EXHIBIT 1

An Evaluation of the Partisan Fairness of the Michigan Independent Citizens Redistricting Commission's State House Districting Plan

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1 Introduction

My name is Christopher Warshaw. I am an Associate Professor of Political Science at George Washington University. Previously, I was an Associate Professor at the Massachusetts Institute of Technology from July 2016 - July 2017, and an Assistant Professor at MIT from July 2012 - July 2016.

I have been asked by Counsel to analyze relevant data and provide my expert opinions about the Commission's proposed Hickory State House districting plan. In particular, I have been asked to evaluate whether the plan provides a disproportionate advantage to any political party based on generally accepted measures of partisan fairness. I have also been asked to evaluate the alternative State House plan from the Promote the Vote organization.

2 Qualifications and Publications

My Ph.D. is in Political Science, from Stanford University, where my graduate training included courses in political science and statistics. I also have a J.D. from Stanford Law School. My academic research focuses on public opinion, representation, elections, and polarization in American Politics. I have written over 20 peer reviewed papers on these topics. Moreover, I have written multiple papers that focus on elections and two articles that focus specifically on redistricting. I also have a forthcoming book that includes an extensive analysis on the causes and consequences of partisan gerrymandering in state governments.

My curriculum vitae is attached to this report. All publications that I have authored and published appear in my curriculum vitae. My work is published or forthcoming in peer-reviewed journals such as: the *American Political Science Review*, the *American Journal of Political Science*, the *Journal of Politics*, *Political Analysis*, *Political Science Research and Methods*, the *British Journal of Political Science*, the *Annual Review of Political Science*, *Political Behavior*, *Legislative Studies Quarterly*, *Science Advances*, the *Election Law Journal*, *Nature Energy*, *Public Choice*, and edited volumes from Cambridge University Press and Oxford University Press. My book entitled *Dynamic Democracy in the American States* is forthcoming from the University of Chicago Press. My non-academic writing has been published in the *New York Times* and the *Washington Post*. My work has also been discussed in the *Economist* and many other prominent media outlets.

My opinions in this case are based on the knowledge I have amassed over my education,

training and experience, including a detailed review of the relevant academic literature. They also follow from statistical analysis of the following data:

- In order to calculate partisan bias in state house elections on the Hickory plan in Michigan, I examined:
  - GIS Files with the 2012-2020 Michigan State House plan and the proposed 2022-30 plan): I obtained the Hickory plan from the Michigan Independent Citizens Redistricting Commission's website and the Promote the Vote plan from Counsel.
  - Precinct-level data on recent statewide Michigan elections: I use a shapefile of the precincts in Michigan from the Voting and Election Science Team (University of Florida, Wichita State University). I obtained these data from the Harvard Dataverse.[1] I obtained precinct-level data on elections from 2012-20 from the Michigan Secretary of State's office.
  - Estimates of the partisan bias in previous state legislative elections: As part of my peer reviewed academic research, I have estimated the partisan bias of districting plans used in previous state legislative elections around the country from 1972-2020 (Stephanopoulos and Warshaw 2020). This analysis was based on state legislative election results from 1972-2020 collected by Carl Klarner and a large team of collaborators (Klarner et al. 2013). They also utilize data on presidential election returns in state legislative districts. For elections between 1972 and 1991, I used data on county-level presidential election returns from 1972-1988 collected by the Inter-university Consortium for Political and Social Research (ICPSR 2006) and mapped these returns to state legislative districts. For elections between 1992 and 2001, I used data on presidential election returns in the 2000 election collected by McDonald (2014) and Wright et al. (2009). For elections between 2002 and 2011, I used data on the 2004 and 2008 presidential elections collected by Rogers (2017). For elections between 2012 and 2020, I used data on presidential election returns from the DailyKos website and PlanScore.org.
  - The Plan Score website: PlanScore is a project of the nonpartisan Campaign Legal Center (CLC) that enables people to score proposed maps for their partisan, demographic, racial, and geometric features. I am on the social science advisory team for PlanScore.

1. See `https://dataverse.harvard.edu/dataverse/electionscience`.

I have previously provided expert reports in six redistricting-related cases:

- Between 2017 and 2019, I provided reports for *League of Women Voters of Pennsylvania v. Commonwealth of Pennsylvania*, No. 159 MM 2017, *League of Women Voters of Michigan* v. *Johnson*, 17-14148 (E.D. Mich), and *APRI et al.* v. *Smith et al.*, No. 18-cv-357 (S.D. Ohio). My expert testimony was found to be admissible and credible in each of these cases and was extensively cited by the judges in their decisions.

- In the current redistricting cycle, I have provided reports in *League of Women Voters* v. *Ohio Redistricting Commission*, No. 2021-1193, *League of Women Voters* vs. *Kent County Apportionment Commission*, and *League of Women Voters of Ohio* v. *Ohio Redistricting Commission*, No. 2021-1449.

