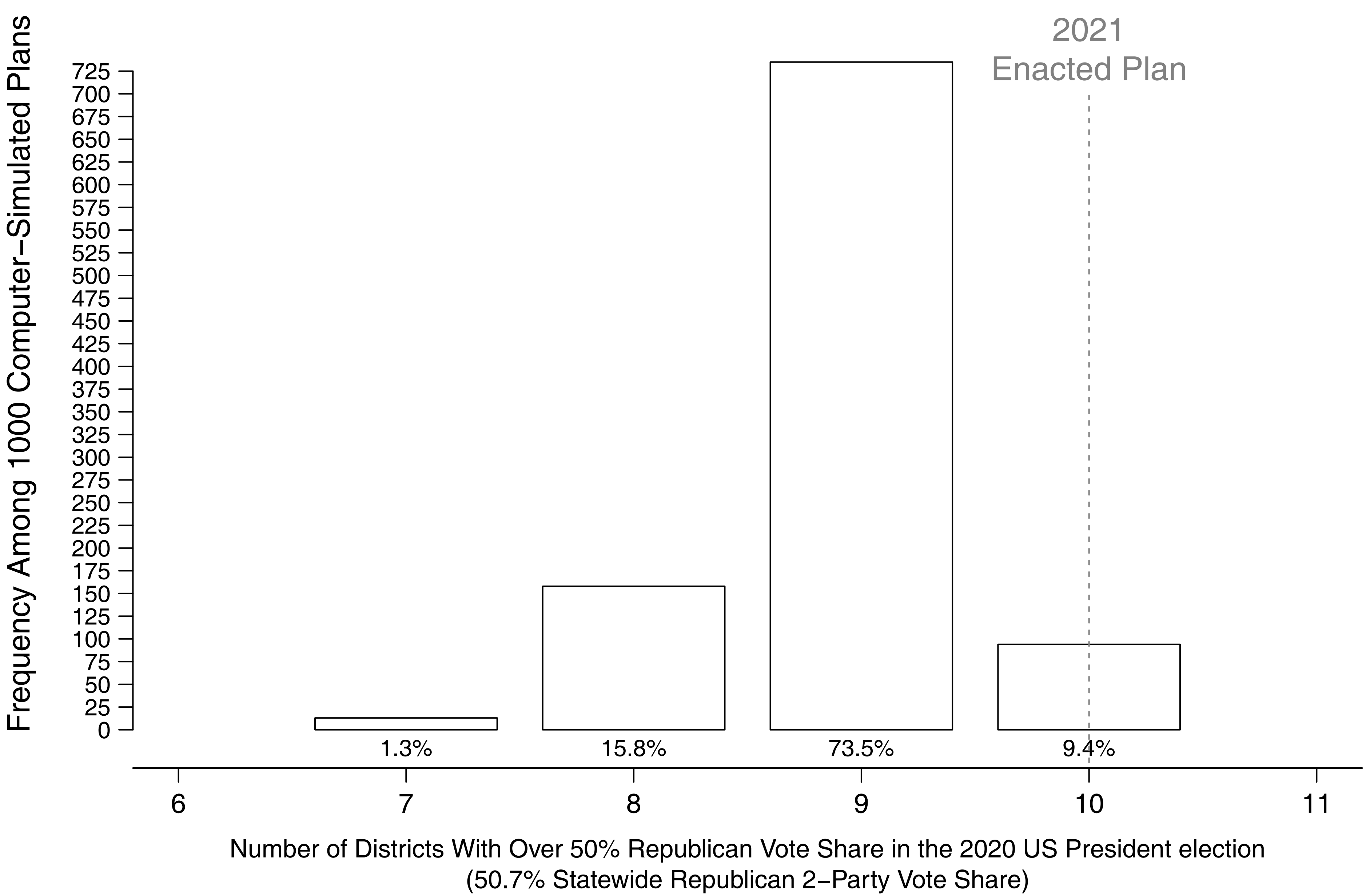

**Figure B10: Comparisons of Enacted SB 740 Plan to 1,000 Computer−Simulated Plans
Number of Districts With Over 50% Republican Vote Share in the 2020 US Senator election
(50.9% Statewide Republican 2−Party Vote Share)**

