Evaluation of Remedial Plans
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Summary: This report evaluates the likely performance and partisan fairness of remedial plans for North Carolina Congressional, state Senate, and state House maps in the cases of *Harper v. Hall* and *NCLCV v. Hall*. Remedial plans were submitted by the North Carolina General Assembly ("Legislative Defendants"). Harper plaintiffs offered two remedial maps, Congressional and state Senate. The NCLCV plaintiffs also offered a set of three remedial maps. This report finds that all three of the Legislative Defendants' plans favor Republicans in six metrics evaluated: seat partisan asymmetry, mean-median difference, partisan bias, lopsided wins, declination angle, and efficiency gap. The seat partisan asymmetry in 1.7 seats in the Congressional plan, 2.1 seats in the Senate plan, and 7.2 seats in the House plan. The Harper plaintiffs' plans show mixed or no advantage for either party. The NCLCV plaintiffs' plans show a Democratic advantage for the Congressional plan, mixed or no advantage for the Senate plan, and a Republican advantage for the House plan. In no case did the Legislative Defendants' remedial map come closer to partisan symmetry than the plaintiffs' alternative(s).

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About Prof. Wang: Sam Wang is a professor at Princeton University, appointed in neuroscience with affiliation with the Program in Law and Public Affairs. He directs the Electoral Innovation Lab, a policy and research group which uses statistics, science, and law to analyze election systems, and in which capacity he soversee the Princeton Gerrymandering Project (gerrymander.princeton.edu), which provides non-partisan analysis of redistricting plans and reforms. He has published extensively on the subject of redistricting. In particular, he has written in the Stanford Law Review and the Election Law Journal on the subject of practical tests for detecting partisan gerrymandering. In these articles he has analyzed the mean-median difference and introduced a new measure, the lopsided-wins test. These measures fall into a broad category of tests of partisan symmetry, a topic on which he has been cited in two U.S. Supreme Court decisions.

I. INTRODUCTION

This report analyzes the remedial plans offered by parties in the North Carolina redistricting cases *Harper v. Hall* and *NCLCV v. Hall*. Those cases found that North Carolina's new Congressional, state House, and state Senate redistricting plans were illegal partisan gerrymanders in violation of the state constitution. The state Supreme Court has instructed the General Assembly to provide remedial maps for all three plans. The General Assembly provided these remedial maps on Friday, February 18, 2022, two passed on a partisan vote (Congressional and Senate) and one passed on a bipartisan vote (House). At that time the NCLCV plaintiffs also offered a set of three remedial maps. Harper plaintiffs offered two remedial maps, Congressional and state Senate.

I have analyzed these plans to determine their likely partisan performance. I apply statistical measures of partisan fairness to determine the amount of partisan favor that these maps show to either Republicans or Democrats.

Before applying the many tests for partisan fairness, I will briefly review the rationale and interpretations of the various tests.

II. MEASURING PARTISAN FAIRNESS

The broad majority of metrics used by the court to evaluate partisan fairness address the question of whether voters, counted in total within the state, are represented fairly given a particular arrangement of Congressional or legislative districts. These metrics are calculated based on voter behavior in recent elections. Some of the metrics allow a variety of likely future scenarios to be explored empirically.

Because the relationship between voting and representation is complex, it is useful to evaluate multiple metrics. The use of multiple metrics helps guard against the possibility that a particular metric may vary by chance. The use of multiple metrics also guards against the possibility that redistricters might cater to one specific metric, to create the appearance of compliance while maintaining a hidden partisan advantage. I will therefore consider a variety of metrics together, in their totality.

A. Partisan seat asymmetry

An important concept is whether the two parties would have commensurate outcomes if their vote shares were exchanged. The general concept of partisan symmetry has old roots[1]. A particularly simple measure is to ask how many seats each party would win if it attained the same statewide share of the vote; in this report I refer to the difference between the two seat counts as partisan seat asymmetry. Partisan seat asymmetry can also be calculated for a variety of likely swings in voter behavior; in this case, the average amount of asymmetry serves as a straightforward measure of partisan advantage over a range of plausible scenarios.

Another method for evaluating the fairness in the number of seats, given a total statewide vote, is the efficiency gap. The efficiency gap measures how far a pattern of outcomes deviates from expectations for a particular statewide vote, and is therefore a way of quantifying partisan advantage (though not necessarily a bright-line test)[2]. It has been proposed that an efficiency gap of 7 percentage points be used as a threshold to define undue advantage. However, it must be noted that the efficiency gap can jump in value when a single close race is won or lost. Therefore it is helpful to average the efficiency gap across a range of scenarios.

B. The mean-median difference

The mean-median difference is a long-standing measure of what statisticians call skewness[3]. Applied to a district plan, the mean-median difference provides one way of testing whether an unusual pattern of districts is found above or below the statewide average. Such an unusual pattern is one way that an artful redistricting plan can build systematic advantage for one party. The mean-median difference can often help detect undue partisan advantage in a closely divided state such as North Carolina[4].

C. Tests of voter packing

When one side's voters are packed into a few districts to reduce their opportunities to elect representatives, they will be present in unusually large numbers in those districts. A direct way to measure packing is to compare the average vote share of Democratic-leaning and Republican-leaning districts. The party with the larger average win is potentially packed by its opponents in order to dilute

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[1] Gill v. Whitford, 138 S. Ct. 1916, 1933 (2018).(citing Brief of Heather K. Gerken et al. as Amici Curiae Supporting Appellees at 27.

[2] Eric McGhee, *Symposium: The efficiency gap is a measure, not a test.* SCOTUSblog, August 11, 2017. https://www.scotusblog.com/2017/08/symposium-efficiency-gap-measure-not-test/ (last visited on February 21, 2022).

