

IN THE SUPREME COURT OF OHIO

**LEAGUE OF WOMEN VOTERS OF
OHIO, *et al.*,**

Petitioners,

v.

**OHIO REDISTRICTING COMMISSION,
et al.,**

Respondents.

Case No. 2021-1449

**Original Action Filed Pursuant to Ohio
Const., art. XIX, Sec. 3(A)**

**PETITIONERS' EVIDENCE TO MOTION TO ENFORCE COURT'S ORDER
(Affidavit of Dr. Kosuke Imai)**

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IN THE SUPREME COURT OF OHIO

LEAGUE OF WOMEN VOTERS OF
OHIO, *et al.*,

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OHIO REDISTRICTING COMMISSION,
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Respondents.

Case No. 2021-1449

Original Action Filed Pursuant to
Ohio Const., Art. XI

AFFIDAVIT OF KOSUKE IMAI

Franklin County
/ss
State of Ohio

Now comes affiant Kosuke Imai, having been first duly cautioned and sworn,
deposes and states as follows:

1. I am over the age of 18 and fully competent to make this declaration. I have personal knowledge of the statements and facts contained herein.
2. For the purposes of this litigation, I have been asked by counsel for Petitioners to analyze relevant data and provide my expert opinions.
3. To that end, I have personally prepared the report attached to this affidavit as Exhibit B, and swear to its authenticity and to the faithfulness of the opinions expressed, and, to the best of my knowledge, the accuracy of the factual statements made therein.

FURTHER AFFIANT SAYETH NAUGHT

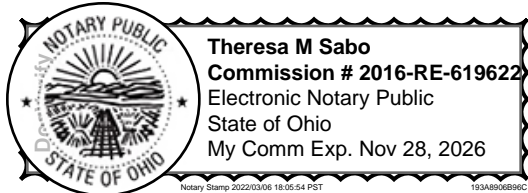
Executed on 03/06/2022, 2022.

Kosuke Imai

Signed on 2022/03/06 17:05:54 -8:00

Kosuke Imai

Sworn and subscribed before me this 03/06/2022, 2022



Theresa M Sabo

Notary Public

Notarial act performed by audio-visual communication

EXHIBIT B

IN THE SUPREME COURT OF OHIO

League of Women Voters of Ohio, *et al.*

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v.

Ohio Redistricting Commission, *et al.*

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Const., Art. XIX, Sec. 3(A)

EXPERT REPORT

Kosuke Imai, Ph.D.

March 6, 2022

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I. INTRODUCTION AND SCOPE OF WORK

1. My name is Kosuke Imai, Ph.D., and I am a Professor in the Department of Government and the Department of Statistics at Harvard University. I specialize in the development of statistical methods and computational algorithms for and their applications to social science research. I am also affiliated with Harvard's Institute for Quantitative Social Science. My qualifications and compensation are described in my initial report that was submitted to this court.

2. I have been asked by counsel representing the relators in this case to analyze relevant data and provide my expert opinions related to whether Ohio's recently revised congressional districting plan (which I will refer to as the "revised plan" in this report) meets the criteria in Article XIX, Section 1(C)(3)(a) of Ohio's Constitution. More specifically, I have been asked to statistically analyze the revised plan's compliance with Article XIX, Section 1(C)(3)(a)'s requirement that "[t]he general assembly shall not pass a plan that unduly favors or disfavors a political party or its incumbents" by comparing it against the 5,000 alternative plans that were generated as the basis of simulation analysis in my initial report for this case.

II. SUMMARY OF OPINIONS

3. My analysis yields the following findings:
- The revised plan exhibits a significant partisan bias in favor of the Republican Party. Under the revised plan, the vote share margins for three nominally Democratic-leaning districts are unusually narrow when compared to my 5,000 simulated plans. In contrast, Republican-leaning districts are much safer under the revised plan than the corresponding districts in the simulated plans. These differences are substantial in magnitude and statistically significant.
 - This partisan bias of the revised plan originates from the Congressional districts in Hamilton and Franklin Counties. In Hamilton County, the revised plan cracks Democratic voters into Districts 1 and 8, reducing the Democratic advantage of District 1. In Franklin County, the revised plan packs a disproportionately large number of Democratic voters into District 3, increasing the Republican advantage of the surrounding districts.

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- The revised plan’s decision to favor the Republican party in Hamilton and Franklin Counties led to highly non-compact districts. District 1, which combines a part of Cincinnati and its environs with Warren County, is much less compact than the corresponding county under the simulated plans. Similarly, District 15, which combines a part of Franklin County with five other counties in the western part of the state, splits a total of five counties and is much less compact than the corresponding districts under the simulated plans.
- I submitted an example plan to the Ohio Redistricting Commission on February 22, 2022 that is compliant with Article XIX of the Ohio Constitution. This example plan is less biased, has fewer county splits, and is more compact than the revised plan.

III. METHODOLOGY

4. In my initial expert report for this case, I conducted simulation analyses to evaluate the enacted plan (SB 258; hereafter “enacted plan”). As explained in that report, the redistricting simulation analysis has the ability to directly account for political geography and redistricting rules specific to the state. By comparing a proposed plan with simulated plans that are generated using a set of redistricting criteria, it is possible to assess the partisan bias of the plan relative to the set of alternative plans one could have drawn by following those specified criteria.

