No. 16-1161

In The Supreme Court of the United States

BEVERLY R. GILL, ET AL., APPELLANTS,

v.

WILLIAM WHITFORD, ET AL., APPELLEES

ON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE WESTERN DISTRICT OF WISCONSIN

JOINT APPENDIX
VOLUME II

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The following documents have been omitted in printing this joint appendix because they appear on the following pages in the appendix to the Jurisdictional Statement:

Use of Efficiency Gap in Analyzing Partisan Gerrymandering

Report for State of Wisconsin, *Whitford v. Nichol*

Nicholas Goedert

December 2, 2015

I. Introduction

My name is Nicholas Goedert, and I am currently a Visiting Assistant Professor of Government and Law at Lafayette College in Easton, Pennsylvania. I teach classes in American electoral politics, voter behavior, the United States Congress, constitutional law, and representation theory.

I have been retained by the defendants in this lawsuit to provide expert opinions in the case titled above. More specifically, I have been asked to offer opinions on using the efficiency gap to measure partisan gerrymandering as done by the plaintiffs' experts Professor Kenneth Mayer and Professor Simon Jackman.

II. Qualifications and compensation

I received a Ph.D. in Politics from Princeton University in 2012, where I completed a dissertation on congressional redistricting, and my graduate training included courses in quantitative methods and statistics. I received my undergraduate degree in Social Studies from Harvard University in 2001, and a J.D. from Georgetown University Law Center in 2006, where I specialized in election law. My curriculum vitae is attached to this report.

All my publications that I have authored or published appear in my curriculum vitae. Those publications include peer-reviewed journals such as: *The American Journal of Political Science*, *State Politics and Policy Quarterly*, *PS: Political Science and Politics*, *Election Law Journal*, and *Research and Politics.*

I have published, or have forthcoming publications, specifically on the effects of districting methods on competition in congressional elections in *State Politics and Policy Quarterly* and *Election Law Journal*, and on the effects of geographic bias in congressional districting in *Research and Politics* and in The Monkey Cage political science blog at *The Washington Post.*

I am being compensated at a rate of $175 per hour.

III. Summary

1.) Despite claims in the plaintiffs' complaint, a large efficiency gap does not necessarily imply an unbalanced map. Instead, a large efficiency gap implies deviation from a predetermined seats/votes curve representing "hyper-proportionate" or "hyper-responsive" representation. Thus, using an efficiency gap standard creates the same constitutional issues as the proportional representation standard the Court has previously rejected. Moreover, requiring adherence to a specific seats/votes curve may discourage legislatures from drawing maps that would fulfill normatively desirable objectives, such as maximizing competitive elections or achieving proportional representation, but do not conform to this expected seats/votes curve. (Section IV)

2.) The plaintiffs' complaint alleges that an efficiency gap of 7% in a single election is sufficient for presumptive unconstitutionality. But evidence in both the academic literature and the plaintiffs' expert report show that efficiency gaps of the size proposed in the complaint are highly unstable and not particularly informative of future or durable gaps. In fact, as many as half of all maps that exceed this threshold in one election during a decade will be biased in favor of the opposite party in another election during the same decade. And even those few maps that are significantly and durably biased in favor of one party are mostly not even drawn with clear partisan intent. (Section V)

3.) The plaintiffs' complaint lacks a crucial addition "sensitivity testing" prong suggested in the academic literature. Without an additional test of durability, a majority of single election results exceeding the predetermined threshold would be false positives, because they are either not drawn with partisan motivation, or they would be biased in favor of the opposite party in another election during the same decade. The test of durability in Jackman's report is somewhat unclear and arbitrarily conditions durability on the results of small handful of elections. Additionally, even including the sensitivity testing prong as detailed in the literature would be potentially constitutionally problematic. (Section VI)

4.) The expert report of Mayer purports to show that an alternate map (i.e. the Demonstration Plan) could have been drawn with much lower efficiency gap in 2012. However, the map created by Mayer was generated based on significant information, the overall 2012 electoral environment, that was unknowable to the legislature at the time the map needed to be drawn. The Demonstration Plan is also deliberately drawn to exclude information that legislators would likely incorporate into their districting decisions, in the form of incumbency and anticipated uncontested races. Additionally, the report does not provide data on what bias we should expect to observe under the Demonstration Plan given the range of possible future election results. (Section VII)

5.) Any judgment about the partisan motivation behind pro-Republican bias in a map should be made in the context of bias due to the asymmetric geographic dispersion of partisans. This dispersion has generated Republican bias in many states' maps across the nation over the last few decades, growing in the most recent election cycles, as observed in both the academic literature and the plaintiffs' expert report. It has also generated Republican bias in two different non-partisan maps drawn in Wisconsin, in a few cases in excess of the bias observed in the most recent election cycle under the Republican-drawn map. Evidence of this bias is also observed in an analysis of the distribution of Wisconsin wards. (Section VIII)

IV. General Properties of Efficiency Gap

A. Efficiency gap demands codification of a specific relationship of seats to votes that amounts to hyper-proportional representation

Efficiency gap is defined both by the plaintiffs and in the academic literature as the ratio of one major party's wasted votes to the other major party's wasted votes. In a single-member, majority rule district, all votes for a losing candidate are wasted, and votes for a winning candidate in excess of the 50% threshold needed for victory are also wasted. Thus in all individual seat elections with two candidates, exactly half of the votes are counted as wasted, with the losing candidate accounting for a greater share of wasted vote the closer the election is.

Although a precise calculation of efficiency gap across a collection of races requires knowing the total number of votes cast for each major party candidate in each race, this can be simplified into a linear seats/votes curve with zero bias and a slope of 2 if one assumes equal turnout in all districts. (McGhee 2014, p. 80). This simplification is used in the Stephanopoulos and McGhee article originally advocating for efficiency gap as a standard for adjudicating partisan gerrymanders (p. 853), as well as the historical analysis in the plaintiffs' expert report by Jackman (section 6.1, p. 18). I concur that this shortcut is an appropriate and useful summary measure of efficiency gap and also use it in subsequent examples in this report. However, the fact that efficiency gap under basic assumptions simplifies to a single linear seats/votes curve also displays its drawbacks for use as a standard for a Court to judge the constitutionality of a map.

The Supreme Court has stated on multiple occasions that the Constitution does not guarantee a right to proportional representation of any particular group, a sentiment echoed in both the majority and dissent in *Vieth* (*Vieth v. Jubelirer*, 541 U.S. at 288; *Vieth v. Jubelirer* 541 U.S. at 338 (Stevens, J., dissenting); *Davis v. Bandemer*, 478 U.S. at 111). And the Court has additionally been wary of adopting a standard for partisan gerrymanders that would amount to proportional representation (*Davis v. Bandemer* 478 U.S. at 155). Yet the efficiency gap test would codify a very specific translation of seats to votes that is essentially "hyper-proportional" representation. Every 1 percentage point increase in vote would be expected to translate into a 2 percentage point increase in seats in order for a map to be measured as fair.

This formula does have the advantage of roughly conforming with the observed average seat/votes curve in historical U.S. congressional and legislative elections (see e.g. Tufte 1973, Goedert 2014). But this correlation is coincidental and not connected to the theory behind EG. Moreover, the correlation is not guaranteed to hold up over time, especially as populations become more polarized in their partisanship. Codifying this relationship between seats and votes would constrain states wishing to reform their voting or districting systems. There are several ways in which states might wish to draw districts for normatively good reasons that would be seen as highly biased, and thus potentially unconstitutional, when measured under EG, especially when taking into account unpredictable electoral tides.

B.) An efficiency gap standard may discourage drawing of competitive districts

Because they are highly sensitive to tides, implementing an efficiency gap standard may discourage legislatures from drawing maps with too many competitive seats. During a wave election favoring either party, competitive districts may all fall in one direction, causing an extreme EG measurement favoring that party despite the balanced intent behind drawing these districts.

For example, suppose a state with 20 districts contained a roughly even number of Democrats and Republicans, but that the state's mapmakers chose to draw half these districts to be evenly balanced, and half to clearly favor one party. So ten districts are drawn to be 50% Democratic and 50% Republican, while five districts are drawn to be overwhelmingly (e.g 75%) Democratic, while the last five districts are drawn to be similarly overwhelmingly Republican.

Now, suppose in one election the Democrats win 55% of the two-party vote overall (a wave slightly smaller than 2008 at the national congressional level), and that this gain in vote share is spread approximately evenly across the state. Each party would still win the five seats that were drawn to be safe for them, but the Democrats would also win all ten seats drawn to be most competitive. Thus, the Democrats would win 75% of the seats with 55% of the vote. Efficiency Gap would prescribe that a fair map would assign Democrats only 60% of the seats with this vote share, and so this map would be measured as 15% biased in favor of the Democrats. Of course, if Republicans won 55% of the vote, evenly spread across the state, the map would have a 15% Republican bias under efficiency gap. But the test suggested by the plaintiffs asks the Court to evaluate the constitutionality of a map based only on the bias measured in one election.

Moreover, during a time in which several states are moving to reform their redistricting process and incorporating the value of political competition into reform considerations, we do observe real maps that efficiency gap would judge too sensitive to shifting tides on both sides. For example, Arizona congressional districts are drawn by a nonpartisan commission that since 2001 is required by state law to try to drawn competitive districts when possible. After the 2000 Census, this commission drew half the state's 8 districts in a balance within 6% of the national average presidential vote share throughout the decade (as measured by Cook's PVI, a measure of the partisanship of congressional districts relative to the nation based on recent presidential election results). The result has been a great deal of competition and partisan turnover since 2002, but large fluctuations in efficiency gap. As shown in Table 1 below, the map had an efficiency gap of 14% in favor of Republicans in 2002, but this switched signs twice during the decade, favoring Democrats in 2006 and 2008, and switching back to Republicans in 2010. Under a new, but still nonpartisan map, this switched back a third time in 2012, with an efficiency gap favoring Democrats of 14%. This Commission has at various times been accused by both parties of acting with partisan intent; efficiency gaps may yield spurious evidence of partisan bias even when motivated only by desire to enhance competition.

Table 1. Arizona Congressional Results, 2002-2012

Year	GOP seats	GOP Vote	Eff. Gap
2002	75.0%	55.7%	13.6%
2004	75.0%	60.9%	3.1%
2006	50.0%	52.1%	-4.2%
2008	37.5%	46.4%	-5.4%
2010	62.5%	53.1%	6.2%
2012	44.4%	54.3%	-14.1%

C.) An efficiency gap standard may discourages enactment of proportional representation.

While the Court has held that the Constitutional does not *require* it, proportional representation of political parties *is* a permissible goal that a state may choose to adopt (*Vieth v. Jubelirer*, 541 U.S. 338 (Stevens, J., dissenting); *Gaffney v. Cummings*, 412 U.S. at 754). But because the efficiency gap requires a 2:1 "hyper-proportional" relationship between seats and votes, it may also discourage the drawing of districts to achieve 1:1 proportional representation. For example, suppose a state's partisan identification is 60% Democrat and 40% Republican and has 20 districts. The state wishes to achieve fair proportional representation, and so draws 12 districts to be 100% Democratic and 8 districts to be 100% Republican. If Democrats do get 60% of the vote, they will win 60% of seats, but EG requires that a fair map would award 70% of seats to Democrats in this scenario. Thus, the map that was both proportional and virtually guaranteed to yield a Democratic majority would be measured by EG to be biased by 10% in favor of Republicans.

Note that the above hypothetical would create a map completely resistant to shifts in partisan tides, which may be normatively undesirable. But one might also imagine a map drawn to achieve proportional representation and still be responsive to change. For example, imagine a state with 20 districts, evenly balanced between Democrats and Republicans in an election without tides favoring either party. Suppose District 1 is drawn to be 97.5% Democratic, and then each subsequent district is drawn to be 5% more Republican than the last. So District 2 is 92.5% Democratic; District 10 is 52.5% Democratic; District 11 is 47.5% Democratic; and District 20 is 2.5% Democratic and 97.5% Republican (see Table 2 below).

Table 2. Efficiency Gap Under Hypothetical Map Designed to Create Proportional Representation

District	Partisan Baseline (% Dem under 50/50 Statewide Party Split)	Winning Party under statewide vote: 50% Dem	55% Dem	60% Dem
1	97.5%	D	D	D
2	92.5%	D	D	D
3	87.5%	D	D	D
4	82.5%	D	D	D
5	77.5%	D	D	D
6	72.5%	D	D	D
7	67.5%	D	D	D
8	62.5%	D	D	D
9	57.5%	D	D	D
10	52.5%	D	D	D
11	47.5%	R	D	D
12	42.5%	R	R	D
13	37.5%	R	R	R
14	32.5%	R	R	R
15	27.5%	R	R	R
16	22.5%	R	R	R
17	17.5%	R	R	R
18	12.5%	R	R	R
19	7.5%	R	R	R
20	2.5%	R	R	R
Statewide Total	50%	10 D/10 R	11 D/9 R	12 D/8 R
Efficiency Gap		0%	-5%	-10%

Under an election that is split 50/50 in the vote, Democrats will likely win districts 1 though 10, and Republicans districts 11 through 20, yielding no net efficiency gap. But if the balance of the electorate changes, either permanently or through a single wave election, the seat share for each party will likely shift proportionately, create efficiency gap bias. If Democrats win 60% of the vote statewide, they will now win districts 1 though 12, or 60% of the seats. Yet efficiency gap prescribes that a party should win 70% of the seats with this vote share, so the map would be judged as 10% biased (and thus presumptively unconstitutional) in favor of the *Republicans*.

We can also observe anecdotal evidence of large efficiency gaps in real maps designed to draw safe and roughly proportional districts by bipartisan agreement. In the 2000's decade, Democrats controlled all branches of state government in California, but instead of crafting an aggressively partisan congressional map, worked closely with Republicans in the legislature to draw districts that would protect incumbents of both parties and thus create almost entirely safe seats. In 2008, Democrats won 64% of the congressional seats in California with approximately 64% of the statewide vote share. But efficiency gap would judge this map to be biased in favor of Republicans by 14% that year, and thus presumptively unconstitutional were this the first year after redistricting, despite being drawn under Democratic control, and passed by large majorities of both parties in the legislature.

Contrary to the plaintiffs' assertion in complaint paragraph 51, a large efficiency gap does not imply a map is unbalanced, as shown in the above examples. Even a "balanced" map can show extreme EG bias under some (or even all) electoral tides conditions and varying normative definitions of balance.

V. Historical Instability and Fluctuations in Efficiency Gap

A. Past results demonstrate enormous instability even within a given decade and sensitivity to very realistic partisan tides

The plaintiffs' complaint alleges that a districting plan should be considered presumptively unconstitutional if an efficiency gap of 7% is observed in a single election (paragraph 86) (though they also propose that the Court could declare the specific Wisconsin plan unconstitutional without setting an exact threshold). In doing so, they rely on the Jackman report (p. 56), and also cite research by Stephanopoulos & McGhee (2015) suggesting an 8% threshold for state house plans. The complaint alleges that "where the efficiency gap is large and much greater than the historical norm…intent to systematically disadvantage voters based on their political beliefs can be inferred by the severity of the gerrymander alone" (Plaintiffs' complaint, paragraph 6). Yet both the academic research and data presented by the plaintiffs' expert show that such intent cannot be inferred.

Indeed, as both the Jackman report and the Stephanopoulos & McGhee article comprehend, merely observing a given threshold gap in a single election is not very informative as to the gap that we might expect over the lifetime of a plan. Indeed, Jackman acknowledges that "Conditional on observing an election with $EG > .07$, there is a 45% chance that *under the same plan* we will observe $EG < 0$." (p. 56). In other words, about half of all plans over the past 40 years that crossed the threshold for presumptive unconstitutionality in one election are also biased in favor of the opposing party in at least one election during the same decade. As measured by Stephanopoulos and McGhee, this is also true of 5 out of 14 state house plans crossed their 8% threshold for Republican bias during the 2000's decade (Stephanopoulos and McGhee 2015, p. 882).

And several iconic examples of Republican gerrymanders did not even display a consistent efficiency gap through the decade. Perhaps most famously, the Pennsylvania congressional map drawn by Republicans and upheld in *Vieth v. Jubilirer* elected Republicans to just 7 of 19 seats based on about 44% of the major-party in 2008, resulting in an efficiency gap bias EG bias in favor of *Democrats* in 2008. Similar backfires occurred the same year in other states districted by Republicans such as Virginia and Ohio. By the estimates of Stephanopoulos and McGhee, 18 of the 23 congressional or state legislative plans that were alleged in suits prior to 2010 to be unlawful partisan gerrymanders were actually measured as being biased in both directions during the decade of their existence. And the *only* plans definitively biased in favor of Republicans occurred in Florida in the 2000's, a state that served as an iconic example of bias created from geographic dispersion rather than intentional gerrymander, as discussed in Section VIII below.

B. Very few plans are unambiguous as to sign, and they are usually not even partisan gerrymanders

Indeed, it is rare that a map is clearly is biased in favor or one party or another over the course of an entire decade, and the few plans that are clearly biased are not even necessarily partisan gerrymanders. On p. 53, the Jackman report mentions that only 12% (17 out of 141) of state legislative plans analyzed over four decades are unambiguous as to the direction of their bias, based on his measurement of confidence over imputations in uncontested races; these 17 plans are listed on Table 1 on p. 55. 16 of the 17 plans are biased in favor of the Republicans, suggesting natural geographic bias favoring Republicans discussed further below. But more importantly, most of these plans are *not* partisan gerrymanders. Of the 16 most Republican plans, only six or seven would plausibly be called partisan gerrymanders from the standpoint of partisan control of the districting process. Instead, they include such plans as the New York legislature in every decade (usually under split control), an example used by Rodden and Chen to demonstrate asymmetric geography. Additionally, the short list also includes the Wisconsin map from 2001-2010 that was drawn by a court. So a durable bias in favor of Republicans is not even a sign of deliberate partisan intent in even the strongest anecdotal evidence.

VI. Testing the Aensitivity and Durability of Efficiency Gap

A. The plaintiffs' complaint does not include a crucial second part to the empirical test for presumptive unconstitutionality, sensitivity testing for future results

Stephanopoulos and McGhee also allow that "most redistricting plans are volatile enough that their precise consequences cannot be forecast with great accuracy. Specifically, a plan's efficiency gap in one election is a relatively weak predictor of its gap in the next election" (p. 864). Therefore, observing a certain gap in one election is *not* a sufficient test of presumptive unconstitutionality for Stephanopoulos and McGhee. Instead, they suggest that for a map to be presumed unconstitutional, it should not only reach a specified level of bias in a particular election, but also be very unlikely to switch signs in bias over the foreseeable elections in the future (p. 889). "(W)e recommend setting the bar at…8 percent or state house plans, *with the further proviso that sensitivity testing show that the efficiency gaps are unlikely to hit zero over the plans' lifetime*." (p. 887, emphasis mine).

Stephanopoulos and McGhee evaluate the second criteria through "sensitivity testing", shifting the actual election results by 7.5% in each direction for congressional plans, and 5.5% in each direction for legislative plans, and calculating the gaps for each shift (p. 864). Under this second test, most of the instances of efficiency gaps beyond the initial threshold would *not* be judged presumptively unconstitutional because the simulated gap is too unstable.

The plaintiffs' complaint includes no such second part to the test for presumptive unconstitutionality. Without this second part to the test, almost any plan could be judged presumptively unconstitutional under some election conditions. Thus, the EG standard could come down to a pure subjective evaluation of partisan intent, combined with a well-time fluke election result.

B. Jackman's report contains testing of robustness of EG measures over time, but it is unclear how these are to be incorporated into the test

In place of an explicit sensitivity testing prong to be applied to each map at issue, the Jackman report implies that sensitivity testing though modeling a future range of possible election results is unnecessary because efficiency gaps of a certain magnitude are historically unlikely to switch signs when observed in the first elections after redistricting. But conditioning one's observations only on particular election results is rather arbitrary, and in this case, likely biases toward a finding of EG durability. This is because among the notable national "wave elections" during in the period from 1972-2014 (e.g. 1974, 1994, 2008, 2010), none occurred immediately following a redistricting year. Instead, most post-redistricting elections occurred in years of relative partisan balance at the legislative level. The lack of notable wave elections among those picked to condition on is probably coincidental, but likely does result in less instability than if the durability of EG measurements were observed after such a wave election. There is no guarantee that in the future, a wave election will not occur immediately after redistricting, and thus applying this standard to future cycles would inappropriately imply durability. A more accurate test would be how often a gap of a certain magnitude in *any* cycle implied consistency across an entire decade. As previously noted, this test gives us much less confidence about the durability of a single EG measurement.

C. Even the Stephanopoulos & McGhee sensitivity testing is a flawed way to judge constitutionality after a single election

But even the sensitive test as proposed by Stephanopoulos and McGhee is problematic. The Stephanopoulos and McGhee sensitivity testing prong is an important acknowledgement of the fluctuations observed in efficiency gap as electoral tides shift. Yet as the authors themselves concede, this test involves simulating future election results assuming a hypothetical uniform swing across all districts, a method found problematic in evaluations of partisan bias by Justice Kennedy in *LULAC v. Perry* (548 U.S. at 420). The authors justify the use of this method nevertheless by saying it is not used to calculate the point estimate of bias, only the uncertainty. But given the overwhelming number of false positives generated from reliance on the point estimate alone, this underestimates the importance of the sensitivity testing prong in the final determination of constitutionality.

Additionally, Stephanopoulos and McGhee argue that their sensitivity test involves hypothetical swings much smaller than needed to evaluate the symmetry of partisan bias, as they only swing results in either direction 7.5 percentage points in the case of congressional maps, and 5.5 points in the case of state legislative maps. Yet this shift may not be sufficient to simulate the plausible range of election results than may be observed with a decade. For example, the Republican share of the two-party aggregated national popular vote in congressional elections jumped from 44.5% in 2008 to 53.5% in 2010 (a nine point swing). So shifting the 2008 national result 7.5 points in both directions would have been insufficient to encompass the actual national result two years later. And within a single state, where small variations in incumbency and candidate choice may have greater impact on aggregated results, fluctuations across elections could be even larger.

VII. Discussion of Mayer Demonstration Plan and Data Imputation

Both the expert reports of Jackman and Mayer rely on imputing votes for counterfactual electoral situations. Most frequently, this is done in case of past election results where a candidate was running without major party opposition. When measuring the bias in a map from an academic standpoint, imputing vote share in unopposed races seems entirely appropriate, as do the specific methods used in both reports to make these imputations. However, this seems more problematic in the context of a legal challenge to a map asserting that a particular individual's constitutional rights have been violated. Specifically, if an individual votes for party A in an election with no major party opposition, it would be curious to allege that individual's right to political representation has been violated because they hypothetically may have voted for party B had a different district been drawn to induce party B to run a candidate. And it would be even more curious to blame that hypothetical lack of representation on the mapmaker as opposed to the party that chose to run no candidate in the district or the voter who nevertheless voted for the opposing party.

But the most concerning imputation decisions come in the case of the demonstration plan presented in the Mayer expert report. The plaintiffs claim that this demonstration plan shows that these alternate districts would have produced an efficiency gap bias of only 2%. However, this calculation is made not by assuming that any of the existing candidates in the 2012 elections ran in new districts, but by imputing a baseline partisanship for each new district, and adjusting this baseline for 2012 electoral conditions, assuming all districts are contested by both major parties and no districts are contested by incumbents (Mayer report, p. 31 and 45). As with the previous discussion of imputation of votes in uncontested races, this technique seems appropriate in studying the baseline characteristics of a map for academic purposes. But legislators will of course not draw a map assuming that no incumbents will run, or that all races will be contested. Instead, the actual mapmakers will probably have a fair idea of which districts will be contested by which incumbents, and which districts are likely to be uncontested. So while it may have been possible to draw a map with a low baseline bias in partisanship absent the effects of incumbency or uncontested elections, this would not be the most accurate data that legislators would be able to access in terms of predicting actual election outcomes.