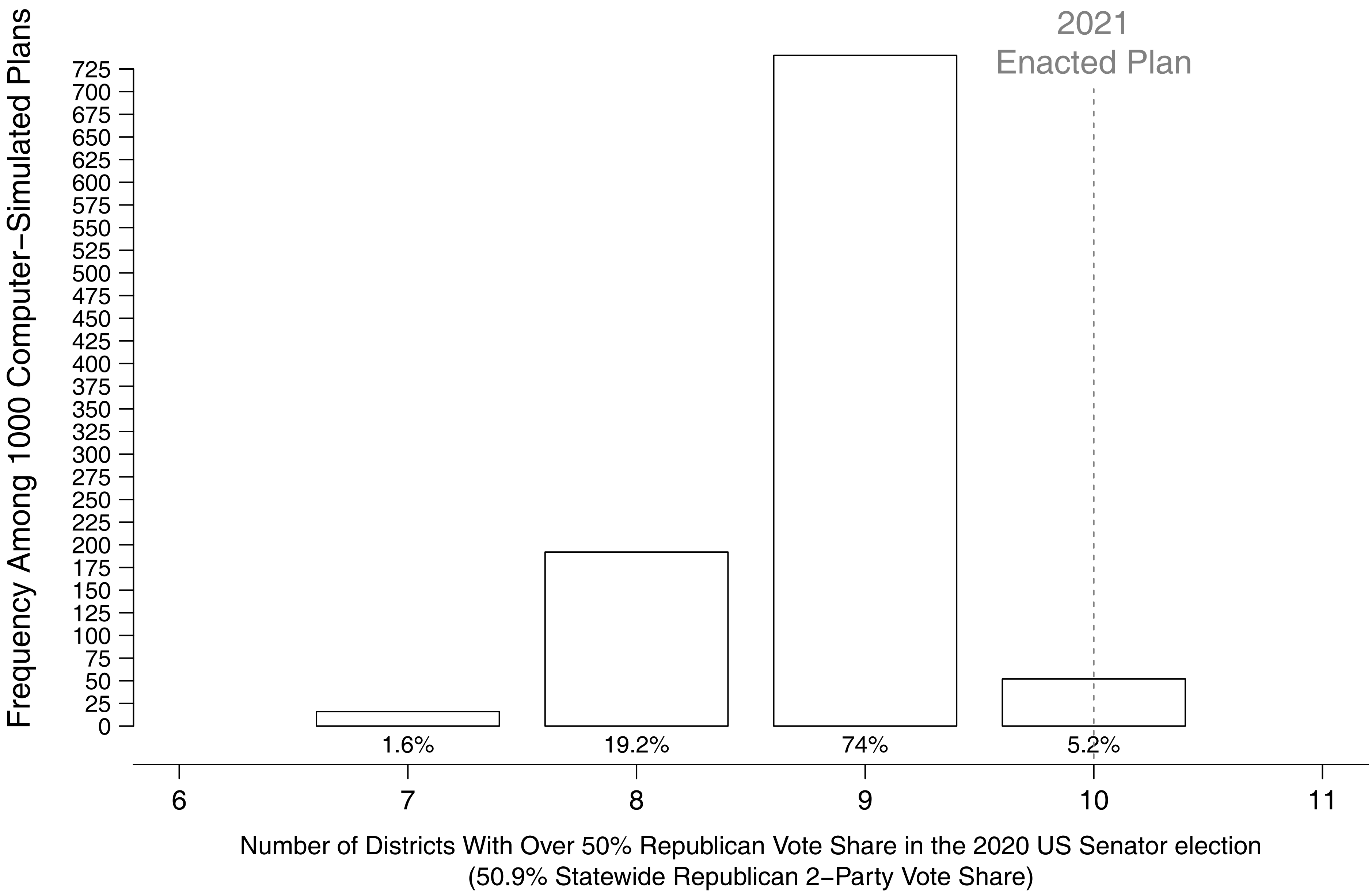

EXHIBIT I

Preliminary analysis of SL 2021-174 Congressional districting

Wesley Pegden

November 29, 2021

1 Qualifications

I am an associate professor in the department of Mathematical Sciences at Carnegie Mellon University, where I have been a member of the faculty since 2013. I received my Ph.D. in Mathematics from Rutgers University in 2010 under the supervision of József Beck, and I am an expert on stochastic processes and discrete probability. My research has been funded by the National Science Foundation and the Sloan Foundation. A list of my publications with links to online manuscripts is also available at my website at `http://math.cmu.edu/~wes`. I am an expert on the use of Markov Chains for the rigorous analysis of gerrymandering, and have published papers[1] developing techniques for this application in *Proceedings of the National Academy of Sciences* and *Statistics and Public Policy*, hereafter referred to by [CFP] and [CFMP], respectively.

