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)**

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(Affidavit of Dr. Christopher Warshaw)

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I, Theresa M Sabo, did witness the participants named above electronically sign this document.

IN THE SUPREME COURT OF OHIO

LEAGUE OF WOMEN VOTERS OF OHIO, et al.,	
Petitioners	**Case No. 2021-1449**
v.	**Original Action Pursuant to Ohio Const., Art. XI**
OHIO REDISTRICTING COMMISSION, et al.,	
Respondents.	

AFFIDAVIT OF CHRISTOPHER WARSHAW

Franklin County
/ss
State of Ohio

Now comes affiant Christopher Warshaw, 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 Relators 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 A, 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.

Christopher Warshaw
Signed on 2022/03/06 17:09:34 -8:00

Christopher Warshaw

Sworn and subscribed before me this 03/06/2022 day of _____, 2022.

Signed on 2022/03/06 17:09:34 -8:00

Notary Public

NOTARY PUBLIC STATE OF OHIO

Theresa M Sabo
Commission # 2016-RE-619622
Electronic Notary Public
State of Ohio
My Comm Exp. Nov 28, 2026

Notary Stamp 2022/03/06 18:09:34 PST 56BE908CE6AF

Notarial act performed by audio-visual communication

EXHIBIT A

An Evaluation of the Partisan Bias in Ohio's Enacted March 2, 2022 Congressional Districting Plan

Christopher Warshaw*

March 6, 2022

*Associate Professor, Department of Political Science, George Washington University. warshaw@gwu.edu. Note that the analyses and views in this report are my own, and do not represent the views of George Washington University.

Contents

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 representing the relators in this case to analyze relevant data and provide my expert opinions about whether Ohio's enacted congressional districting plan meets the requirement in Article XIX.01, Section 3(A) of Ohio's Constitution that "If the general assembly passes a congressional district plan under division (C)(1) of this section by a simple majority of the members of each house of the general assembly, and not by the vote described in division (C)(2) of this section", then "The general assembly shall not pass a plan that unduly favors or disfavors a political party or its incumbents."

2 Qualifications, Publications and Compensation

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 partisan gerrymandering. 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 congressional elections on the enacted, March 2 plan in Ohio, I examined:
  - GIS Files with the 2012-2020 Ohio Congressional plan and the enacted plan): I obtained the 2012-2020 plan from the state website, the original plan from Counsel in this case, and the March 2 enacted plan from the Ohio Redistricting Commission's website
  - Precinct-level data on recent statewide Ohio elections: I use precinct-level data on Ohio's statewide elections between 2016-20 from the Voting and Election Science Team (University of Florida, Wichita State University). I obtained these data from the Harvard Dataverse.[1]
  - Precinct-level data on recent statewide Ohio elections: I use a GIS file with precinct-level data on the results of the 2020 congressional elections in Ohio that I obtained from Counsel in this case.
  - The PlanScore 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.
- In order to compare the maps in Ohio to other congressional elections across the nation over the past five decades, I examined:
  - A large data set on candidacies and results in Congressional elections: I obtained results from 1972-2018 collected by the Constituency-Level Elections Archive (CLEA) (Kollman et al. 2017). The results from 1972-1990 are based on data collected and maintained by the Inter-university Consortium for Political and Social Research (ICPSR) and adjusted by CLEA. The data from 1992-2018 are based on data collected by CLEA from the Office of the Clerk at the House of the Representatives. I supplemented this dataset with recent election results collected by the MIT Election and Data Science Lab (MIT Election and Data Science Lab 2017) and Dave Leip's Atlas of U.S. Presidential Elections.

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

- Data on presidential election returns and incumbency status in Congressional elections. I used data on elections in congressional districts from 1972-2020 collected by Professor Gary Jacobson (University of California, San Diego). This dataset has been used in many Political Science studies and has canonical status in the Political Science profession (Jacobson 2015).
- Information on who controlled each redistricting plan in Congressional elections (e.g., Democrats, Republicans, or a Commission) from 1972-2012 assembled by the Brennan Center (Brennan Center 2017).
- I imputed vote shares and turnout in uncontested districts and then calculated the partisan bias metrics described on pp. 6-14 of this report using the methodology described in Stephanopoulos and Warshaw (2020).

I have previously provided expert reports in this case, as well as six other redistricting-related cases and several Census-related cases (see my CV for a current list). I am being compensated at a rate of $325 per hour. The opinions in this report are my own, and do not represent the views of George Washington University.

3 Summary

This report examines whether the Ohio Redistricting Commission's March 2 plan meets the criteria in the Ohio Constitution. Article XIX.01, Section 3(A) of Ohio's Constitution requires that "If the general assembly passes a congressional district plan under division (C)(1) of this section by a simple majority of the members of each house of the general assembly, and not by the vote described in division (C)(2) of this section", then "The general assembly shall not pass a plan that unduly favors or disfavors a political party or its incumbents."

Ohio's Constitutional criteria, which require that congressional districting plans passed without bipartisan support not unduly favor or disfavor a political party, are related to a long-line of Political Science literature on partisan gerrymandering and democratic representation. 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 whether Ohio's newly enacted, March 2 Congressional map meets the requirements of Article XIX.01, Section 3(A) in its Constitution. First, I analyze the results of the 2020 Congressional election on the newly enacted, March 2 map. Second, I use a composite of previous statewide election results between 2016-2020 to analyze the new map.[2] Third, I complement this approach using the open source PlanScore.org website, which is a project of the Campaign Legal Center.[3] 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.[4] Based on these three approaches, I characterize the bias in Ohio's plans based on a large set of established metrics of partisan fairness. I also place the bias in Ohio's plans into historical perspective. Finally, I analyze the compactness of the districts in the enacted plan.

All of these analyses indicate an extreme level of pro-Republican bias in Ohio's enacted, March 2 Congressional plan. There are 10 strongly Republican districts, 2 strongly Democratic districts, and 3 potentially competitive districts, two of which lean toward Republicans. In the average election, Republicans are likely to get about 55% of the statewide vote and about 75-80% of the seats in Ohio's congressional delegation. Thus, the plan clearly unduly favors the Republican party. Moreover, it favors Republicans nearly as much as the Commission's initial, enacted plan did.