Moreover, the Mayer plan sets out to predict bias using the actual 2012 election outcome, a narrow statewide victory for the Democrats in terms of aggregated vote totals. But this particular outcome in unknowable to mapmakers at the time maps must be drawn. Mayer points out that this outcome was close to the projection produced by Gaddie or district baseline partisanship prior to the election. But this outcome (where the statewide vote in 2012 closely matched baseline partisanship) was mostly coincidental. It could just as easily have happened that this cycle produced a wave election in favor of either the Democrats or the Republicans, strongly deviating from all baseline estimates. Mayer provides no estimates for the efficiency gap of the demonstration plan under the range of plausible election outcomes facing legislators at the time they were drawing the map.

VIII. Geographical Bias in Wisconsin and the Nation

A. Bias from Geographic Dispersion of Partisan: General Arguments

The test proposed in the plaintiffs' complaint allows that a map exceeding the predetermined threshold for bias may rebut the presumption of unconstitutionality by showing such bias is "inevitable given the state's underlying political geography" (paragraph 84). The plaintiffs propose to show that such bias should not be deemed "inevitable" by presenting one specific demonstration plan that, through a series of imputations, would have displayed much lower bias in 2012.

But creating a hypothetical plan with lower bias after knowing the result of a particular election is not a reasonable way to evaluate the propensity of a state's underlying geography to generate bias, or ability of a nonpartisan actor to anticipate a particular election result prior to the election happening. Instead, evaluation of whether political geography substantially contributed to bias is more appropriately measured by any of several other techniques, including: (1) comparing bias observed in Wisconsin to other comparable states during the same time period; (2) comparing the current map in Wisconsin to previous maps in the same state drawn without partisan motivation; and (3) simulating nonpartisan districts. Any of these methods would suggest that the asymmetric geographic dispersion of partisans makes it much easier and more natural for even a nonpartisan or bipartisan regime to draw a map biased in favor of Republicans in Wisconsin, particularly when the statewide electorate is evenly balanced.

This report does not attempt to simulate nonpartisan districts beyond a simple analysis of ward distribution, but recent research suggests such simulations create substantial Republican bias in state legislatures in several states with similar political geography. Chen and Rodden (2013) show how recent political geography generates substantial Republican bias in legislative elections in states across the nation, even when districts are drawn randomly, while still incorporating values of contiguity and compactness. Chen and Rodden use the geography of Florida as a detailed example, with several very compact urban areas of very concentrated Democratic strength, surrounded by much more sprawling regions of more modest Republican advantage. Yet they simulate random state legislative district in more than 15 additional state (Wisconsin not among the states where data for such simulation was available), and find "that Florida is not an outlier…average bias in favor of Republicans is substantial – surpassing 5% of state legislative seats – around half the states for which simulations were possible" (Chen & Rodden 2013, p. 262).

B. Evidence of growing geographic in nation as a whole

Under multiple different measures, overall bias has been found to be shifting increasingly toward Republicans across the nation in recent decades. Using a very simple methodology, I also find that geography generated an average of 7% bias in the 2012 congressional elections in states even controlling for the partisanship of districting (Goedert 2014, p. 4). And the Jackman report notes that while the overall average efficiency gap in all state house elections from 1972 to 2014 is very close to zero, the average was significantly more likely to be biased in favor of Democrats in 1970s and 1980s, and more likely to be biased toward Republicans in later decades, especially the 2010s. On p. 44, the Jackman report states that while 5 of the 10 most pro-Republican efficiency gap estimates from the past 40 years were observed in the two most recent cycles (none being in Wisconson), *all* of the 10 most pro-Democratic estimates occurred prior to 2002.

Additionally, Stephanopoulos and McGhee find that Republican bias in the average state house plan has gradually grown from -1.5% in the 1970s and 1980's to 2.1% in the 2000's, peaking at 3.7% in 2012 (Stephanopoulos & McGhee 2015, p. 871-2; graph on p. 873). While Stephanopoulos and McGhee attribute much of this growth in prior decades to "favorable trends in voters' residential patterns", they also claim the "spike" in 2012 was caused by more extreme partisan gerrymanders. Nevertheless, this overall bias in favor of Republicans is largely a continuation of a recent trend in political geography. Regardless of how it is measured, geography appears to play a potentially significant role in biasing election results. If the Court is insistent on using efficiency gap as a standard to measure partisan intent, it would seem clear that an adjustment for geography, which is not the result of such intent, should be made in lieu of a predetermined hard-and-fast threshold.

C. Evidence of asymmetric bias in historical Jackman data

On p. 60-61 of his report, Jackman describes Republican bias as more durable and certain than Democratic bias of the same magnitude. This is apparently noted to suggest that Republican bias observed in a single election should be viewed by the Court as especially dangerous dues to its potential to perpetuate across cycles. But this same observation would also suggest that Republican bias, where observed, is more likely to be due to a more permanent geographic distribution of partisans, rather than more temporary considerations of legislators in anticipation of a single election cycle. This is further supported in Table 1 on p. 55 of the Jackman report. As mentioned above, of the 17 plans that Jackman claims are unambiguous as to sign throughout an entire decade, 16 are biased toward Republicans, and most of these 16 are not Republican gerrymanders.

D. Specific evidence from Wisconsin

We can see the overall trend toward Republican bias even without partisan intent specifically in the efficiency gap measurements in Wisconsin. From Figure 35 of the Jackman report, Wisconsin saw a larger negative efficiency gap in 2012 than any election in the last 40 years. However, this is just one of nine consecutive cycles of negative efficiency gaps, including seven cycles under two different bipartisan or court-drawn maps, gaps which with slight exceptions at the end of the 2000s, have grown steadily larger over two decades.

And the efficiency gap observed in the most recent 2014 cycle is not at all unusual for recent electoral history in Wisconsin. This is to be expected from geographical bias when tides shift strongly in favor of one party. Using a slightly different but analogous measure of bias, I find in two articles published in *Research and Politics* that average bias across several congressional maps drawn by Republicans declined from 19% to 9% between 2012 and 2014. This decline in bias under the somewhat stronger Republican tide in 2014 is echoed in Jackman's efficiency gap measurements from Wisconsin, which declines from 14% to just under 9%. As mentioned above, the efficiency gap found is Wisconsin in 2014 is actually lower than the bias observed under the court drawn state legislative map in Wisconsin in two cycles of the previous decade: 2004 and 2006.

E. Analysis of Wisconsin Districts at the ward level

Even without regard to a specific district map, we can see the bias inherent in Wisconsin's geography at the ward level. Chen and Rodden posit that bias in several states comes out of a surplus of lean-Republican and safe Democratic pockets of population, compared to relative lack of lean-Democratic and safe Republican pockets. And mapping the distribution of Wisconsin wards confirms this exact pattern.

Based on the 2012 presidential election results, we can estimate what share of the two-party vote a Democrat would project to win in each ward in an election where each party won 50% of the statewide vote (data drawn from supplemental attachment to Mayer expert report). Since President Obama won 53.5% of the two-party statewide vote in 2012, this is most simply done by shifting each ward's actual Democratic vote share down by 3.5%. So a ward that voted 56% for Obama in 2012 would be estimated to vote 52.5% Democratic in an evenly balanced election. Figure 1 below shows the proportion of wards, as well as the share of statewide vote these wards comprise, at each level of Democratic support, demonstrating a clear geographic bias favoring lean-Republican wards.

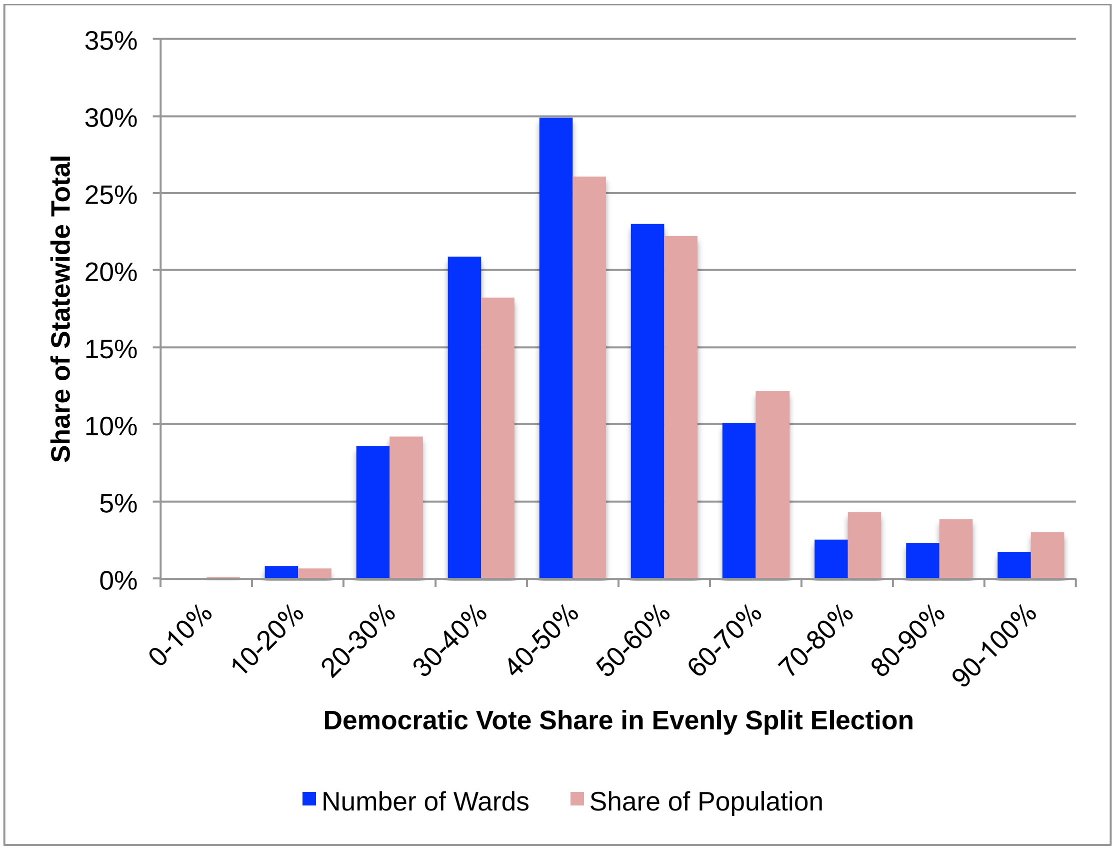

Figure 1. Wisconsin Ward Projections in Evenly Divided Statewide Election (Based on uniform swing from 2012 Presidential Election Results)

The number of wards in Figure 1 peaks at 40-50% Democratic vote, indicating the surplus of areas that marginally favor Republicans. At the same time, while there are virtually no wards voting overwhelmingly Republican there are several wards that vote overwhelmingly Democratic, and these wards are larger than most other wards in the state.

In an election evenly divided between the parties statewide, Republicans would win 60.2% of wards, comprising 54.4% of the voting population. In fact, a majority of all wards in the state (50.8% of wards, comprising 44.3% of voting population) would be won by Republicans with less than 70% of the vote. In contrast, less than a third of wards would be won by Democrats with less than 70% of the vote. Meanwhile, there are many more wards, comprising a much larger share of the population, that were extremely Democratic. In the evenly balanced election, 4% of wards, comprising 7% of voting population, would be won by the Democrat with *more* 80% of the vote. Less than 1% of wards comprising less than 1% of population would be Republicans by a similarly huge margin.

Overall, it would appear that the recent results in Wisconsin are in line with both a national trend over the past two decades of greater natural Republican bias due to the increasing concentration of Democratic voters in compact urban areas. Republican control of the redistricting process does increase bias toward Republicans in election cycles where the vote share is close to even, but this is highly sensitive to very realistic shifts in the vote share, and should also be considered the context of geographic bias in the same direction.

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Expert report of Professor Simon Jackman

Expert report of Professor Kenneth Mayer
Supplemental Data File: LTSB 2012 Election Data (excel format)

Cases

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Analysis of the Efficiency Gaps of Wisconsin's Current Legislative District Plan and Plaintiffs' Demonstration Plan

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July 3, 2015

Table of Contents

I. Introduction

My name is Kenneth Mayer and I currently am a Professor of Political Science at the University of Wisconsin-Madison, and a faculty affiliate at the Lafollette School of Public Affairs, at the University. I joined the faculty in 1989. I teach courses on American politics, the presidency, Congress, campaign finance, election law, and electoral systems.

I have been retained by counsel representing the plaintiffs in this lawsuit (the "Plaintiffs") to analyze and provide expert opinions. I have been asked to determine whether, in my opinion, it is possible to create a Wisconsin state legislative map that does not result in systemic partisan advantage, by drawing a legislative district plan that has an efficiency gap as close to zero as possible while complying with federal and state requirements at least as well as the plan enacted by the Wisconsin legislature in Act 43.[1]

I submit this report, which contains the opinions that I intend to give in this matter. I describe my methods for estimating the state Assembly vote in actual and hypothetical state legislative redistricting plans, and for calculating the efficiency gap for Act 43 and for the alternative demonstration plan I drew.

My opinions, which are based on the technical and specialized knowledge that I have gained from my education, training and experience, are premised on commonly used, widely accepted and reliable methods of analysis, the application of the legal requirements of redistricting, and are based on my review and analysis of the following information and materials:

- Redistricting materials available from the Wisconsin legislature at http://legis.wisconsin.gov/gis/data, including Geographic Information System (GIS)

[1] The federal requirements are equal population, compliance with Section 2 of the Voting Rights Act, and the ban on racially gerrymandered districts. The state requirements are contiguity, compactness, and respect for political subdivisions (counties, towns, cities, and villages).

files for Act 43 districts, and ward level election data for 2012

- Census Bureau data on population, citizenship, and location of institutionalized populations as explained below
- Election data from the 2013-2014 Wisconsin *Blue Book* for the 2012 State Assembly and presidential elections
- Election data from the Government Accountability Board, including ward level 2012 election results for State Assembly and presidential elections.
- GIS data, including Census population figures, block assignments, and shape files for Wisconsin, available in the GIS program Maptitude for Redistricting
- Files submitted by defendants in *Baldus et al. v. Brennan et al.*

I conducted my analysis using Stata, Excel, R, and Maptitude for Redistricting.

II. Qualifications, Publications, Testimony, and Compensation

I have a Ph.D. in political science from Yale University, where my graduate training included courses in econometrics and statistics. My undergraduate degree is from the University of California, San Diego, where I majored in political science and minored in applied mathematics. My curriculum vitae is attached to this report as Exhibit 1.

All publications that I have authored and published in the past ten years appear in my curriculum vitae, attached as Exhibit 1. Those publications include the following peer-reviewed journals: Journal of Politics, American Journal of Political Science, Election Law Journal, Legislative Studies Quarterly, Presidential Studies Quarterly, American Politics Research, Congress and the Presidency, Public Administration Review, and PS: Political Science and Politics. I have also published in law reviews, including the Richmond Law Review, the UCLA Pacific Basin Law Journal, and the University of Utah Law Review. My work on campaign finance has been published in Legislative Studies Quarterly, Regulation, PS: Political Science and Politics, Richmond Law Review, the Democratic Audit of Australia, and in an edited volume on electoral competitiveness published by the Brookings Institution Press. My research on campaign finance has been cited by the Government Accountability Office, and by legislative research offices in Connecticut and Wisconsin.

My work on election administration has been published in the Election Law Journal, American Journal of Political Science, Public Administration Review, and American Politics Research. I was part of a research group retained as a consultant by the Wisconsin Government Accountability Board to review their compliance with federal mandates and reporting systems, and to survey local election officials throughout the state. I serve on the Steering Committee of the Wisconsin Elections Research Center, a unit with the UW-Madison College of Letters and Science. In 2012 I was retained by the U.S. Department of Justice to analyze data and methods regarding Florida's efforts to identify and remove claimed ineligible noncitizens from the statewide file of registered voters.

In the past eight years, I have testified as an expert witness in trial or deposition in the following cases: *Baldus et al. v. Brennan et al.,* 849 F. Supp. 2d 840 (E.D. Wis. 2012); *Milwaukee Branch of the NAACP et al. v. Walker et al.,* 2014 WI 98, 357 Wis. 2d 469, 851 N.W. 2d 262; *McComish et al. v. Brewer et al.,* No.CV- 08-1550, 2010 WL 2292213 (D. Ariz. June 23, 2010); and *Kenosha County v. City of Kenosha*, No. 11-CV-1813 (Kenosha County Circuit Court, Kenosha, WI, 2011).

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

III. Opinions

A. Summary

My opinions may be summarized as follows.

- Using a model that estimates baseline ward-level partisanship, I conclude that the redistricting plan enacted by Act 43 is significantly biased against Democrats, with an efficiency gap of 11.69%. The plan achieves this via the use of classic "packing and cracking" gerrymandering techniques: concentrating Democratic voters into districts where they have overwhelming majorities (packing), and drawing other districts so that Democrats constitute partisan minorities well below 50% and unlikely to win legislative seats (cracking). In doing so, Republicans guarantee a strong majority of legislative seats, even if they obtain well below 50% of the statewide legislative vote. In 2012, Republicans won 61% of State Assembly seats (60 of 99) while achieving only 46.5% of the statewide vote (as measured by the presidential vote, a common proxy for statewide partisanship).

- Using the same measure of partisan strength that the Wisconsin state legislature used in assessing partisan impact of proposed districts in Act 43, Act 43 has an efficiency gap of 12.36%.

- I created a demonstration redistricting plan (the "Demonstration Plan") that is equivalent to Act 43 on population deviation, has fewer political subdivision splits, and has better compactness scores, with a much lower efficiency gap score of 2.20%. This is less than one-fifth of the Act 43 efficiency gap.

- The Demonstration Plan shows that the partisan advantage secured in Act 43 was in no sense required in order to adhere to the constitutional and statutory requirements of legislative redistricting.

B. Measuring Partisanship in Actual and Hypothetical Districting Plans

The efficiency gap is a measure of "wasted votes" that fall into two categories: those votes cast for a losing candidate in a district (lost votes), and votes cast for the winning candidate above what is necessary to win (surplus votes). In an existing set of districts, the calculation is based on the actual vote in each district, with adjustments for uncontested races (Stephanopoulos and McGhee 2015). Larger imbalances in the number of wasted votes signify a degree of partisan unfairness against the political party with more wasted votes.

Calculating the efficiency gap in the Demonstration Plan requires estimating what the underlying partisan vote would be in each newly drawn (and hypothetical) district. The gap cannot be estimated by simply rearranging the votes cast in actual Assembly contests into a new district configuration, as the votes cast for specific Assembly candidates in each district are a function of the electoral environment in that district and whether a race is even contested by both parties. A large literature has developed around the problem of estimating the likely election results in redistricting plan alternatives and calculating summary statistics that characterize existing and hypothetical plans (Gelman and King 1994; Cain 1985).

In most applications, the partisan consequences of a redistricting plan are expressed in terms of the effect on *future* elections: using prior election results to predict outcomes in subsequent election cycles, or estimating the statewide vote swing required to significantly change the partisan composition of the legislature from one election to the next (Gelman and King 1990; Cain 1985). The results are typically expressed as the estimated two-party vote percentages in each new district (Gelman and King 1994), which are sufficient to forecast who will win an election and calculate swing ratios and seats-votes curves.[2]

My aim is different. Instead of estimating future election results for an existing or proposed hypothetical plan, my goal was to determine whether it was possible to draw a district plan following the 2010 Census that minimized the efficiency gap while maintaining strict fidelity to the federal and state constitutional requirements of population equality, contiguity, compactness, respect for political subdivisions, and compliance with the Voting Rights Act. The efficiency gap is a function of the *number* of wasted votes, and therefore requires a model that generates predictions of *how many votes* would have been cast for Democratic and Republican candidates in 2012 in a different district configuration, rather than simply vote

[2] Winners are determined by which candidate receives >50% of the vote in a two party race. Seats votes curves depend on the number of seats a party wins in an election (determined by the number of races in which that party received >50% of the vote) and the statewide vote totals in legislative races or some other set of statewide races

percentages. My methods provide a way of estimating what the 2012 Assembly election results would have been in such a Demonstration Plan.

Given appropriate data, it is possible to generate reliable and accurate vote count predictions that can be aggregated to any district boundaries. What is required is a set of independent variables that accurately predict the vote in state Assembly elections but which are to the greatest extent possible *exogenous* to that vote, meaning that the independent variables have underlying values that do not themselves depend on the district vote. If this condition is met, we can estimate what the district vote would have been in an alternative district configuration, since the independent variables do not depend on any particular district configuration. This is not an issue in models that predict future election results, since by definition variables measured today are exogenous to outcomes that occur several years in the future. Because I use one set of election results (the 2012 presidential vote) as part of a model that predicts another set of contemporaneous election results (the 2012 Assembly vote), it is an important but manageable methodological issue.

My method consists of two steps. The first is the construction of a regression model that predicts the 2012 Assembly vote as a function of partisanship, population, demographics, incumbency, and fixed geographic boundaries in Wisconsin's roughly 6,600 wards. In doing so, I establish the empirical relationships between a set of exogenous variables independent of any specific district configurations and the actual Assembly vote in existing wards. In the second step, I use this model to generate a forecast of Assembly vote preferences as a function of these independent variables, and disaggregate this forecast to the Census block level. Using these block level estimates of the Assembly vote, I draw a Demonstration Plan and estimate the Assembly vote and efficiency gap in the resulting districts.

1. Step One: A Model of Voting in Assembly Elections

Estimating the Assembly vote in alternative district configurations requires a model that can generate accurate estimates of the underlying partisanship of a district. As I noted above, the most common models regress the observed Assembly vote on measures of district partisan preferences and other variables known to affect the vote, and generate a predicted value of the vote based on the values of the independent variables. Changing district boundaries will change the values of the independent variables as new voters are moved into the district and others moved out, which in turn allows forecasts of what the vote would be in those new districts.

What I am interested in estimating is *how many* votes will be cast for Democratic and Republican candidates in each district in a demonstration district plan. This involves a different set of variables than is typical in models that evaluate the percentage of votes each party receives, since I require a measure that accounts for both differences in ward populations and variation in turnout.

I use ward level vote totals as the unit of analysis to increase the number of observations available and allow for more precise estimates. Wisconsin's 99 Assembly districts are composed of roughly 6,600 wards, with districts containing between 24 and 153 wards. While the ideal population of an Assembly district is 57,444, wards have an average population of approximately 869 people, and are far more demographically homogeneous.[3]

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[3] Legislative Technology Services Bureau data show 6,592 wards in Wisconsin, of which 66 are unpopulated and another 50 have fewer than 10 people. The average populated ward contains 869 people. Wisconsin statutes 5.15 (2)(b) specifies a permissible population range for wards of 300-4,000, depending on a municipality's size, with exceptions allowed in certain circumstances (for example, when single blocks exceed a permitted ward size, or when a municipality is divided into multiple counties or school districts, contains islands, or has wards that must be altered to match district boundaries).