I testified as an expert witness in the *League of Women Voters of Pennsylvania v. Commonwealth of Pennsylvania* case in which the 2011 Congressional districting was found to be an unconstitutional partisan gerrymander, and as well as the *Common Cause v. Lewis* case in North Carolina. I previously served as a member of the bipartisan Pennsylvania Redistricting Reform Commission under appointment by the governor.

2 Executive Summary

I was asked to conduct a preliminary analysis of whether the S.L. 2021-174 Congressional Districting passed in North Carolina drawn in a way which made extreme use of partisan considerations.

To conduct my analysis, I take the enacted plan as a starting point and make a sequence of many small random changes to the district boundaries. This methodology is intended to detect whether the district lines were carefully drawn to optimize partisan considerations; in particular, if the plans in question were not intentionally drawn to maximize partisan advantage, then making small random changes should not significantly decrease the plan's partisan bias.

Specifically, my method begins with the enacted plan and uses a Markov Chain—a sequence of random changes—to generate billions of comparison districtings against which I compare the enacted plans. These comparison districtings are generated by making a sequence of small random changes to the enacted plans themselves, and preserve districting criteria such as population deviation, compactness, and splitting of counties.

The analysis I conduct of the enacted plan using this data has two levels. The first level of my analysis consists simply of comparing the partisan properties of the enacted plans to the large sets of comparison maps produced by my Markov Chain, and I report how unusual the enacted plans are with respect to their partisan properties, against this comparison set. **Quantitatively, I find the enacted S.L. 2021-174 Congressional plan exhibits greater partisan bias than 99.99% of the billions of comparison districtings of North Carolina produced by my algorithm.**

[1]

- M. Chikina, A. Frieze, W. Pegden. Assessing significance in a Markov Chain without mixing, in *Proceedings of the National Academy of Sciences* **114** (2017) 2860–2864
- M. Chikina, A. Frieze, J. Mattingly, W. Pegden. Separating effect from significance in Markov chain tests, in *Statistics and Public Policy* **7** (2020) 101–114.

The next level of my analysis uses the mathematical results I have developed with my co-authors in [CFP] and [CFMP] to translate the results of the above comparison into a statement about how the enacted plans compare against *all* other districtings of North Carolina satisfying the districting criteria I consider in this report. In other words, the theorem that I use in the second level analysis allows me to compare the enacted plan against not only the billions of plans that my simulations produce through making small random changes, but also against all other possible districtings of North Carolina satisfying the districting criteria I consider.

Consider the following: when I make a sequence of small random changes to an enacted plan as described above, this can be viewed as a test of whether the partisan bias in the current districting is fragile, in the sense that it evaporates when the boundary lines of the district are perturbed. The theorems proved in [CFP] and [CFMP] establish that it is mathematically impossible for the political geography of a state to cause such a result. That is: while political geography might conceivably interact with districting criteria to create a situation where typical districtings of a state are biased in favor of one party, it is mathematically impossible for the political geography of a state to interact with districting criteria to create a situation where typical districtings of a state exhibit a *fragile* or *optimized* partisan bias, which quickly evaporates when small changes are made. This allows us to rigorously demonstrate that a districting is optimized with respect to partisanship, and is an outlier among *all* districtings of a state satisfying the criteria I consider, with respect to this property.

2.1 Comparison Criteria

The comparison districtings used by method are required to satisfy various criteria in ways that constrain them to be similar in several respects to the enacted map being evaluated. For the preliminary analysis, all comparison maps were constrained to have population deviation at most 2%, and to have compactness scores at good as the enacted map, up to an error of at most 2%, no more precinct splits than the enacted map, and no more county traversals than the enacted map. These restrictions are denoted "conditions A" in the results below. I also conducted three additional tests which additionally constrain the number of municipality splits ("conditions B"), additionally constrain incumbents protected by the enacted map to be protected by all comparison maps ("conditions C"), or additionally constrain both ("conditions D").

2.2 Note on Population Deviation

My method does not simulate the results of elections for hypothetical elections at the per-person level, and thus do not enforce 1-person population deviation on districts (instead using a cutoff like 2%, as described above), as direct voter preference data is not available at sufficient granularity. Note that this same limitation faces mapmakers who might try to draw a favorable districting for their party; a practical approach is to first use the available data to draw a "coarse" map with the desired properties, and then make small changes to the map (e.g., which split VTDs) to satisfy the population constraint.