In the actual 2020 congressional election, Democrats received 43% of the two-party vote (and Republicans 57%), but Democrats only won 25% (4) of the seats (and Republicans won 75%). This was already one of the most extreme partisan gerrymanders of a congressional map in modern history (See *APRI et al.* v. *Smith et al.*, No. 18-cv-357 (S.D. Ohio)). Based on the congressional election results, the new plan is just as extreme. On the new map, Democrats would only win 20% (3) of the seats using the precinct-level results of the 2020 congressional election while Republicans would win 80% (12) of the seats.

The new plan also displays an extreme level of partisan bias when I evaluate it based on the results of recent statewide elections. In the 2020 presidential election, Democrat Joe Biden received about 46% of the two-party vote.[5] However, he would have only won 27% (4) of the Congressional districts under the March 2 plan. In the 2018 gubernatorial

2. These include the following elections: 2016 Presidential, 2016 Senate, 2018 Senate, 2018 gubernatorial, 2018 attorney's general, 2018 Secretary of State, 2018 Auditor, 2018 Treasurer, and 2020 Presidential.

3. I am on the social science advisory board of Plan Score, but do not have any role in PlanScore's evaluation of individual maps.

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

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

election, Democrat Richard Cordray did a little bit better. He received about 48% of the two-party vote. Yet again, however, he would have only won 33% of the districts under the enacted, March 2 plan. In the 2016 presidential election, Democrat Hillary Clinton received about 46% of the two-party vote. But she would too have only won 27% of the revised plan's seats.

Based on all the available statewide elections in Ohio between 2016-2020, I find that the enacted, March 2 Congressional plan leads to a much higher Republican share of the seats than their share of the statewide vote. Indeed, across all statewide elections during this period, the Democrats' statewide two-party vote share averaged about 45% of the vote, but they are only likely to win about 28% of the seats.[6]

I reach the same conclusion using the predictive model on the PlanScore website. It indicates that the enacted, March 2 plan favors Republican candidates in 97% of scenarios. Even though Republicans only get about 56% of the statewide vote in recent elections (and Democrats get 44%), PlanScore analysis indicates that Republicans are expected to win 76% of the seats in Ohio's Congressional delegation (and Democrats would win 24% of the seats).[7] Based on generally accepted Political Science metrics (the Efficiency Gap and the Declination), PlanScore indicates that Ohio's enacted, March 2 plan would have historically extreme levels of pro-Republican bias. In fact, the pro-Republican bias in Ohio's Congressional plan is larger than 96% of previous plans in the United States from 1972-2020.

Overall, this analysis indicates that the Commission's plan unduly favors the Republican party. This conclusion is based on a wide variety of approaches to project future election results and to estimate the partisan bias of the plan. Regardless of the approach I use, it is clear that the map has an extreme level of bias in favor of the Republican party. Moreover, the March 2 plan is almost as biased in favor of Republicans as the Commission's original, enacted plan that I evaluated in my report on November 30, 2021.

The rest of this report proceeds as follows. First, I provide a brief overview of par-

6. There are a variety of ways we could aggregate previous statewide elections to create a composite index (see the discussion on p. 7-8 of my January 25th report in the parallel case about the constitutionality of the state legislative plans in Ohio). In my main analysis, I weight the composite scores to give each election cycle equal weight in the index. This ensures that the composite index is not overly influenced by whatever election year happens to have the most elections (2018 in the case of Ohio). This is important because much of the uncertainty in projecting future elections comes from variation across electoral cycles rather than across contests within cycles. So, in my view, it is useful to not disproportionately weight the index toward any particular election year. In the appendix, however, I show that I reach similar conclusions using a composite index that weights each statewide contest equally (rather than each year equally).

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

tisan gerrymandering and how social scientists measure the degree of partisan bias in a districting plan. I then provide a systematic evaluation of the partisan fairness of Ohio's enacted, March 2 congressional districting plan. Finally, I discuss the compactness of the districts on the Commission's plan.

4 Background on Partisan Gerrymandering

The goal of partisan gerrymandering is to create legislative districts that are as "efficient" as possible in translating a party's vote share into seat share (McGhee 2014, 2017; Caughey, Tausanovitch, and Warshaw 2017). In practice, this entails drawing districts in which the supporters of the advantaged party constitute either a slim majority (e.g., 55% of the two-party vote) or a small minority (e.g., 20%). The former is achieved by "cracking" local opposing-party majorities across multiple districts and the latter by "packing" them into a few overwhelming strongholds. In a "cracked" district, the disadvantaged party narrowly loses, while in a "packed" district, the disadvantaged party wins overwhelmingly (Buzas and Warrington 2021). The resulting *asymmetry* or *advantage* in the efficiency of the vote–seat relationships of the two parties lies at the core of normative critiques of partisan gerrymandering. Asymmetries in the translation of votes to seats "offer a party a means of increasing its margin of control over policy without winning more votes from the public" (McGhee 2014).

In addition to creating a plan that skews the vote-seat curve toward their party, the advantaged party also often seeks to build a map that is *insulated* against changes in the public's preferences. This type of unresponsive map enables the advantaged party to continue to win the majority of seats even in the face of large gains in the disadvantaged party's statewide vote share. It ensures that the gerrymander is durable over multiple election cycles.

There are a number of approaches that have been proposed to measure partisan advantage 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). While no measure is perfect, much of the recent literature has focused on a handful of related approaches that I described in my November 30th report.[8] I utilize these approaches to quantify the partisan fairness of

8. These metrics are described in depth on pp. 6-13 of my November 30, 2021 report on the Commission's original enacted congressional plan. Note that the exact calculation methods for the efficiency gap and declination differ slightly across sources. To calculate the efficiency gap I use the formula:

$$EG = S_D^{margin} - 2 * V_D^{margin} \quad (1)$$

the Commission's enacted congressional plan.