5. I evaluate the revised plan’s compliance with Article XIX, Section 1(C)(3)(a) by comparing it with the same set of 5,000 simulated plans as those used in my initial report to evaluate the enacted plan. Recall that these simulated plans are equally or more compliant with other relevant requirements of Article XIX than the enacted plan (see the initial report for details). In Appendices A and B, I show that my simulated plans are also more compact and have fewer county splits than the revised plan. I present the evaluation of the revised plan based on a total of nine statewide elections from 2016 to 2020, which were used by the Commission.

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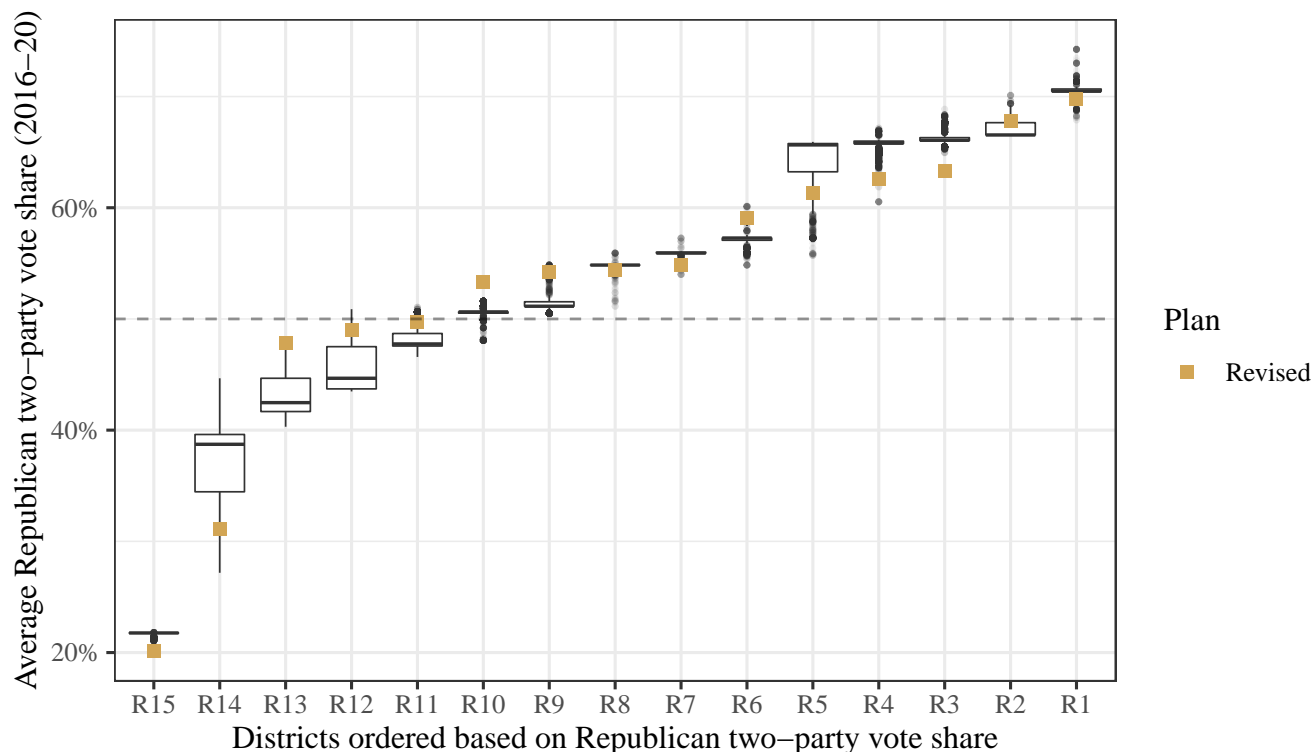


Figure 1: Expected Republican vote share for districts using the statewide elections from 2016 to 2020. For any given plan, the districts are ordered based on their expected Republican vote share. Boxplots represent the distribution of the expected Republican vote share across the simulated plans, whereas the orange square corresponds to the expected Republican vote share under the revised plan.

IV. OUTLIER ANALYSIS

6. I evaluate the partisan bias of the revised plan by comparing its district-level vote shares against those under my 5,000 simulated plans. In Figure 1, for any given plan (revised or simulated), I ordered the districts based on the magnitude of their expected Republican vote share. This means that under any given plan, district R1 yields the highest expected vote share while district R15 is expected to give the least support to the Republican candidate (to be clear, the R1 through R15 district identifiers do not correspond to the Congressional district numbers in the revised or enacted plan). If the expected Republican vote share of each ordered district under the revised plan (red square) diverges from the corresponding distribution of the simulated plans (boxplot), it constitutes evidence of possible partisan bias. Note that in a boxplot, the “box”

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contains 50% of the data points (those from 25 percentile to 75 percentile to be exact) with the horizontal line indicating the median value whereas the vertical lines coming out of the box, called “whiskers”, indicate the range, which contains most data. Any data points that are beyond these whiskers are considered as outliers according to the most common definition, which was also used in my initial report.¹

7. The figure shows clear evidence that the revised plan favors the Republican party. For all of my 5,000 simulated plans, districts R9 and R10 (the 9th and 10th most Republican-leaning districts, respectively) slightly lean toward the Republican party with narrow margins. The expected median Republican vote shares for these districts are equal to 51.1% and 50.6%, respectively. In other words, they are toss-up districts under the simulated plans. Yet under the revised plan, both of these districts are safely Republican with the expected Republican vote shares equal to 54.2% and 53.3%. According to the aforementioned definition, these two points associated with the revised plan are clear statistical outliers, with the vote shares of district R9 and R10 under the revised plan being 3.4 and 5.5 standard deviations away from the simulation median, respectively.