I verify that the distinction between 1-person and 2% population deviation do not drive the results of my analysis in two ways.

First, I simply redo my most constrained analysis ("Conditions D") with a 1% population deviation constraint, and obtain similar results.

Second, I analyze a course VTD-level version of the enacted map (itself with nearly 2% population deviation), and show that even this coarse version of the enacted map is an extreme outlier with respect to partisan bias, before small changes are made to it to produce the enacted 1-person-deviation map. This demonstrates that the course VTD-level "blueprint" for the map is an extreme outlier, optimized for partisan considerations, among alternative VTD-level maps with similar population deviation, even before the small changes used to achieve 1-person deviation are accounted for.

These results are shown in Section 3.

2.3 Election data

The partisan characteristics of each of the billions of maps generated by my algorithm is compared to that of the enacted map through the lens of historical election data. I use the 2020 Attorney General race as a proxy for expected partisan voting patterns given knowledge available at the time the disputed plan was drawn.

2.4 Comparison metric

Using the election data indicated above, my analysis compares the partisanship of districtings according to **the average number of seats Republicans would expect to win in the districting**, based on a random uniform swing model with the historical voting data I use.

The *uniform swing* is a simple model frequently used to make predictions about the number of seats a party might win in an election, based on partisan voting data. Suppose, for example, that given data from a previous Congressional election in North Carolina, we would like to predict how many seats Republicans will win in an upcoming Congressional election with the same districting, assuming that at a statewide level, we expect them to outperform by 1.5 percentage points their results from the last election.

A uniform swing would simply add 1.5 percentage points to Republican performance in every district in data from the last election, and then evaluate how many seats would be won with these shifted voting outcomes.

When I am evaluating the partisanship of a comparison districting (to compare it to the enacted plan), I am interested in the number of seats we expect Republicans might win in the districting, given unknown shifts in partisan support. In particular, the metric I use is:

> How many seats, on average, would Republicans win in the given districting, if a random[2] uniform swing is applied to the historical voting data being used?

2.5 First level analysis

The first level of my analysis simply uses the procedure described above to generate a large set of comparison districtings against which one can compare the enacted plan. As discussed above, these comparison maps adhere to districting criteria in ways that constrain them to be similar in several respects to the enacted map being evaluated.

We will see below that in hundreds of runs of my algorithm, the enacted plan is found to be exhibit more partisan bias than 99.99% of comparison maps, i.e., it is among the most partisan 00.01% of found by the algorithm, since $100\% - 99.99\% = 00.01\%$.

The first level of my analysis simply reports the comparison of the enacted map to the comparison districtings produced in these runs. Even without applying the mathematical theorems we have developed in [CFP] and [CFMP], this gives strong, intuitively clear evidence of intent to create partisan bias in the districting: if the districting had not been drawn to carefully optimize its partisan bias, we would expect naturally that making small random changes to the districting would not have such a dramatic and consistent partisan effect.

2.6 Second level analysis

In the first level of my analysis, I compare enacted plans to comparison districtings produced by my algorithm (which makes random changes to the existing map while preserving districting criteria).

The next level of my analysis goes further than this, and enables a rigorous comparison to *all* alternative districtings of North Carolina satisfying the districting criteria I consider here. It does this by comparing how optimized for partisanship an evaluated plan is to how optimized alternative plans are.

2.6.1 Defining "optimized for partisanship"

Roughly speaking, when I say that a districting is *optimized for partisanship*, I mean that its partisan characteristics are highly sensitive to small random changes to the boundary lines.

[2]The random choice of my uniform swing is made from a normal distribution whose standard deviation is 4 percentage points, which is roughly the standard deviation of the swing in the past five North Carolina gubernatorial elections.

Formally, when I say that a districting is *optimized for partisanship* in this report, I mean that there is a high probability that when I make small random changes to the districting, its partisanship will be an extreme outlier among the comparison maps produced by the small random changes.

The yardstick I use to measure this property of a given map is the *ε-fragility* of a map. Given a small threshold ε like $\varepsilon = 00.01\%$, I can ask: what is the probability that when I make a sequence of small random changes to the map, the map will be in the most extreme ε fraction of maps encountered in the sequence of random changes? The probability of this occurrence is the ε-fragility of the map, and it is this probability that I use to quantify how optimized for partisanship a map is.