5 Partisan Bias in Ohio's Enacted, March 2 Congressional Map

In this section, I will provide a more systematic evaluation of the partisan fairness of Ohio's enacted, March 2 congressional districting plan (see Figure 1 for a map of the plan). In order to evaluate the enacted plan, we need to predict future election results on this map. Unfortunately, there is no way to know, with certainty, the results of future elections. Thus, I use three complementary methodologies to predict future congressional elections in Ohio and generate the various metrics I discussed earlier. I compare the Commission's March 2 plan to the 2012-2020 plan and the original enacted plan from November.

Figure 1: Map of Enacted, March 2 Congressional Districts from PlanScore.org

5.1 2020 Congressional election results

First, I use the 2020 precinct-level congressional results on both the 2012-20 map and re-aggregated to the enacted, March 2 map to estimate the various metrics. This approach implicitly assumes that future elections will look like the 2020 election. These endogenous elections are likely to be an excellent predictor of future voting patterns in congressional

where S_D^{margin} is the Democratic Party's seat margin (the seat share minus 0.5) and V_D^{margin} is the Democratic Party's vote margin (McGhee 2017, 11-12). I use the declination formula discussed in Warrington (2018, 42).

elections. Based on these results, Republicans would win 57% of the votes, but 80% of the seats on the March 2 plan. In other words, Republicans would win 23 percentage points more seats than votes.

Metric	Value	More Biased than this % Historical Plans	More Pro-Republican than this % Historical Plans
2012-2020 Plan			
Republican Seat Share	75%		
Efficiency Gap	-11%	78%	91%
Declination	-.51	85%	91%
Mean-Median Diff	-4%	57%	78%
Symmetry Bias	-12%	78%	87%
Average		75%	87%
Commission's Original, Enacted Plan			
Republican Seat Share	87%		
Efficiency Gap	-23%	98%	99%
Declination	-.90	97%	97%
Mean-Median Diff	-3%	42%	72%
Symmetry Bias	-10%	69%	83%
Average		77%	88%
Commission's Enacted March 2 Plan			
Republican Seat Share	80%		
Efficiency Gap	-16%	91%	96%
Declination	-.61	92%	95%
Mean-Median Diff	-3%	36%	70%
Symmetry Bias	-17%	91%	93%
Average		77%	89%

Table 1: Partisan bias metrics for Congressional plan based on 2020 Congressional election results re-aggregated onto enacted, March 2 map

The average efficiency gap of the enacted, March 2 plan based on the precinct-level 2020 House results is -16% in a pro-Republican direction (see Table 1). This is more extreme than 91% of previous Congressional plans nationwide over the past five decades (1972-2020) and more pro-Republican than over 96% of previous plans. The plan is more pro-Republican than 95% of prior plans in the country using the declination metric. The other metrics also show that Ohio's enacted, March 2 plan has a large pro-Republican bias. When we average across all four metrics, the plan is more extreme than 77% of previous plans and more pro-Republican than 89% of previous plans (which is nearly identical to the Commission's original, enacted plan).

5.2 Composite of previous statewide elections

Next, I use a composite of previous statewide election results between 2016-2020 re-aggregated to the enacted, March 2 map. 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.

		2016-2020 Composite	
Metric	Value	More Biased than this % Historical Plans	More Pro-Republican than this % Historical Plans
2012-2020 Plan			
Republican Seat Share	74%		
Efficiency Gap	-16%	90%	96%
Declination	-.56	89%	93%
Mean-Median Diff	-3%	39%	71%
Symmetry Bias	-17%	91%	93%
Average		77%	88%
Commission's Original, Enacted Plan			
Republican Seat Share	76%		
Efficiency Gap	-18%	93%	97%
Declination	-.59	92%	95%
Mean-Median Diff	-2%	24%	63%
Symmetry Bias	-10%	69%	83%
Average		70%	85%
Commission's Enacted March 2 Plan			
Republican Seat Share	72%		
Efficiency Gap	-14%	86%	94%
Declination	-.44	81%	88%
Mean-Median Diff	-1%	17%	59%
Symmetry	-11%	73%	84%
Average		70%	85%

Table 2: Composite bias metrics for enacted, March 2 Congressional plan based on statewide elections

When I average across these statewide elections from 2016-2020, Democrats win 45% of the votes and 28% of the seats (see Table 2). The average efficiency gap of the enacted, March 2 plan based on these previous election results is -14%. This is more extreme than 86% of previous plans and more pro-Republican than 94% of previous plans. The plan is also more pro-Republican than 88% of previous plans using the declination metric. The mean-median and symmetry also show that Ohio's plan has a substantial pro-Republican bias. When I average across all four metrics, the plan is more extreme than 70% of previous plans and more pro-Republican than 85% of previous plans.[9]

9. In the Appendix, I show that I reach very similar results if I average previous elections across

5.3 PlanScore

Third, I evaluate the enacted, March 2 plan using a predictive model from the PlanScore.org website. PlanScore uses a statistical model of the relationship between districts' latent partisanship and election outcomes. This enables it to estimate district-level vote shares for a new map and the corresponding partisan gerrymandering metrics.[10] It then calculates various partisan bias metrics. In this case, PlanScore provides estimates of the efficiency gap and declination.[11]

PlanScore also indicates that the Congressional plan has a substantial pro-Republican bias (Table 3). According to PlanScore, the enacted, March 2 plan has a pro-Republican efficiency gap of 13%. The plan favors Republicans in 99% of the scenarios estimated by PlanScore.[12] Moreover, it is more extreme than 91% of previous plans and more pro-Republican than 97% of previous plans.

Metric	Value	Favors Rep's in this % of Scenarios	More Biased than this % Historical Plans	More Pro-Republican than this % Historical Plans
2012-2020 Plan				
Republican Seat Share	74%			
Efficiency Gap	-12%	96%	90%	97%
Declination	-.42	95%	87%	93%
Average		96%	89%	95%
Commission's Original, Enacted Plan				
Republican Seat Share	79%			
Efficiency Gap	-16%	99%	97%	97%
Declination	-.58	99%	95%	98%
Average		99%	96%	98%
Commission's Enacted March 2 Plan				
Republican Seat Share	76%			
Efficiency Gap	-13%	99%	91%	97%
Declination	-.47	98%	90%	95%
Average		99%	91%	96%

Table 3: PlanScore partisan bias metrics for enacted, March 2 Congressional plan

contests rather than weighting each year equally.