8. Furthermore, under the revised plan, districts R11, R12, and R13 lean much less strongly towards the Democratic party than under a vast majority of the simulated plans. For example, the expected median Republican vote share for R11 under the simulated plans is 47.8%. In other words, this district strongly leans towards the Democratic party under the simulated plans. Under the revised plan, however, it becomes a toss-up district. Its expected Republican vote share is 49.7%, which is 1.9 percentage points (or 1.9 standard deviations) higher than the simulation median. Indeed, 86.6% of my 5,000 simulated plans have a lower expected Republican vote share for R11 than the revised plan.

9. Similarly, the expected median Republican vote shares for R12 and R13 are 44.7% and 42.5%, respectively, under my simulated plans, implying that these are safe Democratic dis-

1. According to this definition (Tukey, John W. 1977. *Exploratory Data Analysis*. Pearson), an outlier represents a data point that is beyond a distance of 1.5 interquartile range (IQR) below the first quartile or above the third quartile. If the data based on the simulated plans were normally distributed, the revised plan is regarded as an outlier if it is at least 2.70 standard deviations away from the average simulated plan.

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tricts. Under the revised plan, however, the expected vote shares for R12 and R13 are 49.0% and 47.8%, respectively, which are 4.3 and 5.3 percentage points (or 2.8 and 3.5 standard deviations) higher than the corresponding simulation median. That is, the Democratic advantages of these districts are substantially reduced under the revised plan. Indeed, for these two districts, less than 0.25% of my 5,000 simulated plans yield as high levels of expected Republican vote share as the revised plan.

10. Lastly, the revised plan packs Democratic voters in districts R14 and R15, which are the two most Democratic-leaning districts. This is indicated by the fact that these districts have much lower levels of expected Republican vote shares under the revised plan than under the simulated plans. In contrast, the revised plan avoids packing Republican voters in the five safest Republican districts (districts R1 to R5). Indeed, R3, R4, and R5 have much lower levels of expected Republican vote shares under the revised plan than under the simulated plans. The expected Republican vote shares for districts R3 and R4 are also statistical outliers, which are 5.0 and 5.1 standard deviations away from the simulation median, respectively.

11. In sum, my outlier analysis shows that the revised plan clearly favors the Republican party in comparison with my 5,000 simulated plans. The revised plan does so by turning Democratic-leaning districts into toss-up districts while making slightly Republican-leaning districts into safe Republican districts.

V. LOCAL ANALYSIS

12. Next, as done in my initial report, I conduct a detailed analysis of the Congressional districts in Hamilton and Franklin Counties. I show that the partisan bias of the revised plan identified in my outlier analysis above originates in these districts. In Hamilton County, the revised plan cracks Democratic voters into Districts 1 and 8, substantially reducing the Democratic advantage of District 1. In Franklin County, the revised plan packs Democratic voters into District 3, increasing the Republican advantage of the surrounding districts.

13. My analysis of each county proceeds as follows. For each precinct, I first compute the expected two-party vote share of the district to which the precinct is assigned under the revised

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plan. I then perform the same calculation under each simulated plan and average these expected vote shares across all of the simulated plans. Comparison of these two numbers reveals whether the revised plan assigns a precinct to a district whose political leaning is different from what would be expected under the simulated plans.

A. Hamilton County

14. I begin by illustrating the above calculation through an example. Precinct 061031BEZ of Cincinnati lies within District 1 of the revised map, which has an expected Republican two-party vote share of 49.00%. The same precinct, however, belongs to different districts in most of the simulated maps, each with their own Republican vote share. The average Republican vote share for the districts to which this precinct is assigned across all of the simulated plans is 44.42%, which is 5.48 percentage points lower than under the revised plan. So, based on the representative set of simulated plans that have less partisan bias, precinct 061031BEZ is assigned to a more Republican-leaning district under the revised plan than under the average simulation plan.

15. The left map of Figure 2 presents the expected vote shares of districts under the revised plan, while the right map shows, for each precinct, the average expected two-party vote share of districts to which the precinct is assigned across the simulated plans. Under the revised plan, Democratic areas are cracked to yield two Republican-leaning districts and one highly competitive district, despite a significant concentration of Democratic voters in and around Cincinnati. As the right figure indicates, a large part of the area north of the city of Cincinnati, which is part of District 8 under the revised plan, would normally be expected to belong to a safe Democratic district. Because the revised plan lumps it with District 8, this area instead belongs to safely Republican districts.

16. Similarly, voters in Cincinnati would normally be expected to belong to a strongly Democratic-leaning district under the simulated plans, as indicated by its darker blue color in the right map. The unusual pairing of Hamilton and Warren counties in the revised plan's District 1, however, makes these voters part of a much less Democratic-leaning district.