[3] David P. Doane & Lori E. Seward, Measuring Skewness: A Forgotten Statistic?, J. STAT. EDUC., July 2011, at 9-10; Karl Pearson, Contributions to the Mathematical Theory of Evolution—1: Skew Variation in Homogeneous Material, PHIL.TRANSACTIONS ROYAL SOC'Y, 1895, at 343, 374-76.

[4] Samuel S.-H. Wang, Three Tests for Practical Evaluation of Partisan Gerrymandering, 68 STAN. L. REV. 1263, 1263–1321 (2016); Michael D. McDonald & Robin E. Best, Unfair Partisan Gerrymanders in Politics and Law1: A Diagnostic Applied to Six Cases, 14 ELECTION L.J. 312, 312 (2015).

voting power. The concept of comparing averages dates to the foundations of statistics[5], and when applied to redistricting such a comparison is called the "lopsided-wins test".

A more recent measure of packing is the declination, a measure that can be read from a graph visually. Declination takes advantage of the fact that a pattern of packing induces an elbow-like shape in the graph. The amount of bend in the elbow defines the declination. Declination also makes use of the number of districts won by each party. the larger the declination, the more voters are packed into a small number of districts.

III. ELECTION DATA AND ANALYSIS METHODS

I estimated the likely performance of Congressional, Senate, and House maps in two ways. First, I evaluated vote totals in the proposed districts using ten statewide elections from 2014 to 2020. Second, I allowed the vote totals to vary above and below an average of these elections, as a means of evaluating a range of future scenarios that may arise in the coming decade. After these two steps, I then evaluated a variety of measures of partisan symmetry.

I used datasets for the following elections:

- President: 2016, 2020
- Senate: 2014, 2016, 2020
- Governor: 2016, 2020
- Lieutenant Governor: 2016, 2020
- Attorney General: 2016, 2020

In these elections, the two-party vote share ranged between 46.7% and 52.3% for Democrats, and between 47.7% and 53.3% for Republicans.

In addition, I used a composite ("2016-2020 Composite") that is averaged with equal weights from three components: (1) the average of President 2016 and 2020, (2) the average of Senate 2016 and 2020, and (3) the average of Governor and Attorney General 2020. In the 2016-2020 Composite, the two-party vote share was 49.0% for Democrats and 51.0% for Republicans.

IV. EVALUATION OF CONGRESSIONAL REMEDIAL PLANS

A. Legislative Defendants' Plan

As an example of how the analysis is done, **Exhibit 1** shows calculations for the Legislative Defendants' plan in district-by-district form, using the 2016-2020 Composite. The plan is also evaluated according to the 10 individual election datasets (**Exhibit 2**).

[5] Rigorous methods for comparing averages were first developed for controlling the quality of ingredients in the production of Guinness beer. The "Student t test" was devised by a master brewer, William Sealy Gossett, working pseudonymously to protect the trade secret. S.L. Zabell, "On Student's 1908 Article 'The Probable Error of a Mean'", 103 JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION 1.

For all 10 election datasets evaluated, the projected outcome for the Legislative Defendants' map was always between 4 and 8 Democratic seats, and between 6 and 10 Republican seats. The average outcome for the 10 election datasets was 5.3 Democratic seats and 8.7 Republican seats.

Exhibit 1: A fairness "dashboard" for the Legislative Defendants' remedial Congressional plan. Pink shading indicates Republican advantage, and blue shading indicates Democratic advantage.

LEGISLATIVE DEFENDANTS' CONGRESSIONAL PLAN

District	D share	R share	Margin (%)
1	54.7%	45.3%	9.5
2	64.8%	35.2%	29.7
3	38.7%	61.3%	-22.5
4	67.5%	32.5%	35.1
5	44.2%	55.8%	-11.6
6	50.6%	49.4%	1.2
7	50.6%	49.4%	1.1
8	42.0%	58.0%	-16.0
9	38.7%	61.3%	-22.6
10	29.5%	70.5%	-40.9
11	44.9%	55.1%	-10.2
12	67.4%	32.6%	34.8
13	48.5%	51.5%	-2.9
14	48.9%	51.1%	-2.2
			-1.3 average margin

DISTRICT RATINGS	
6	D favored
8	R favored
4	competitive within 7 points
PROBABILISTIC OUTCOME	
5.8	Expected D wins
8.2	Expected R wins

LOPSIDED WINS	
59.3	Average D win voteshare (%)
58.1	Average R win voteshare (%)
1.2	R advantage

PARTISAN ASYMMETRY	
6.3	D seats in 50-50 election
7.7	R seats in 50-50 election
1.4	R seat advantage
2.4	average R seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.26%	mean D-R (margin %)
-2.58%	median D-R (margin %)
0.7%	R advantage (vote %)

DECLINATION	
11.4	R advantage

EFFICIENCY GAP	
7.4%	R advantage (averaged)

Exhibit 2: Evaluation of the Legislative Defendants' remedial Congressional plan using data from ten elections.