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

11. The partisan symmetry and mean-median difference scores are only shown when the parties' statewide vote shares fall between 45% and 55% because outside this range the metrics' assumptions are less plausible (McGhee 2017, 9). In the PlanScore model, the Democrats' two-party vote share is just below 45%.

12. See `https://planscore.campaignlegal.org/plan.html?20220303T200000.374167789Z`

6 Competitiveness of Districts

In this section, I use a variety of approaches to estimate the number of competitive districts in both the 2012-20 congressional plan, the original enacted plan, and the March 2 plan (see Table 4). My analysis indicates that the enacted, March 2 plan has just one more competitive district than the 2012-2020 plan.

Data:	2020 House Results		Composite (2012-20)	PlanScore			**Mean**
Metric:	45-55	Historical Swing	45-55	45-55	20%+ Prob. of Each Party Win.	50%+ Prob. Flip in Dec.	
Plan	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2012-20 Plan	2	1	3	3	2	5	2
Commission's Original Plan	3	3	5	4	2	4	3.5
Commission's March 2 Plan	3	2	4	4	2	4	3

Table 4: Number of competitive districts using various data sources and metrics.

First, I use the actual 2020 House results to examine the number of competitive districts. In column 1 of Table 4, I begin by tallying the number of districts where each party's two-party vote share was between 45 and 55%. This approach indicates there are 2 competitive districts on the 2012-20 plan and 3 competitive districts on the enacted March 2 plan. As I discussed earlier, however, it is not clear that a sharp threshold at 55% is the best measure of competitiveness.

Based on the approach in Henderson, Hamel, and Goldzimer (2018, Appendix, p. 2), we can also define competitiveness based on whether a district is likely to switch parties at least once per decade based on the maximal swing in the two-party vote. In column 2 of Table 4, I use this approach to tally the number of districts that each party would win at least once over the course of the decade based on the historical range of statewide election results between 2016-2020. Specifically, I conduct a uniform swing to simulate what would happen if the 2020 congressional election were held in the best year for Democrats (2012).[13] I then examine the number of districts that would have been won at least once by each party. This approach indicates there was 1 competitive district on the 2012-20 plan and 2 competitive districts on the enacted March 2 plan.

Next, I use a composite of the 2016-2020 statewide election results to estimate the number of competitive districts. Once again, in column 3 of Table 4, I tally the number of districts where each party's two-party vote share was between 45 and 55%. This approach indicates there was 1 competitive district on the 2012-20 plan and 4 competitive districts on the March 2 plan.

13. It is worth noting, however, that 2012 appears to have been a high-water mark for Democrats in Ohio, and their electoral performance has not come close to this level in subsequent elections.

Lastly, I use PlanScore to estimate the potential competitiveness of individual districts on the enacted, March 2 plan. In column 4 of Table 4, I show the number of districts where PlanScore estimates that each party's two-party vote share is expected to be between 45 and 55%. This approach indicates there were 3 competitive districts on the 2012-20 plan and 4 competitive districts on the enacted, March 2 plan.

It is also possible to use PlanScore to evaluate whether a district is likely to switch parties at least once per decade (Henderson, Hamel, and Goldzimer 2018). PlanScore conducts 1,000 simulations of possible electoral scenarios based on the results of the 2012-2020 congressional and state legislative elections in every state. Using these simulations, PlanScore provides an estimate of the probability that each party will win each seat as well as whether they are likely to have at least a 50% chance of winning each seat once over the course of the decade. In column 5 of Table 4, I estimate the number of districts where each party has at least a 20% chance of winning according to PlanScore. This approach indicates there were 2 competitive districts on the 2012-20 plan and 2 competitive districts on the enacted, March 2 plan. In column 6 of Table 4, I conduct a similar analysis where I tally the number of districts that each party would have at least a 50% chance of winning at least once over the course of the decade. This approach indicates there are 5 competitive districts on the 2012-20 plan and 4 competitive districts on the enacted, March 2 plan.

Finally, column 7 of Table 4 averages across all of these approaches. It indicates there are about 2 competitive districts on the 2012-2020 plan and 3 competitive seats on the March 2 plan.

Moreover, it is important to note that the fact that there are about three potentially competitive districts on the enacted, March 2 plan does not mean that each party has a 50-50 chance at winning these districts. In fact, Republicans are favored in two of these districts. We can see this using each of the predictive approaches I've used in this report that are summarized in Table 5. The table shows that only one of the three competitive districts (shown in grey) slightly leans toward Democrats. So Republicans are likely to win at least two of these districts in the average election. This is especially true if Republicans also have an incumbency advantage in most of these districts (see Jacobson 2021, for more on the incumbency advantage in 2020). Overall, 12 of the 15 districts on the enacted plan lean toward Republicans.

	Projected Democratic Vote Share			
District	House 2020	Composite (2016-2020)	PlanScore	Average Dem. Share
1	0.50	0.51	0.52	0.51
2	0.25	0.29	0.25	0.26
3	0.69	0.69	0.69	0.69
4	0.29	0.31	0.30	0.30
5	0.34	0.37	0.34	0.35
6	0.34	0.39	0.33	0.36
7	0.41	0.44	0.43	0.43
8	0.37	0.37	0.37	0.37
9	0.47	0.49	0.46	0.47
10	0.42	0.46	0.46	0.45
11	0.78	0.79	0.75	0.78
12	0.31	0.35	0.32	0.33
13	0.49	0.51	0.49	0.49
14	0.40	0.43	0.40	0.41
15	0.43	0.45	0.44	0.44

Table 5: Democratic Vote Share Projections for Each District on Commission's March 2 Plan using a Variety of Methods. Competitive districts in grey, Democratic districts in blue, and Republican districts in red.

7 Compactness

In this section, I examine the compactness of the districts on the Commission's March 2 plan. I focus on two commonly used compactness metrics to evaluate the compactness of the plans. First, 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. Second, 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 (See Figure 2 for illustrations of each metric from Ansolabehere and Palmer (2016, 751)). Each of these metrics falls within the range of [0,1] and a score closer to 1 indicates a more compact district.