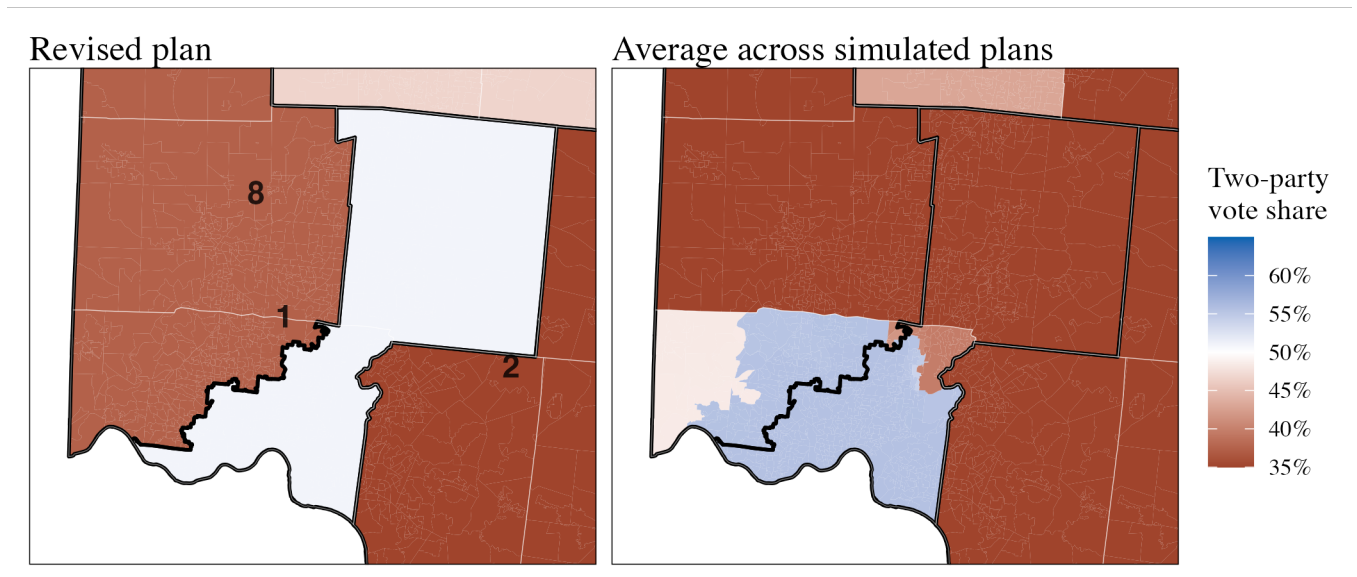


Figure 2: Congressional districts in Hamilton County. The left map presents the expected two-party vote shares of districts under the revised plan, while the right map shows, for each precinct, the average expected two-party vote share of districts to which the precinct is assigned across the simulated plans. The revised plan’s district boundaries are shown with thick black lines. While under the simulated plans, Cincinnati and its environs are expected to belong to a safe Democratic-leaning district, the revised plan cracks Democratic voters, resulting in a toss-up district.

17. As a result of these manipulations and additional splits of Hamilton County, the revised plan has no safe Democratic seats under the average statewide contest, whereas the simulated plans are expected to yield a relatively safe Democratic seat. In sum, in Hamilton County, the revised plan turns one safe Democratic district into a toss-up district by cracking Democratic voters.

B. Franklin County

18. Analogous to the above analysis of Hamilton county, Figure 3 compares the revised plan with the average across the simulated plans in Franklin County. In this county, the revised plan packs Democratic voters into a single, heavily Democratic, District 3, leaving Districts 4, 12, and 15 to be safely Republican. Much of the area inside Franklin County belongs to District 15, which is a safe Republican district, under the revised plan. In contrast, under the simulated plans, the entire area of Franklin County is expected to belong to a Democratic-leaning district, as is