	Lt. Gov. 2016	Senator 2016	President 2016	Lt. Gov. 2020	Senator 2020	Senator 2014	President 2020	Attorney Gen 2020	Attorney Gen 2016	Governor 2020	10-election average	2016-2020 composite
Democratic vote share (two-party)	46.7%	47.0%	48.1%	48.3%	49.1%	49.2%	49.3%	50.1%	50.3%	52.3%	49.0%	49.3%
Democratic seats	4	4	4	4	6	6	5	6	6	8	5.3	6
Republican seats	10	10	10	10	8	8	9	8	8	6	8.7	8
Partisan seat asymmetry	1	2	3	2	0	2	1	2	2	2	1.7	2
Mean-median difference	2.7%	2.1%	1.3%	0.3%	0.7%	2.1%	-0.1%	0.3%	2.2%	0.1%	1.2%	0.7%
Partisan bias	3.2%	4.1%	5.4%	4.8%	5.0%	5.2%	5.2%	5.1%	5.7%	4.5%	4.8%	5.2%
Lopsided wins difference	2.6%	4.2%	10.3%	10.4%	0.9%	0.6%	7.8%	5.2%	5.3%	4.2%	5.1%	2.4%
Declination angle (degrees)	28.5	30.5	37.3	37.9	9.1	8.5	27.0	15.7	15.9	-1.0	20.9	11.4
Efficiency gap	14.4%	14.1%	11.3%	10.0%	7.5%	8.3%	5.6%	2.4%	4.3%	-9.5%	6.8%	7.4%

Pink shading indicates a Republican advantage. Blue indicates a Democratic advantage.
The efficiency gap for the 2016-2020 composite is averaged over a range of possibilities within 7 points of the composite.

1. Partisan seat asymmetry

I calculated the partisan seat asymmetry, i.e. the difference in seat breakdown that would result if the two parties traded total vote shares. I did this by creating a counterfactual in which I added a fixed percentage to the vote share in all districts, an assumption called "uniform swing.' In 9 out of 10 cases[6], Republicans won more seats than the Democrats with the same vote share. For example, using the Governor 2020 race, Democrats win 52.3% of the vote and get 8 out of 14 districts. In my counterfactual, if Republicans win 52.3% of the vote, they would get 10 out of 14 districts. The difference between 10 and 8 is 2 - in other words, this plan has 2-seat partisan seat asymmetry.

Averaging across all 10 elections, the advantage was 1.7 more seats for Republicans, or 12% of the 14-seat Congressional delegation.

To test the robustness of this finding, I re-calculated the partisan seat asymmetry by taking the 2016-2020 composite and adding uniform swings to create scenarios in which Democrats and Republicans win an additional margin up to 7 points on top of their performance in the 2016-2020 composite. In each of these scenarios, I then calculated the partisan seat asymmetry as previously described. Averaging across these scenarios, the partisan seat asymmetry was again 1.7 seats favoring Republicans.

To summarize the partisan seat asymmetry analysis: The Legislative Defendants' remedial plan contains an average advantage of approximately 1.7 Congressional seats for Republicans, and this advantage persists across a wide range of likely scenarios that may arise.

2. Metrics of partisan fairness

I then calculated five metrics that are used to test for partisan advantage: (a) the mean-median difference, (b) partisan bias, (c) lopsided wins, (d) the efficiency gap, and (e) the declination. I found that for all five tests, the metric showed an advantage for Republicans.

Across 10 elections, the average mean-median difference was 1.2% favoring Republicans.

I calculated the efficiency gap for a variety of scenarios, in the same way that I calculated partisan seat asymmetry: I added uniform swings to create scenarios in which Democrats and Republicans win an additional margin up to 7 points on top of their performance in the 2016-2020 composite. Under these assumptions, the average efficiency gap was 6.8% favoring Republicans. In six out of 10 election datasets, the efficiency gap was greater than 7%.

B. Comparisons with the Harper and NCLCV Plans

To compare the Legislative Defendants' plan with two other Congressional plans offered by the Harper plaintiffs and the North Carolina League of Conservation Voters (NCLCV), I evaluated all three plans using the 2016-2020 Composite. This Composite has two advantages: it is close to 50% for each party

[6] The only case where there was no asymmetry was Senator 2020.

(favoring Republicans slightly), and it averages out effects that may be peculiar to a specific election or type of office.

The results are shown below in **Exhibit 3**.

Exhibit 3: Comparison of Legislative Defendants' Congressional Plan, the Harper plaintiffs' plan, and the NCLCV's plan.

	Legislative Defendants	Harper plaintiffs	NCLCV
Statewide Democratic vote share (2016-2020 composite)	49.3%	49.3%	49.3%
Estimated performance:			
Democratic-favored seats	6	7	8
Republican-favored seats	8	7	6
minimum Democratic seats	4	5	4
maximum Democratic seats	8`	8	8
Asymmetry measures (positive = Republican advantage):			
Seat partisan asymmetry	1.7 seats	0.2 seats	-0.6 seats
Technical metrics:			
Mean-median difference	0.7%	0.1%	-1.7%
Partisan bias	5.2%	1.0%	-0.4%
Lopsided wins difference	2.4%	-2.3%	-9.9%
Declination angle	11.4°	-3.1°	-18.6°
Efficiency gap	7.4%	1.1%	-0.5%
Color key:			
Democratic advantage	Republican advantage		

First, it should be noted that the Legislative Defendants' plan has 6 Democratic-favored districts, the Harper plaintiffs' plan has 7 Democratic-favored districts, and the NCLCV plan has 8 Democratic-favored districts. However, such an estimate does not capture the full complexity of the pattern of districts as constructed in each plan. For this reason it is helpful to evaluate the other measures. The Legislative Defendants' plan shows favor to Republicans in all six measures tested. The NCLCV plan shows favor to Democrats in all six measures.

The Harper plaintiffs' plan shows no clear pattern of advantages to either party. The metrics for the Harper plain are generally close to zero, including seat partisan asymmetry of 0.2 seat, a mean-median difference of 0.1%, and an efficiency gap of 1.1%. The smallness and mixed nature of these metrics indicates that the Harper plaintiffs' plan is balanced in a way that gives special favor to neither Democrats or Republicans.