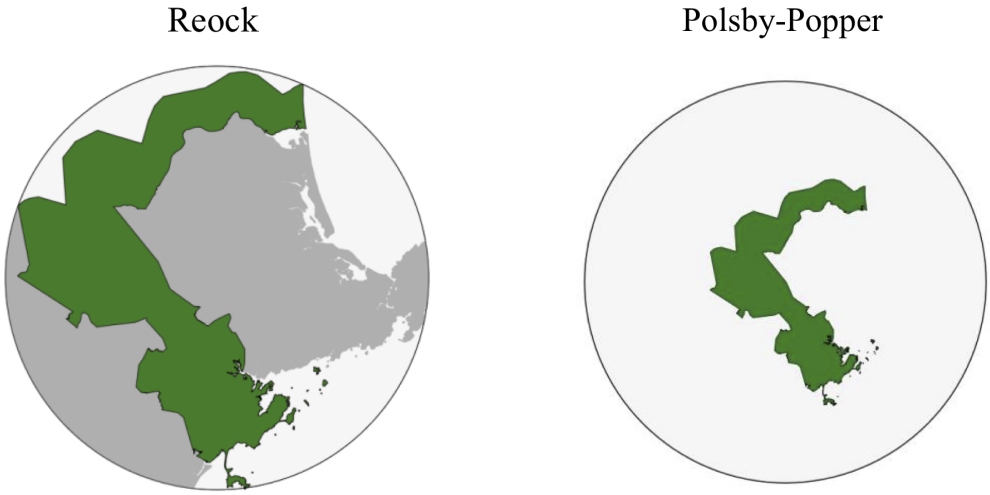

Figure 2: Illustration of Compactness Measures from Ansolabehere and Palmer (2016)

Table 6 shows the compactness metrics for the Commission's enacted, March 2 plan.[14] The districts vary widely in their compactness levels.

District	Reock	Polsby-Popper
1	0.31	0.25
2	0.49	0.31
3	0.69	0.51
4	0.37	0.31
5	0.23	0.20
6	0.29	0.22
7	0.33	0.22
8	0.29	0.28
9	0.27	0.27
10	0.51	0.44
11	0.46	0.40
12	0.59	0.31
13	0.41	0.27
14	0.48	0.65
15	0.28	0.14
Mean	0.40	0.32

Table 6: Compactness Metrics for Districts on Commission's Enacted, March 2 Plan. Higher scores indicate higher levels of compactness.

District 15 receives the lowest compactness scores. Its Reock score is 0.28 and its Polsby-Popper score is 0.14. Both of these scores rank in the bottom quintile of the compactness scores for all congressional districts over the past 200 years (see Figure 3 which shows the distribution of compactness measures for all congressional districts from

14. The compactness scores were calculated in the software program, R, using the `redistmetrics` package.

1789-2013 from Ansolabehere and Palmer (2016)).[15] They also rank in the bottom quintile of the compactness scores for congressional districts around the country in the 2020 cycle. Figure 4 shows how district 15's Reock score compares to other districts around the country in 2020, illustrating that it is an outlier in its level of non-compactness.[16]

			Percentile				
Measure	Mean	SD	10%	25%	50%	75%	90%
Reock	0.405	0.110	0.260	0.326	0.408	0.481	0.546
Polsby-Popper	0.293	0.158	0.080	0.178	0.287	0.400	0.511

Figure 3: Distribution of Compactness Measures for All Congressional Districts from Ansolabehere and Palmer (2016)

District 1 also receives relatively low compactness scores. Its Reock score is 0.31 and its Polsby-Popper score is 0.25. Its Reock score is in the bottom quartile for all congressional districts over the past 200 years (see Figure 3), and its Polsby-Popper is well below the average for all congressional districts over the past two centuries. Moreover, Figure 4 shows that its Reock score is in the bottom tercile of the compactness scores for congressional districts around the country in the 2020 cycle.

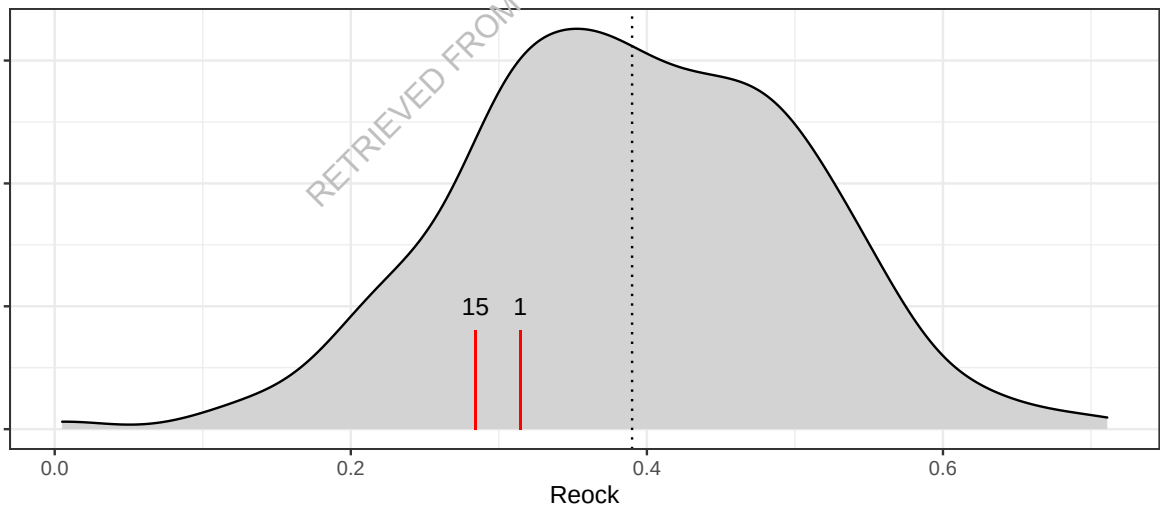

Figure 4: Comparison of District 1 and 15's Reock Score to All 435 Congressional Districts in 2020. Higher scores indicate higher levels of compactness. The dotted line shows the average Reock score of districts in 2020.