There are four reasons analysis at the ward level is preferable to analysis at the district level. The first is a matter of sheer numbers: the precision of coefficient estimates, forecasting accuracy, and overall statistical power are all strongly related to the number of observations (or sample size). An *n* of 6,600 is far preferable to an *n* of 99, all other things being equal.[4]

The second is the amount of information lost when smaller units are ignored. From a statistical standpoint, using district data when ward data are available imposes the assumption that the values of all of the ward-level variables are equal to the district level variables, when we know this to be untrue immediately upon inspection. Assembly district 1, for example, has 110 populated wards, ranging in population between one and 999 people. In 2012, 73.4% of the voting age population cast ballots in the Assembly contest, and the victorious Republican Assembly candidate received 51.3% of the vote. At the ward level, however, there was considerable variation, with the Republican vote percentage ranging from a low of 38.4% to a high of 75%, and turnout ranging from 50% to over 90%. Ignoring this information and variation will lead to less accurate estimates and forecasts.

Third, in the second step of the analysis I disaggregate ward level estimates to the block level. Minimizing the differences in size and maximizing the homogeneity across that disaggregation will lead to more accurate block level estimates.

And fourth, each Census block is assigned to a single ward,[5] with a unique numerical code that identifies the block's location.[6] These codes allow for disaggregating ward level data

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[4] The larger n also means that OLS is an accurate method of estimating the underlying relationships, whereas more complicated techniques may be required with smaller sample sizes (Afshartous and de Leeuw 2005).

[5] The Census Bureau uses the term "Voting Tabulation District" (VTD). Most states call VTDs precincts. In Wisconsin these units are called "wards."

[6] These are known as FIPS (Federal Information Processing Standard) codes. http://www.census.gov/geo/reference/ansi.html.

into blocks and generating inputs for the redistricting software I use in the second step of my analysis.

I use two main sources of data. The first is redistricting data prepared by the Wisconsin Legislative Technology Services Bureau (LTSB), which consists of spreadsheets with ward level Census population data and election results, as well as ward and district shape files containing this data that can be imported into GIS software.[7] The second source is official election results published by the Government Accountability Board (GAB), both online and in the 2013 edition of the *Wisconsin Blue Book*.

In my experience working with large data sets, and especially when dealing with complex GIS data, I have found data errors to be a common problem. I assessed the reliability of the LTSB data by checking it against the GAB election data, and found numerous errors that required correction, as well some errors that could not be corrected.[8] I describe these errors and my corrections in greater detail in an annex to this report. All subsequent references to ward level vote or population counts uses these corrected vote totals.

The regression model used to predict Assembly vote totals takes the standard form of

$$Y_i = \alpha + \beta X_i + \varepsilon_i,$$

where Y_i is the dependent variable in ward i, X_i is a set of independent variables in ward i, and α, β, and ε_i are parameters estimated as a function of the variables. The full model is:

$$\begin{matrix} Assembly \\ Vote \end{matrix}_{\,i} = \alpha + \beta_1 Total\ VEP_i + \beta_2 Black\ VEP_i + \beta_3\ Hispanic\ VEP_i$$

[7] The files are available at http://legis.wisconsin.gov/gis/data. The 2012 election results are in the file Wards_111312_ED_110612.xlsx.
[8] As I note in the Annex, I was not able to allocate 0.21% of the vote in 2012 because of inconsistencies between electoral data reported by the GAB and the geographic redistricting data reported by the LTSB. This small number of votes will not change any of my analysis or conclusions, and such errors are inevitable when working with large data sets.

$$+\beta_4 \begin{matrix} Democratic \\ Presidential\ Vote_i \end{matrix} + \beta_5 \begin{matrix} Republican \\ Presidential\ Vote_i \end{matrix}$$

$$+\beta_6 \begin{matrix} Democratic \\ Incumbent_i \end{matrix} + \beta_7 \begin{matrix} Republican \\ Incumbent_i \end{matrix} + \sum_{j=1}^{71} \gamma_j County_j + \varepsilon_i$$

Where

Assembly Vote	Number of votes cast for the Republican or Democratic candidate in the 2012 Assembly election in ward i. I estimate separate equations for the Democratic and Republican candidates
Total VEP	Voting eligible population in ward *i*, as measured in the 2010 Census
Black VEP	Voting eligible Black population in ward *i*
Hispanic VEP	Voting eligible Hispanic population in ward *i*
Democratic Presidential Vote	Number of votes cast for Barack Obama in the 2012 presidential election in ward *i*
Republican Presidential Vote	Number of votes cast for Mitt Romney in the 2012 presidential election in ward *i*
Democratic Incumbent	1 if the Assembly election in ward *i* has a Democratic incumbent, 0 otherwise, multiplied by the VEP in ward *i*
Republican Incumbent	1 if the Assembly election in ward *i* has a Republican incumbent, 0 otherwise, multiplied by the VEP in ward *i*
County	Set of fixed effects dummy variables for each county. Dunn County is the excluded value.[9]

The model explains the Assembly vote as a function of four types of variables: district demographics, underlying partisanship, incumbency, and fixed geographic effects.

[9] When using dummy variables (which take binary values of either 0 or 1) to measure effects in units or conditions across the full population, one unit must be excluded, as otherwise perfect collinearity prevents estimation (Greene 1990, 240-241).

a. The Dependent Variable: Ward level Assembly Vote

The key quantity of interest in this analysis is the number of Assembly votes for each party, and it is the dependent variable in the model, using LTSB ward data that I corrected using the process outlined above. Since I am interested in estimating actual vote counts and not the percentage of the two party vote, I estimate separate equations for votes received by each party.[10] Estimating vote counts provides more accuracy than vote percentages, as it controls for variations in turnout across districts.[11]

b. Independent Variables: Demographic Data

The first three independent variables - Total Voting Age Population (VEP), Black VEP, and Hispanic VEP - are the 2010 Census voting age population counts by ward, adjusted to remove ineligible voters.[12] Total VEP constitutes a baseline of the size of the voting population, reflecting the fact that the number of votes will be a function of total population. Black and Hispanic VEP are additional controls that reflect the partisan tendencies of key subpopulations as

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[10] The reliance on actual numbers of voters eliminates the Modified Areal Unit Problem, which results when group statistics such as vote percentages or demographic fractions are aggregated into different geographic units levels. All of my variables and measures are scale invariant (see King 1996).

[11] The number of votes cast in Assembly races varies considerably even in in contested races. In 2012, the number of major party votes cast in the highest turnout Assembly election in the 23rd Assembly district, 36,205, was almost twice the number cast in the 90th Assembly district, 18,735, and almost 5 times the number cast in the uncontested 8th district, 7,869 (numbers taken from GAB figures).

[12] The voting eligible population (VEP) adjusts the voting age population by removing adults who are not eligible to vote. In Wisconsin, the two largest categories of ineligible adults that can be identified geographically are noncitizens and adults in prison for felonies. Noncitizens were removed using the 2008-2012 5 year American Community Survey county level noncitizen estimates (available at http://www.census.gov/acs/www/data_documentation/2012_release/. Institutionalized prison populations were identified using Census Bureau "Advanced Group Quarters" files for Wisconsin, available at .http://www2.census.gov/census_2010/02-Advance_Group_Quarters/, and described in http://www.census.gov/newsroom/releases/archives/2010_census/cb11-tps13.html. There are individuals on probation or extended supervision who are also ineligible to vote. I was not able to systematically identify their locations, but they are dispersed enough that they will not have a material effect on my resulting estimates or conclusions. All regression results and district estimates are materially unchanged when the unadjusted data are used.

well as turnout likelihood. Traditionally, both African American and Hispanic populations vote at lower rates that whites, although in 2012 African American turnout was comparable to white turnout.   Hispanic populations vote at lower rates than other demographic groups, in part because of a higher noncitizen population, but also because of socioeconomic factors known to reduce turnout.

I expect weak relationships for these measures because of the importance of the next set of variables, which reflect actual voting in the 2012 presidential election.

c. Independent Variables: Measures of Partisanship

The next two variables are the number of votes cast for the Democratic and Republican candidates for president in the 2012 election.   The presidential vote is widely used as an exogenous measure of district level partisanship (Ansolabehere, Snyder and Stewart 2000, 2001; Gelman and King 1994; Glazier, Grofman, and Robbins 1987; McDonald 2014; Jacobson 2003, 2009), and it correlates very strongly with other more complex measures of partisan strength (Levendusky, Pope, and Jackman 2008).

The presidential vote is, not surprisingly, an extremely strong predictor of the legislative vote. If we know how many votes were cast for the Republican presidential candidate in a ward we will have a very good idea, subject to some conditions, of how many votes will be cast for the Republican candidate in the legislative election in that ward. While not everyone who votes for the Republican presidential candidate will vote for the Republican state legislative candidate, nearly all will, and we can precisely quantify the nature of that relationship.

The strength of the relationship between presidential and Assembly votes is clear in Figures 1 through 3, which plot the total Assembly vote, Republican Assembly vote, and Democratic Assembly vote in 2012 by the respective presidential vote in each contested ward (where voters have an opportunity to express a preference for either party in the legislative race).

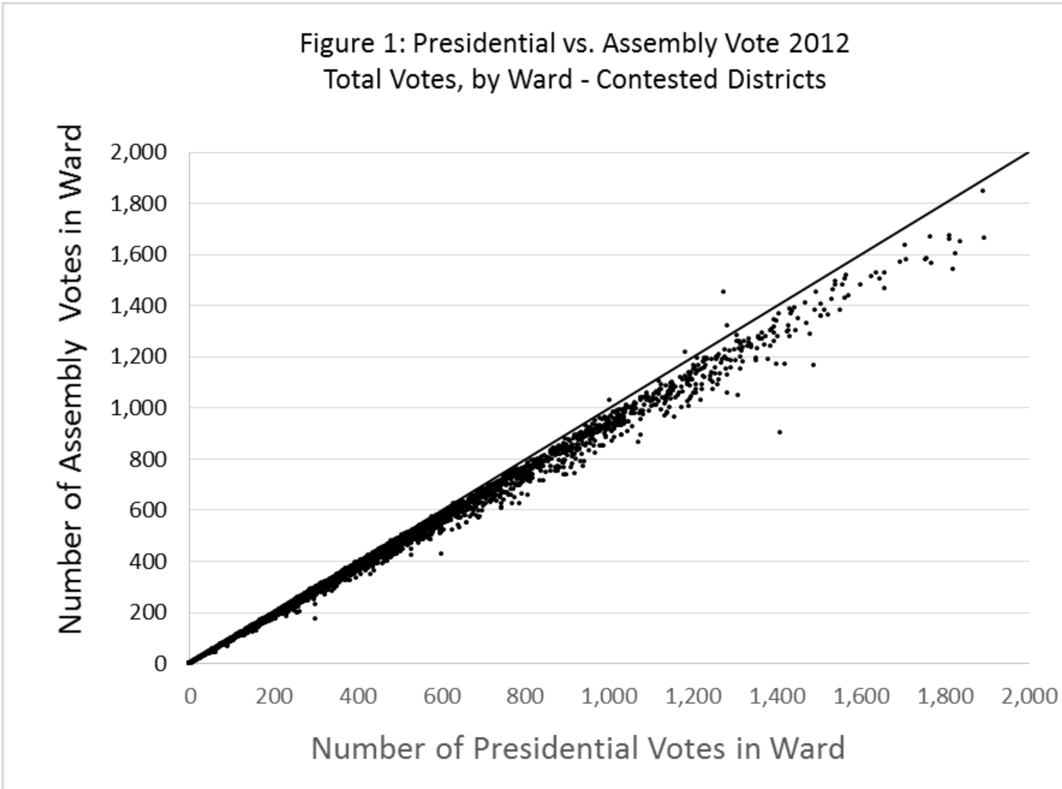

Figure 1: Presidential vs. Assembly Vote 2012
Total Votes, by Ward - Contested Districts
Number of Assembly Votes in Ward
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Number of Presidential Votes in Ward

SA40

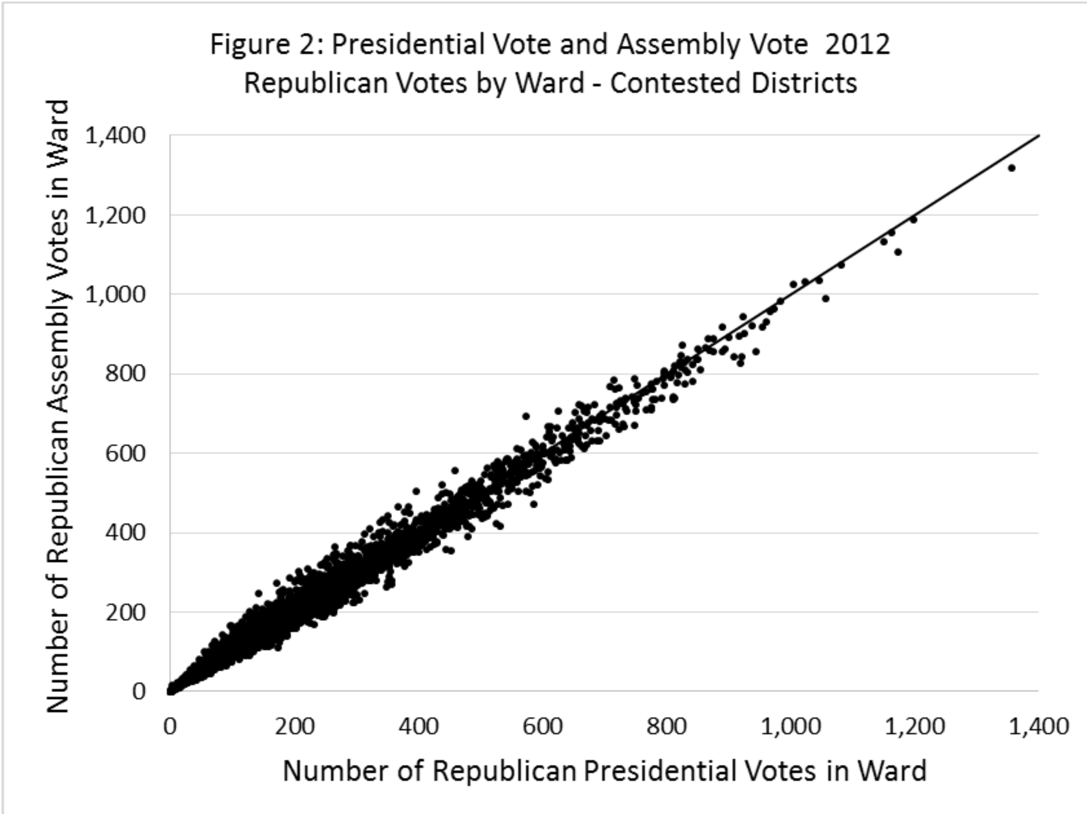
Figure 2: Presidential Vote and Assembly Vote 2012
Republican Votes by Ward - Contested Districts
Number of Republican Assembly Votes in Ward
1,400
1,200
1,000
800
600
400
200
0
0
200
400
600
800
1,000
1,200
1,400
Number of Republican Presidential Votes in Ward

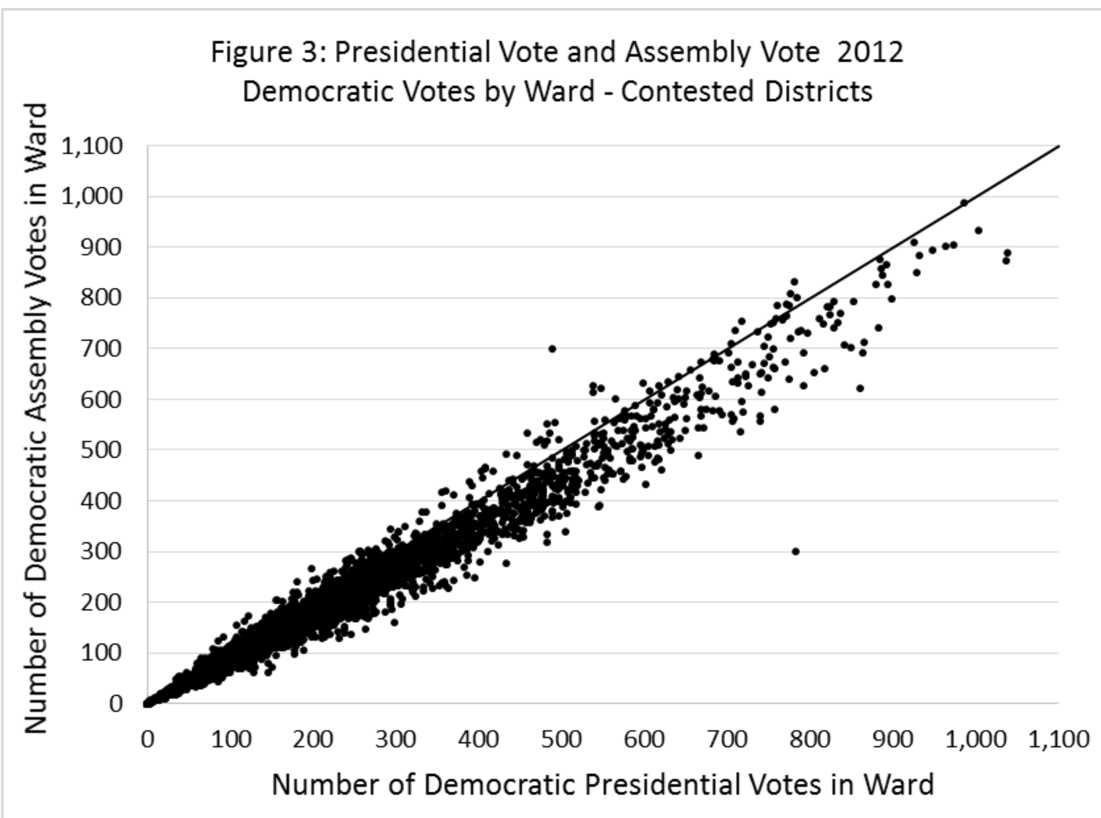
Figure 3: Presidential Vote and Assembly Vote 2012
Democratic Votes by Ward - Contested Districts
Number of Democratic Assembly Votes in Ward
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
Number of Democratic Presidential Votes in Ward

Figure 1 shows that the number of presidential votes cast in a ward is very strongly related to the number of Assembly votes, although almost all wards show a "roll off" as some presidential voters opt not to mark the ballot in the assembly race (the reference line shows where the number of presidential and Assembly votes would be equal). Such drop-offs are ubiquitous in down-ticket races, because voters have less information about lower-level candidates and often have weaker or nonexistent preferences (Wattenberg, McAllister, and Salvanto 2000).

The graphs for the Republican (Figure 2) and Democratic (Figure 3) votes show more variance around this reference line, indicating that some voters are splitting their tickets by voting for a presidential candidate of one party and an Assembly candidate of the other. Nevertheless, the relationship between the number the Republican and Democratic presidential and Assembly votes is apparent. Taken together, these figures indicate that the presidential vote is a very strong predictor of the Assembly vote.

An important property of the presidential vote as an independent variable in this model is that it can be treated as exogenous to (i.e., not caused by) the legislative vote. Exogeneity can be described in two ways. The first is in causal terms. Most voters will vote for the same party for the president and state Assembly, as the above graphs show. These voters are consistent because they are Democrats or Republicans, and partisanship is the factor that explains both vote choices. Other voters will make their Assembly choice based on their presidential vote, because they use party labels as a cue when voting in a down-ticket race. "[P]arties are generally known by the presidential candidates they nominate, and candidates for state legislative races are a good deal less well known to voters than the congressional candidates who ride presidential coattails" (Campbell 1986, 46). Few voters, if any at all, will decide on an Assembly candidate first and then vote for president on the basis of their Assembly vote preference. The causal arrow runs from the presidential vote to the Assembly vote, not from the Assembly vote to the presidential vote. This is why we speak of presidential coattails affecting legislative races, and not the other way around (Campbell 1986; Jacobson 2009).

The second reason why the presidential vote is exogenous to the Assembly vote is that it is not affected by local district-level conditions such as incumbency, spending, or candidate quality (Abramowitz, Alexander, and Gunning 2006, 87). The broader factors that influence the presidential vote, and the presidential candidates themselves, are the same in every Assembly district. The presidential vote is affected by underlying partisanship, national conditions and the characteristics of the presidential candidates, factors that are constant whether that vote is aggregated at the state, district, or ward levels.

To put it another way, a change in the statewide presidential vote is virtually certain to affect state legislative election results. Adding or subtracting hundreds of thousands of Democrats or Republicans will alter voting patterns at the district level. However, nobody would expect that the statewide presidential result will be affected by the configuration of legislative districts. The statewide presidential vote would be the same, no matter how the district lines are drawn. Consequently, we can consider the presidential vote as exogenous to, but a causal factor of, the state legislative vote.

d. Independent Variables: Incumbency

The incumbency advantage is perhaps the most well-known feature of contemporary legislative elections (Jacobson 2009, 30-35). Legislative incumbents rarely lose, and usually win by large margins. All other things being equal, an incumbent will get more votes than a non-incumbent. The causes of this advantage are less important in this context than its magnitude.[13] The model takes into account the incumbency advantage by noting whether an incumbent is running in an Assembly district.

Incumbency effects are measured with a dummy variable equal to 1 when a candidate is an incumbent, and 0 otherwise,[14] multiplied by the ward voting eligible population to create an interactive variable that accounts for differences in size from one ward to the next. Since the dependent variable is an actual vote count, the value of incumbency – in terms of how many additional votes incumbents receive – will vary with the number of voters who reside in a ward.

e. Independent Variables: County Effects

The last set of variables estimate the effect that county geography has on the Assembly vote. Some counties in Wisconsin are heavily Republican (Ozaukee, Washington, Waukesha) and some heavily Democratic (Dane, Douglas, Milwaukee). It is possible that a voters' county of residence could have an effect on the vote choice, whether because of sorting, socialization or assimilation, or other unobserved effects. Including dummy variables for each county will capture these effects if they exist. There are 71 county variables (excluding Dunn County) set to 1 when a ward is located in that county, 0 otherwise.

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[13] In the political science literature, the incumbency advantage has been attributed to the political skills and campaign experience of officeholders, higher name recognition, fundraising advantages, constituency service, redistricting, and the ability to scare off quality challengers.

[14] Incumbents were identified using 2012 election data in the 2013 *Wisconsin Blue Book*. In the 43rd and 61st Assembly districts two incumbents were paired against each other; these districts were coded as having no incumbent, since the advantage cancels. In the 7th Assembly district, the Democratic incumbent lost in the primary election and ran a write in campaign in the general election. Because the incumbent was not on the ballot, this district is also coded as having no incumbent.

f. Estimation and Results

Using Stata IC 11.2 I performed ordinary least squares regression, using 2012 ward data from contested districts where both Republican and Democratic candidates were on the ballot.[15] Analyzing contested races solves the problem of trying to estimate partisan support in a district where voters have no opportunity to express their support for one side (Gelman and King 1994). The fact that Republicans registered 0 Assembly votes in the 78th district (Madison), and Democrats 0 votes in the 58th district (Washington County), does not mean there are no Republicans in the 78th or Democrats in the 58th districts, or that a Republican or Democratic candidate would receive zero votes if one were on the ballot. Using uncontested races in this initial analysis would produce inaccurate estimates of party strength in those districts.

The results for the Democratic and Republic regression models appear in Table 1.[16] Most variables show the expected effects, particularly the very strong impact of the presidential vote. The r^2 values are extremely high, and the standard errors of the regression models (Root MSE) are low. The model is also extremely accurate: when compared to actual ward vote, the model's predictions of the Republican ward totals are within 16 votes, and the Democratic predictions are within 18 votes.

Figure 4 shows the overall accuracy of the model by plotting the predicted ward level vote totals by the actual vote totals in each ward. Predictions for both Democrats and

[15] This major-party contested definition is standard. It counts as uncontested four districts where one major party candidate was not on the ballot but received votes as a write in (districts 7, 17, 48, and 57), and one district (district 95) where one major party candidate was on the ballot but did not campaign and received only 50 votes (or 0.24%). This is consistent with methods used in the literature, which often uses a 95% threshold for the winning candidate as a standard (Gelman and King 1990, 274).