I also recently provided testimony to Pennsylvania's Bipartisan Reapportionment Commission about the partisan fairness of its proposed State House plan. In addition, I have provided expert testimony and reports in several cases related to the U.S. Census: *State of New York et al.* v. *United States Department of Commerce*, 18-cv-2921 (S.D.N.Y.), *New York* v. *Trump*; *Common Cause* v. *Trump*, 20-cv-2023 (D.D.C.), and *La Union Del Pueblo Entero (LUPE)* v. *Trump*, 19-2710 (D. Md.).

I am being compensated at a rate of $350 per hour. The opinions in this report are my own, and do not represent the views of George Washington University.

3 Summary

The relationship between the distribution of partisan support in the electorate and the partisan composition of the government—what Powell (2004) calls "vote–seat representation"—is a critical link in the longer representational chain between citizens' preferences and governments' policies. If the relationship between votes and seats systematically advantages one party over another, then some citizens will enjoy more influence—more "voice"—over elections and political outcomes than others (Caughey, Tausanovitch, and Warshaw 2017).

I use three complementary methodologies to project future election results in order to evaluate the partisan fairness of the Commission's State House plan. First, I use a composite of previous statewide election results between 2012-2020 to analyze the new map.[2] Second, I analyze the results of the State House elections from 2012-2020 on

2. These include the following elections: 2012 Presidential, 2016 Presidential, 2020 Presidential, 2014

the newly proposed map. Third, I complement these approaches using the open source PlanScore.org website, which is a project of the Campaign Legal Center. PlanScore uses a statistical model to estimate district-level vote shares for a new map based on the relationship between presidential election results and legislative results between 2012-2020.[3] Based on these three approaches, I characterize the bias in Michigan's plans based on a large set of established, generally accepted metrics of partisan fairness and place the bias in Michigan's plans into historical perspective.

All of these analyses indicate that the proposed map has a meaningful, disproportionate level of pro-Republican bias.

- In the 2020 presidential election, Democrat Joe Biden received about 51.4% of the two-party vote, but he would have only won 49% of the State House districts on the Hickory plan.[4] Based on the statewide elections in Michigan between 2012-2020, the Democrats' statewide two-party vote share averaged about 52.2% of the vote, but they would have won just 50.4% of the seats under the Hickory plan.[5] Moreover, my analysis indicates that Democrats would only win about 42.5% of the seats on the Hickory plan when they win exactly half the statewide vote based on the composite of previous statewide elections. Across four generally accepted measures of partisan fairness, the composite elections indicate a meaningful level of pro-Republican bias in the Hickory plan. Moreover, there is a substantial likelihood Democrats could receive a minority of the seats while winning a majority of the votes.[6]

- In the 2020 State House elections in Michigan, Democrats received 50.01% of the statewide vote, but they would only win 48% of the districts on the Hickory plan. Across all the State House elections from 2012-2020, Democrats received an average of about 52% of the vote. But they would have only won 48.5% of the seats on the Hickory plan. In other words, Democrats would have received a minority of the seats

Governor, 2018 Governor, 2014 Attorney General, 2018 Attorney General, 2014 Secretary of State, 2018 Secretary of State, 2012 Senate, 2014 Senate, 2018 Senate and 2020 Senate election.

3. See `https://planscore.campaignlegal.org/models/data/2021D/` for more details.

4. Following standard convention, throughout my analysis I focus on two-party vote shares.

5. I weight the composite scores to give each election cycle equal weight in the index.

6. My estimates of the partisan bias in the Hickory plan based on the efficiency gap and the mean-median difference are not significantly different from the assessment of the Commission's analyst, Dr. Lisa Handley (See `https://tinyurl.com/2xh872ab`). Her lopsided votes metric also indicates a pro-Republican bias in the Hickory plan. But this metric is not widely used in the academic literature so I do not use it in my report. Indeed, Warrington (2019) finds that "the logic behind this test fails even for moderate swings in statewide support." The declination metric that I use in my analysis, and report below, is similar in spirit to lopsided margins, but generally performs better (see Warrington (2019) for details). The only metric Dr. Handley examines that does not clearly indicate a pro-Republican bias is the seats-votes ratio. However, this metric is not generally accepted in the academic literature because there is no reason to expect a perfectly proportional ratio between seats and votes.

while winning a majority of the votes. Across four generally accepted measures of partisan fairness, the re-aggregated State House elections from 2012-2020 indicate a meaningful level of pro-Republican bias in the Hickory plan.

- I also reach the same conclusion that the plan has a pro-Republican bias in the translation of votes to seats using the predictive model on the PlanScore website. PlanScore projects that Democrats would get about 51% of the statewide vote, but are expected to win 48% of the seats in the proposed State House plan.[7] Across 1000 simulations, PlanScore indicates that the Hickory plan favors Republican candidates in 99% of scenarios. Based on generally accepted Political Science metrics for partisan fairness, PlanScore also indicates that Michigan's Hickory plan would have a pro-Republican bias.