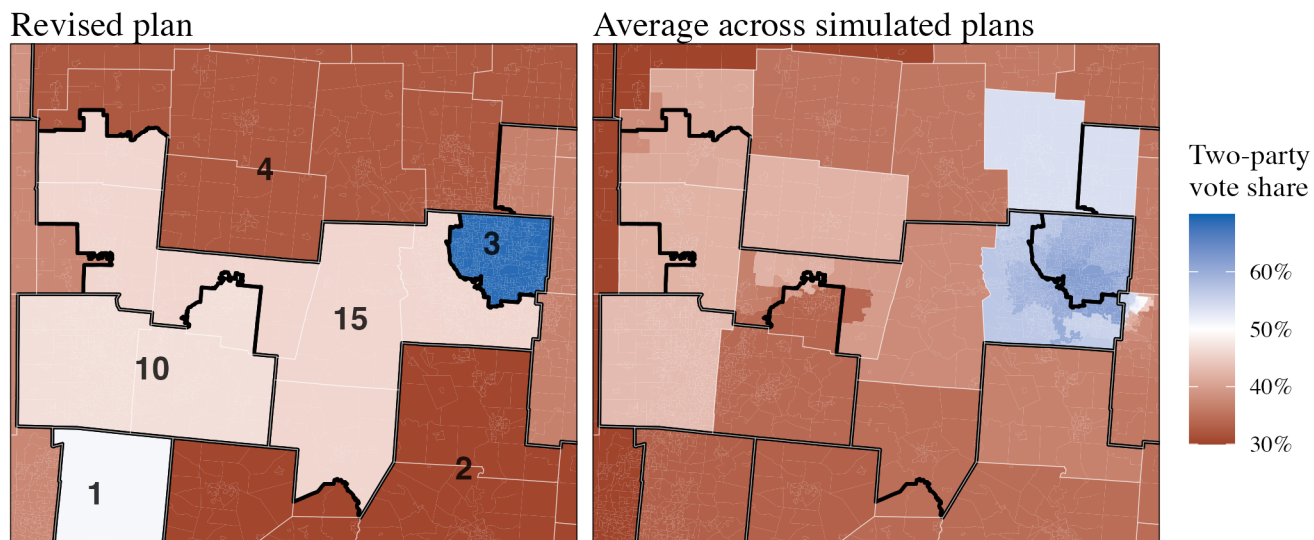


Figure 3: Congressional districts in Franklin County. The left map presents the expected two-party vote shares of districts under the revised plan, while the right map shows, for each precinct, the average expected two-party vote share of districts to which the precinct is assigned across the simulated plans. The revised plan's district boundaries are shown with thick black lines. While under the simulated plans, all of Franklin County are expected to belong to a Democratic district, the revised plan packs Democratic voters, leaving much of the city of Columbus in a Republican district stretching most of the way to Cincinnati.

Delaware County and part of Fairfield County.

19. In other words, the revised plan packs Democratic voters into District 3 and submerges the Democratic voters in the rest of Franklin County into District 15 that stretches out to the west. By doing so, the revised plan creates a safe Republican district and deprives Democratic voters in the rest of the county of a reasonable opportunity to elect a Democratic candidate.

VI. COMPACTNESS ANALYSIS

20. The signs of partisan biases in Hamilton and Franklin Counties under the revised plan manifest as highly non-compact districts in these counties. I analyze the compactness of two relevant districts, Districts 1 and 15 of the revised plan, by comparing them with the average compactness under my simulated plans. My analysis shows that these two districts are highly non-compact in comparison to the corresponding districts in my simulated plans.

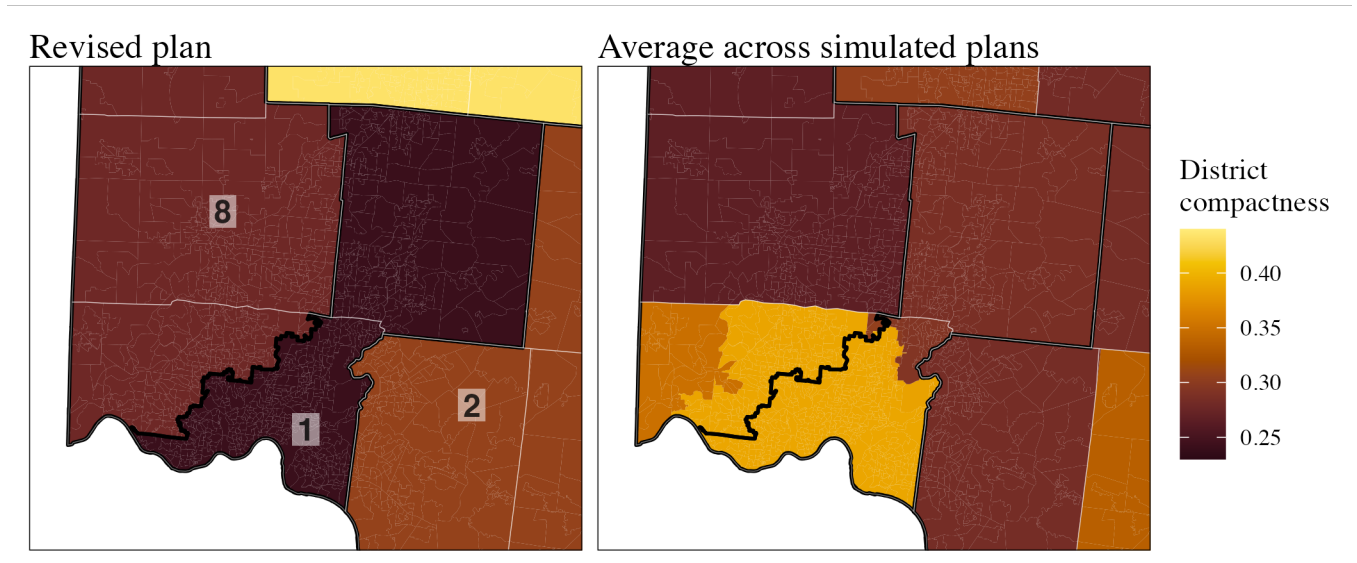


Figure 4: Compactness of District 1 under the Revised Plan. The left map presents the Polsby-Popper compactness score of each district under the revised plan, while the right map shows, for each precinct, the average compactness of districts to which the precinct is assigned across the simulated plans. The revised plan’s district boundaries are shown with thick black lines. District 1 is highly non-compact as indicated by a dark color while under the simulated plans the precincts of District 1 are expected to belong to much more compact districts as indicated by a much lighter color.

A. District 1 of the Revised Plan

21. The left map of Figure 4 shows the compactness of District 1 under the revised plan. This district combines part of Cincinnati and its environs with Warren County, resulting in a highly non-compact shape with the Polsby-Popper compactness score of 0.241. In contrast, as shown in the right map of the figure, the simulated plans on average assign the precincts of District 1 to much more compact districts. In particular, because a majority of my simulated plans keep Cincinnati and its environs in the same district, these areas are expected to belong to a more compact district (indicated by a lighter color). In fact, the average district compactness score for these precincts under the simulated plans is 0.341, which is 42% higher than the compactness score of District 1 under the revised plan.