Dashboards for the Harper and NCLCV plaintiffs' plans are given in **Exhbits 4 and 5**.

Exhibit 4: Fairness dashboard for the Harper plaintiffs' Congressional plan.

HARPER PLAINTIFFS' CONGRESSIONAL PLAN

District	D share	R share	Margin (%)
1	54.6%	45.4%	9.2
2	63.9%	36.1%	27.9
3	38.5%	61.5%	-23.0
4	67.1%	32.9%	34.1
5	34.9%	65.1%	-30.2
6	61.0%	39.0%	22.0
7	42.7%	57.3%	-14.5
8	31.8%	68.2%	-36.3
9	48.3%	51.7%	-3.5
10	32.7%	67.3%	-34.6
11	44.9%	55.1%	-10.2
12	68.6%	31.4%	37.2
13	52.5%	47.5%	5.1
14	50.5%	49.5%	1.0
		-1.1	average margin

DISTRICT RATINGS	
7	D favored
7	R favored
3	competitive within 7 points
PROBABILISTIC OUTCOME	
6.7	Expected D wins
7.3	Expected R wins

LOPSIDED WINS	
59.7	Average D win voteshare (%)
60.9	Average R win voteshare (%)
-1.1	D advantage

PARTISAN ASYMMETRY	
6.9	D seats in 50-50 election
7.1	R seats in 50-50 election
0.2	R seat advantage
0.8	average R seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.14%	mean D-R (margin %)
-1.23%	median D-R (margin %)
0.05%	R advantage (vote %)

DECLINATION	
-3.1	D advantage

EFFICIENCY GAP	
1.1%	R advantage (averaged)

Exhibit 5: Fairness dashboard for the NCLCV plaintiffs' Congressional plan.

NCLCV PLAINTIFFS' CONGRESSIONAL PLAN

District	D share	R share	Margin (%)
1	46.2%	53.8%	-7.7
2	51.9%	48.1%	3.7
3	40.3%	59.7%	-19.3
4	51.8%	48.2%	3.6
5	65.0%	35.0%	29.9
6	64.0%	36.0%	28.0
7	50.5%	49.5%	0.9
8	32.3%	67.7%	-35.4
9	66.7%	33.3%	33.4
10	52.4%	47.6%	4.9
11	53.9%	46.1%	7.7
12	40.4%	59.6%	-19.1
13	32.3%	67.7%	-35.5
14	44.9%	55.1%	-10.2
		-1.1	average margin

DISTRICT RATINGS	
8	D favored
6	R favored
4	competitive within 7 points
PROBABILISTIC OUTCOME	
7.1	Expected D wins
6.9	Expected R wins

LOPSIDED WINS	
57.0	Average D win voteshare (%)
60.6	Average R win voteshare (%)
-3.6	D advantage

PARTISAN ASYMMETRY	
7.4	D seats in 50-50 election
6.6	R seats in 50-50 election
-0.8	D seat advantage
-0.6	average D seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.08%	mean D-R (margin %)
2.24%	median D-R (margin %)
-1.66%	D advantage (vote %)

DECLINATION	
-18.6	D advantage

EFFICIENCY GAP	
-0.5%	D advantage (averaged)

V. EVALUATION OF STATE SENATE REMEDIAL PLANS

A. The Legislative Defendants' remedial plan

A comparison of metrics for the Legislative Defendants' remedial Senate plan, as well as the Harper plaintiffs' and NCLVL plaintiffs' proposed plans, are shown in **Exhibit 6**. Individual dashboards for the three plans are shown in **Exhibits 7, 8, and 9**.

The Legislative Defendants' plan favors 22 Democrats and 28 Republicans as scored according to the 2016-2020 election composite (**Exhibit 6**). The range of likely outcomes is 19 to 26 Senate seats for Democrats, and 24 to 31 Senate seats for Republicans. The seat partisan asymmetry is a 2.1-seat difference in favor of Republicans. All of the five other metrics also favor Republicans. This plan contains 7 competitive races, as defined as margins of 7 percentage points or smaller (**Exhibit 7**).

A. The Harper plaintiffs' and NCLCV plaintiffs' plans

The Harper plaintiffs' plan favors 22 Democrats and 28 Republicans. The range of likely outcomes is 21 to 28 Senate seats for Democrats, and 22 to 29 Senate seats for Republicans. The seat partisan asymmetry is a 1.3-seat difference in favor of Democrats. The five other metrics are of mixed effect, showing no clear advantage. This plan contains 7 competitive races (**Exhibit 8**).

The NCLCV plaintiffs' plan favors 24 Democrats and 26 Republicans. The range of likely outcomes is 19 to 28 Senate seats for Democrats, and 22 to 31 Senate seats for Republicans. The seat partisan asymmetry is a 1.3-seat difference in favor of Democrats. The five other metrics are of mixed effect, showing no clear advantage. This plan contains 9 competitive races (**Exhibit 9**).

Exhibit 6: Comparison of state Senate plans.

	Legislative Defendants	Harper plaintiffs	NCLCV
Statewide Democratic vote share (2016-2020 composite)	49.3%	49.3%	49.3%
Estimated performance:			
Democratic-favored seats	22	22	24
Republican-favored seats	28	28	26
minimum Democratic seats	19	21	19
maximum Democratic seats	26	28	28
competitive races (margin <7 points)	7	7	9
Asymmetry measures (positive = Republican advantage):			
Seat partisan asymmetry	2.1 seats	1.3 seats	1.3 seats
Technical metrics:			
Mean-median difference	0.8%	-0.1%	-0.1%
Partisan bias	4.2%	1.1%	1.6%
Lopsided wins difference	4.0%	3.5%	0.0%
Declination angle	11.4°	11.1°	2.3°
Efficiency gap	2.2%	-0.9%	-0.9%

Color key:	
Democratic advantage	Republican advantage

Exhibit 7: Fairness dashboard for the Legislative Defendants' state Senate remedial plan.