15. It includes data on 9,276 different districts and 34,996 district-Congress dyads (i.e. the Congressional elections each district was used for).

16. The Reock scores for all 435 districts in use in 2020 were calculated using PlanScore.org.

8 Conclusion

Overall, there is a substantial Republican bias in the translation of votes to seats in the newly enacted, March 2 congressional plan in Ohio. Based on a variety of metrics, the pro-Republican bias in Ohio's congressional districting plan is very large relative to other states over the past 50 years. It is also nearly as unfair as the original, enacted plan. Moreover, the new map does not contain significantly more competitive districts than the 2012-2020 plan and has fewer than the original, enacted plan. Overall, the Commission's March 2 plan unduly favors congressional candidates from the Republican Party.

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Supplementary Appendix

A Alternative Composite Indices

Metric	Value	More Biased than this % Historical Plans	More Pro-Republican than this % Historical Plans
2012-2020 Plan			
Efficiency Gap	-16%	91%	96%
Declination	-.57	89%	93%
Mean-Median Diff	-3%	41%	72%
Symmetry	-22%	97%	98%
Average		80%	90%
Enacted Plan			
Efficiency Gap	-17%	93%	97%
Declination	-.55	88%	93%
Mean-Median Diff	-2%	19%	61%
Symmetry	-12%	78%	86%
Average		70%	84%
March 2 Plan			
Efficiency Gap	-12%	82%	93%
Declination	-.36	74%	83%
Mean-Median Diff	-1%	16%	59%
Symmetry	-14%	84%	89%
Average		64%	81%

Table A1: Composite partisan bias metrics for Congressional plan based on all elections from 2016-2020, averaging across contests rather than across years

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Academic Employment

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Associate Professor (2020-present)

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Stanford University, Ph.D., Political Science, 2012

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Stanford Law School, Juris Doctorate, 2011

Williams College, B.A., *magna cum laude*, 2002

Research Interests

American Politics, Representation, Elections, Public Opinion, State & Local Politics, Environmental Politics and Policy, Statistical Methodology

Research

Publications

Book

"Dynamic Democracy: Public Opinion, Elections, and Policy Making in the American States." Forthcoming. University of Chicago Press. (with Devin Caughey)

Peer Reviewed Articles

24. "The Effect of Television Advertising in United States Elections." Forthcoming. *American Political Science Review*. (with John Sides and Lynn Vavreck).

23. "Using Screeners to Measure Respondent Attention on Self-Administered Surveys: Which Items and How Many?" 2021. *Political Science Research and Methods*. 9(2): 430–437. (with Adam Berinsky, Michele Margolis, and Mike Sances)
22. "The Impact of Partisan Gerrymandering on Political Parties." 2020. *Legislative Studies Quarterly*. 45(4): 609-643. (with Nicholas Stephanopoulos)
21. "Fatalities from COVID-19 are reducing Americans' support for Republicans at every level of federal office." 2020. *Science Advances*. (with Lynn Vavreck and Ryan Baxter-King)
20. "Accountability for the Local Economy at All Levels of Government in United States Elections." 2020. *American Political Science Review*. 114(3): 660-676. (with Justin de Benedictis-Kessner)
19. "Politics in Forgotten Governments: The Partisan Composition of County Legislatures and County Fiscal Policies." 2020. *Journal of Politics*. 82(2): 460-475. (with Justin de Benedictis-Kessner)
18. "On the Representativeness of Primary Electorates." 2020. *British Journal of Political Science*. 50(2): 677-685. (with John Sides, Chris Tausanovitch, and Lynn Vavreck)
17. "Geography, Uncertainty, and Polarization." 2019. *Political Science Research and Methods*. 7(4): 775-794. (with Nolan McCarty, Jonathan Rodden, Boris Shor, and Chris Tausanovitch)
16. "Policy Ideology in European Mass Publics, 1981–2016." 2019. *American Political Science Review*. 113(3): 674-693. (with Devin Caughey and Tom O'Grady)
15. "Does Global Warming Increase Public Concern About Climate Change?" 2019. *Journal of Politics*. 81(2): 686-691. (with Parrish Bergquist)
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13. "The Ideological Nationalization of Party Constituencies in the American States". 2018. *Public Choice*. Keith Poole Symposium. 176(1-2): 133-151. (with James Dunham and Devin Caughey)
12. "Policy Preferences and Policy Change: Dynamic Responsiveness in the American States, 1936-2014." 2018. *American Political Science Review*. 112(2): 249-266. (with Devin Caughey)
11. "Does the Ideological Proximity Between Candidates and Voters Affect Voting in U.S. House Elections?" 2018. *Political Behavior*. 40(1): 223-245. (with Chris Tausanovitch)
10. "Partisan Gerrymandering and the Political Process: Effects on Roll-Call Voting and State Policies." *Election Law Journal.* December, 2017. 16(4): 453-469. Symposium on Partisan Gerrymandering and the Efficiency Gap. (with Devin Caughey and Chris Tausanovitch)
9. "Incremental Democracy: The Policy Effects of Partisan Control of State Government." 2017. *Journal of Politics*. 79(4): 1342-1358. (with Devin Caughey and Yiqing Xu)
8. "Renewable energy policy design and framing influences public support in the United States." 2017. *Nature Energy*. 2(17107). (with Leah Stokes)
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6. "The Dynamics of State Policy Liberalism, 1936-2014." 2016. *American Journal of Political Science*. 60(4): 899-913. (with Devin Caughey)
5. "Mayoral Partisanship and Municipal Fiscal Policy." 2016. *Journal of Politics*. 78(4): 1124-1138. (with Justin de Benedictis-Kessner)

4. "Dynamic Estimation of Latent Opinion Using a Hierarchical Group-Level IRT Model." 2015. *Political Analysis*. 23(2): 197-211. (with Devin Caughey)
3. "Representation in Municipal Government." 2014. *American Political Science Review*. 108(3): 605-641. (with Chris Tausanovitch)
2. "Measuring Constituent Policy Preferences in Congress, State Legislatures and Cities." 2013. *Journal of Politics*. 75(2): 330-342. (with Chris Tausanovitch)
1. "How Should We Measure District-Level Public Opinion on Individual Issues?" 2012. *Journal of Politics*. 74(1): 203-219. (with Jonathan Rodden)

Editor Reviewed Articles in Journals and Law Reviews

4. "A preference for constant costs." 2020. *Nature Climate Change*. News & Views. 10: 978–979
3. "Public Opinion in Subnational Politics." 2019. *Journal of Politics*. 81(1): 352-363. Editor reviewed for Symposium on Subnational Policymaking. (with Devin Caughey)
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1. "Business as Usual? Analyzing the Doctrinal Development of Environmental Standing Doctrine since 1976." 2011. *Harvard Law and Policy Review*. Volume 5.2. (with Gregory Wannier).