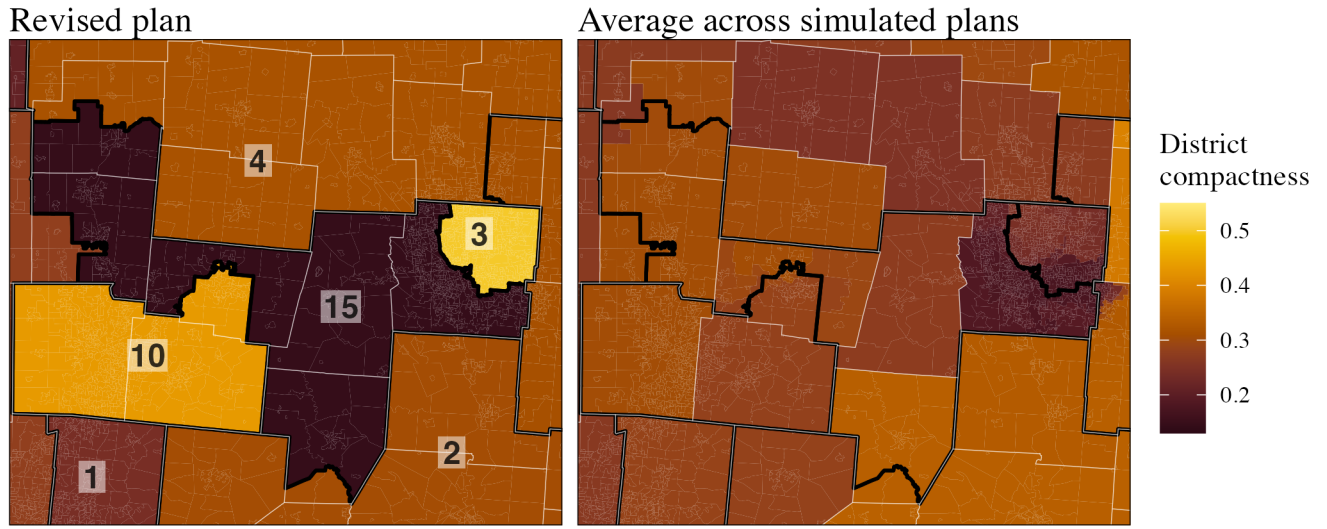


Figure 5: Compactness of District 15 under the Revised Plan. The left map presents the Polsby-Popper compactness score of each district under the revised plan, while the right map shows, for each precinct, the average compactness of districts to which the precinct is assigned across the simulated plans. The revised plan's district boundaries are shown with thick black lines. District 15 is highly non-compact as indicated by a dark color while under the simulated plans the precincts of District 15 are expected to belong to much more compact districts as indicated by a much lighter color.

B. District 15 of the Revised Plan

22. The left map of Figure 5 shows the compactness of District 15 under the revised plan. This district combines part of Columbus and its environs with Madison County and extends into five other counties in the west. As a result, the district splits a total of five counties and has a highly non-compact shape with the Polsby-Popper compactness score of 0.144, the lowest of all fifteen districts under the revised plan (though District 3 that packs Democratic voters of Columbus is highly compact). In contrast, as shown in the right map of the figure, the simulated plans on average assign the precincts of District 15 to much more compact districts (indicated by a lighter color). In fact, the average district compactness score for these precincts under the simulated plans is 0.224, which is 56% higher than the compactness score of District 15 under the revised plan.