In other words, **one districting is considered more optimized for partisanship than another if it is more likely to have its partisan qualities consistently reduced when making a random sequence of small changes to its boundary lines.**

2.6.2 Comparing an enacted plan to the set of *all* alternatives

My analysis enables a rigorous comparison of an enacted plan to **all possible districting plans of the state** satisfying the districting criteria I consider, with respect to how optimized for partisanship the districtings are.

My method produces a rigorous p-value (statistical significance level) which precisely captures the confidence one can have in the findings of my "second level" analyses. In particular my second-level claims in this report are all valid at a statistical significance of $p = .002$. This means that the probability that I would report an incorrect number (for example, claiming that a districting is among the most optimized for partisanship 00.01% of all districtings, when in fact it is merely among the most 00.015% optimized for partisanship) is at most 00.2%. To put this in context, clinical trials seeking regulatory approval for new medications frequently target a significance level of $p = .05$ (5%), a much looser standard than I hold myself to in this report.

2.6.3 Some intuition for why this is possible

It should be emphasized that it may seem remarkable that I can make a rigorous quantifiable comparison to *all* possible districtings, without actually generating all such districtings; this is the role of our theorems from [CFP] and [CFMP], which have simple proofs which have been verified by the mathematical community.

To give some nontechnical intuition for why this kind of analysis is possible, these results roughly work by showing that in a very general sense, it is not possible for an appreciable fraction of districtings of a state to appear optimized for partisanship in the sense defined in Section 2.6.1. In other words, it is *mathematically impossible* for any state, with any political geography of voting preferences and any choice of districting criteria, to have the property that a significant fraction of the possible districtings of the state satisfying the chosen districting criteria appear optimized for partisanship (as measured by their ε-fragility).

2.7 Results

For each of the four conditions described in 2.1, I did $2^{35} \approx 34$ billion steps. In this section I give the first-level and second-level analyses of these results, along with the output of each run.

2.7.1 Conditions A

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.999943%	9	99.999943%	17	99.99971%	25	99.9998%
2	99.999973%	10	99.999908%	18	99.999987%	26	99.9999953%
3	99.99978%	11	99.99972%	19	99.99992%	27	99.999962%
4	99.9998%	12	99.99933%	20	99.9994%	28	99.99964%
5	99.999901%	13	99.999927%	21	99.999988%	29	99.999979%
6	99.99967%	14	99.999962%	22	99.99904%	30	99.99964%
7	99.999985%	15	99.999983%	23	99.9999965%	31	99.9989%
8	99.999908%	16	99.99977%	24	99.999986%	32	99.999976%

- **First level analysis:** In *every* run, the districting was in the most partisan 00.0011% of districtings (in other words, 99.9989% were less partisan, in *every* run).

- **Second level analysis:** My theorems imply that the enacted Congressional districting is among the most optimized-for-partisanship 00.003% of all alternative districtings of North Carolina satisfying my districting criteria (in other words, 99.997% are less optimized for partisanship), measured by their ε-fragility for $\varepsilon = 00.0011\%$.

2.7.2 Conditions B

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.999989%	9	99.9995%	17	99.999943%	25	99.9978%
2	99.9986%	10	99.99999981%	18	99.99982%	26	99.999915%
3	99.99962%	11	99.999955%	19	99.99929%	27	99.99957%
4	99.999901%	12	99.999959%	20	99.9985%	28	99.99998%
5	99.999914%	13	99.99988%	21	99.99945%	29	99.999972%
6	99.9999982%	14	99.9988%	22	99.99976%	30	99.999935%
7	99.99986%	15	99.999964%	23	99.99979%	31	99.99964%
8	99.999926%	16	99.9989%	24	99.999996%	32	99.999958%

- **First level analysis:** In *every* run, the districting was in the most partisan 00.0021% of districtings (in other words, 99.9979% were less partisan, in *every* run).

- **Second level analysis:** My theorems imply that the enacted Congressional districting is among the most optimized-for-partisanship 00.0063% of all alternative districtings of North Carolina satisfying my districting criteria (in other words, 99.9937% are less optimized for partisanship), measured by their ε-fragility for $\varepsilon = 00.0021\%$.