The remainder of the report proceeds as follows. First, I discuss how social scientists measure partisan bias in a districting plan. Next, I examine the partisan fairness of the proposed State House plan, and compare it to the fairness of other plans around the country over the past 50 years. Finally, I briefly conclude.

4 Background on Partisan Fairness

This section provides background about how social scientists conceptualize partisan fairness in a districting plan. Partisan advantage in a districting plan means that one party's voters are more "cracked" and "packed" than the other side's supporters. In cracked districts, voters' preferred candidates lose by relatively narrow margins; in packed districts, their candidates of choice win by enormous margins (Stephanopoulos and McGhee 2015). Thanks to disproportionate cracking and packing, the disfavored party is less able than the favored party to convert its statewide support among voters into legislative representation. This gives the favored party the ability to shift policies in its direction (Caughey, Tausanovitch, and Warshaw 2017) and build a durable advantage in downstream elections (Stephanopoulos and Warshaw 2020). It can even lead to undemocratic outcomes where the advantaged party wins the majority of the seats and controls the government while only winning a minority of the votes. In Michigan, this occurred in four of the five State House elections between 2012-2020 – when Republicans received a majority of the seats while winning a minority of the votes.

7. This is a probabilistic estimate based on 1000 simulations of possible elections using a model of the elections between 2012-2020.

There are a number of approaches that have been proposed to measure partisan fairness in a districting plan. These approaches focus on asymmetries in the efficiency of the vote–seat relationships of the two parties. In recent years, at least 10 different approaches have been proposed (McGhee 2017; Warrington 2019). While no measure is perfect, much of the recent literature has focused on four related approaches that I describe below.

4.1 Efficiency Gap

Both cracked and packed districts "waste" more votes of the disadvantaged party than of the advantaged one (McGhee 2014; Stephanopoulos and McGhee 2015).[8] This suggests that partisan fairness can be measured based on asymmetries in the number of wasted votes for each party. The *efficiency gap* (EG) focuses squarely on the number of each party's wasted votes in each election. It is defined as "the difference between the parties' respective wasted votes, divided by the total number of votes cast in the election" (Stephanopoulos and McGhee 2015, 831; see also McGhee 2014, 2017). All of the losing party's votes are wasted if they lose the election. When a party wins an election, the wasted votes are those above the 50%+1 needed to win.

If we adopt the convention that positive values of the efficiency gap imply a Democratic advantage in the districting process and negative ones imply a Republican advantage, the efficiency gap can be written mathematically as:

$$EG = \frac{W_R}{n} - \frac{W_D}{n} \tag{1}$$

where W_R are wasted votes for Republicans, W_D are wasted votes for Democrats, and n is the total number of votes in each state.

Table 1 provides a simple example about how to calculate the efficiency gap with three districts where the same number of people vote in each district. In this example, Democrats win a majority of the statewide vote, but they only win 1/3 seats. In the first district, they win the district with 75/100 votes. This means that they only wasted the 24 votes that were unnecessary to win a majority of the vote in this district. But they lose the other two districts and thus waste all 40 of their votes in those districts. In all, they waste 104 votes. Republicans, on the other hand, waste all 25 of their votes in the first district. But they only waste the 9 votes unnecessary to win a majority in the two districts they win. In all, they only waste 43 votes. This implies a pro-Republican

8. The authors of the efficiency gap use the term "waste" or "wasted" to describe votes for the losing party and votes for the winning party in excess of what is needed to win an election. Since the term is used by the efficiency gap authors, I use it here when discussing the efficiency gap.

efficiency gap of $\frac{43}{300}$ - $\frac{104}{300}$= -20%.

Table 1: Illustrative Example of Efficiency Gap

District	Democratic Votes	Republican Votes
1	75	25
2	40	60
3	40	60
Total	155 (52%)	145 (48%)
Wasted	104	43

In order to account for unequal population or turnout across districts, the efficiency gap formula in equation 1 can be rewritten as:

$$EG = S_D^{margin} - 2 * V_D^{margin} \tag{2}$$

where S_D^{margin} is the Democratic Party's seat margin (the seat share minus 0.5) and V_D^{margin} is is the Democratic Party's vote margin. V_D^{margin} is calculated by aggregating the raw votes for Democratic candidates across all districts, dividing by the total raw vote cast across all districts, and subtracting 0.5 (McGhee 2017, 11-12). In the example above, this equation also provides an efficiency gap of -20% in favor of Republicans. But it could lead to a slightly different estimate of the efficiency gap if districts are malapportioned or there is unequal turnout across districts.[9]

The efficiency gap mathematically captures the packing and cracking that are at the heart of partisan gerrymanders (Buzas and Warrington 2021). It measures the extra seats one party wins over and above what would be expected if neither party were advantaged in the translation of votes to seats (i.e., if they had the same number of wasted votes). A key advantage of the efficiency gap over other measures of partisan bias is that it can be calculated directly from observed election returns even when the parties' statewide vote shares are not equal.