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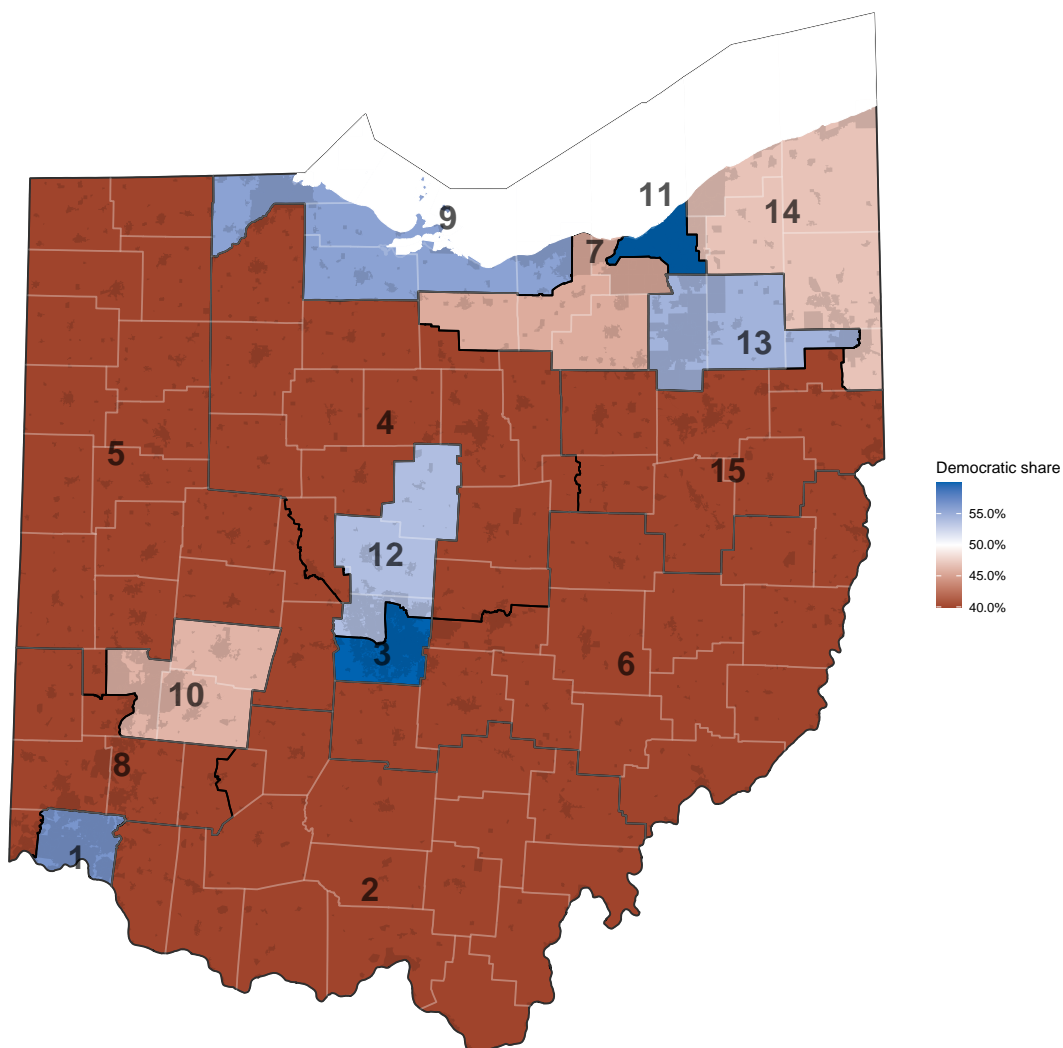


Figure 6: Example Congressional Plan Submitted to the Ohio Redistricting Commission on February 22, 2022.

VII. EXAMPLE PLAN

23. On February 22, 2022, I submitted an example plan (hereafter “example plan”) that is more compliant with Article XIX of the Ohio constitution than the enacted plan. This example plan, shown in Figure 6, demonstrates that it is possible to generate a redistricting plan, which is free of the partisan bias and compactness problems while complying with the other redistricting requirements of the Ohio Constitution.

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24. One important difference between the example plan and the revised plan is how Hamilton County is treated. Under the example plan, District 1 is wholly contained in Hamilton County without spilling into Warren County as done in the revised plan. As a result, District 1 does not cross a county line and is much more compact under the example plan (Polsby-Popper compactness score of 0.474) than under the revised plan (compactness score of 0.241). Unlike the revised plan, which cracks Democratic voters in Cincinnati and its northern environs into two districts (Districts 1 and 8), the example plan keeps these areas together in a single compact district (District 1). This makes District 1 a safer Democratic district under the example plan (Democratic vote share of 56.3%) than under the revised plan (Democratic vote share of 51.0%).

25. Another key difference lies in Franklin County. Under the example plan, this county is split into two districts. District 3 contains the southern part of Franklin County while the northern part of the county is included in District 12. This way of splitting Franklin County is consistent with a majority of my simulated plans and avoids creating a highly non-compact district. The revised plan's decision to spill into Madison County rather than Delaware County led to the creation of District 15, which splits five counties and has an extremely low compactness score of 0.144. In contrast, District 12 of the example plan is much more compact with a compactness score of 0.250. The partisan implication of this difference is clear. Under the example plan, both Districts 3 and 12 are Democratic-leaning with Democratic vote shares of 65.7% and 53.7%, respectively, whereas the revised plan ends up with one packed Democratic district (District 3 with the Democratic vote share of 68.9%) and one safe Republican district (District 15 with the Democratic vote share of 45.8%).

26. Beyond these two key differences, the example plan is much more compact than the revised plan. Indeed, the example plan is even more compact than the simulated plans (see Appendix A). The example plan also has fewer county splits than the revised plan (see Appendix B).

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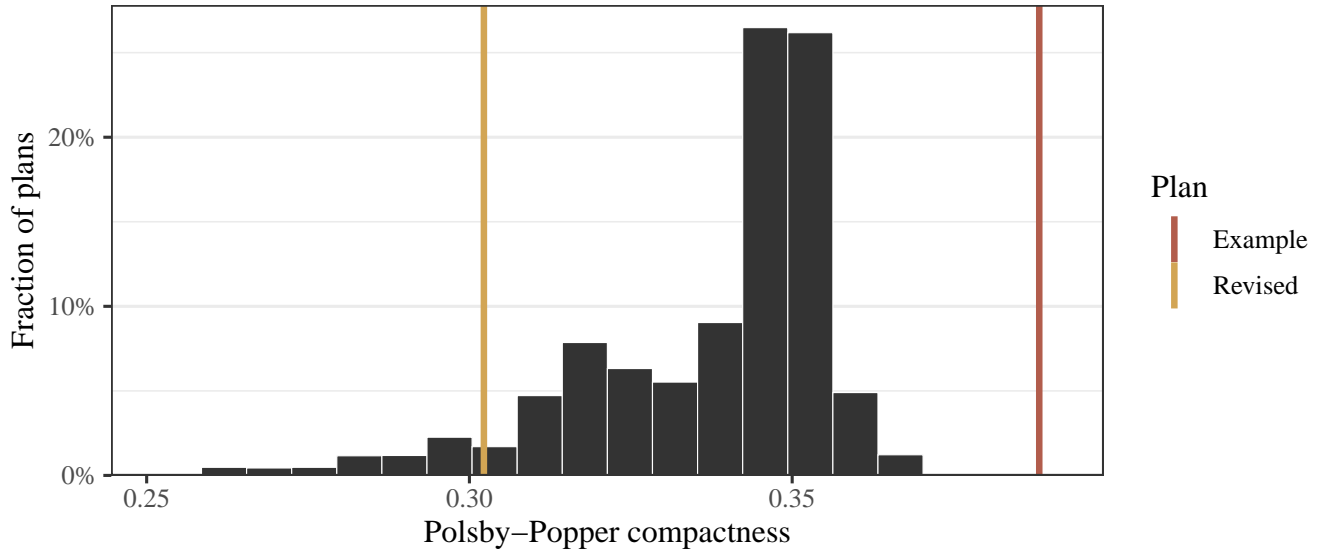