LEGISLATIVE DEFENDANTS' SENATE PLAN

District	D share	R share	Margin (%)
1	38.7%	61.3%	-22.5
2	42.2%	57.8%	-15.6
3	53.5%	46.5%	7.1
4	48.0%	52.0%	-3.9
5	57.2%	42.8%	14.4
6	34.6%	65.4%	-30.9
7	49.4%	50.6%	-1.2
8	39.8%	60.2%	-20.3
9	40.1%	59.9%	-19.8
10	37.8%	62.2%	-24.3
11	51.2%	48.8%	2.4
12	40.6%	59.4%	-18.9
13	63.7%	36.3%	27.4
14	71.9%	28.1%	43.7
15	67.6%	32.4%	35.2
16	65.0%	35.0%	30.1
17	50.9%	49.1%	1.8
18	51.2%	48.8%	2.4
19	55.7%	44.3%	11.3
20	72.3%	27.7%	44.5
21	49.7%	50.3%	-0.7
22	79.1%	20.9%	58.2
23	66.1%	33.9%	32.1
24	49.5%	50.5%	-1.0
25	40.7%	59.3%	-18.5
26	42.7%	57.3%	-14.5
27	57.1%	42.9%	14.2
28	75.8%	24.2%	51.5
29	33.2%	66.8%	-33.5
30	27.3%	72.7%	-45.4
31	44.6%	55.4%	-10.7
32	59.9%	40.1%	19.9
33	30.7%	69.3%	-38.6
34	44.8%	55.2%	-10.4
35	37.0%	63.0%	-25.9
36	23.8%	76.2%	-52.5
37	34.8%	65.2%	-30.4
38	80.1%	19.9%	60.3
39	64.8%	35.2%	29.6
40	70.5%	29.5%	41.0
41	67.6%	32.4%	35.1
42	54.6%	45.4%	9.1
43	37.4%	62.6%	-25.3
44	30.5%	69.5%	-39.0
45	30.0%	70.0%	-40.0
46	38.6%	61.4%	-22.7
47	36.8%	63.2%	-26.4
48	35.8%	64.2%	-28.3
49	63.2%	36.8%	26.3
50	36.2%	63.8%	-27.6

DISTRICT RATINGS	
22	D favored
28	R favored
7	competitive within 7 points
PROBABILISTIC OUTCOME	
22.5	Expected D wins
27.5	Expected R wins

LOPSIDED WINS	
63.6	Average D win voteshare (%)
61.6	Average R win voteshare (%)
2.0	R advantage

PARTISAN ASYMMETRY	
23.2	D seats for 50-50 vote
26.8	R seats for 50-50 vote
3.7	R seat advantage
2.1	average R seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.0%	mean D-R (margin %)
-2.6%	median D-R (margin %)
0.8%	R advantage (vote %)

DECLINATION (angle, in degrees)	
11.4	R advantage

EFFICIENCY GAP	
2.2%	R advantage

Exhibit 8: Fairness dashboard for the Harper plaintiffs' state Senate plan.

HARPER PLAINTIFFS' SENATE PLAN

District	D share	R share	Margin (%)
1	38.7%	61.3%	-22.5
2	42.2%	57.8%	-15.6
3	53.5%	46.5%	7.1
4	48.0%	52.0%	-3.9
5	57.2%	42.8%	14.4
6	34.6%	65.4%	-30.9
7	49.6%	50.4%	-0.9
8	40.0%	60.0%	-20.0
9	40.1%	59.9%	-19.8
10	37.8%	62.2%	-24.3
11	51.2%	48.8%	2.4
12	40.6%	59.4%	-18.9
13	59.0%	41.0%	17.9
14	66.3%	33.7%	32.5
15	55.9%	44.1%	11.9
16	77.7%	22.3%	55.4
17	58.3%	41.7%	16.6
18	54.2%	45.8%	8.4
19	55.6%	44.4%	11.1
20	78.7%	21.3%	57.3
21	49.6%	50.4%	-0.7
22	72.8%	27.2%	45.6
23	66.1%	33.9%	32.1
24	49.5%	50.5%	-1.0
25	41.8%	58.2%	-16.4
26	49.1%	50.9%	-1.7
27	56.5%	43.5%	13.0
28	67.3%	32.7%	34.6
29	33.0%	67.0%	-33.9
30	27.3%	72.7%	-45.4
31	49.7%	50.3%	-0.5
32	56.2%	43.8%	12.3
33	30.7%	69.3%	-38.6
34	44.8%	55.2%	-10.4
35	36.2%	63.8%	-27.6
36	24.1%	75.9%	-51.8
37	35.2%	64.8%	-29.6
38	80.5%	19.5%	61.0
39	61.3%	38.7%	22.6
40	69.2%	30.8%	38.4
41	67.5%	32.5%	35.1
42	57.9%	42.1%	15.7
43	38.4%	61.6%	-23.1
44	31.1%	68.9%	-37.8
45	30.1%	69.9%	-39.7
46	28.2%	71.8%	-43.6
47	37.0%	63.0%	-26.0
48	46.0%	54.0%	-8.0
49	60.2%	39.8%	20.5
50	35.6%	64.4%	-28.8