Book Chapters

5. "Elections and Parties in Environmental Politics." 2020. *Handbook on U.S. Environmental Policy*. David Konisky, ed. (with Parrish Bergquist)
4. "Latent Constructs in Public Opinion." 2018. *Oxford Handbook on Polling and Polling Methods*. R. Michael Alvarez and Lonna Atkeson, ed. Oxford: Oxford University Press.
3. "The Application of Big Data in Surveys to the Study of Elections, Public Opinion, and Representation." 2016. *Data Analytics in Social Science, Government, and Industry*. R. Michael Alvarez, ed. Cambridge: Cambridge University Press.
2. "The Political Economy of Expropriation and Privatization in the Oil Sector." 2012. *Oil and Governance: State-Owned Enterprises and the World Energy Supply*. David G. Victor, David Hults, and Mark Thurber, eds. Cambridge: Cambridge University Press.
1. "Democratization and Countermajoritarian Institutions: The Role of Power and Constitutional Design In Self-Enforcing Democracy." 2012. *Comparative Constitutional Design*. Cambridge: Cambridge University Press. (with Susan Alberts and Barry R. Weingast).

Policy Reports

1. "Reforming Baltimore's Mayoral Elections." 2020. Abell Foundation Report. `https://www.abell.org/publications/reforming-baltimores-mayoral-elections`

Articles Under Review

"The Effect of Fox News Channel on U.S. Elections: 2000-2020" (with Elliott Ash, Sergio Galletta, and Matteo Pinna)
(Invited to revise and resubmit at the *American Political Science Review*)

"Moderates" (with Anthony Fowler, Seth Hill, Jeff Lewis, Chris Tausanovitch, Lynn Vavreck)
(Invited to revise and resubmit at the *American Political Science Review*)

"Partisan Polarization in the Mass Public in South Korea and the United States"

"How Partisanship in Cities Influences Housing Policy" (with Justin de Benedictis-Kessner and Dan Jones)

Works in Progress

"Electoral Accountability for Ideological Extremism in American Elections" (with Devin Caughey)

"Gerrymandering in Local Governments" (with Yamil Valez)

"When Mass Opinion Goes to the Ballot Box: A National Assessment of State Level Issue Opinion and Ballot Initiative Results" (with Jonathan Robinson and John Sides)

"Inequalities in Participation, Voting, and Representation in Local Governments" (with Justin de Benedictis-Kessner and John Sides)

"The Ideology of State Party Platforms " (with Justin Phillips and Gerald Gamm)

Non-Academic Writing

"Here are six big takeaways from the 2020 elections." *Washington Post*. November 7, 2020. (with Emily Thorson)

"TV ads still win elections. And Democrats are buying a lot more of them." *Washington Post*. October 28, 2020. (with John Sides and Lynn Vavreck)

"How Local Covid Deaths Are Affecting Vote Choice." *New York Times*. July 28, 2020. (with Lynn Vavreck)

"Allowing Only Older Americans to Vote by Mail Leads to Severe Racial Disparities." *Election Law Blog*. July 1, 2020.

"A coronavirus recession would hurt all kinds of Republican candidates – not just Trump." *Washington Post*, Monkey Cage. March 18, 2020. (with Justin de Benedictis-Kessner).

"The Supreme Court is deciding a gerrymandering case. Here's the social science that the Justices need to know." *Washington Post*, Monkey Cage. June 1, 2019.

"New research shows just how badly a citizenship question would hurt the 2020 Census." *Washington Post*, Monkey Cage. April 22, 2019. (with Matt Barreto, Matthew A. Baum, Bryce J. Dietrich, Rebecca Goldstein, and Maya Sen)

"G.O.P. Senators Might Not Realize It, but Not One State Supports the Health Bill." *New York Times*. June 14, 2017. (with David Broockman)

Invited Talks

2021-2022: American University

2020-2021: University of Maryland; Stony Brook University

2019-2020: Princeton; UC Berkeley

2018-2019: Stanford; Northeast Political Methodology Meeting at NYU; University of Maryland

2017-2018: USC PIPE Symposium on Studying Subnational Policy Making; BYU; University of Chicago Conference on Political Polarization

2016-2017: University of Virginia; UCLA

2015-2016: Washington University in St. Louis; Texas A&M; Arizona State University Conference on Campaigns, Elections and Representation

2014-2015: Yale; Columbia; Duke

2013-2014: Princeton; Boston University; Rochester University

2012-2013: MIT American Politics Conference; Columbia Representation Conference; Princeton Media & Politics Conference; Annual Meeting of the Society for Political Methodology

Grants

Russell Sage Foundation, 2019-2021 ($119,475)

GW UFF, 2019-2020 ($14,433)

MIT Elections Lab, 2019-2020 ($14,000)

Jeptha H. and Emily V. Wade Award, 2014-2016 ($59,686)

MIT Energy Institute (MITEI) Seed Grant, 2014-2016 ($137,147)

MIT SHASS Research Fund, 2012-2014 ($8,734)

Software

dgo: Dynamic Estimation of Group-Level Opinion. 2017. R package. `https://CRAN.R-project.org/package=dgo`. (with James Dunham and Devin Caughey)

Awards and Honors

OVPR Early Career Scholar at George Washington University, 2019.