Figure 7: Polsby-Popper compactness scores for the simulated redistricting plans. Overlaid are scores for the revised plan (orange) and example plan (red). Larger values indicate more compact districts.

VIII. APPENDIX

A. Compactness of the Revised, Simulated and Example Plans

1. In this appendix, I show that the simulated plans are more compliant with Section 2(B)(2), which requires districts to be compact, than the revised plan. I also show that the example plan is more compact than either the revised plan or simulated plans. I use the Polsby-Popper score, a commonly-used quantitative measures of district compactness. Figure 7 shows that a vast majority (roughly 93%) of the simulated plans are more compact than the revised plan according to the Polsby-Popper score. Moreover, the example plan is more compact than any of the simulated plans. The result clearly implies that it is possible to be compliant with Section 1(C)(3)(a) without sacrificing compliance with Section 2(B)(2).

B. County Splits of the Revised, Simulated and Example Plans

2. Similar to compactness, it is possible to be compliant with Section 1(C)(3)(a) without splitting counties more than the revised plan. The left plot of Figure 8 shows that the number of counties split once is much less under any of the simulated plans than under the revised plan. The bulk of the simulated plans, as well as the revised plan, do not split any counties twice. As a

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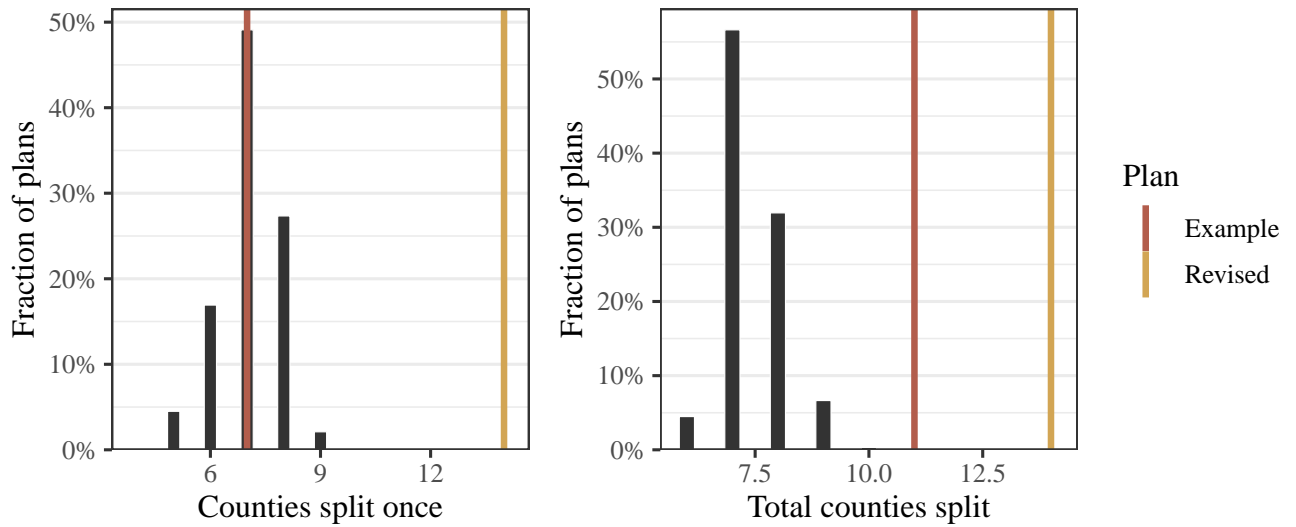


Figure 8: The number of county splits for the simulated redistricting plans. Overlaid are the scores for the revised plan (orange) and example plan (red). The left plot shows the number of counties that are split once under each plan, whereas the right plot shows the number of counties that are split either once or twice. No county is split more than twice under the revised plan, the example plan, or any of the simulated plans.

result, the total number of counties split under the revised plan is much greater than that under any of the simulated plans, and is also greater than the total number of counties split under my example plan (see the right plot of the figure).

CERTIFICATE OF SERVICE

I, Freda J. Levenson, hereby certify that on this 7th day of March 2022, I caused a true and correct copy of the following documents to be served by email upon the counsel listed below:

Petitioners' Evidence to Motion to Enforce Court's Order - Affidavit of Dr. Kosuke Imai

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