DISTRICT RATINGS	
22	D favored
28	R favored
7	competitive within 7 points
PROBABILISTIC OUTCOME	
23.8	Expected D wins
26.2	Expected R wins

LOPSIDED WINS	
62.9	Average D win voteshare (%)
61.1	Average R win voteshare (%)
1.8	R advantage

PARTISAN ASYMMETRY	
24.6	D seats for 50-50 vote
25.4	R seats for 50-50 vote
0.8	R seat advantage
-1.3	average D seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.1%	mean D-R (margin %)
-1.0%	median D-R (margin %)
-0.1%	D advantage (vote %)

DECLINATION (angle, in degrees)	
11.1	R advantage

EFFICIENCY GAP	
-0.9%	D advantage

Exhibit 9: Fairness dashboard for the NCLCV plaintiffs' state Senate plan.

NCLCV PLAINTIFFS' SENATE PLAN

District	D share	R share	Margin (%)
1	53.5%	46.5%	7.1
2	38.7%	61.3%	-22.5
3	42.2%	57.8%	-15.6
4	48.0%	52.0%	-3.9
5	57.2%	42.8%	14.4
6	34.6%	65.4%	-30.9
7	51.9%	48.1%	3.8
8	38.4%	61.6%	-23.3
9	40.1%	59.9%	-19.8
10	37.8%	62.2%	-24.3
11	51.2%	48.8%	2.4
12	40.6%	59.4%	-18.9
13	51.0%	49.0%	1.9
14	73.1%	26.9%	46.1
15	65.3%	34.7%	30.5
16	64.5%	35.5%	29.0
17	52.0%	48.0%	3.9
18	65.5%	34.5%	31.1
19	66.5%	33.5%	32.9
20	72.0%	28.0%	44.0
21	39.9%	60.1%	-20.2
22	79.6%	20.4%	59.2
23	66.1%	33.9%	32.1
24	49.5%	50.5%	-1.0
25	40.5%	59.5%	-19.1
26	51.4%	48.6%	2.8
27	59.0%	41.0%	17.9
28	62.6%	37.4%	25.2
29	33.4%	66.6%	-33.2
30	27.3%	72.7%	-45.4
31	49.3%	50.7%	-1.4
32	57.6%	42.4%	15.1
33	30.7%	69.3%	-38.6
34	44.8%	55.2%	-10.3
35	37.0%	63.0%	-25.9
36	24.1%	75.9%	-51.8
37	36.6%	63.4%	-26.9
38	66.6%	33.4%	33.1
39	73.1%	26.9%	46.3
40	72.5%	27.5%	45.0
41	54.4%	45.6%	8.9
42	68.8%	31.2%	37.6
43	38.2%	61.8%	-23.7
44	31.1%	68.9%	-37.8
45	29.7%	70.3%	-40.6
46	28.5%	71.5%	-42.9
47	36.8%	63.2%	-26.3
48	49.7%	50.3%	-0.7
49	56.6%	43.4%	13.3
50	36.4%	63.6%	-27.2

DISTRICT RATINGS	
24	D favored
26	R favored
9	competitive within 7 points
PROBABILISTIC OUTCOME	
24.1	Expected D wins
25.9	Expected R wins

LOPSIDED WINS	
62.2	Average D win voteshare (%)
62.2	Average R win voteshare (%)
0.0	R advantage

PARTISAN ASYMMETRY	
24.8	D seats for 50-50 vote
25.2	R seats for 50-50 vote
0.5	R seat advantage
-1.3	average D seat advantage

MEAN-MEDIAN DIFFERENCE	
-1.0%	mean D-R (margin %)
-0.8%	median D-R (margin %)
-0.1%	D advantage (vote %)

DECLINATION (angle, in degrees)	
2.3	R advantage

EFFICIENCY GAP	
-0.9%	D advantage

Exhibit 10: Comparison of state House plans.

	Legislative Defendants	NCLCV
Democratic vote share (two-party)	49.3%	49.3%
Democratic-majority seats	57	58
Republican-majority seats	63	62
minimum Democratic seats	47	51
maximum Democratic seats	64	65
Seat partisan asymmetry	7.2	4.1
Mean-median difference	0.9%	1.1%
Partisan bias	2.7%	1.7%
Lopsided wins difference	7.1%	3.5%
Declination angle (degrees)	4.5	2.7
Efficiency gap	3.0%	1.6%

Color key:

Democratic advantage	Republican advantage

Exhibit 11: Fairness dashboard for the Legislative defendants' state House plan.

LEGISLATIVE DEFENDANTS' REMEDIAL HOUSE PLAN

District	D %	R %	Margin (%)
1	38.0%	62.0%	-23.9
2	55.9%	44.1%	11.8
3	40.4%	59.6%	-19.2
4	40.6%	59.4%	-18.7
5	51.1%	48.9%	2.2
6	43.4%	56.6%	-13.2
7	43.8%	56.2%	-12.4
8	58.2%	41.8%	16.3
9	51.4%	48.6%	2.8
10	46.2%	53.8%	-7.7
11	66.1%	33.9%	32.2
12	47.3%	52.7%	-5.4
13	30.7%	69.3%	-38.6
14	37.1%	62.9%	-25.7
15	35.8%	64.2%	-28.4
16	33.0%	67.0%	-34.0
17	39.1%	60.9%	-21.7
18	55.1%	44.9%	10.2
19	38.9%	61.1%	-22.1
20	49.5%	50.5%	-1.1
21	66.7%	33.3%	33.4
22	42.2%	57.8%	-15.7
23	60.7%	39.3%	21.4
24	51.8%	48.2%	3.6
25	52.0%	48.0%	4.0
26	42.2%	57.8%	-15.6
27	63.1%	36.9%	26.2
28	33.8%	66.2%	-32.4
29	83.8%	16.2%	67.5
30	85.6%	14.4%	71.2
31	81.2%	18.8%	62.4
32	57.3%	42.7%	14.6
33	62.8%	37.2%	25.6
34	62.0%	38.0%	24.1
35	51.1%	48.9%	2.2
36	56.2%	43.8%	12.4
37	47.3%	52.7%	-5.4
38	85.4%	14.6%	70.9
39	61.2%	38.8%	22.4
40	54.7%	45.3%	9.4
41	63.1%	36.9%	26.3
42	71.2%	28.8%	42.3
43	49.6%	50.4%	-0.8