[16] Standard errors were adjusted to reflect the aggregation (or clustering) of wards into districts. The full set of variables is included in an appendix to this report.

Republicans are grouped tightly around the 45-degree line where predicted and actual values would be equal.

Figure 5 shows the accuracy of the model at the district level, which is the more relevant quantity for real-world applicability. I calculated district level results by aggregating wards into the associated Assembly district, using LTSB assignments. The district-level estimates are very close to the actual vote totals, and the average absolute error is 356 votes for Democratic candidates and 344 votes for Republican candidates.

Table 1
Regression Results: 2012 Assembly Votes, Contested Districts
County fixed effect variables not shown,

	Independent Variable	
Dependent Variable	Assembly Republican Votes	Assembly Democratic Votes
Total Voting Eligible Population	0.009 (.0070)	-0.008 (.0122)
Black Voting Eligible Population	-0.026 (.0215)	-0.021 (.044)
Hispanic Voting eligible Population	-0.0083 (.0321)	-0.149** (.05)
Democratic Presidential Votes	0.0072 (.0173)	0.931*** (.028)
Republican Presidential Votes	0.946*** (.0086)	0.013 (.013)
Democratic Assembly Incumbent	-0.021*** (.006)	0.028*** (.007)
Republican Assembly Incumbent	0.011** (.0042)	-0.014** (.005)
Constant	-0.92 (7.52)	9.8 (5.4)
N	5,282	5,282
r^2	.9903	.9843
Root MS Error	15.8	17.7

Robust standard errors clustered by Assembly District in parentheses.
*p<.05, **p<0.01, ***p<0.001

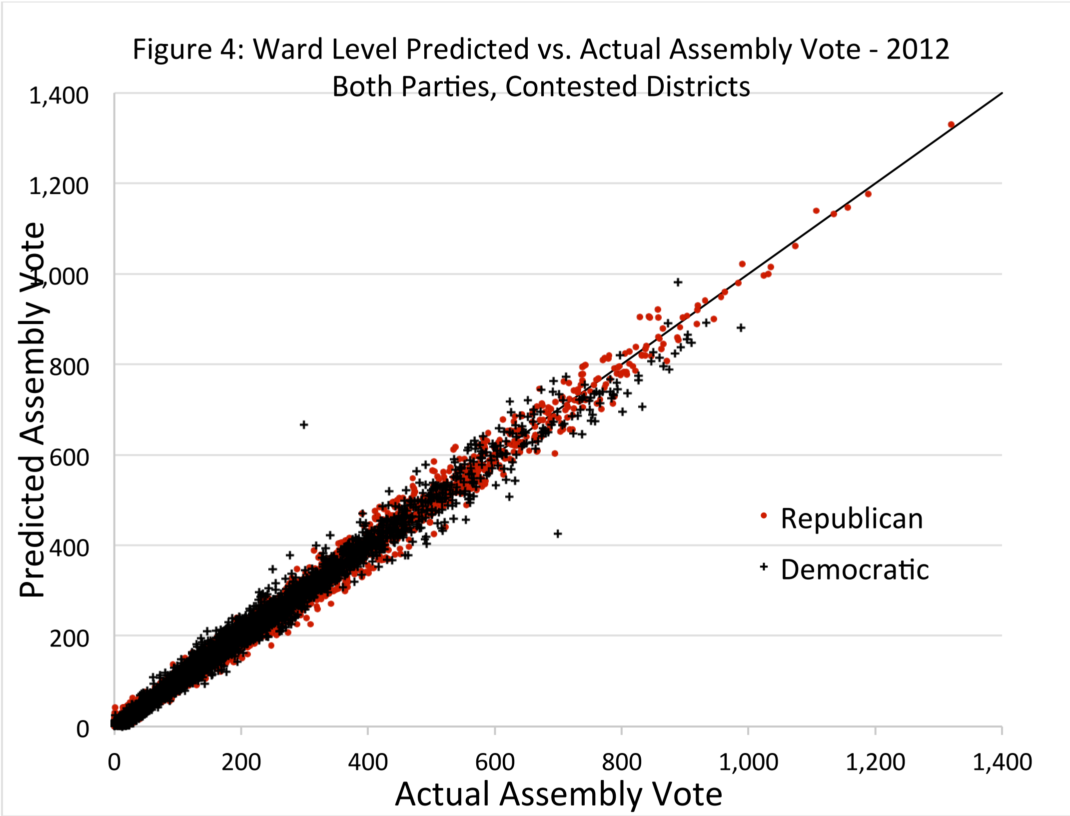
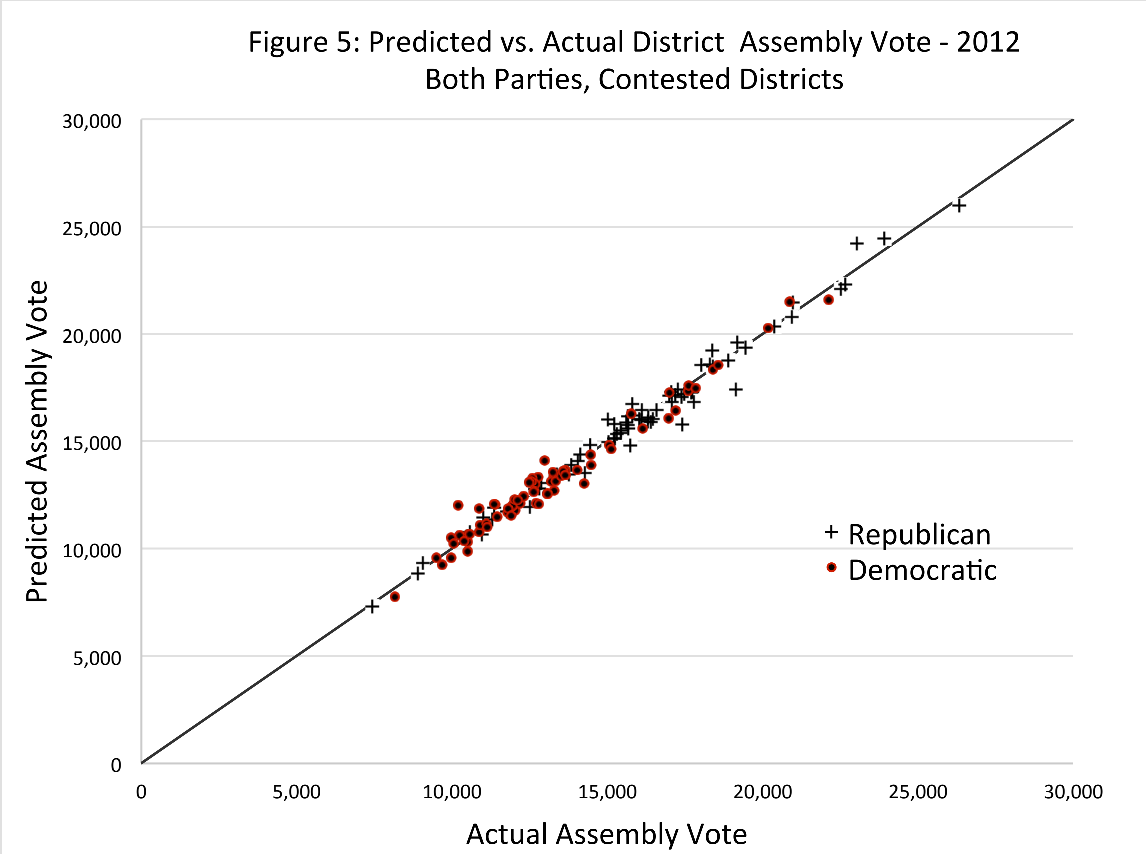


Figure 4: Ward Level Predicted vs. Actual Assembly Vote - 2012
Both Parties, Contested Districts
Predicted Assembly Vote
1,400
1,200
1,000
800
600
400
200
0
0
200
400
600
800
1,000
1,200
1,400
Actual Assembly Vote
Republican
Democratic



As important as the prediction of actual district vote totals is the model's ability to accurately identify the winner, as the efficiency gap calculation is sensitive to the party of the winners and losers.[17] The accuracy of the model is shown in Table 2, which gives the actual and predicted vote percentages of the two-party vote for Republican candidates in contested districts.[18]

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[17] All of the votes for a losing candidate are defined as wasted, whereas only those votes in excess of the number required to win are wasted for the winner.
[18] The vote percentages were calculated using the actual and predicted vote totals.

Table 2 - Predicted vs. Actual Vote Percentages, Contested Districts

Assembly District	Actual GOP Vote %	Predicted GOP Vote %	Correct Winner?	Error
1	51.3%	52.3%	Y	1.0%
2	58.7%	58.8%	Y	0.1%
3	60.4%	58.6%	Y	-1.8%
4	55.7%	54.6%	Y	-1.0%
5	55.9%	57.6%	Y	1.7%
6	59.5%	59.9%	Y	0.4%
13	60.6%	60.4%	Y	-0.2%
14	59.1%	60.7%	Y	1.6%
15	58.3%	57.1%	Y	-1.2%
20	42.4%	40.9%	Y	-1.5%
21	59.3%	56.9%	Y	-2.5%
23	62.3%	61.8%	Y	-0.5%
24	62.4%	61.0%	Y	-1.4%
25	57.7%	57.0%	Y	-0.7%
26	51.3%	55.1%	Y	3.8%
27	57.8%	54.4%	Y	-3.5%
28	56.2%	56.5%	Y	0.3%
29	55.9%	55.2%	Y	-0.7%
30	55.8%	56.5%	Y	0.7%
31	56.5%	55.9%	Y	-0.7%
32	59.1%	59.7%	Y	0.6%
33	64.9%	63.8%	Y	-1.0%
34	61.3%	60.9%	Y	-0.4%
35	56.0%	55.9%	Y	-0.1%
36	59.0%	60.0%	Y	1.0%
37	54.3%	56.0%	Y	1.7%
38	60.0%	61.9%	Y	1.9%
39	60.4%	60.0%	Y	-0.4%
41	58.0%	57.4%	Y	-0.5%
42	56.6%	54.8%	Y	-1.8%
43	42.3%	42.9%	Y	0.7%
44	38.4%	40.1%	Y	1.7%
45	36.1%	35.2%	Y	-1.0%
46	35.2%	34.5%	Y	-0.7%
47	29.0%	30.2%	Y	1.1%
49	54.4%	54.6%	Y	0.3%
50	51.7%	51.8%	Y	0.1%
51	51.9%	49.9%	N	-2.0%
52	60.7%	60.1%	Y	-0.6%
53	60.1%	62.9%	Y	2.8%
54	39.8%	42.0%	Y	2.3%
55	65.2%	59.2%	Y	-6.1%
56	58.3%	59.7%	Y	1.3%
60	71.2%	72.6%	Y	1.4%
61	55.7%	55.6%	Y	-0.1%
62	53.1%	53.9%	Y	0.8%
63	58.4%	57.7%	Y	-0.6%

67	53.3%	53.5%	Y	0.2%
68	52.4%	50.7%	Y	-1.8%
69	61.2%	58.5%	Y	-2.7%
70	49.7%	50.1%	N	0.4%
71	39.0%	39.3%	Y	0.2%
72	50.2%	51.3%	Y	1.1%
74	41.0%	41.1%	Y	0.1%
75	48.9%	49.2%	Y	0.2%
80	36.1%	35.3%	Y	-0.8%
81	38.1%	39.6%	Y	1.4%
82	60.3%	61.6%	Y	1.4%
83	69.8%	71.6%	Y	1.9%
84	62.8%	61.8%	Y	-1.0%
85	48.2%	48.7%	Y	0.5%
86	55.7%	56.1%	Y	0.4%
87	58.6%	58.3%	Y	-0.3%
88	52.5%	54.1%	Y	1.7%
89	59.1%	59.2%	Y	0.1%
90	39.6%	37.7%	Y	-1.9%
93	50.8%	52.0%	Y	1.2%
94	39.4%	39.4%	Y	0.0%
96	59.6%	59.7%	Y	0.1%
97	64.7%	64.4%	Y	-0.3%
98	70.5%	70.0%	Y	-0.5%
99	76.3%	77.0%	Y	0.7%

The regression model identifies the correct winner in 70 of 72 districts (97.2%); that is, it accurately identifies the candidate who received the most votes. In the two misclassified races, the Republican candidates received 51.9% and 49.7% of the vote. The average absolute error in the vote margin is 1.49%.

g. Out of Sample Forecasting Accuracy

These results, which compare predicted election results to the actual election results, demonstrate that the model is very accurate. A harder test involves the accuracy of predictions using data not in the sample – that is, applying the model to data and election results that are different from the data used to estimate the model. To test the model's out of sample accuracy, I reran the model 72 times (once for every contested district) excluding every ward in one single contested district each time,[19] and then used the results of that estimation to predict the vote totals in wards in the excluded district using the independent variable values for those wards. For example, in the first run I excluded all wards in Assembly district 2 (see footnote 20), and estimated the model using data from the other seventy one contested districts. I then used the results to predict the vote totals in the 2nd district, and compared the prediction to the actual vote totals. Since we know the actual election results in excluded districts, this exercise is a "hard test" of the model's general predictive ability.

Figure 6 and Table 3 show the results for the 60 contested districts in which the full model could be estimated.[20] The average district forecast error of the Republican vote percentage increased slightly, to 2.1%, but the out of sample forecasts identified the correct winner in 59 out of 60 races (98.3%). In Figure 6, which plots the actual versus predicted vote totals, the points are not grouped as tightly around the 45-degree line as they are in the full model predictions (Figure 5), but still show a very high degree of accuracy.

Table 3 -Out of Sample Predicted vs. Actual Vote Percentages, Contested Districts

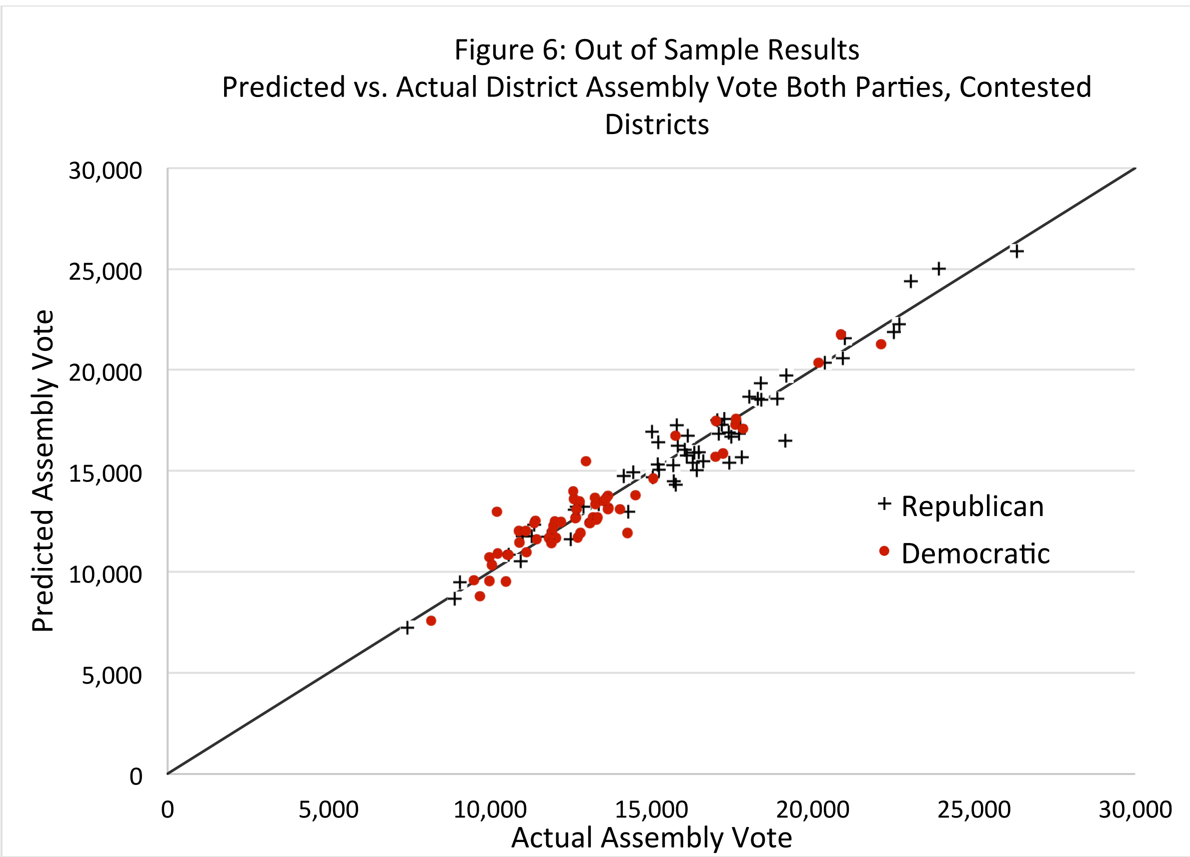
Assembly District	Actual GOP Vote %	Predicted GOP Vote %	Correct Winner?	Error
2	58.7%	59.0%	Y	0.3%
3	60.4%	57.5%	Y	-2.9%
4	55.7%	54.3%	Y	-1.3%
5	55.9%	58.9%	Y	2.9%
13	60.6%	60.4%	Y	-0.2%

[19] Uncontested districts were not included in the analysis for reasons specified in section B(1)(f) above.

[20] In twelve districts (districts 1, 6, 34, 35, 36, 49, 68, 74, 75, 93, 94 and 96), at least one county was entirely contained in a single district, making it impossible to estimate the fixed effect coefficient value for that county. Consequently, when the out-of-sample predictions were calculated, a variable was missing. An accurate test involves districts for which it was possible to estimate the full model.

14	59.1%	61.0%	Y	1.8%
15	58.3%	56.7%	Y	-1.6%
20	42.4%	39.9%	Y	-2.5%
21	59.3%	56.3%	Y	-3.1%
23	62.3%	61.4%	Y	-0.9%
24	62.4%	60.2%	Y	-2.3%
25	57.7%	55.7%	Y	-2.0%
26	51.3%	58.6%	Y	7.3%
27	57.8%	50.3%	Y	-7.5%
28	56.2%	55.1%	Y	-1.2%
29	55.9%	54.6%	Y	-1.3%
30	55.8%	57.2%	Y	1.4%
31	56.5%	55.7%	Y	-0.9%
32	59.1%	60.2%	Y	1.1%
33	64.9%	63.0%	Y	-1.9%
37	54.3%	56.3%	Y	2.0%
38	60.0%	62.3%	Y	2.3%
39	60.4%	59.0%	Y	-1.5%
41	58.0%	56.2%	Y	-1.7%
42	56.6%	51.8%	Y	-4.8%
43	42.3%	43.3%	Y	1.1%
44	38.4%	40.8%	Y	2.5%
45	36.1%	34.1%	Y	-2.0%
46	35.2%	34.1%	Y	-1.0%
47	29.0%	30.9%	Y	1.8%
50	51.7%	53.1%	Y	1.4%
51	51.9%	48.7%	N	-3.2%
52	60.7%	59.4%	Y	-1.3%
53	60.1%	64.4%	Y	4.4%
54	39.8%	43.8%	Y	4.0%
55	65.2%	56.0%	Y	-9.3%
56	58.3%	59.9%	Y	1.6%
60	71.2%	73.9%	Y	2.8%
61	55.7%	54.9%	Y	-0.8%
62	53.1%	54.5%	Y	1.4%
63	58.4%	57.1%	Y	-1.3%
67	53.3%	54.7%	Y	1.4%
69	61.2%	57.2%	Y	-4.0%
70	49.7%	49.7%	Y	0.0%
71	39.0%	40.1%	Y	1.1%
72	50.2%	53.0%	Y	2.8%
80	36.1%	35.1%	Y	-1.0%
81	38.1%	40.8%	Y	2.6%

82	60.3%	62.0%	Y	1.8%
83	69.8%	71.8%	Y	2.0%
84	62.8%	61.7%	Y	-1.1%
85	48.2%	49.0%	Y	0.8%
86	55.7%	56.9%	Y	1.2%
87	58.6%	54.6%	Y	-3.9%
88	52.5%	54.6%	Y	2.1%
89	59.1%	59.0%	Y	-0.1%
90	39.6%	36.9%	Y	-2.7%
97	64.7%	64.2%	Y	-0.5%
98	70.5%	69.9%	Y	-0.5%
99	76.3%	77.3%	Y	1.0%



The model does an excellent job accurately forecasting vote totals and election results, and provides a solid foundation for estimating hypothetical vote totals in an alternative district plan.

h. Comparison to 2011 Republican Expert Baseline Partisanship Measure

The method I have outlined here is a standard technique in the analysis of redistricting plans: creating a baseline measure of partisanship that is independent of a particular district configuration, and applying those estimates to alternative hypothetical district plans.

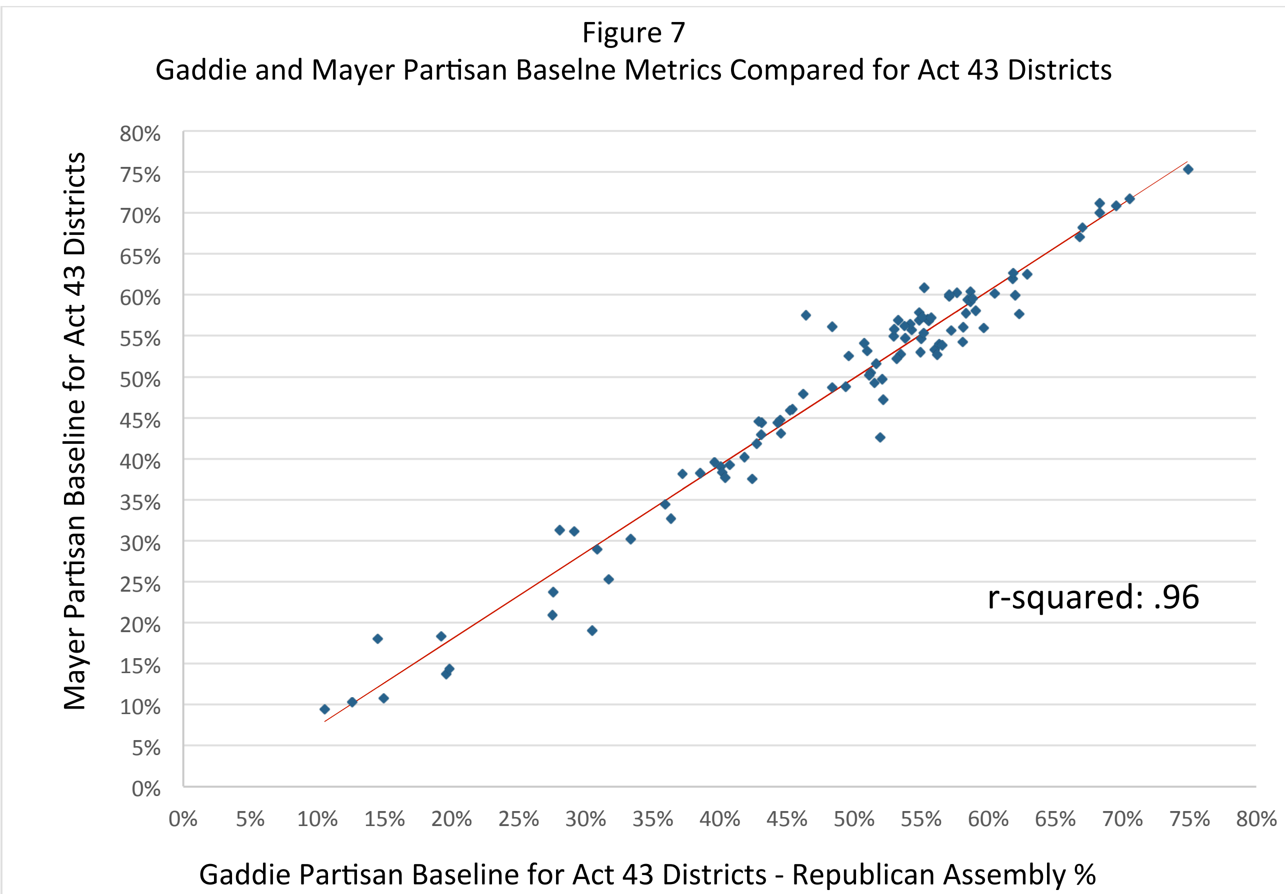
Indeed, in preparing the district plan that would become Act 43, the state legislature went through the same analytical exercise, generating partisanship measures to forecast what the election results would be in the districts enacted in that plan. The expert that the legislative Republicans relied on to conduct that analysis, Dr. Ronald Keith Gaddie, described the process and method as "an effort to create a partisan normal vote measure or a partisan baselining measure to use to apply to different districts to ascertain their political tendency."[21] The results of his regression analysis of the districts in Act 43 are in a spreadsheet used to evaluate the plan entitled "Final Map" which contains open seat baseline partisan estimates for existing and new Assembly districts.