4.2 Mean-median Difference

Another metric that some scholars have proposed to measure partisan bias in a districting plan is the *mean-median difference*: the difference between a party's vote share in the median district and their average vote share across all districts. If the party wins more

9. In general, the two formulations of the efficiency gap formula yield very similar results. Because Democrats tend to win lower-turnout districts, however, the turnout adjusted version of the efficiency gap in equation 2 tends to produce results that suggest about a 2% smaller disadvantage for Democrats than the version in Equation 1 (see McGhee 2018).

votes in the median district than in the average district, they have an advantage in the translation of votes to seats (Krasno et al. 2018; Best et al. 2017; Wang 2016). In statistics, comparing a dataset's mean and median is a common statistical analysis used to assess skews in the data and detect asymmetries (Brennan Center 2017).

The mean-median difference is very easy to apply (Wang 2016). It is possible, however, for packing and cracking to occur without any change in the mean-median difference (Buzas and Warrington 2021). That is, a party could gain seats in the legislature without the mean-median gap changing (McGhee 2017).[10] It is also sensitive to the outcome in the median district (Warrington 2018b). In addition, the mean-median difference lacks a straightforward interpretation in terms of the number of seats that a party gains.

4.3 Symmetry in the Vote-Seat Curve Across Parties

Basic fairness suggests that in a two-party system each party should receive the same share of seats for identical shares of votes. The *symmetry* idea is easiest to understand at an aggregate vote share of 0.5—a party that receives half the vote ought to receive half the seats—but a similar logic can apply across the "seats-votes curve" that traces out how seat shares change as vote shares rise and fall. For example, if a party receives a vote share of 0.57 and a seat share of 0.64, the opposing party should also expect to receive a seat share of 0.64 if it were to receive a vote share of 0.57. An unbiased system means that for V share of the votes a party should receive S share of the seats, and this should be true for all parties and vote percentages (Niemi and Deegan 1978; Gelman and King 1994; McGhee 2014; Katz, King, and Rosenblatt 2020).

Gelman and King (1994, 536) propose two ways to measure partisan bias in the symmetry of the vote-seat curve. First, it can be measured using counter-factual election results in a range of statewide vote shares between .45 and .55. Across this range of vote shares, each party should receive the same number of seats. Symmetry captures any departures from the standard that each party should receive the same seat share across this range of plausible vote shares. For example, if partisan bias is -0.05, this means that the Democrats receive 5% fewer seats in the legislature than they should under the symmetry standard (and the Republicans receive 5% more seats than they should). Second, symmetry can be measured based on the seat share that each party receives when they split the statewide vote 50-50. In an unbiased system, each party should receive 50% of

10. As McGhee (2017), notes, "If the median equals the win/loss threshold–i.e., a vote share of 0.5–then when a seat changes hands, the median will also change and the median- mean difference will reflect that change. But if the median is anything other than 0.5, seats can change hands without any change in the median and so without any change in the median-mean difference." See also Buzas and Warrington (2021) who make a similar point using simulated packing and cracking.

the seats in a tied statewide election. Here, the partisan bias statistic is the "expected proportion of the seats over 0.5 that the Democrats receive when they receive exactly half the average district vote."

A weakness of the symmetry approach is that it requires the analyst to calculate counterfactual elections. This approach has both conceptual and empirical limitations. At a conceptual level, it is not clear that it aligns perfectly with the usual definition of a gerrymander. Indeed, "when observers assert that a district plan is a gerrymander, they usually mean that it systematically benefits a party (and harms its opponent) in actual elections. They do not mean that a plan would advantage a party in the hypothetical event of a tied election, or if the parties' vote shares flipped" (Stephanopoulos and McGhee 2015, 857). At an empirical level, in order to generate symmetry metrics, we need to simulate counter-factual elections by shifting the actual vote share in each district a uniform amount (McGhee 2014).[11] In general, this uniform swing assumption seems reasonable based on past election results (though is probably less reasonable in less competitive states). Moreover, it has been widely used in past studies of redistricting. But there is no way to conclusively validate the uniform swing assumption for any particular election.

An important strength, however, of the symmetry approach is that it is based on the shape of the seats-votes curve and not any particular point on it. As a result, it is relatively immune to shifts in party performance (McGhee 2014). For instance, the bias toward Republicans in Michigan's State House elections was very similar in 2012-2020. Moreover, the symmetry approach has been very widely used in previous studies of redistricting (Gelman and King 1994; McGhee 2014). Overall, the symmetry approach is useful for assessing partisan advantage in the districting process.