DISTRICT RATINGS	
57	D favored
63	R favored
17	competitive within 7 points
PROBABILISTIC OUTCOME	
55.9	Expected D wins
64.1	Expected R wins

LOPSIDED WINS	
64.0	Average D win voteshare (%)
63.2	Average R win voteshare (%)
0.8	R advantage (%)

PARTISAN ASYMMETRY	
56.7	D seats in 50-50 election
63.3	R seats in 50-50 election
4.0	R seat advantage
7.2	average R seat advantage

MEAN-MEDIAN DIFFERENCE	
-0.6%	mean D-R margin (%)
-2.4%	median D-R margin (%)
0.9%	R advantage

DECLINATION ANGLE (degrees)	
4.5	R advantage

EFFICIENCY GAP	
3.1%	R advantage (averaged)

44	62.3%	37.7%	24.6
45	57.4%	42.6%	14.8
46	37.9%	62.1%	-24.1
47	49.1%	50.9%	-1.9
48	54.6%	45.4%	9.2
49	67.7%	32.3%	35.3
50	57.5%	42.5%	15.1
51	40.7%	59.3%	-18.6
52	43.5%	56.5%	-13.0
53	35.2%	64.8%	-29.6
54	53.8%	46.2%	7.6
55	41.6%	58.4%	-16.7
56	85.9%	14.1%	71.8
57	57.6%	42.4%	15.2
58	73.0%	27.0%	46.0
59	50.3%	49.7%	0.7
60	62.3%	37.7%	24.6
61	80.7%	19.3%	61.4
62	50.3%	49.7%	0.6
63	52.2%	47.8%	4.5
64	40.5%	59.5%	-18.9
65	35.8%	64.2%	-28.5
66	70.7%	29.3%	41.4
67	28.9%	71.1%	-42.3
68	38.3%	61.7%	-23.5
69	34.8%	65.2%	-30.4
70	24.6%	75.4%	-50.9
71	71.0%	29.0%	42.1
72	75.2%	24.8%	50.5
73	50.9%	49.1%	1.9
74	47.5%	52.5%	-4.9
75	44.4%	55.6%	-11.1
76	39.2%	60.8%	-21.6
77	24.7%	75.3%	-50.6
78	26.3%	73.7%	-47.5
79	38.7%	61.3%	-22.6
80	25.6%	74.4%	-48.8
81	28.9%	71.1%	-42.2
82	46.2%	53.8%	-7.6
83	25.9%	74.1%	-48.2
84	33.9%	66.1%	-32.2
85	27.6%	72.4%	-44.8
86	31.5%	68.5%	-37.0
87	27.2%	72.8%	-45.5
88	69.5%	30.5%	39.0
89	26.0%	74.0%	-48.0
90	24.9%	75.1%	-50.1

91	30.9%	69.1%	-38.3
92	69.3%	30.7%	38.6
93	42.9%	57.1%	-14.2
94	24.0%	76.0%	-52.1
95	34.5%	65.5%	-30.9
96	37.1%	62.9%	-25.7
97	27.5%	72.5%	-45.0
98	48.6%	51.4%	-2.8
99	84.1%	15.9%	68.2
100	75.9%	24.1%	51.8
101	76.6%	23.4%	53.2
102	78.9%	21.1%	57.8
103	51.1%	48.9%	2.3
104	54.3%	45.7%	8.6
105	55.9%	44.1%	11.8
106	69.0%	31.0%	38.0
107	82.3%	17.7%	64.5
108	32.9%	67.1%	-34.3
109	40.8%	59.2%	-18.5
110	33.3%	66.7%	-33.5
111	31.2%	68.8%	-37.7
112	61.2%	38.8%	22.5
113	34.3%	65.7%	-31.4
114	65.7%	34.3%	31.3
115	55.1%	44.9%	10.2
116	59.3%	40.7%	18.6
117	40.4%	59.6%	-19.2
118	38.5%	61.5%	-22.9
119	43.9%	56.1%	-12.1
120	27.0%	73.0%	-46.1

Exhibit 12: Fairness dashboard for the NCLCV plaintiffs' state House plan.