Figure 7 compares Dr. Gaddie's open-seat baseline partisanship measure for the Act 43 districts with the equivalent results of my model, excluding the 8th and 9th Assembly districts which were redrawn by the Federal Court and are therefore not comparable. Gaddie's partisan baseline measure is plotted on the x-axis, and my measure on the y-axis. My measure is the expected partisan performance in actual Act 43 districts, with incumbency effects removed.[22] The two measures are strongly related, indicating that both are capturing stable features of partisanship in Wisconsin. The line is a bivariate regression line produced by using Dr. Gaddie's partisanship estimate as the independent variable and my measure as the dependent variable.

[21] Deposition, January 20, 2012, p. 196.
[22] I generated this data by calculating predicted values for my model in Act 43 districts, setting all incumbency variables to zero.

The r-squared for this regression is 0.96, indicating that the two measures are almost perfectly related, and are both capturing the same underlying partisanship.

The most important characteristics of Gaddie's measure is that it constitutes a true forecast of what was expected to occur in the 2012 elections, since the measure itself was generated in 2011 using data from the 2004-2010 elections. As I show below, this metric can be used to generate an efficiency gap measure of what was likely to happen (indeed, what *did* happen) in the 2012 election.



2. Step Two – Predicting Votes in a Demonstration District Plan

a. Creating a Demonstration District Plan

With the model parameters in hand, I can estimate baseline partisanship and vote totals in every ward, including those uncontested by both parties (because I have independent variables in all wards, even when only one party is on the Assembly ballot). For uncontested districts, the predicted ward vote totals are what would be expected if both parties ran a candidate, based on the values of the independent variables in the wards. I then use these predicted ward level vote totals to generate vote estimates at the Census block level, and build a demonstration district using Census blocks as my basic unit. Because the variables used in the model are exogenous to district configuration and the out of sample predictions are accurate, the results of the analysis in Step one represent a valid measure of what the Assembly vote would have been in a different district configuration.

I calculated estimated "open seat" vote totals, by subtracting the incumbency advantage in every district in which an incumbent ran. This is a more accurate method of determining the baseline partisanship of a district, as it removes the effect of incumbents, who may or may not be running in an alternative plan. This baseline process is standard in the discipline, and was used by the expert retained by the state legislature, Dr. Ronald Keith Gaddie, to analyze the partisan effects of Act 43 during the redistricting process.

To obtain block level vote estimates, I disaggregated the ward level predicted values for the Democratic and Republican vote totals to individual blocks in that ward, based on each block's share of the ward vote eligible population. This technique is widely used and accepted in the discipline (McDonald 2014; Pavia. and López-Quílez 2013). Census blocks have a voting eligible population range between 0 and 2,988, with an average of approximately 17 people. Wards contain an average of 40 blocks, although the range is substantial, with a minimum of 1 and a maximum of 740. At the end of this disaggregation process, I have a predicted Democratic and Republican Assembly vote total for each Census block in the state.

Table 4 shows an illustrative example, using Ward 23 in the city of Waukesha. This ward, located in the southeastern part of the city, had a 2010 Census population of 1,426, a voting age population of 1,089, and a voting eligible population of 1,071. The voting model generated estimates of 552 Republican and 318 Democratic votes in an open seat Assembly race in that ward. The ward contains twenty five Census blocks ranging in population from 0 to 127, with a voting eligible population range of 0 to 115.

The first column in Table 4 is the block's geographic identifier, a unique code.[23] The next column is the block's voting eligible population (VEP) calculated as described in the previous section by removing noncitizens and institutionalized persons (although there are no prisons in this ward). The third column is the block's share of the ward's total VEP of 1,071; for the first block in the table it is 38 ÷ 1,071= .0352, or 3.52%. The next column is block level Republican vote estimate, calculated as 3.52% the ward Republican vote of 552, or 19.438. While the table rounds these vote totals, I use fractional values in the actual calculations.

[23] The identifier is a combination of state, county, Census tract, and block FIPS codes.

Table 4 - Ward to Block Disaggregation
City of Waukesha Ward 23

Ward Voting Eligible Population				**1,071**
Ward Estimated Republican Assembly Vote				**552**
Ward Estimated Democratic Assembly Vote				**318**
Block Geographic Identifier	**Block VEP**	**Block Share of Ward VEP (Block VEP ÷ 1,071)**	**Block Level Republican Vote Estimate (Block Share * 522)**	**Block Level Democratic Vote Estimate (Block Share * 318)**
551332024001002	38	3.52%	19	11
551332024001003	56	5.24%	29	17
551332024001004	65	6.06%	33	19
551332024001005	30	2.77%	15	9
551332024001007	47	4.37%	24	14
551332024001008	81	7.57%	42	24
551332024001009	12	1.11%	6	4
551332024001010	50	4.70%	26	15
551332024001011	26	2.46%	14	8
551332024001012	25	2.32%	13	7
551332024001013	44	4.14%	23	13
551332024001014	60	5.57%	31	18
551332024001015	30	2.77%	15	9
551332024001016	53	4.99%	28	16
551332024001017	0	0.00%	0	0
551332024002009	10	0.93%	5	3
551332024002010	50	4.68%	26	15
551332024002011	65	6.06%	33	19
551332024002012	37	3.44%	19	11
551332024002013	39	3.61%	20	12
551332024003036	41	3.78%	21	12
551332024003039	15	1.39%	8	4
551332024003040	62	5.76%	32	18
551332024003042	22	2.01%	11	6
551332025005011	115	10.73%	59	34

Next, I input this block level data into a commercial GIS software package used for redistricting (Maptitude for Redistricting 2013, Build 2060) matching each block in the database of estimated votes with the same block in the Maptitude data using the block identification code.

Finally, I drew a redistricting plan with the goal of minimizing the efficiency gap while adhering to the Wisconsin and federal Constitutional requirements of equal population, contiguity, compactness, and respect for political subdivisions. Beyond these criteria. the primary decision rule was creating competitive districts where possible, and balancing the number of districts with large Democratic and Republican majorities.

Figures 8 and 9 show the statewide map and the districts in the Milwaukee area.

Figure 8 – Demonstration Plan Statewide Map

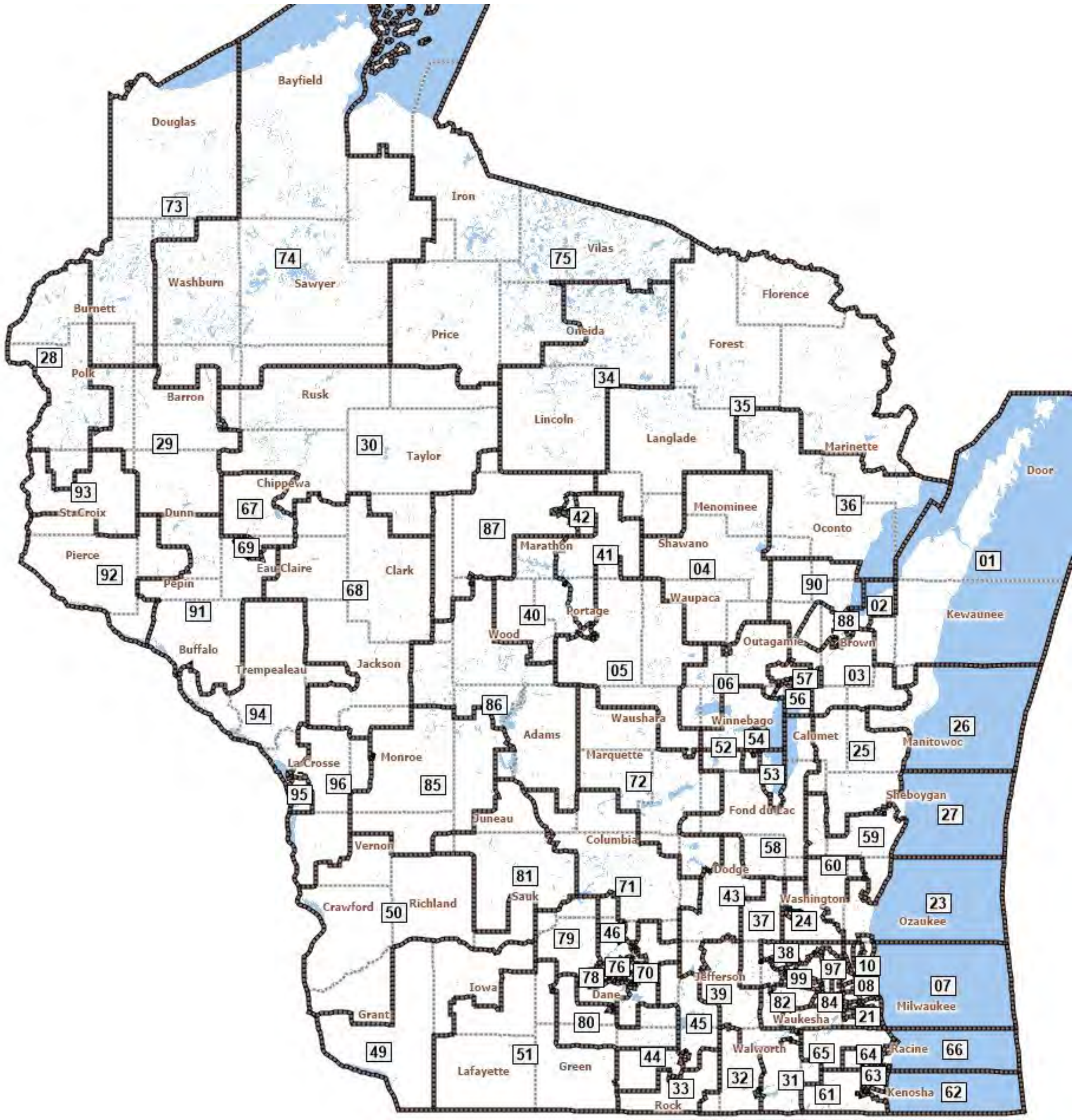
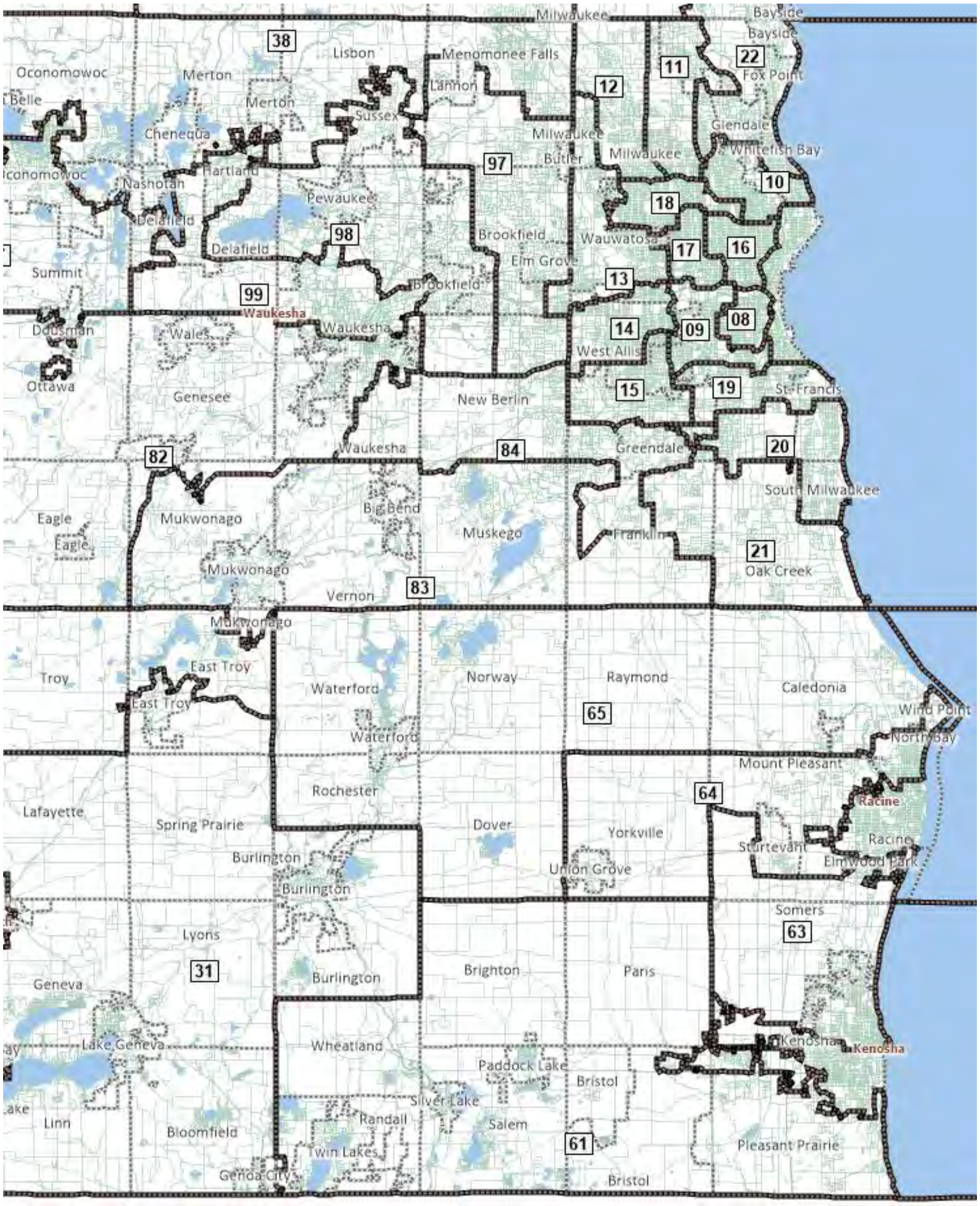


Figure 9 – Demonstration Plan - Milwaukee Area



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b. Constitutional and Statutory Requirements

Table 5 shows the summary data for the Demonstration Plan (the full tables are in the annex to this report) and comparison data for the actual 2012 plan implemented in Act 43.[24] The Demonstration Plan has a marginally larger population deviation, but is well below even the strictest standards applied to state legislative districts (a difference of 0.1% translates into 57 people). The population range in the Demonstration Plan is 57,191 to 57,686, a difference of 495 people. Given the ideal Assembly district population of 57,444, this is a deviation of 0.86%. The Demonstration Plan is more compact on average than Act 43, and has fewer municipal splits (119 compared to 120 in Act 43). On all constitutional requirements, the Demonstration Plan is comparable to Act 43.

Table 5 - Plan Comparison to Act 43

		Demonstration Plan	Act 43
Population Deviation		0.86%	0.76%
Average Compactness (Reock)		0.41	0.28
Number of Municipal Splits	County	55	58
	City Town Village	64	62

Act 43 created six majority-minority Black population districts (numbers 10-12 and 16-18), ranging from 56.7% -67.6% Black population, and from 51.1%-61.8% Black voting age population. The Demonstration Plan retains six Majority Black Assembly districts, ranging from 60.0% to 63.4% Black population, and from 56.2% to 60.5% Black voting age population:

[24] Act 43 figures are taken from the Joint Final Pretrial Report filed in *Baldus et al. vs Brennan et al.*11-CV-562, filed February 24, 2012.

Table 6 - Black Majority Districts in Demonstration Plan						
Assembly District	**Population**	**Voting Age Population**	**Black Population**	**Black Percentage of Population**	**Black Voting Age Population**	**BVAP%**
10	57,195	41,528	36,593	64.0%	25,125	60.5%
11	57,455	40,510	34,822	60.6%	22,762	56.2%
12	57,420	38,774	34,923	60.8%	21,829	56.3%
16	57,282	42,469	36,321	63.4%	23,920	56.3%
17	57,437	39,639	34,450	60.0%	22,275	56.2%
18	57,241	40,840	35,316	61.7%	24,054	58.9%

In *Baldus et al. v. Brennan et al.*, a federal Court created a majority Latino district in Milwaukee (the 8th Assembly District). The Demonstration Plan retains the boundaries of this district thereby insuring compliance with Section 2 of the Voting Rights Act.

C. Efficiency Gap Calculations

With the model described in Step one above and the block-level partisanship baseline it generates, I can analyze any existing or hypothetical district configuration and generate predicted vote totals and efficiency gap measures for the Demonstration Plan.

1. Analysis of Act 43

Any discussion of Act 43 must begin with the basic fact that in 2012 Republicans achieved a 60-39 majority in the Assembly in an election in which the Democratic Party achieved 53.5% of the statewide two-party presidential vote. The imbalance between the Republican Party's statewide vote margin at the top of the ticket (46.5%) and its Assembly majority (60.6%) turns the very notion of partisan symmetry on its head. That standard, according to King and Grofman (2007,8) "requires that the number of seats one party would receive if it garnered a particular percentage of the vote be identical to the number of seats the other party would receive if it had received the same percentage of the vote" (2007,8). Here, it means that Democrats would have had to obtain 60 Assembly seats with 46.5% of the vote, an absurd proposition that requires a party's legislative seat share to go *up* as its share of the vote goes *down*.

This result was achieved via the classic gerrymandering strategies of packing and cracking. Figure 10, a histogram of Republican two party vote percentages in 2012, shows the pattern. Here, the bars to the right of 50% indicate a Republican victory. Twenty three Democratic candidates were uncontested, indicating a significant level of packing (the bar at the far left side of the figure); uncontested races occur largely when one party sees zero probability of winning because the majority party has such overwhelming majorities in the district. By contrast, only four Republicans were uncontested. Act 43 also successfully cracked Democratic majorities in other districts, creating Republican majorities that were either marginal (twelve in the 50-55% range) or relatively safe (thirty nine in the 55-65% range). The 2012 results are consistent with what was forecast in 2011, as shown by Figure 11, a histogram of Dr. Gaddie's baseline partisanship measure for Act 43 districts. This measure forecast fifty one Assembly districts with between 50% and 65% Republican vote share. This is the same number that actually occurred, fifty one.

Figure 12 shows the baseline partisanship district forecasts for Act 43, using the model outline in Step one, above. It is very similar to Dr. Gaddie's forecast and the actual results: it forecast fifty districts with between 50% and 65% Republican vote share.

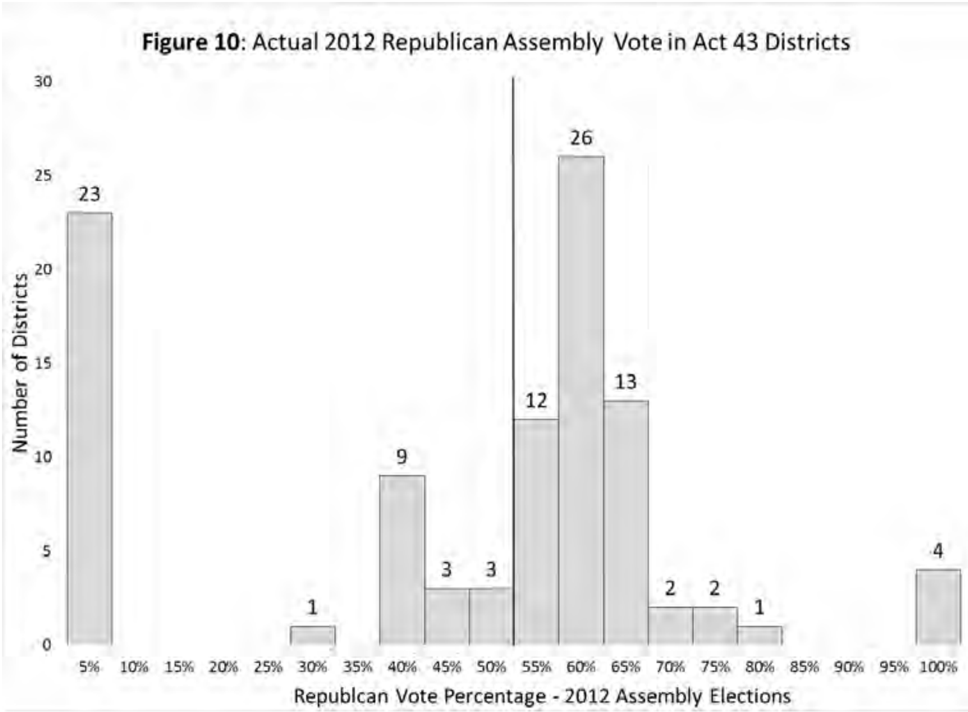


Figure 10: Actual 2012 Republican Assembly Vote in Act 43 Districts
Number of Districts
30
25
20
15
10
5
0
23
1
9
3
3
12
26
13
2
2
1
4
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%
Republcan Vote Percentage - 2012 Assembly Elections