The symmetry metric is closely related to the efficiency gap. In the special case where each party receives half of the statewide vote, the symmetry and the efficiency gap metrics are mathematically identical (Stephanopoulos and McGhee 2015, 856). More generally, the symmetry and efficiency gap yield very similar substantive results when each party's statewide vote share is close to 50% (as is the case in Michigan). When elections are uncompetitive, however, and one party wins a large percentage of the statewide vote, the efficiency gap and these symmetry metrics are less correlated with one another (857).

11. In principle, the uniform swing election could be relaxed, and swings could be estimated on a district-by-district basis. But this is rarely done in practice since it would require a much more complicated statistical model, and probably would not improve estimates of symmetry very much.

4.4 Declination

Another measure of asymmetries in redistricting plans is called *declination* (Warrington 2018b, 2018a). The declination metric treats asymmetry in the vote distribution as indicative of partisan bias in a districting plan (Warrington 2018a). If all the districts in a plan are lined up from the least Democratic to the most Democratic, the mid-point of the line formed by one party's seats should be about as far from the 50 percent threshold for victory on average as the other party's (McGhee 2018).

Declination suggests that when there is no partisan bias in a plan, the angles of the lines (θ_D and θ_R) between the mean across all districts and the point on the 50% line between the mass of points representing each party will be roughly equal. When they deviate from each other, the smaller angle (θ_R in the case of Michigan's plans over the past decade) will generally identify the favored party. To capture this idea, declination takes the difference between those two angles (θ_D and θ_R) and divides by $\pi/2$ to convert the result from radians to fractions of 90 degrees.[12] This produces a number between -1 and 1. As calculated here, positive values favor Democrats and negative values favor Republicans. Warrington (2018b) suggests a further adjustment to account for differences in the number of seats across legislative chambers. I use this adjusted declination estimate in the analysis that follows.[13]

4.5 Comparison of Partisan Bias Measures

All of the measures of partisan advantage discussed in the previous sections are closely related both theoretically and empirically (McGhee 2017; Stephanopoulos and McGhee 2018). Thus, when all the metrics point in the same direction, we can draw a particularly robust conclusion.

Broadly speaking, all of the metrics consider how votes between the two parties are distributed across districts (Warrington 2018a). For example, the efficiency gap is mathematically equivalent to partisan bias in tied statewide elections (Stephanopoulos and McGhee 2018). Also, the median-mean difference is similar to the symmetry metric, since any perfectly symmetric seats-votes curve will also have the same mean and median (McGhee 2017).

Second, each of the concepts are closely related empirically, particularly in states with competitive elections. The various measures have high correlations with one another.[14]

12. This equation is: $\delta = 2^* (\theta_R - \theta_D) / \pi$.

13. This adjustment uses this equation: $\hat{\delta} = \delta * \ln(\text{seats}) / 2$

14. While each measure is highly correlated with one another, the efficiency gap and declination measures are particularly closed related and the symmetry and mean-median measures are very closely related.

Moreover, most of the variation in the metrics can be summarized on a single latent dimension (Stephanopoulos and McGhee 2018; Stephanopoulos and Warshaw 2020). So, overall, while there may be occasional cases where the metrics disagree about the amount of bias in a particular plan, the various metrics usually yield similar results for the degree of partisan bias in a districting plan (Nagle 2015).

5 Partisan Fairness of Michigan's proposed State House Map

In this section, I will provide a comprehensive evaluation of the partisan fairness of Michigan's proposed State House districting plan. In order to evaluate the Hickory plan, we need to predict future election results on this map. Thus, I use three complementary methodologies to predict future State House elections in Michigan and generate the various metrics I discussed earlier.

5.1 Composite of previous statewide elections

First, I use a composite of previous statewide election results between 2012-2020 re-aggregated to the proposed map.[15] For each year, I estimate each party's vote share, seat share, and the average of the partisan bias metrics across races. I then average them together to produce a composite result. This approach implicitly assumes that future voting patterns will look like the average of these recent statewide elections.

When I average across these statewide elections from 2012-2020, Democrats win 52% of the votes, but only 50% of the seats on the Hickory plan (see Table 2).[16] In other words, they win a clear majority of the votes, but only win about half the seats. This provides an initial indication that the plan provides a disproportionate advantage to the Republican Party. A more detailed look at the partisan fairness metrics reinforces this

This could be because the efficiency gap and the declination consider the seats actually won by each party, while the symmetry metric and the mean-median difference do not (Stephanopoulos and McGhee 2018, 1557). In addition, the efficiency gap and the declination appear to best capture the packing and cracking that characterize partisan gerrymandering (Buzas and Warrington 2021).