APSA award for best journal article on State Politics & Policy in 2016.

Award for best paper on State Politics & Policy at the 2014 American Political Science Conference.

Graduate Fellowship, Dept. of Political Science, Stanford University, 2006-2012

David A. Wells Prize in Political Economy for Best Undergraduate Economics Thesis, Williams College, 2002

Phi Beta Kappa, Williams College, 2002

Teaching Experience

Instructor:

Measurement Models (Graduate-level) (GW), 2020

Political Representation (Graduate-level) (GW), 2019

Elections (GW), 2018, 2019, 2021

Multi-level and Panel Models (Graduate-level) (GW), 2017, 2018, 2019, 2021

Public Opinion (GW), 2017

American Political Institutions (Graduate-level) (MIT), 2014, 2016

Public Opinion and Elections (MIT), 2016

Energy Policy (MIT), 2013

Democracy in America (MIT), 2013, 2014

Constitutional Law & Judicial Politics (MIT), 2013, 2015

Making Public Policy (MIT), 2012, 2014

Teaching Assistant:

Introduction to American Law (Stanford University), 2010

Judicial Politics and Constitutional Law (Stanford University), 2009

Political Economy of Energy Policy (Stanford University), 2008

Introduction to International Relations (Stanford University), 2008

Introduction to Public Policy (Stanford University), 2007

Introduction to Econometrics (Williams College), 2002

Graduate Advising

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Alex Beck (Dissertation committee chair)

Dickson Su (Dissertation committee chair)

Kerry Synan (Dissertation committee co-chair)

Jared Heern (Dissertation committee member)

Colin Emrich (Graduates in 2021, Dissertation committee member)

Massachusetts Institute of Technology:

Leah Stokes (Graduated in 2015, Dissertation committee member)

Krista Loose (2016, Dissertation committee member)

Tom O'Grady (2017, Dissertation committee member)

Justin de Benedictis-Kessner (2017, Dissertation committee member)

Alex Copulsky (2017, Masters thesis committee member)

James Dunham (2018, Dissertation committee member)

Parrish Bergquist (2018, Dissertation committee member)

Meg Goldberg (2019, Dissertation committee member)

University Service

George Washington University:

Member, Academic Program Review Committee, Sociology Dept., 2021

Coordinator, Graduate Political Science Admissions Committee, 2019-2020

Coordinator, American Politics Workshop, 2018-2020

Member, Methods Exam Committee, 2017-2020

Member, Graduate Political Science Admissions Committee, 2018-2019

Massachusetts Institute of Technology:

Member, Energy Education Task Force, 2012-2017

Parking and Transit Committee, 2013-2017

Member, Graduate Political Science Admissions Committee, 2013-2015

Faculty Fellow, Burchard Scholars, 2013-2015

Stanford University (as graduate student):

President, Stanford Environmental Law Society, 2009-2010

Executive Board Member, Stanford Environmental Law Society 2008-2010

Member, University Committee on Graduate Studies, 2007-2009

Member, University Library Committee, 2007-2008

President, Political Science Graduate Students Association, 2007-2008

Professional Service

Reviewer: American Political Science Review, American Journal of Political Science, Journal of Politics, Political Analysis, Political Behavior, Econometrica, Quarterly Journal of Political Science, Legislative Studies Quarterly, Political Research Quarterly, American Politics Research, British Journal of Political Science, Journal of Law and Courts, Public Opinion Quarterly, Political Science Research and Methods, State Politics and Policy Quarterly, Journal of Experimental Political Science, Nature Climate Change, Urban Affairs Review, Journal of Health Politics, Policy and Law, Perspectives on Politics, Review of Economics and Statistics, Cambridge University Press

Member, Best Dissertation Committee, Urban Politics Section of the American Political Science Assoc., 2021

Member, Program Committee, Midwest Political Science Association Conference, 2020

Lead Organizer, Local Political Economy APSA Pre-Conference at George Washington University, 2019

Member, Planning Committee, Cooperative Congressional Election Study (CCES), 2018

Member, Best Paper Committee, State Politics Section of the American Political Science Assoc., 2018

Editorial Board, Journal of Politics, 2017-18

Executive Committee, Urban Politics Section of the American Political Science Association, 2015-2017

Organizing Committee, Conference on Ideal Point Models at MIT, http://idealpoint.tahk.us, 2015

Member, Best Paper Committee, Urban Politics Section of the American Political Science Assoc., 2015

Consulting

Partisan Gerrymandering:

Expert, *League of Women Voters of Michigan* vs *Michigan Independent Citizens Redistricting Commission* (2022), State House Districts

Expert, *League of Women Voters of Ohio* v. *Ohio Redistricting Commission* (2021), Congressional districts

Expert, *League of Women Voters of Ohio* v. *Ohio Redistricting Commission* (2021), State Legislative Districts

Expert, *League of Women Voters* vs. *Kent County Apportionment Commission* (2021)

Expert, *APRI et al.* v. *v. Smith et al.* (2018-2019)

Expert, *League of Women Voters of Michigan* v. *Johnson* (2018-2019)

Expert, *League of Women Voters of Pennsylvania* v. *the Commonwealth of Pennsylvania* (2017-18)

Census:

Expert, *La Union del Pueblo Entero , et al.* v. *Trump*, Effect of Excluding Undocumented Immigrants from Census on Apportionment (2020)

Expert, *Common Cause et al.* v. *Trump*, Effect of Excluding Undocumented Immigrants from Census on Apportionment (2020)

Expert, *State of New York* v. *Trump*, Effect of Excluding Undocumented Immigrants from Census on Apportionment (2020)

Expert, *New York Immigration Coalition* v. *US Dept of Commerce* & *State of NY* v. *US Dept of Commerce*, Effects of Undercount on Census due to Citizenship Question (2018)

Policy Reports:

Consultant, *Abell Foundation*, Report on Potential Institutional Reforms for Baltimore's City Elections

Community Service

PlanScore: Social Science Advisory Team (2020-2021)

Sierra Club: National Board of Directors (2009-2015)

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. Christopher Warshaw

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