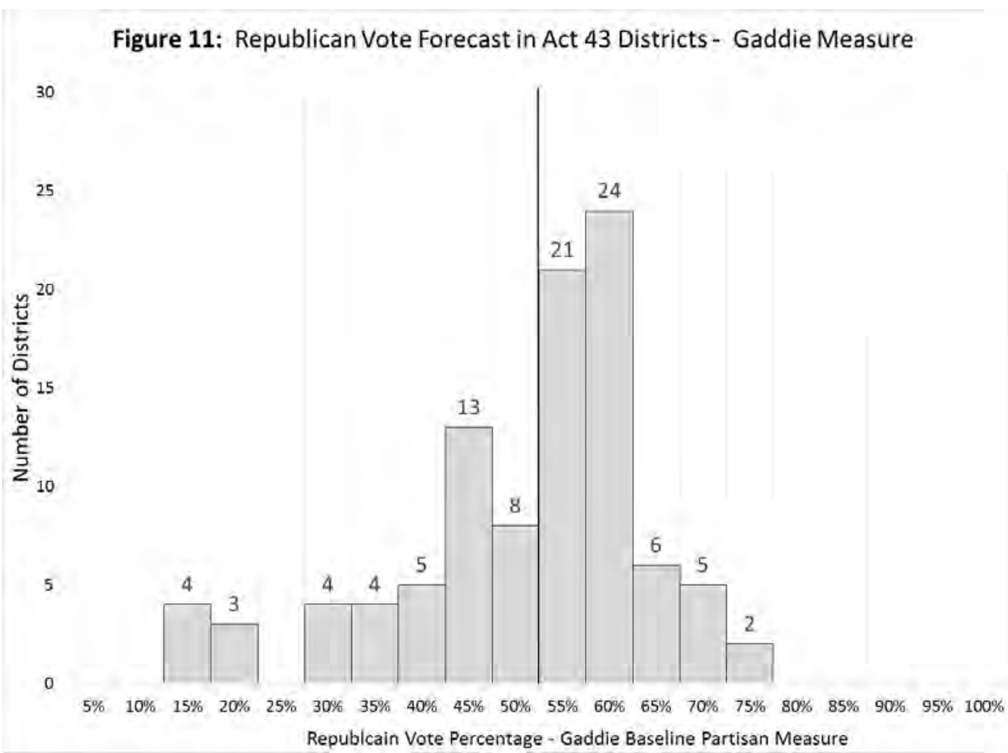
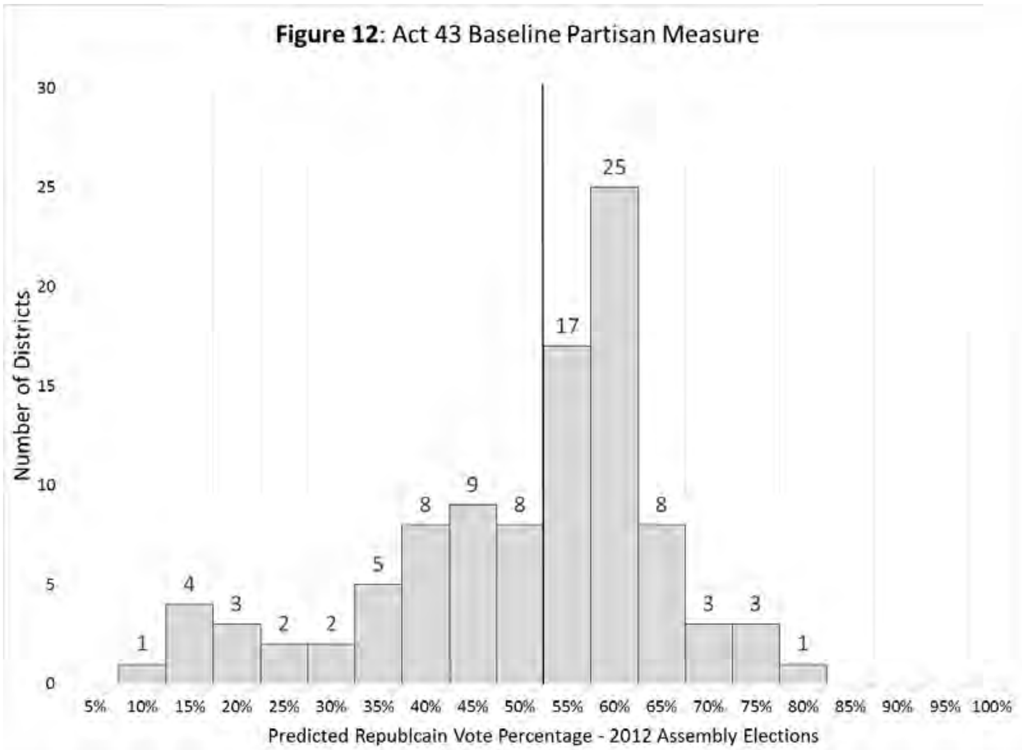


Figure 11: Republican Vote Forecast in Act 43 Districts - Gaddie Measure
Number of Districts
30
25
20
15
10
5
0
4
3
4
4
5
13
8
21
24
6
5
2
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%
Republcain Vote Percentage - Gaddie Baseline Partisan Measure



The treatment of the city of Sheboygan shows how this cracking was achieved. Sheboygan is a city on the Lake Michigan shoreline with a population of 49,285. It is a strongly Democratic area, voting 58.7%-41.3% for Obama in 2012; my baseline partisanship estimate for the city is 58.2%. The city is small enough to be contained in a single Assembly district in which it would constitute 86% of the ideal population, and it was entirely within the 26th Assembly district in both the 1992 and 2001 redistricting rounds. The areas surrounding it – the Village of Kohler and the Towns of Sheboygan and Wilson are all strongly Republican (with vote percentages for Romney of 62.8 %, 56.3%, and 59.4%, respectively; together, these municipalities constitute an area that is 58.2% Republican, as measured by the presidential vote).

Keeping the city of Sheboygan together would have created a Democratic district, made up of the city itself (58.7% Democratic) with the remaining 14% of population drawn from one of the Republican areas around it. The result would have been a District that was roughly 54%-56% Democratic.

Act 43, however, split Sheboygan into separate Assembly districts, placing 32,640 residents of the city into the 26^{th} District, and 16,645 into the 27^{th}. With the city split, these areas were combined into the Republican areas surrounding the city, producing two Republican districts: the 26^{th} (51.3% Republican in the 2012 Assembly race; baseline open seat partisanship measure of 53.3%) and the 27^{th} (57.9% Republican in the 2012 Assembly race, baseline open seat partisanship measure of 52.3%).

Figure 13, below, shows the split into Districts 26 and 27:

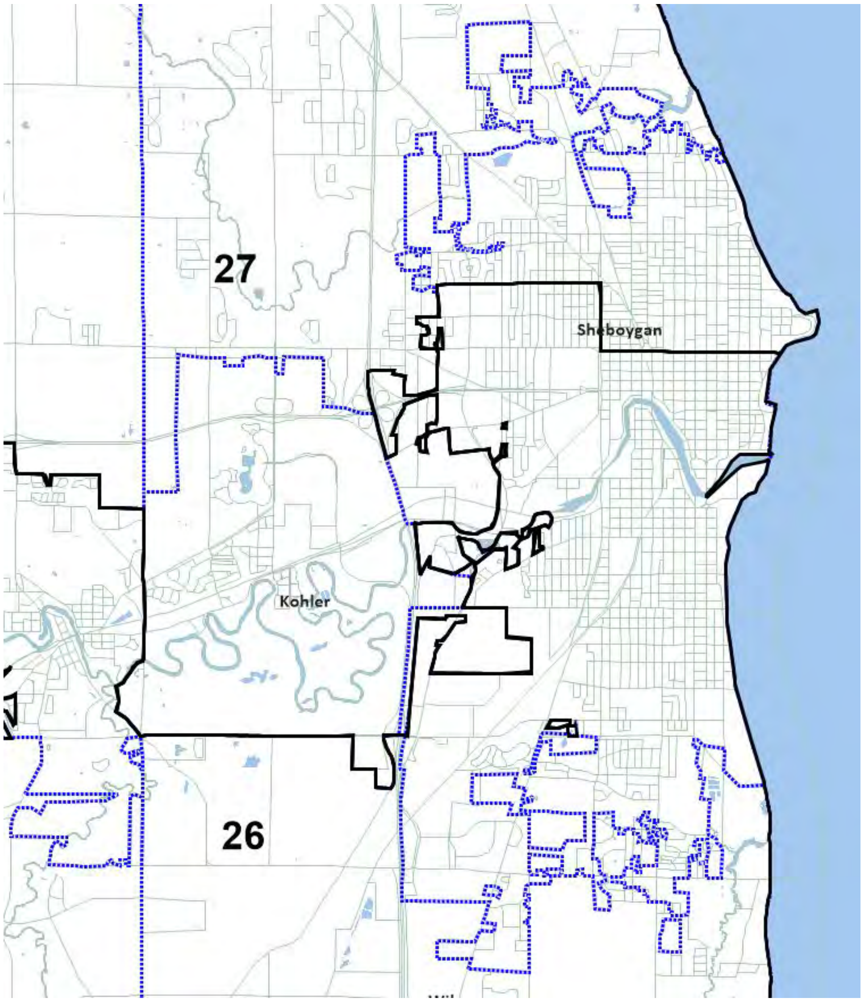


Figure 13– Act 43 Treatment of Sheboygan

2. Efficiency Gap Calculations for Act 43 and The Demonstration Plan

Recall that the efficiency gap is a measure of gerrymandering based on the difference in the number of "wasted votes." Votes cast for losing candidates are wasted, as are surplus votes for winning candidates above what is necessary to win. The gap is defined as the difference between the sum of wasted votes for the two parties, divided by the total number of votes cast in the election.

Comparing a hypothetical district plan (where vote totals are predicted) to an existing district plan (where vote totals are known) requires care, in large part because it can be difficult to know with certainty what districts will have incumbents (or how incumbents might rearrange themselves after a redistricting cycle), and because not every district will be contested in an actual election (Stephanopoulos and McGhee 2015).

Handling uncontested races is a straightforward problem; the key is applying a consistent rule to all plans being compared. In the efficiency gap calculation for my plan, I measure underlying partisan strength in each district by estimating the number of votes that would be cast for each party in an open seat election each district, *assuming that all races are contested*. In the actual 2012 Assembly elections, only 72 of 99 seats were contested by both major parties, leaving 27 uncontested races. Uncontested races by themselves will not necessarily have a dramatic effect on efficiency gap calculations as long as the number of races is small, or if uncontested districts are evenly split between the parties (as a rule, one uncontested race with only a Democrat will cancel out one uncontested race with only a Republican, conditioned on the number of votes cast in each race). But a significant imbalance in uncontested races will have a material effect on the results. Of the 27 uncontested races in 2012, 23 were in Democratic districts and only 4 in Republican districts.

In the academic redistricting literature, uncontested seats are typically handled by imputing what the vote totals would have been if a race had been contested (Gelman and King 1990), or assigning each uncontested race a 75%-25% vote split in favor of the party whose candidate ran unopposed (Gelman and King 1994; Stephanopoulos and McGhee 2015). Because I have direct measures of partisanship and vote predictions, I am able to generate accurate estimates of what the vote totals would have been in Act 43's uncontested districts had both parties fielded candidates. In applying this method to the uncontested districts in the 2012 State Assembly elections, I create two directly equivalent sets of data: one for the Demonstration Plan, with predicted values of open seat vote totals for all districts, and one for the districts created in Act 43, using open seat estimates for each district. Efficiency gap results for the two redistricting plans constructed this way can be compared directly.

Table 7 shows the full set of efficiency gap calculations for the Demonstration Plan, with incumbency effects removed. For each district I calculate an estimated Democratic and Republican vote total, and forecast a winner. The resulting columns show the number of "wasted votes," counting all votes cast for a losing candidates, and surplus votes for winning candidates (equal to ½ of the margin of victory). Totals for each party are summed, and the efficiency gap calculated as the Net Wasted Votes (here, Democratic Wasted Votes – Republican Wasted Votes) divided by the total number of votes cast in the election.

The data in Table 7 (on page 48) show that the Demonstration Plan results in 741,984 wasted Democratic votes (column E), obtained by adding the number of lost Democratic votes cast for losing candidates (566,634, column A) and the number of surplus Democratic votes cast for winners above what was necessary to win (175,350, column C). The same calculation for Republicans (using columns B and D) results in 689,570 wasted Republican votes. The difference between these two numbers, 781,984 - 689,570 = 62,414 net wasted Democratic votes. Dividing 62,414 by the predicted total number of votes 2,843,108, produces the baseline efficiency gap for my plan, .0220, or 2.20%.

Table 8 (on page 50) shows the same calculation for Act 43 districts, using estimated partisan vote totals with incumbent advantages removed. Act 43 resulted in a total of 332,552 net wasted Democratic votes. The efficiency gap of Act 43 is 11.69%, more than five times larger than the Demonstration Plan.

Table 9 (on page 52) shows the efficiency gap calculation for the partisan baseline prediction used by Dr. Gaddie during the drawing of the Act 43 districts, applying his partisanship division to the total number of votes predicted from my model in each district. As described above in section III(B)(1)(h) above, this is the predicted baseline partisanship measure of Act 43. It produces a forecast Efficiency Gap for Act 43 of 12.36%.

Table 10 summarizes these results:

	Table 10: Summary Statistics for Redistricting Plans		
	My Plan Baseline	**Act 43 Baseline**	**Act 43 - Gaddie Measure**
party split (R-D)	48-51	57-42	58-41
Wasted Republican Votes	679,570	544,893	535,057
Wasted Democratic Votes	741,984	877,445	886,403
Gap	62,414	332,552	351,346
Total Democratic Votes	1,454,117	1,454,717	1,394,018
Total Republican Votes	1,388,991	1,389,958	1,448,901
Total Votes	2,843,108	2,844,676	2,842,919
Efficiency Gap (gap/total votes)	**2.20%**	**11.69%**	**12.36%**

Three things are worth emphasizing. The first is that the predicted partisan effect of Act 43, represented by the Gaddie metric, produced an efficiency gap calculation (12.36%) that was very close to the actual partisan effect of Act 43, as measured by the efficiency gap calculation for the actual 2012 partisan baseline (11.69%). In brief, the architects of the Act 43 districts expected a partisan result that was almost identical to what actually occurred. The second is the large reduction in the efficiency gap that I am able to produce, which I have achieved without any departure from the core constitutional and statutory requirements of redistricting. The

Demonstration Plan is equivalent to Act 43 on all key criteria: population deviation, compactness, number of political subdivision splits, and compliance with the Voting Rights Act. At the same time, I have generated an efficiency gap score 82% smaller than the Act 43 gap. And third, I have reached this efficiency gap score with virtually identical numbers of Democratic and Republican voters as exist under Act 43. Given that my partisan estimates, once incumbency effects are removed, are *entirely exogenous to any particular district configuration*, these can be considered the same statewide set of voters. By placing the same voters as exist in Act 43 into a new set of districts designed to minimize the effects of gerrymandering while adhering to constitutional standards, I have generated a plan that is fair to both parties.

Figure 14 shows the distribution of baseline Republican vote predictions in the Demonstration Plan Assembly districts. The districts are far more balanced, with similar numbers of districts between 40% - 50% (twenty seven) and between 50% - 60% (twenty nine). There are also roughly equal numbers of districts above 65% (twelve) and below 35% (sixteen).

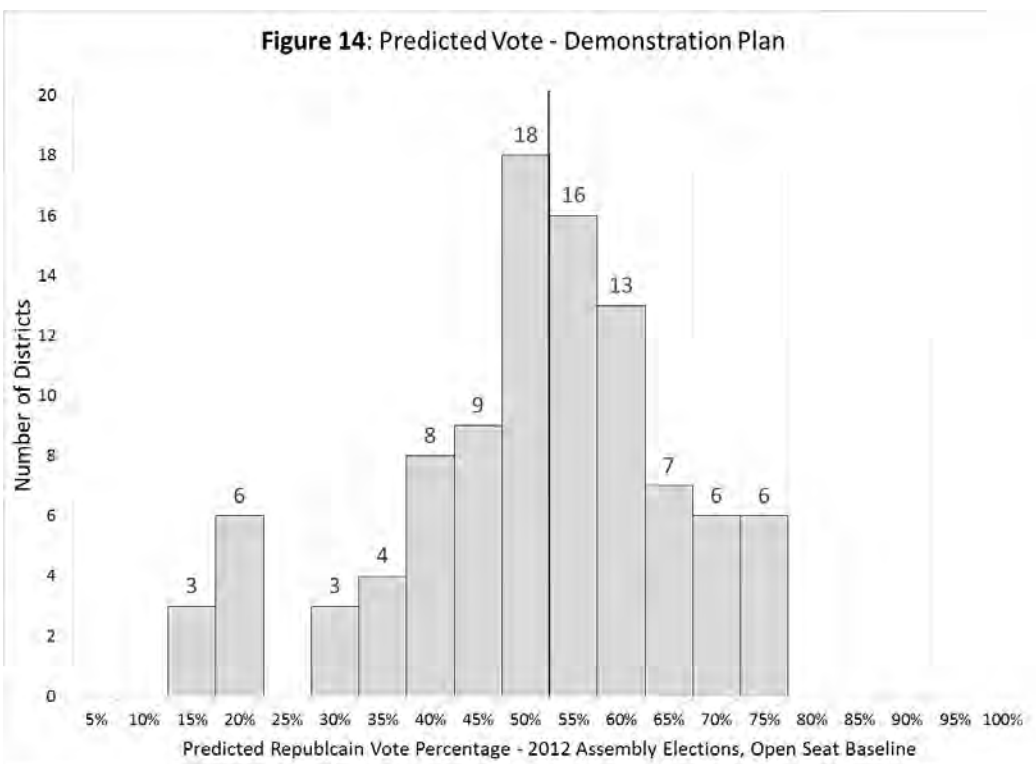


Table 7 - Efficiency Gap Calculation for Demonstration District Plan - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	16,259	16,414	Republican	16259	0	0	78	16259	78	16181
2	11,805	10,025	Democratic	0	10025	890	0	890	10025	-9136
3	11,243	17,807	Republican	11243	0	0	3282	11243	3282	7961
4	10,881	12,790	Republican	10881	0	0	955	10881	955	9926
5	13,497	13,845	Republican	13497	0	0	174	13497	174	13323
6	11,045	17,627	Republican	11045	0	0	3291	11045	3291	7753
7	22,822	10,214	Democratic	0	10214	6304	0	6304	10214	-3910
8	7,192	1,695	Democratic	0	1695	2749	0	2749	1695	1054
9	10,497	5,635	Democratic	0	5635	2431	0	2431	5635	-3205
10	25,348	3,270	Democratic	0	3270	11039	0	11039	3270	7769
11	22,374	4,855	Democratic	0	4855	8759	0	8759	4855	3904
12	20,041	4,039	Democratic	0	4039	8001	0	8001	4039	3962
13	15,950	16,510	Republican	15950	0	0	280	15950	280	15670
14	13,575	13,799	Republican	13575	0	0	112	13575	112	13464
15	13,412	14,901	Republican	13412	0	0	745	13412	745	12667
16	21,234	2,856	Democratic	0	2856	9189	0	9189	2856	6333
17	21,769	3,569	Democratic	0	3569	9100	0	9100	3569	5531
18	23,817	4,954	Democratic	0	4954	9431	0	9431	4954	4477
19	15,160	10,904	Democratic	0	10904	2128	0	2128	10904	-8776
20	14,118	12,901	Democratic	0	12901	609	0	609	12901	-12292
21	12,257	16,911	Republican	12257	0	0	2327	12257	2327	9930
22	18,335	14,831	Democratic	0	14831	1752	0	1752	14831	-13079
23	10,922	25,459	Republican	10922	0	0	7268	10922	7268	3654
24	8,667	25,868	Republican	8667	0	0	8601	8667	8601	66
25	12,179	18,248	Republican	12179	0	0	3034	12179	3034	9145
26	13,251	14,527	Republican	13251	0	0	638	13251	638	12613
27	14,935	11,755	Democratic	0	11755	1590	0	1590	11755	-10165
28	12,617	15,591	Republican	12617	0	0	1487	12617	1487	11131
29	14,180	12,954	Democratic	0	12954	613	0	613	12954	-12341
30	11,308	15,165	Republican	11308	0	0	1929	11308	1929	9379
31	11,304	16,117	Republican	11304	0	0	2406	11304	2406	8898
32	12,685	13,787	Republican	12685	0	0	551	12685	551	12135
33	14,609	10,151	Democratic	0	10151	2229	0	2229	10151	-7922
34	13,139	15,690	Republican	13139	0	0	1275	13139	1275	11864
35	11,288	16,503	Republican	11288	0	0	2607	11288	2607	8681
36	11,516	14,997	Republican	11516	0	0	1741	11516	1741	9775
37	9,222	22,240	Republican	9222	0	0	6509	9222	6509	2713
38	9,710	25,021	Republican	9710	0	0	7655	9710	7655	2055
39	10,747	17,526	Republican	10747	0	0	3390	10747	3390	7357
40	15,061	13,947	Democratic	0	13947	557	0	557	13947	-13391
41	16,784	13,120	Democratic	0	13120	1832	0	1832	13120	-11288
42	13,254	12,282	Democratic	0	12282	486	0	486	12282	-11796
43	12,658	13,606	Republican	12658	0	0	474	12658	474	12184
44	16,477	10,886	Democratic	0	10886	2795	0	2795	10886	-8091
45	16,352	13,589	Democratic	0	13589	1382	0	1382	13589	-12207
46	20,583	11,418	Democratic	0	11418	4582	0	4582	11418	-6835
47	20,208	9,888	Democratic	0	9888	5160	0	5160	9888	-4728

48	24,457	8,840	Democratic	0	8840	7808	0	7808	8840	-1032
49	13,625	13,477	Democratic	0	13477	74	0	74	13477	-13403
50	12,289	13,709	Republican	12289	0	0	710	12289	710	11579
51	14,760	13,323	Democratic	0	13323	718	0	718	13323	-12605
52	12,376	19,416	Republican	12376	0	0	3520	12376	3520	8857
53	12,388	13,362	Republican	12388	0	0	487	12388	487	11902
54	14,032	12,240	Democratic	0	12240	896	0	896	12240	-11344
55	13,565	15,300	Republican	13565	0	0	868	13565	868	12697
56	12,553	14,518	Republican	12553	0	0	983	12553	983	11570
57	14,897	13,016	Democratic	0	13016	941	0	941	13016	-12075
58	9,325	21,180	Republican	9325	0	0	5927	9325	5927	3398
59	11,565	21,984	Republican	11565	0	0	5209	11565	5209	6356
60	8,756	22,415	Republican	8756	0	0	6830	8756	6830	1926
61	12,933	16,576	Republican	12933	0	0	1822	12933	1822	11112
62	15,181	9,999	Democratic	0	9999	2591	0	2591	9999	-7408
63	15,640	9,902	Democratic	0	9902	2869	0	2869	9902	-7033
64	15,089	13,470	Democratic	0	13470	810	0	810	13470	-12660
65	12,721	19,816	Republican	12721	0	0	3547	12721	3547	9173
66	16,286	6,362	Democratic	0	6362	4962	0	4962	6362	-1401
67	15,321	14,226	Democratic	0	14226	547	0	547	14226	-13678
68	11,958	12,124	Republican	11958	0	0	83	11958	83	11875
69	17,902	12,022	Democratic	0	12022	2940	0	2940	12022	-9083
70	18,661	12,266	Democratic	0	12266	3197	0	3197	12266	-9069
71	15,081	13,884	Democratic	0	13884	599	0	599	13884	-13285
72	11,180	16,542	Republican	11180	0	0	2681	11180	2681	8500
73	17,137	10,785	Democratic	0	10785	3176	0	3176	10785	-7609
74	17,712	14,219	Democratic	0	14219	1747	0	1747	14219	-12472
75	13,902	17,700	Republican	13902	0	0	1899	13902	1899	12002
76	30,929	6,811	Democratic	0	6811	12059	0	12059	6811	5248
77	26,708	6,059	Democratic	0	6059	10325	0	10325	6059	4266
78	24,413	9,847	Democratic	0	9847	7283	0	7283	9847	-2564
79	20,439	13,294	Democratic	0	13294	3572	0	3572	13294	-9722
80	20,179	11,644	Democratic	0	11644	4267	0	4267	11644	-7377
81	13,703	12,741	Democratic	0	12741	481	0	481	12741	-12260
82	9,871	21,201	Republican	9871	0	0	5665	9871	5665	4206
83	9,241	23,075	Republican	9241	0	0	6917	9241	6917	2324
84	11,990	22,700	Republican	11990	0	0	5355	11990	5355	6634
85	10,028	13,190	Republican	10028	0	0	1581	10028	1581	8448
86	13,853	13,494	Democratic	0	13494	180	0	180	13494	-13314
87	11,358	17,003	Republican	11358	0	0	2823	11358	2823	8535
88	14,209	11,142	Democratic	0	11142	1533	0	1533	11142	-9609
89	13,374	15,771	Republican	13374	0	0	1199	13374	1199	12175
90	11,349	17,468	Republican	11349	0	0	3059	11349	3059	8290
91	14,807	13,845	Democratic	0	13845	481	0	481	13845	-13364
92	14,907	14,594	Democratic	0	14594	157	0	157	14594	-14437
93	12,441	18,057	Republican	12441	0	0	2808	12441	2808	9633
94	16,171	11,759	Democratic	0	11759	2206	0	2206	11759	-9553
95	19,769	9,949	Democratic	0	9949	4910	0	4910	9949	-5040
96	14,665	13,836	Democratic	0	13836	415	0	415	13836	-13421
97	11,492	24,222	Republican	11492	0	0	6365	11492	6365	5128
98	9,864	24,773	Republican	9864	0	0	7454	9864	7454	2410
99	10,783	19,160	Republican	10783	0	0	4188	10783	4188	6594
TOTALS	**1,454,117**	**1,388,991**		**566,634**	**536,783**	**175,350**	**142,787**	**741,984**	**679,570**	**62,414**