15. These include the following elections: 2012 Presidential, 2016 Presidential, 2020 Presidential, 2014 Governor, 2018 Governor, 2014 Attorney General, 2018 Attorney General, 2012 Senate, 2014 Senate, 2018 Senate, 2020 Senate, 2014 Secretary of State, and 2018 Secretary of State election.

16. I weight the composite scores to give each election cycle equal weight in the index. The seat-level projections are based on the 13 statewide elections where I have precinct-level data. This approach ensures that my results are not arbitrarily influenced by the fact that more election contests took place in some years than others. However, I reach very similar results when I weight each contest equally (see the Supplementary Appendix to my report).

Metric	Value	2012-2020 Composite > Biased than this % Elections	2012-2020 Composite > Pro-Rep. than this % Elections
Hickory plan			
Democratic Vote Share	52%		
Democratic Seat Share	50%		
Efficiency Gap	-4.1%	43%	76%
Mean-Median	-2.9%	58%	76%
Symmetry Bias	-7.4%	74%	84%
Declination	-31.1%	62%	80%
Average		60%	80%
Promote the Vote plan			
Democratic Vote Share	52%		
Democratic Seat Share	53%		
Efficiency Gap	-1.1%	12%	61%
Mean-Median	-2.5%	51%	74%
Symmetry Bias	-4.6%	50%	72%
Declination	-17.2%	38%	65%
Average		33%	66%

Table 2: Composite bias metrics for Hickory plan based on statewide elections

conclusion:

- The plan has a pro-Republican efficiency gap of 4.1%. This indicates that Democrats' votes are 4.1% percentage points more likely to be wasted than Republicans' votes. Moreover, the Hickory plan has an efficiency gap more pro-Republican than 76% of previous state house plans around the country over the past fifty years.

- The plan has a pro-Republican mean-median difference of 2.9%. This indicates that Republicans do 2.9 percentage points better in the median district than in the mean district, which gives them an advantage in the translation of votes to seats. Moreover, the Hickory plan has an mean-median difference more pro-Republican than 76% of previous state house plans around the country over the past fifty years.

- The plan has a pro-Republican symmetry bias of 7.4%. This indicates that Republicans are likely to get about 57.4% of the seats when they win 50% of the votes. Moreover, the Hickory plan has a symmetry bias more pro-Republican than 84% of previous state house plans around the country over the past fifty years.

- The plan has a pro-Republican declination of 0.31. This indicates that Democratic voters are much more packed and cracked than Republican voters. Moreover, the Hickory plan has a declination more pro-Republican than 80% of previous state house plans around the country over the past fifty years.

- Overall, the Hickory plan is more pro-Republican than 79% of previous plans based on these metrics.

In contrast, the Promote the Vote plan scores better on each of these metrics:

- The plan has a pro-Republican efficiency gap of 2.1% (compared to 4.1% for Hickory).
- The plan has a pro-Republican mean-median difference of 2.5% (compared to 2.9% for Hickory).
- The plan has a pro-Republican symmetry bias of 4.6% (compared to 7.4% for Hickory).
- The plan has a pro-Republican declination of 0.17 (compared to 0.31 for Hickory).

Overall, the composite of previous statewide elections indicates that the Hickory plan has a meaningful pro-Republican bias across all four measures, and that the Promote the Vote plan is fairer than the Hickory plan across all four measures.

5.2 2012-2020 State House election results

Next, I use the 2012-2020 precinct-level State House results on both the 2012-20 map and re-aggregated to the proposed Hickory and Promote the Vote maps to estimate the various metrics. This approach implicitly assumes that future elections will look like the average of previous State House elections. These endogenous election are likely to be an excellent predictor of future voting patterns in State House elections. But it is important to keep in mind that they could be affected by the individual candidates in each race as well as a host of other factors that wouldn't look exactly the same in future elections.

The Hickory plan has a pro-Republican bias in the vote-seat relationship based on the re-aggregated State House results. Democrats would win 52% of the votes and just 49% of the seats on the Hickory plan. Once again, this provides an initial indication that the plan gives a disproportionate advantage to a political party; in this case against Democrats, and in favor of Republicans. A more detailed look at the partisan fairness metrics reinforces this conclusion:

- The plan has a pro-Republican efficiency gap of 4.6%. This is more pro-Republican than 77% of previous state house plans around the country over the past fifty years.