2.7.3 Conditions C

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.999998%	9	99.999938%	17	99.999965%	25	99.9999941%
2	99.99964%	10	99.99982%	18	99.99945%	26	99.99982%
3	99.9978%	11	99.99987%	19	99.999924%	27	99.999957%
4	99.9995%	12	99.99984%	20	99.99987%	28	99.99984%
5	99.99998%	13	99.99921%	21	99.999956%	29	99.99987%
6	99.99979%	14	99.99961%	22	99.99949%	30	99.99955%
7	99.999979%	15	99.99972%	23	99.99962%	31	99.99988%
8	99.99982%	16	99.999921%	24	99.99938%	32	99.99984%

- **First level analysis:** In *every* run, the districting was in the most partisan 00.0022% of districtings (in other words, 99.9978% were less partisan, in *every* run).

- **Second level analysis:** My theorems imply that the enacted Congressional districting is among the most optimized-for-partisanship 00.0065% of all alternative districtings of North Carolina satisfying my districting criteria (in other words, 99.9935% are less optimized for partisanship), measured by their ε-fragility for $\varepsilon = 00.0022\%$.

2.7.4 Conditions D

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.9997%	9	99.99976%	17	99.99958%	25	99.99979%
2	99.99989%	10	99.999924%	18	99.9999942%	26	99.999986%
3	99.99962%	11	99.99982%	19	99.99963%	27	99.9978%
4	99.99976%	12	99.9999986%	20	99.9999983%	28	99.99969%
5	99.99988%	13	99.99979%	21	99.99954%	29	99.9995%
6	99.99958%	14	99.999986%	22	99.999904%	30	99.999984%
7	99.999986%	15	99.99954%	23	99.99989%	31	99.999955%
8	99.999956%	16	99.999965%	24	99.99971%	32	99.999962%

- **First level analysis:** In *every* run, the districting was in the most partisan 00.0022% of districtings (in other words, 99.9978% were less partisan, in *every* run).

- **Second level analysis:** My theorems imply that the enacted Congressional districting is among the most optimized-for-partisanship 00.0065% of all alternative districtings of North Carolina satisfying my districting criteria (in other words, 99.9935% are less optimized for partisanship), measured by their ε-fragility for $\varepsilon = 00.0022\%$.

3 Conclusion

Based on my analysis, I find the enacted S.L. 2021-174 Congressional plan is optimized for Republican partisan bias to an extreme degree, moreso than 99.99% of all alternative districtings satisfying the criteria I examined in this report.

Appendix: Population deviation analysis

In this section we show results from running our algorithm under conditions discussed in Section 2.2.

First, we use the most restrictive "Conditions D" but impose a requirement of $\leq 1\%$ population deviation, obtaining the following results:

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.9986%	9	99.99947%	17	99.9975%	25	99.99907%
2	99.99939%	10	99.99987%	18	99.999928%	26	99.99969%
3	99.999961%	11	99.99958%	19	99.99973%	27	99.99984%
4	99.99923%	12	99.9999969%	20	99.99929%	28	99.9996%
5	99.99963%	13	99.9999%	21	99.99916%	29	99.999998%
6	99.9998%	14	99.99989%	22	99.99922%	30	99.99983%
7	99.9989%	15	99.99982%	23	99.9988%	31	99.998%
8	99.999911%	16	99.9988%	24	99.99934%	32	99.99945%

Next, we run our algorithm on a coarse "whole-precinct" version of the enacted map. This is the districting obtained by assigning each split VTD to the district with which its intersection is greatest, and is a coarse starting point from which one can obtain a 1-person deviation map by carefully splitting VTD's. Its population deviation from ideal is 1.8%. In the results below, we see that this coarse version of the enacted map also exhibits extreme partisan bias, demonstrating that the appearance of partisan bias is not created by the maps adherence to strict constraints on population deviation.

Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan	Run	Percentage of comparison maps less partisan than enacted plan
1	99.99937%	9	99.99942%	17	99.99942%	25	99.99939%
2	99.99949%	10	99.99917%	18	99.9997%	26	99.99941%
3	99.9989%	11	99.99942%	19	99.99988%	27	99.99992%
4	99.99921%	12	99.9989%	20	99.99987%	28	99.99986%
5	99.9982%	13	99.99926%	21	99.99976%	29	99.99981%
6	99.99924%	14	99.999904%	22	99.99969%	30	99.999903%
7	99.9995%	15	99.99972%	23	99.99904%	31	99.99954%
8	99.99976%	16	99.9996%	24	99.99976%	32	99.99951%

I hereby certify that the foregoing statements are true and correct to the best of my knowledge, information, and belief.

Wesley Pegden
11/29/21