Table 8 - Efficiency Gap Calculation for Act 43 - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	16,235	16,628	Republican	16235	0	0	197	16235	197	16038
2	12,398	16,357	Republican	12398	0	0	1980	12398	1980	10419
3	12,623	16,636	Republican	12623	0	0	2006	12623	2006	10617
4	13,926	15,576	Republican	13926	0	0	825	13926	825	13101
5	12,710	16,017	Republican	12710	0	0	1654	12710	1654	11056
6	10,929	14,938	Republican	10929	0	0	2005	10929	2005	8924
7	13,793	11,778	Democratic	0	11778	1007	0	1007	11778	-10771
8	7,342	1,738	Democratic	0	1738	2802	0	2802	1738	1064
9	10,023	4,533	Democratic	0	4533	2745	0	2745	4533	-1787
10	25,306	2,897	Democratic	0	2897	11205	0	11205	2897	8308
11	21,698	3,368	Democratic	0	3368	9165	0	9165	3368	5797
12	19,700	5,222	Democratic	0	5222	7239	0	7239	5222	2018
13	13,345	20,358	Republican	13345	0	0	3506	13345	3506	9839
14	14,499	21,025	Republican	14499	0	0	3263	14499	3263	11235
15	13,006	17,310	Republican	13006	0	0	2152	13006	2152	10853
16	22,293	2,342	Democratic	0	2342	9975	0	9975	2342	7633
17	24,088	4,047	Democratic	0	4047	10020	0	10020	4047	5973
18	22,204	2,692	Democratic	0	2692	9756	0	9756	2692	7064
19	22,759	10,364	Democratic	0	10364	6198	0	6198	10364	-4166
20	16,066	12,856	Democratic	0	12856	1605	0	1605	12856	-11252
21	12,566	15,324	Republican	12566	0	0	1379	12566	1379	11187
22	11,290	22,958	Republican	11290	0	0	5834	11290	5834	5456
23	14,260	21,633	Republican	14260	0	0	3687	14260	3687	10573
24	13,885	20,335	Republican	13885	0	0	3225	13885	3225	10659
25	12,032	15,933	Republican	12032	0	0	1950	12032	1950	10082
26	13,639	15,559	Republican	13639	0	0	960	13639	960	12679
27	14,709	16,360	Republican	14709	0	0	826	14709	826	13883
28	12,719	15,302	Republican	12719	0	0	1291	12719	1291	11428
29	12,909	14,662	Republican	12909	0	0	876	12909	876	12033
30	14,019	16,951	Republican	14019	0	0	1466	14019	1466	12553
31	13,273	15,615	Republican	13273	0	0	1171	13273	1171	12102
32	11,255	15,359	Republican	11255	0	0	2052	11255	2052	9203
33	11,226	18,298	Republican	11226	0	0	3536	11226	3536	7690
34	12,445	19,355	Republican	12445	0	0	3455	12445	3455	8991
35	12,270	15,525	Republican	12270	0	0	1628	12270	1628	10643
36	11,403	15,672	Republican	11403	0	0	2134	11403	2134	9269
37	12,707	16,202	Republican	12707	0	0	1747	12707	1747	10960
38	12,668	19,129	Republican	12668	0	0	3231	12668	3231	9437
39	11,491	17,211	Republican	11491	0	0	2860	11491	2860	8630
40	11,485	13,597	Republican	11485	0	0	1056	11485	1056	10429
41	11,719	14,492	Republican	11719	0	0	1387	11719	1387	10332
42	13,705	15,462	Republican	13705	0	0	879	13705	879	12826
43	17,380	13,075	Democratic	0	13075	2153	0	2153	13075	-10923
44	16,680	10,304	Democratic	0	10304	3188	0	3188	10304	-7116
45	15,153	9,691	Democratic	0	9691	2731	0	2731	9691	-6959
46	19,173	11,534	Democratic	0	11534	3819	0	3819	11534	-7714
47	21,609	9,340	Democratic	0	9340	6135	0	6135	9340	-3205
48	24,517	7,635	Democratic	0	7635	8441	0	8441	7635	806
49	12,307	13,621	Republican	12307	0	0	657	12307	657	11650

50	12,467	12,326	Democratic	0	12326	71	0	71	12326	-12256
51	14,173	13,048	Democratic	0	13048	563	0	563	13048	-12485
52	11,294	15,656	Republican	11294	0	0	2181	11294	2181	9113
53	9,875	16,753	Republican	9875	0	0	3439	9875	3439	6437
54	15,180	12,882	Democratic	0	12882	1149	0	1149	12882	-11733
55	12,634	16,971	Republican	12634	0	0	2169	12634	2169	10465
56	12,564	18,576	Republican	12564	0	0	3006	12564	3006	9559
57	14,387	11,676	Democratic	0	11676	1355	0	1355	11676	-10321
58	8,843	22,417	Republican	8843	0	0	6787	8843	6787	2055
59	8,784	21,725	Republican	8784	0	0	6471	8784	6471	2313
60	9,848	23,989	Republican	9848	0	0	7071	9848	7071	2778
61	13,145	16,481	Republican	13145	0	0	1668	13145	1668	11477
62	14,828	17,309	Republican	14828	0	0	1240	14828	1240	13588
63	13,233	16,830	Republican	13233	0	0	1799	13233	1799	11434
64	15,702	11,307	Democratic	0	11307	2198	0	2198	11307	-9109
65	15,105	7,929	Democratic	0	7929	3588	0	3588	7929	-4341
66	16,162	5,472	Democratic	0	5472	5345	0	5345	5472	-127
67	13,769	14,674	Republican	13769	0	0	453	13769	453	13316
68	13,663	13,005	Democratic	0	13005	329	0	329	13005	-12676
69	11,083	14,347	Republican	11083	0	0	1632	11083	1632	9451
70	12,211	14,387	Republican	12211	0	0	1088	12211	1088	11123
71	17,614	11,383	Democratic	0	11383	3115	0	3115	11383	-8267
72	14,294	13,895	Democratic	0	13895	199	0	199	13895	-13696
73	17,353	10,784	Democratic	0	10784	3284	0	3284	10784	-7500
74	17,095	13,772	Democratic	0	13772	1662	0	1662	13772	-12110
75	15,000	13,418	Democratic	0	13418	791	0	791	13418	-12627
76	30,939	6,805	Democratic	0	6805	12067	0	12067	6805	5262
77	26,925	6,041	Democratic	0	6041	10442	0	10442	6041	4402
78	24,163	9,857	Democratic	0	9857	7153	0	7153	9857	-2704
79	20,753	13,975	Democratic	0	13975	3389	0	3389	13975	-10586
80	20,369	12,604	Democratic	0	12604	3882	0	3882	12604	-8722
81	16,310	12,356	Democratic	0	12356	1977	0	1977	12356	-10379
82	12,168	18,085	Republican	12168	0	0	2959	12168	2959	9210
83	10,186	23,755	Republican	10186	0	0	6784	10186	6784	3401
84	12,503	18,765	Republican	12503	0	0	3131	12503	3131	9373
85	13,613	12,925	Democratic	0	12925	344	0	344	12925	-12581
86	13,425	17,152	Republican	13425	0	0	1863	13425	1863	11561
87	11,780	15,118	Republican	11780	0	0	1669	11780	1669	10111
88	13,141	14,380	Republican	13141	0	0	620	13141	620	12521
89	11,610	15,516	Republican	11610	0	0	1953	11610	1953	9658
90	12,080	7,309	Democratic	0	7309	2385	0	2385	7309	-4924
91	17,942	11,769	Democratic	0	11769	3086	0	3086	11769	-8683
92	14,285	11,441	Democratic	0	11441	1422	0	1422	11441	-10019
93	15,268	15,393	Republican	15268	0	0	62	15268	62	15206
94	17,408	12,954	Democratic	0	12954	2227	0	2227	12954	-10727
95	19,804	9,627	Democratic	0	9627	5088	0	5088	9627	-4539
96	10,950	14,873	Republican	10950	0	0	1962	10950	1962	8989
97	10,826	18,042	Republican	10826	0	0	3608	10826	3608	7219
98	10,182	21,855	Republican	10182	0	0	5837	10182	5837	4346
99	8,346	25,535	Republican	8346	0	0	8594	8346	8594	-248
TOTALS	**1,454,717**	**1,389,958**		**702,148**	**401,975**	**175,297**	**142,918**	**877,445**	**544,893**	**332,552**

Table 9 - Efficiency Gap Calculation for Act 43 2011 Gaddie Metric - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	15,857	16,651	Republican	15857	0	0	397	15857	397	15461
2	12,983	15,766	Republican	12983	0	0	1391	12983	1391	11591
3	12,976	16,236	Republican	12976	0	0	1630	12976	1630	11346
4	13,742	15,791	Republican	13742	0	0	1025	13742	1025	12717
5	13,134	15,593	Republican	13134	0	0	1230	13134	1230	11904
6	10,779	15,088	Republican	10779	0	0	2155	10779	2155	8624
7	13,967	11,604	Democratic	0	11604	1181	0	1181	11604	-10423
8	6,178	2,709	Democratic	0	2709	1735	0	1735	2709	-974
9	10,173	4,184	Democratic	0	4184	2995	0	2995	4184	-1189
10	24,623	3,547	Democratic	0	3547	10538	0	10538	3547	6992
11	20,235	4,927	Democratic	0	4927	7654	0	7654	4927	2728
12	18,066	6,856	Democratic	0	6856	5605	0	5605	6856	-1251
13	13,929	19,774	Republican	13929	0	0	2922	13929	2922	11007
14	14,693	20,831	Republican	14693	0	0	3069	14693	3069	11624
15	13,497	16,819	Republican	13497	0	0	1661	13497	1661	11835
16	22,223	2,618	Democratic	0	2618	9803	0	9803	2618	7184
17	22,553	5,582	Democratic	0	5582	8486	0	8486	5582	2904
18	21,176	3,719	Democratic	0	3719	8728	0	8728	3719	5009
19	23,838	9,284	Democratic	0	9284	7277	0	7277	9284	-2007
20	16,451	12,471	Democratic	0	12471	1990	0	1990	12471	-10482
21	13,125	14,765	Republican	13125	0	0	820	13125	820	12305
22	11,364	22,885	Republican	11364	0	0	5761	11364	5761	5603
23	15,182	20,658	Republican	15182	0	0	2738	15182	2738	12444
24	14,205	20,015	Republican	14205	0	0	2905	14205	2905	11299
25	13,065	14,887	Republican	13065	0	0	911	13065	911	12154
26	12,853	16,338	Republican	12853	0	0	1743	12853	1743	11110
27	13,611	17,458	Republican	13611	0	0	1923	13611	1923	11688
28	12,609	15,412	Republican	12609	0	0	1401	12609	1401	11208
29	13,519	14,054	Republican	13519	0	0	267	13519	267	13251
30	14,267	16,601	Republican	14267	0	0	1167	14267	1167	13101
31	12,616	16,273	Republican	12616	0	0	1829	12616	1829	10787
32	10,038	16,566	Republican	10038	0	0	3264	10038	3264	6773
33	11,274	18,247	Republican	11274	0	0	3487	11274	3487	7788
34	14,239	17,558	Republican	14239	0	0	1660	14239	1660	12579
35	13,067	14,729	Republican	13067	0	0	831	13067	831	12236
36	12,227	14,848	Republican	12227	0	0	1310	12227	1310	10917
37	12,110	16,799	Republican	12110	0	0	2345	12110	2345	9766
38	12,574	19,218	Republican	12574	0	0	3322	12574	3322	9251
39	10,899	17,782	Republican	10899	0	0	3442	10899	3442	7457
40	10,514	14,561	Republican	10514	0	0	2024	10514	2024	8490
41	11,761	14,467	Republican	11761	0	0	1353	11761	1353	10407
42	13,152	16,036	Republican	13152	0	0	1442	13152	1442	11710
43	17,339	13,113	Democratic	0	13113	2113	0	2113	13113	-10999
44	16,941	10,043	Democratic	0	10043	3449	0	3449	10043	-6595
45	14,886	9,957	Democratic	0	9957	2464	0	2464	9957	-7493
46	17,681	13,010	Democratic	0	13010	2336	0	2336	13010	-10674

47	20,628	10,322	Democratic	0	10322	5153	0	5153	10322	-5169
48	23,290	8,861	Democratic	0	8861	7215	0	7215	8861	-1646
49	13,071	12,859	Democratic	0	12859	106	0	106	12859	-12752
50	11,887	12,908	Republican	11887	0	0	511	11887	511	11376
51	14,637	12,584	Democratic	0	12584	1026	0	1026	12584	-11558
52	11,034	15,918	Republican	11034	0	0	2442	11034	2442	8592
53	9,930	16,099	Republican	9930	0	0	3084	9930	3084	6846
54	15,372	12,690	Democratic	0	12690	1341	0	1341	12690	-11348
55	13,302	16,297	Republican	13302	0	0	1498	13302	1498	11804
56	12,809	18,326	Republican	12809	0	0	2759	12809	2759	10050
57	14,436	11,575	Democratic	0	11575	1431	0	1431	11575	-10145
58	9,211	22,056	Republican	9211	0	0	6422	9211	6422	2789
59	9,669	20,843	Republican	9669	0	0	5587	9669	5587	4083
60	10,307	23,508	Republican	10307	0	0	6601	10307	6601	3706
61	12,661	16,935	Republican	12661	0	0	2137	12661	2137	10524
62	13,959	18,175	Republican	13959	0	0	2108	13959	2108	11851
63	11,973	17,692	Republican	11973	0	0	2860	11973	2860	9113
64	15,452	11,524	Democratic	0	11524	1964	0	1964	11524	-9560
65	14,760	8,274	Democratic	0	8274	3243	0	3243	8274	-5031
66	14,776	6,861	Democratic	0	6861	3957	0	3957	6861	-2904
67	13,748	14,698	Republican	13748	0	0	475	13748	475	13273
68	13,508	13,177	Democratic	0	13177	165	0	165	13177	-13011
69	11,657	13,773	Republican	11657	0	0	1058	11657	1058	10599
70	13,105	13,493	Republican	13105	0	0	194	13105	194	12911
71	17,189	11,807	Democratic	0	11807	2691	0	2691	11807	-9116
72	13,674	14,514	Republican	13674	0	0	420	13674	420	13254
73	16,837	11,300	Democratic	0	11300	2769	0	2769	11300	-8531
74	17,628	13,239	Democratic	0	13239	2195	0	2195	13239	-11044
75	13,590	14,829	Republican	13590	0	0	620	13590	620	12970
76	32,275	5,469	Democratic	0	5469	13403	0	13403	5469	7934
77	26,627	6,339	Democratic	0	6339	10144	0	10144	6339	3804
78	23,528	10,492	Democratic	0	10492	6518	0	6518	10492	-3974
79	20,211	14,516	Democratic	0	14516	2848	0	2848	14516	-11668
80	20,251	12,704	Democratic	0	12704	3773	0	3773	12704	-8931
81	15,887	12,770	Democratic	0	12770	1559	0	1559	12770	-11211
82	12,985	17,269	Republican	12985	0	0	2142	12985	2142	10843
83	10,756	23,185	Republican	10756	0	0	6215	10756	6215	4541
84	13,414	17,854	Republican	13414	0	0	2220	13414	2220	11194
85	13,703	12,843	Democratic	0	12843	430	0	430	12843	-12413
86	15,780	14,789	Democratic	0	14789	495	0	495	14789	-14294
87	12,413	14,420	Republican	12413	0	0	1004	12413	1004	11409
88	12,882	14,638	Republican	12882	0	0	878	12882	878	12004
89	12,009	15,118	Republican	12009	0	0	1554	12009	1554	10455
90	11,556	7,833	Democratic	0	7833	1861	0	1861	7833	-5972
91	18,044	11,816	Democratic	0	11816	3114	0	3114	11816	-8701
92	14,313	11,383	Democratic	0	11383	1465	0	1465	11383	-9919
93	15,014	15,690	Republican	15014	0	0	338	15014	338	14676
94	14,601	15,761	Republican	14601	0	0	580	14601	580	14022
95	18,730	10,701	Democratic	0	10701	4014	0	4014	10701	-6687
96	13,841	11,982	Democratic	0	11982	930	0	930	11982	-11052
97	10,706	18,158	Republican	10706	0	0	3726	10706	3726	6979
98	10,566	21,472	Republican	10566	0	0	5453	10566	5453	5113
99	8,517	25,349	Republican	8517	0	0	8416	8517	8416	102
TOTALS	**1,448,901**	**1,394,018**		**726,238**	**402,334**	**160,165**	**132,723**	**886,403**	**535,057**	**351,346**

D. Conclusions

In this report, I have outlined a method that generates accurate estimates of underlying partisanship using the 2012 presidential election vote, demographics, incumbency, and geographic features to explain patterns of voting in Assembly elections. This method is accurate, as demonstrated by its ability to forecast vote totals at both the individual ward and district levels, and I demonstrate that it generates valid out of sample estimates. It produces results that are very similar to those derived by the expert witness retained by the state legislature during its development of the redistricting map implemented in Act 43.

The results demonstrate that Act 43 was an egregious gerrymander, packing Democratic voters into a small number of districts and distributing Republican voters efficiently in a large number of districts in which they constituted safe majorities. As I demonstrated with the treatment of the city of Sheboygan in Act 43, areas of Democratic strength large enough to constitute majorities in single districts were unnecessarily split and then combined with larger Republican populations to create additional Republican districts and eliminate Democratic districts. The city, which had been in a single Democratic Assembly district since 1992, was split into two Republican districts. This packing and cracking was so successful that Republicans won 61% of Assembly seats in 2012, while obtaining only 46.5% of the statewide presidential vote.

The scope of the gerrymander is demonstrated by the efficiency gap calculation for Act 43: 11.69%. Based on the baseline partisanship estimates produced by Dr. Ronald Keith Gaddie during the drawing of the Act 43 plan, this was the intended outcome: using Gaddie's baseline estimates, Act 43 had an expected efficiency gap of 12.36 %.

However, I drew a demonstration districting plan that was equivalent to Act 43 on population deviation, municipal splits, and compliance with the Voting Rights Act, and better on compactness, with a dramatically lower efficiency gap score of 2.20%. This proves that Act 43's extreme partisan effects were not required by these constitutional or statutory mandates.

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I. Data Issues

The largest errors in the Legislative Technology Services Bureau (LTSB) data occurred because the two data sets used to create this data do not precisely overlap. In GIS argot, the two sets of data are not reported in the same geography. The LTSB files contained data at the individual ward level, while the official election data is aggregated by reporting unit. Wisconsin elections are administered at the ward level, but are often tabulated and released in *reporting units* consisting of multiple wards.[1] Of Wisconsin's roughly 6,530 populated wards, only about a third report election results at the individual ward level; the rest report results by combining wards into reporting units. As one example, the city of Manitowoc (2010 population 33,736) has 25 wards, but reports election results in 10 reporting units of between 2 and 6 wards each.[2]

In order to generate data at the ward level, my understanding is that the LTSB disaggregated reporting unit results to individual wards based on the fraction of Voting Age Population in each ward comprising the reporting unit. In the process a number of anomalies crept into the data. The LTSB file for 2012 contains wards where the number of votes cast exceeds the voting age population; wards with large voting age populations and an unusually low number of votes, often zero, recorded; wards, municipalities, and districts with vote totals that differ substantially from what the Government Accountability Board (GAB) reports; votes allocated to the wrong district; incorrectly numbered and duplicated wards; and wards in uncontested Assembly districts with votes recorded for both political parties.

[1] Wisconsin Statutes 5.15(6)(b) allows municipalities with a population under 35,000 to combine wards for purposes of using a common polling place, and allows for the tabulation and reporting of combined ward vote totals.

[2] In 2012 the reporting units were Wards 1-2; 5-6; 7-8; 9-10; 11-12; 13-14; 15-16; 3, 4, and 22; and 17-18, 21, and 23-25.

In most cases, correcting the errors in the LTSB data involved manually changing the incorrect ward totals to reflect GAB results. When the GAB data were combined into reporting units, I allocated votes to each ward in the unit based on the ward's share of the voting eligible population, removing noncitizen and prison populations.[3] This process generated more accurate ward level data, and is a standard technique when allocating votes into different geographic levels (McDonald 2014; Pavia and López-Quílez 2013). At times, however, the LTSB and GAB data could not be reconciled, because of wards that appeared in one file but not in the other, or discrepancies in ward geography. The votes I was not able to allocate constituted only 0.21% of the total votes cast in the 2012 Assembly election, and have no effect on any subsequent analysis or my conclusions.

The following table shows some of the problems with the data recorded by the LTSB. It displays the errors in the LTSB 2012 presidential vote totals for the city of Mequon. The GAB Reports columns show the vote totals for each of the city's reporting units taken from the 2014 Wisconsin Blue Book, which I take to be authoritative.[4] The LTSB Data columns show the results of combining the individual ward data in the LTSB ward file into the GAB reporting units. The Difference columns show the errors in the LTSB data. While the vote totals for the municipality are the same in both data sets, every ward total is different.

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[3] The voting eligible population (VEP) adjusts the voting age population by removing adults who are not eligible to vote. In Wisconsin, the two largest categories of ineligible adults are noncitizens and adults in prison for felonies. Noncitizens were removed using the 2008-2012 5 year American Community Survey county level noncitizen estimates (available at http://www.census.gov/acs/www/data_documentation/2012_release/. Institutionalized prison populations were identified and removed using Census Bureau "Advanced Group Quarters" files for Wisconsin, available at http://www2.census.gov/census_2010/02-Advance_Group_Quarters/, and described in http://www.census.gov/newsroom/releases/archives/2010_census/cb11-tps13.html.

[4] Table: Vote for President and Vice President by Ward, November 6, 2012 General Election, 938.