Metric	Value	More Biased than this % Historical Elections	More Pro-Republican than this % Historical Elections
Hickory plan			
Democratic Vote Share	52%		
Democratic Seat Share	49%		
Efficiency Gap	-4.6%	48%	77%
Mean-Median Diff	-3.0%	59%	76%
Symmetry Bias	-4.7%	51%	72%
Declination	-28.2%	58%	76%
Average		54%	76%
Promote the Vote plan			
Democratic Vote Share	52%		
Democratic Seat Share	49%		
Efficiency Gap	-4.4%	46%	77%
Mean-Median	-2.8%	55%	75%
Symmetry Bias	-3.8%	43%	68%
Declination	-29.6%	60%	78%
Average		51%	74%

Table 3: Partisan bias metrics for State House plan based on 2012-2020 State House election results re-aggregated onto each plan

- The plan has a pro-Republican mean-median difference of 3%. This is more pro-Republican than 76% of previous state house plans around the country over the past fifty years.
- The plan has a pro-Republican symmetry bias of 4.7%. This is more pro-Republican than 72% of previous state house plans around the country over the past fifty years.
- The plan has a pro-Republican declination of 0.28. This is more pro-Republican than 76% of previous state house plans around the country over the past fifty years.

Overall, the Hickory plan is more pro-Republican than 76% of previous plans based on these metrics. Moreover, the Promote the Vote plan is less biased using nearly all of these metrics.

5.3 PlanScore

Third, I evaluate the Hickory plan using a predictive model from the PlanScore.org website.[17] PlanScore uses a statistical model of the relationship between districts' latent partisanship and legislative election outcomes. This enables it to estimate district-level

17. See `https://planscore.campaignlegal.org/plan.html?20211229T150932.146318591Z` for the Hickory plan and `https://planscore.campaignlegal.org/plan.html?20211229T151732.170449184Z` for the Promote the Vote plan.

vote shares for a new map and the corresponding partisan bias metrics.[18] It then calculates various partisan bias metrics. Like the earlier approaches, PlanScore indicates that the Hickory plan has a pro-Republican bias (Table 4).

Metric	Value	Favors Rep's in this % of Scenarios	More Biased than this % Historical Plans	More Pro-Rep. than this % Historical Plans
Hickory plan				
Democratic Vote Share	51%			
Democratic Seat Share	48%			
Efficiency Gap	-4.8%	99%	53%	81%
Mean-Median Diff.	-2.4%	99%	45%	70%
Symmetry	-4.9%	99%	55%	75%
Declination	-23.0%	99%	51%	70%
Average		99%	51%	74%
Promote the Vote plan				
Democratic Vote Share	52%			
Democratic Seat Share	51%			
Efficiency Gap	-2.5%	88%	32%	70%
Mean-Median	-1.3%	92%	29%	61%
Symmetry Bias	-3.2%	93%	37%	64%
Declination	-11.0%	85%	28%	60%
Average		90%	32%	64%

Table 4: PlanScore partisan bias metrics for proposed State House plan

According to PlanScore, Democrats are likely to win 51% of the votes, but only 48% of the seats in the average election on the Hickory plan. Once again, this provides an initial indication that the plan is biased against Democrats, and in favor of Republicans. A more detailed look at the partisan fairness metrics reinforces this conclusion:

- The plan has a pro-Republican efficiency gap of 4.8%. The efficiency gap favors Republicans in 99% of the scenarios estimated by PlanScore. It is more pro-Republican than 81% of previous state house plans around the country over the past fifty years.

- The plan has a pro-Republican mean-median difference of 2.4%. The mean-median difference favors Republicans in 99% of the scenarios estimated by PlanScore. It is more pro-Republican than 70% of previous state house plans around the country over the past fifty years.

- The plan has a pro-Republican symmetry bias of 4.9%. The symmetry bias favors Republicans in 99% of the scenarios estimated by PlanScore. It is more pro-Republican than 75% of previous state house plans around the country over the past fifty years.

18. See `https://planscore.campaignlegal.org/models/data/2021D/` for more details.

- The plan has a pro-Republican declination of 0.23. The declination favors Republicans in 99% of the scenarios estimated by PlanScore. It is more pro-Republican than 70% of previous state house plans around the country over the past fifty years.

Overall, the Hickory plan is more pro-Republican than 74% of previous plans based on these metrics. Moreover, the Promote the Vote is less biased using each of these metrics. Figure 1 graphically shows the bias of the Hickory plan compared to previous plans from 1972-2020.[19] Overall, the graphs show that the Hickory plan is well to the right of the distribution of previous plans over the past 50 years. As a result, it has a meaningful pro-Republican bias.