NCLCV PLAINTIFFS' HOUSE PLAN

District	D %	R %	Margin (%)
1	40.9%	59.1%	-18.3
2	58.1%	41.9%	16.2
3	40.4%	59.6%	-19.2
4	35.5%	64.5%	-29.0
5	51.1%	48.9%	2.2
6	41.9%	58.1%	-16.3
7	43.9%	56.1%	-12.3
8	55.8%	44.2%	11.5
9	53.6%	46.4%	7.3
10	51.8%	48.2%	3.7
11	66.2%	33.8%	32.4
12	47.3%	52.7%	-5.4
13	30.7%	69.3%	-38.6
14	29.3%	70.7%	-41.4
15	49.3%	50.7%	-1.4
16	32.7%	67.3%	-34.6
17	52.3%	47.7%	4.6
18	55.3%	44.7%	10.6
19	35.0%	65.0%	-30.0
20	41.9%	58.1%	-16.2
21	54.2%	45.8%	8.3
22	42.2%	57.8%	-15.7
23	60.7%	39.3%	21.4
24	51.9%	48.1%	3.9
25	51.9%	48.1%	3.8
26	43.8%	56.2%	-12.4
27	63.1%	36.9%	26.2
28	35.0%	65.0%	-29.9
29	84.2%	15.8%	68.4
30	82.0%	18.0%	64.0
31	80.9%	19.1%	61.7
32	57.3%	42.7%	14.6
33	84.7%	15.3%	69.4
34	63.5%	36.5%	27.0
35	50.6%	49.4%	1.1
36	59.4%	40.6%	18.8
37	47.5%	52.5%	-5.0
38	65.7%	34.3%	31.4
39	59.7%	40.3%	19.4
40	69.8%	30.2%	39.7
41	66.6%	33.4%	33.2
42	54.8%	45.2%	9.6
43	53.7%	46.3%	7.4

DISTRICT RATINGS	
58	D favored
62	R favored
14	competitive within 7 points
PROBABILISTIC OUTCOME	
57.3	Expected D wins
62.7	Expected R wins

LOPSIDED WINS	
63.9	Average D win voteshare (%)
63.5	Average R win voteshare (%)
0.4	R advantage (%)

PARTISAN ASYMMETRY	
57.8	D seats in 50-50 election
62.2	R seats in 50-50 election
4.0	R seat advantage
4.1	average R seat advantage

MEAN-MEDIAN DIFFERENCE	
-0.5%	mean D-R margin (%)
-2.8%	median D-R margin (%)
1.1%	R advantage

DECLINATION ANGLE (degrees)	
2.7	R advantage

EFFICIENCY GAP	
1.9%	R advantage (averaged)

44	72.4%	27.6%	44.9
45	60.5%	39.5%	20.9
46	40.0%	60.0%	-20.0
47	46.8%	53.2%	-6.4
48	54.6%	45.4%	9.2
49	65.3%	34.7%	30.5
50	56.7%	43.3%	13.3
51	34.9%	65.1%	-30.2
52	41.3%	58.7%	-17.3
53	33.0%	67.0%	-33.9
54	58.0%	42.0%	16.1
55	43.0%	57.0%	-14.0
56	85.8%	14.2%	71.6
57	65.6%	34.4%	31.3
58	65.8%	34.2%	31.7
59	54.7%	45.3%	9.3
60	58.1%	41.9%	16.1
61	80.8%	19.2%	61.7
62	49.0%	51.0%	-2.0
63	54.2%	45.8%	8.3
64	39.2%	60.8%	-21.5
65	35.8%	64.2%	-28.5
66	63.6%	36.4%	27.2
67	28.9%	71.1%	-42.3
68	36.6%	63.4%	-26.7
69	35.2%	64.8%	-29.6
70	24.3%	75.7%	-51.4
71	69.7%	30.3%	39.4
72	74.0%	26.0%	48.1
73	44.3%	55.7%	-11.4
74	47.4%	52.6%	-5.2
75	42.6%	57.4%	-14.7
76	39.2%	60.8%	-21.6
77	24.7%	75.3%	-50.6
78	26.5%	73.5%	-47.0
79	36.0%	64.0%	-28.1
80	28.0%	72.0%	-44.1
81	26.4%	73.6%	-47.1
82	41.7%	58.3%	-16.5
83	35.2%	64.8%	-29.5
84	33.6%	66.4%	-32.8
85	27.7%	72.3%	-44.7
86	31.5%	68.5%	-37.0
87	26.6%	73.4%	-46.8
88	75.0%	25.0%	49.9
89	27.5%	72.5%	-45.0
90	24.8%	75.2%	-50.4

91	35.0%	65.0%	-30.0
92	69.5%	30.5%	39.0
93	43.0%	57.0%	-14.0
94	24.1%	75.9%	-51.8
95	34.3%	65.7%	-31.4
96	36.1%	63.9%	-27.9
97	27.5%	72.5%	-45.0
98	48.2%	51.8%	-3.5
99	59.9%	40.1%	19.9
100	69.1%	30.9%	38.2
101	75.0%	25.0%	50.0
102	80.5%	19.5%	61.1
103	50.7%	49.3%	1.4
104	56.9%	43.1%	13.7
105	57.1%	42.9%	14.2
106	83.1%	16.9%	66.2
107	76.3%	23.7%	52.7
108	32.7%	67.3%	-34.6
109	43.2%	56.8%	-13.6
110	31.5%	68.5%	-37.1
111	32.7%	67.3%	-34.7
112	75.6%	24.4%	51.2
113	33.1%	66.9%	-33.8
114	62.5%	37.5%	25.0
115	61.0%	39.0%	21.9
116	56.7%	43.3%	13.5
117	41.1%	58.9%	-17.8
118	38.5%	61.5%	-22.9
119	43.9%	56.1%	-12.1
120	27.0%	73.0%	-46.1

VIII. CONCLUSIONS

All three of the Legislative Defendants' plans favor Republicans in six metrics evaluated. The Harper plaintiffs' plans show mixed or no advantage for either party. The NCLCV plaintiffs' plans show a Democratic advantage for the Congressional plan, mixed or no advantage for the Senate plan, and a Republican advantage for the House plan. In each case, the plaintiffs' alternative(s) came closer to partisan symmetry than the Legislative Defendants' remedial maps.