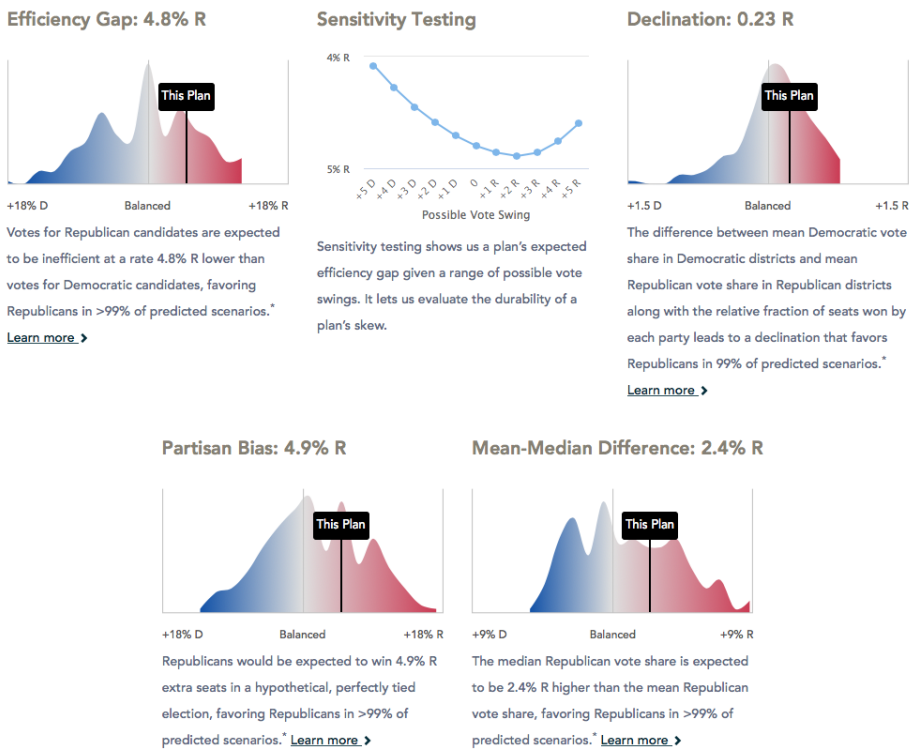

Figure 1: Graphs of PlanScore metrics proposed State House plan compared to previous plans from 1972-2020

6 Compactness

I have also been asked to evaluate the compactness of the plans. Section 6(13)(g) requires that "districts shall be reasonably compact." In this section, I briefly focus on three

19. Note that the PlanScore graphs are oriented so that pro-Republican scores have a positive value.

compactness metrics to evaluate the compactness of the Hickory plan and compare it to the Promote the Vote plan. First, the Polsby-Popper measure is the ratio of the area of the district to the area of a circle whose circumference is equal to the perimeter of the district. Second, the Reock Score is the ratio of the area of the district to the area of a minimum bounding circle that encloses the district's geometry. Finally, the Convex Hull score is a ratio of the area of the district to the area of the minimum convex polygon that can encloses the district's geometry. Each of these metrics falls within the range of [0,1] and a score closer to 1 indicates a more compact district.[20]

Overall, the two plans look very similar in terms of their compactness scores. They each have a Polsby Popper score between .38-.43, a Reock score between .41-.43, and a Convex Hull score of .77-.80. So both plans appear to be reasonably compact. In fact, both plans are more compact than the 2012-2020 State House plan. But the Promote the Vote plan is slightly more compact than the Hickory plan on two of these three compactness metrics.

Plan	Polsby Popper	Reock	Convex Hull
Hickory Plan	0.38	0.41	0.77
Promote the Vote Plan	0.43	0.40	0.80

Table 5: Compactness metrics for Commission's enacted plan and alternative Promote the Vote plan

7 Conclusion

This report has provided a comprehensive, holistic evaluation of the partisan fairness of the Michigan Independent Citizens Redistricting Commission's proposed Hickory State House plan. Based on three methods of projecting future elections and four different, generally accepted partisan bias metrics, I find that the plan provides a disproportionate advantage to the Republican Party based on generally accepted measures of partisan fairness. On this plan, Republicans are likely to win the the majority of the seats even if they win the minority of the votes. Conversely, Democrats could win a minority of the seats while winning a majority of the vote. Thus, the plan does not satisfy a key premise of democratic theory. This is particularly incompatible with democratic principles since partisan control of the legislature has large and growing policy consequences (Caughey, Xu, and Warshaw 2017). Moreover, on nearly every metric I examine, Promote the Vote's proposed plan is fairer than the Hickory plan.

20. I use the mandeR package in R to calculate these compactness scores.

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Supplementary Appendix

In this appendix, I present the partisan bias metrics I discuss in Sections 5.1 of my main report where I weight each statewide contest equally from 2012-2020.

Metric	Value	More Biased than this % Historical Plans	More Pro-Republican than this % Historical Plans
Hickory plan			
Efficiency Gap	-3.7%	39%	74%
Mean-Median Diff	-2.9%	56%	75%
Declination	-.299	60%	78%
Symmetry Bias	-7.6%	75%	84%
Average		58%	78%
Promote the Vote plan			
Efficiency Gap	-1.3%	16%	63%
Mean-Median Diff	-2.7%	54%	75%
Declination	-.197	42%	67%
Symmetry Bias	-5.2%	55%	75%
Average		42%	70%

Table A1: Additional partisan bias metrics for state House plans based on composite election results from 2012-2020 (each contest weighted equally)