Differences Between GAB Reports and LTSB Data
2012 Presidential Election Results for Mequon, WI (Ozaukee County)

	GAB Reports			LTSB Data			Difference		
Reporting Unit (wards)	Obama Votes	Romney Votes	Total Votes	Obama Votes	Romney Votes	Total Votes	Obama Votes	Romney Votes	Total Votes
1	534	890	1424	849	1,522	2,371	315	632	947
2	120	391	511	240	633	873	120	242	362
3,4	637	1,249	1886	415	833	1,248	(222)	(416)	(638)
5, 7B	205	603	808	155	311	466	(50)	(292)	(342)
6, 7A	392	909	1301	292	589	881	(100)	(320)	(420)
8 ,9,10	737	1,245	1982	477	956	1,433	(260)	(289)	(549)
11, 12	635	1,126	1761	527	1,057	1,584	(108)	(69)	(177)
13, 14	353	770	1123	253	506	759	(100)	(264)	(364)
15	380	494	874	579	896	1,475	199	402	601
16	221	491	712	357	766	1,123	136	275	411
17	336	459	795	517	824	1,341	181	365	546
18	204	368	572	322	607	929	118	239	357
19,20,21	639	1,331	1970	410	826	1,236	(229)	(505)	(734)
Totals	5,393	10,326	15,719	5,393	10,326	15,719	0	0	0

Correcting these totals required manually changing the single-ward vote counts to match the GAB data, and allocating votes in reporting units to the individual wards based on the voting-eligible population in each ward in the unit (in the following table, wards in a reporting unit are framed together):

Allocation of Reporting Unit Data to Ward Data

City of Mequon, 2012 Presidential Vote

	GAB Data				Data Used in Voting Model		
Ward	**Obama Votes**	**Romney Votes**	**Ward Voting Eligible Population**	**Ward Share of Reporting Unit VEP**	**Obama Votes**	**Romney Votes**	**Total Votes**
1	534	890	-	-	534	890	1,424
2	120	391	-	-	120	391	511
3	637	1249	1063	53%	336	658	994
4			954	47%	301	591	892
5	205	603	501	67%	137	402	539
7B			250	33%	68	201	269
6	392	909	1240	87%	343	794	1,137
7A			179	13%	49	115	164
8			599	26%	192	324	516
9	737	1245	457	20%	146	247	393
10			1247	54%	399	674	1,073
11	635	1126	1530	60%	380	673	1,053
12			1029	40%	255	453	708
13	353	770	761	63%	221	482	703
14			455	37%	132	288	420
15	380	494	-	-	380	494	874
16	221	491	-	-	221	491	712
17	336	459	-	-	336	459	795
18	204	368	-	-	204	368	572
19			908	46%	291	606	897
20	639	1331	776	39%	249	518	767
21			310	16%	99	207	306
Totals	5,393	10,326			5,393	10,326	15,719

I repeated this process for every instance of inaccurate vote totals in the LTSB, using GAB data as the reference.

II. Full Regression Results

Republican vote totals (bold variables have p<.05)

Independent Variable: Assembly Republican Votes

Dependent Variable	Coefficient	Robust Std. Error	t-statistic	P-value
Total Voting Eligible Population	0.01	0.01	1.32	0.19
Black Voting Eligible Population	-0.03	0.02	-1.21	0.229
Hispanic Voting eligible Population	-0.01	0.03	-0.26	0.796
Democratic Presidential Votes	0.01	0.02	0.42	0.677
Republican Presidential Votes	**0.95**	**0.01**	**110.00**	**0**
Democratic Assembly Incumbent	**-0.02**	**0.01**	**-3.63**	**0.001**
Republican Assembly Incumbent	**0.01**	**0.00**	**2.62**	**0.011**
Adams	-7.27	7.24	-1.00	0.319
Ashland	3.07	7.81	0.39	0.695
Barron	-11.03	7.13	-1.55	0.126
Bayfield	-0.59	7.77	-0.08	0.94
Brown	**-17.12**	**8.29**	**-2.07**	**0.042**
Buffalo	-7.93	7.35	-1.08	0.284
Burnett	-1.97	7.31	-0.27	0.789
Calumet	**17.29**	**7.31**	**2.36**	**0.021**
Chippewa	4.20	10.58	0.40	0.693
Clark	6.23	7.74	0.81	0.423

Columbia	15.01	10.08	1.49	0.141
Crawford	**28.20**	**7.24**	**3.90**	**0**
Dane	1.55	8.53	0.18	0.857
Dodge	8.54	7.88	1.08	0.282
Door	**16.98**	**7.23**	**2.35**	**0.022**
Douglas	-3.14	7.65	-0.41	0.682
EauClaire	0.47	7.83	0.06	0.953
Florence	-7.34	7.52	-0.98	0.332
FondduLac	4.74	8.07	0.59	0.559
Forest	-1.91	7.39	-0.26	0.796
Grant	**24.64**	**7.23**	**3.41**	**0.001**
Green	14.41	9.95	1.45	0.152
GreenLake	11.96	7.36	1.62	0.109
Iowa	15.04	8.08	1.86	0.067
Iron	**20.54**	**7.68**	**2.67**	**0.009**
Jackson	5.74	7.53	0.76	0.449
Jefferson	2.37	8.41	0.28	0.779
Juneau	-4.31	7.29	-0.59	0.556
Kenosha	3.73	7.99	0.47	0.642
Kewaunee	-14.13	7.24	-1.95	0.055
LaCrosse	**-26.58**	**8.43**	**-3.15**	**0.002**
Lafayette	**18.18**	**7.29**	**2.49**	**0.015**
Langlade	4.35	8.30	0.52	0.602
Lincoln	-0.38	7.53	-0.05	0.96
Manitowoc	**19.35**	**9.36**	**2.07**	**0.042**
Marathon	2.01	8.56	0.24	0.815
Marinette	**19.89**	**8.04**	**2.48**	**0.016**
Marquette	6.91	7.26	0.95	0.344
Menominee	-3.08	7.32	-0.42	0.675
Milwaukee	1.96	11.98	0.16	0.871
Monroe	**19.47**	**7.72**	**2.52**	**0.014**
Oconto	3.21	7.95	0.40	0.687
Oneida	12.01	7.95	1.51	0.136
Outagamie	1.90	8.02	0.24	0.814
Ozaukee	13.71	8.82	1.55	0.125
Pepin	-9.83	7.27	-1.35	0.181
Pierce	-9.31	7.18	-1.30	0.199
Polk	-3.47	7.24	-0.48	0.633
Portage	**-20.74**	**7.71**	**-2.69**	**0.009**
Price	5.25	7.75	0.68	0.501
Racine	-6.90	8.23	-0.84	0.404
Richland	16.24	8.55	1.90	0.062
Rock	9.24	8.32	1.11	0.27

Rusk	3.71	7.37	0.50	0.616
SaintCroix	13.80	9.31	1.48	0.143
Sauk	**16.68**	**8.27**	**2.02**	**0.048**
Sawyer	-0.90	7.40	-0.12	0.903
Shawano	2.70	7.86	0.34	0.733
Sheboygan	-6.50	15.54	-0.42	0.677
Taylor	9.96	7.30	1.37	0.176
Trempealeau	1.29	7.21	0.18	0.859
Vernon	**31.54**	**7.29**	**4.33**	**0**
Vilas	3.61	7.64	0.47	0.638
Walworth	-2.00	8.17	-0.24	0.807
Washburn	-10.80	7.31	-1.48	0.144
Washington	14.16	12.70	1.12	0.269
Waukesha	1.18	7.93	0.15	0.882
Waupaca	-8.08	7.26	-1.11	0.27
Waushara	-3.47	7.30	-0.48	0.636
Winnebago	30.00	17.09	1.76	0.084
Wood	-7.60	8.96	-0.85	0.399
Constant	-0.92	7.52	-0.12	0.903

N	5282.00
R-squared	0.9903
Root MSE	15.823

Democratic vote totals

Independent Variable: Assembly Democratic Votes

Dependent Variable	Coefficient	Robust Std. Error	t-statistic	P-value
Total Voting Eligible Population	-0.01	0.01	-0.65	0.52
Black Voting Eligible Population	-0.02	0.04	-0.49	0.63
Hispanic Voting Eligible Population	**-0.15**	**0.05**	**-3.01**	**0.00**
Democratic Presidential Votes	**0.93**	**0.03**	**33.33**	**0.00**
Republican Presidential Votes	0.01	0.01	0.98	0.33
Democratic Assembly Incumbent	**0.03**	**0.01**	**3.85**	**0.00**
Republican Assembly Incumbent	**-0.01**	**0.01**	**-2.77**	**0.01**
Adams	**-14.45**	**6.73**	**-2.15**	**0.04**
Ashland	-4.78	5.58	-0.86	0.40
Barron	**14.57**	**4.04**	**3.60**	**0.00**
Bayfield	-2.82	5.58	-0.50	0.62
Brown	**-21.57**	**7.80**	**-2.77**	**0.01**
Buffalo	5.10	4.86	1.05	0.30
Burnett	-3.84	4.69	-0.82	0.42
Calumet	**-26.32**	**5.81**	**-4.53**	**0.00**
Chippewa	0.98	9.53	0.10	0.92
Clark	-6.83	4.80	-1.42	0.16
Columbia	**-19.51**	**8.15**	**-2.39**	**0.02**
Crawford	**-32.57**	**4.33**	**-7.51**	**0.00**
Dane	-9.39	7.20	-1.31	0.20
Dodge	-8.49	5.27	-1.61	0.11
Door	**-11.92**	**4.51**	**-2.64**	**0.01**
Douglas	-7.18	5.40	-1.33	0.19
EauClaire	1.05	7.22	0.14	0.89
Florence	**-13.53**	**5.33**	**-2.54**	**0.01**
FondduLac	**-25.18**	**4.92**	**-5.12**	**0.00**
Forest	-10.83	6.06	-1.79	0.08

Grant	**-23.14**	**4.26**	**-5.43**	**0.00**
Green	**-15.68**	**6.63**	**-2.36**	**0.02**
GreenLake	**-17.01**	**4.65**	**-3.66**	**0.00**
Iowa	**-19.48**	**4.91**	**-3.96**	**0.00**
Iron	**-30.91**	**5.54**	**-5.58**	**0.00**
Jackson	-12.37	6.44	-1.92	0.06
Jefferson	**-17.18**	**7.09**	**-2.42**	**0.02**
Juneau	-5.78	4.55	-1.27	0.21
Kenosha	1.78	5.33	0.33	0.74
Kewaunee	**17.69**	**4.41**	**4.01**	**0.00**
LaCrosse	**25.17**	**6.69**	**3.76**	**0.00**
Lafayette	**-22.66**	**4.58**	**-4.95**	**0.00**
Langlade	**-22.20**	**6.05**	**-3.67**	**0.00**
Lincoln	**-13.42**	**5.15**	**-2.61**	**0.01**
Manitowoc	**-15.90**	**5.49**	**-2.90**	**0.01**
Marathon	-5.64	6.20	-0.91	0.37
Marinette	**-26.28**	**4.22**	**-6.23**	**0.00**
Marquette	**-15.87**	**4.48**	**-3.54**	**0.00**
Menominee	**-61.44**	**4.41**	**-13.95**	**0.00**
Milwaukee	**-29.20**	**6.47**	**-4.51**	**0.00**
Monroe	**-26.83**	**5.44**	**-4.93**	**0.00**
Oconto	**-12.99**	**4.42**	**-2.94**	**0.00**
Oneida	**-35.94**	**5.19**	**-6.92**	**0.00**
Outagamie	**-14.60**	**6.94**	**-2.10**	**0.04**
Ozaukee	**-17.19**	**5.83**	**-2.95**	**0.00**
Pepin	6.62	4.52	1.46	0.15
Pierce	**12.49**	**4.00**	**3.12**	**0.00**
Polk	5.81	4.32	1.35	0.18
Portage	-0.04	5.13	-0.01	0.99
Price	**-14.62**	**5.64**	**-2.59**	**0.01**
Racine	4.42	5.29	0.83	0.41
Richland	**-26.22**	**5.30**	**-4.95**	**0.00**
Rock	-4.48	8.87	-0.50	0.62
Rusk	-8.01	4.90	-1.64	0.11
SaintCroix	-6.89	6.67	-1.03	0.31
Sauk	**-19.42**	**6.51**	**-2.98**	**0.00**
Sawyer	-6.06	4.64	-1.30	0.20
Shawano	**-14.93**	**4.58**	**-3.26**	**0.00**
Sheboygan	15.96	17.17	0.93	0.36
Taylor	-6.81	4.56	-1.49	0.14
Trempealeau	-3.89	4.29	-0.91	0.37
Vernon	**-32.42**	**4.52**	**-7.18**	**0.00**
Vilas	**-27.14**	**5.48**	**-4.95**	**0.00**

Walworth	0.34	5.26	0.07	0.95
Washburn	6.43	4.74	1.36	0.18
Washington	**-19.23**	**9.75**	**-1.97**	**0.05**
Waukesha	**-17.63**	**5.55**	**-3.18**	**0.00**
Waupaca	**-10.48**	**4.37**	**-2.40**	**0.02**
Waushara	0.21	4.64	0.04	0.97
Winnebago	**-32.12**	**15.94**	**-2.02**	**0.05**
Wood	8.14	6.01	1.35	0.18
Constant	9.80	5.39	1.82	0.07

N	5282.00
R-squared	0.9843
Root MSE	17.675

III. Plan characteristics

A. Population deviation

Assembly District	Population	Deviation from Ideal	% Deviation
1	57,487	43	0.07%
2	57,590	146	0.25%
3	57,686	242	0.42%
4	57,406	-38	-0.07%
5	57,633	189	0.33%
6	57,480	36	0.06%
7	57,208	-236	-0.41%
8	57,196	-248	-0.43%
9	57,420	-24	-0.04%
10	57,195	-249	-0.43%
11	57,455	11	0.02%
12	57,420	-24	-0.04%
13	57,248	-196	-0.34%
14	57,333	-111	-0.19%
15	57,514	70	0.12%
16	57,282	-162	-0.28%
17	57,437	-7	-0.01%
18	57,241	-203	-0.35%
19	57,313	-131	-0.23%
20	57,410	-34	-0.06%
21	57,434	-10	-0.02%
22	57,526	82	0.14%
23	57,476	32	0.06%
24	57,369	-75	-0.13%
25	57,480	36	0.06%
26	57,552	108	0.19%
27	57,191	-253	-0.44%
28	57,515	71	0.12%
29	57,300	-144	-0.25%
30	57,407	-37	-0.06%
31	57,429	-15	-0.03%
32	57,349	-95	-0.17%
33	57,391	-53	-0.09%
34	57,651	207	0.36%
35	57,528	84	0.15%
36	57,377	-67	-0.12%

37	57,671	227	0.40%
38	57,572	128	0.22%
39	57,457	13	0.02%
40	57,495	51	0.09%
41	57,671	227	0.40%
42	57,559	115	0.20%
43	57,444	0	0.00%
44	57,434	-10	-0.02%
45	57,242	-202	-0.35%
46	57,463	19	0.03%
47	57,494	50	0.09%
48	57,568	124	0.22%
49	57,389	-55	-0.10%
50	57,465	21	0.04%
51	57,247	-197	-0.34%
52	57,384	-60	-0.10%
53	57,444	0	0.00%
54	57,443	-1	0.00%
55	57,446	2	0.00%
56	57,342	-102	-0.18%
57	57,404	-40	-0.07%
58	57,436	-8	-0.01%
59	57,554	110	0.19%
60	57,547	103	0.18%
61	57,605	161	0.28%
62	57,632	188	0.33%
63	57,299	-145	-0.25%
64	57,266	-178	-0.31%
65	57,601	157	0.27%
66	57,459	15	0.03%
67	57,378	-66	-0.11%
68	57,254	-190	-0.33%
69	57,424	-20	-0.03%
70	57,415	-29	-0.05%
71	57,228	-216	-0.38%
72	57,654	210	0.37%
73	57,491	47	0.08%
74	57,320	-124	-0.22%
75	57,255	-189	-0.33%
76	57,586	142	0.25%
77	57,398	-46	-0.08%
78	57,579	135	0.24%
79	57,341	-103	-0.18%

80	57,385	-59	-0.10%
81	57,266	-178	-0.31%
82	57,641	197	0.34%
83	57,612	168	0.29%
84	57,375	-69	-0.12%
85	57,529	85	0.15%
86	57,477	33	0.06%
87	57,661	217	0.38%
88	57,533	89	0.15%
89	57,490	46	0.08%
90	57,617	173	0.30%
91	57,374	-70	-0.12%
92	57,421	-23	-0.04%
93	57,280	-164	-0.29%
94	57,509	65	0.11%
95	57,496	52	0.09%
96	57,406	-38	-0.07%
97	57,487	43	0.07%
98	57,485	41	0.07%
99	57,657	213	0.37%

B. Compactness (Reock or smallest circle measure)

Assembly District	Smallest Circle Measure
1	0.44
2	0.46
3	0.42
4	0.55
5	0.39
6	0.35
7	0.52
8	0.66
9	0.39
10	0.45
11	0.39
12	0.36
13	0.28
14	0.44
15	0.49
16	0.52
17	0.52

18	0.30
19	0.30
20	0.44
21	0.40
22	0.34
23	0.42
24	0.42
25	0.57
26	0.49
27	0.53
28	0.31
29	0.49
30	0.50
31	0.60
32	0.45
33	0.30
34	0.42
35	0.49
36	0.43
37	0.34
38	0.24
39	0.30
40	0.51
41	0.39
42	0.33
43	0.29
44	0.43
45	0.37
46	0.35
47	0.26
48	0.43
49	0.35
50	0.44
51	0.53
52	0.56
53	0.27
54	0.28
55	0.37
56	0.57
57	0.26
58	0.40
59	0.37
60	0.55

61	0.39
62	0.25
63	0.43
64	0.27
65	0.32
66	0.32
67	0.56
68	0.52
69	0.31
70	0.28
71	0.34
72	0.35
73	0.28
74	0.37
75	0.36
76	0.23
77	0.39
78	0.51
79	0.59
80	0.33
81	0.55
82	0.37
83	0.26
84	0.28
85	0.58
86	0.36
87	0.35
88	0.35
89	0.56
90	0.52
91	0.49
92	0.49
93	0.42
94	0.44
95	0.42
96	0.39
97	0.32
98	0.41
99	0.30

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WISCONSIN

WILLIAM WHITFORD, et al.,

Plaintiffs,

v.

Case No. 15-CV-421-bbc

GERALD NICHOL, et al.,

Defendants.

DECLARATION OF SEAN P. TRENDE

Sean Patrick Trende, under penalty of perjury, makes the following declaration:

1. I am over 18 years of age and am competent to testify regarding the matters discussed in this declaration.

2. I have been retained in this matter to provide expert testimony. I am compensated at a rate of $300 per hour, excluding travel time.

3. My *curriculum vitae* is attached to this declaration as **Exhibit 1.**

4. A list of materials upon which I relied in the preparation of this declaration are attached as **Exhibit 2.**

INTRODUCTION

5. Plaintiffs in this case attempt to solve the decades-old problem of identifying partisan gerrymanders that are severe enough to violate the federal constitution by introducing a novel measure of partisan gerrymandering, based upon the concept of "wasted votes." The basis for this theory is that a party gerrymanders when members of the opposing party are "packed" into single districts. This allows the gerrymandering party to spread their remaining members over a large number of districts, creating just enough partisan density to win. Because members of the opposing party are packed into districts far in excess of what is needed to win those districts, this should manifest in the opposing party having a disproportionate number of "wasted votes," that is, votes in excess of what are needed to win in given districts.

6. I have a tremendous amount of respect for Dr. Jackman's work (I'm not personally familiar with Dr. Mayer), as well as Dr. McGhee, upon whose work the reports here are based. Nevertheless, there are multiple problems with utilizing this approach to identify unconstitutional partisan gerrymanders.

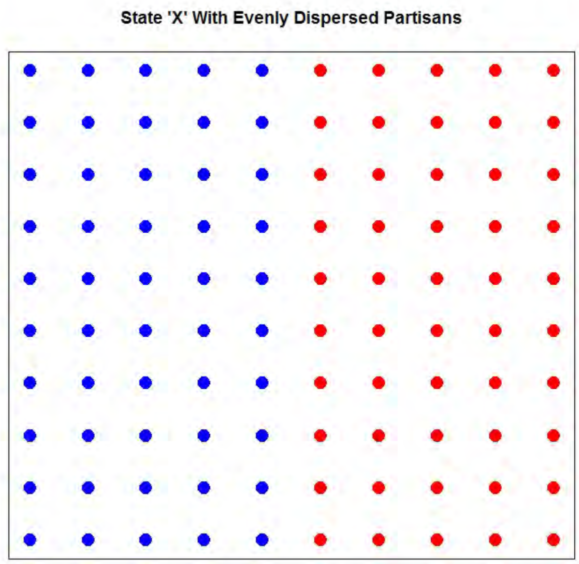
7. First, plaintiffs' experts do not provide a single measurement for the efficiency gap ("EG") for courts to use. Their methods are based upon the same approach, but utilize differing assumptions without providing a basis for the Court to choose among those assumptions. Their two equations lead to different results, which are large enough that they could represent the difference between a plan inviting Court scrutiny and a plan being presumed constitutional.

8. Second, the metric fails to account for the "natural" packing that can occur if party members are disproportionately clustered in certain types of areas, or if a law such as the Voting Rights Act forces packing of partisans of one party, but not of the other. This is important because if efficiency gaps are not accounting for "natural" clustering, then at least some of the asymmetry they are remedying is not a result of state action. If significant geographic clustering occurs, and is not accounted for, then the EG is really acting as a sort of "make up call" for natural effects and for the effects of the Voting Rights Act. This is true even if a mapmaker can draw a map with a smaller efficiency gap.

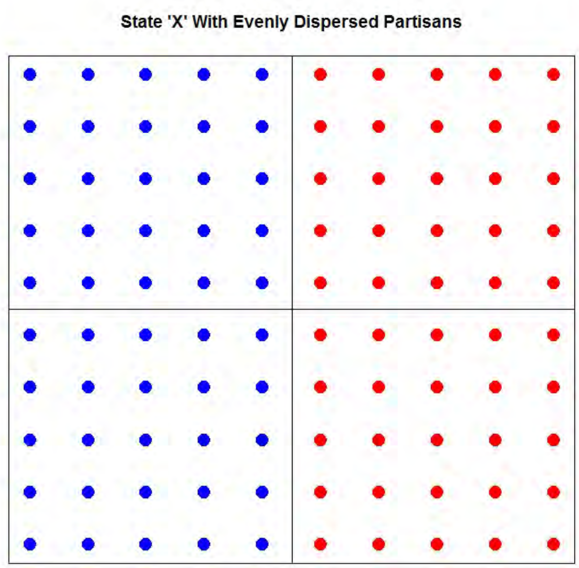
9. To better understand the issue of geographic clustering, and why it is so crucial to understanding the limitations of the wasted votes metric, consider the following examples.

10. The following maps depict a hypothetical state "X." It has 100 individual voters, who live conveniently on a ten-by-ten grid. Voters who always vote for the Republican candidate are color coded red, while voters color who always vote for the Democratic candidate are color coded blue. The state has four legislative districts.

11. We start with an example where the voters are proportionally clustered, with Republicans living in the eastern half of the state and Democrats living in the western half:



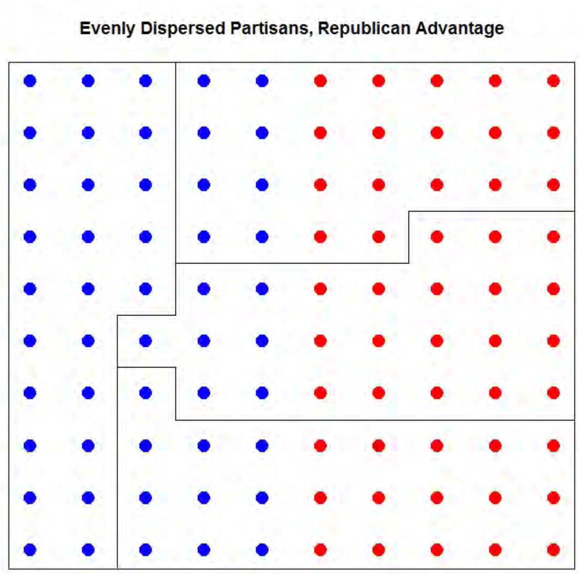
12. We can further imagine a scenario where mapmakers attempt to draw compact districts under neutral principles, and so simply divide the state into evenly matched quadrants:



13. In this scenario, the parties are evenly matched, and the EG is zero.

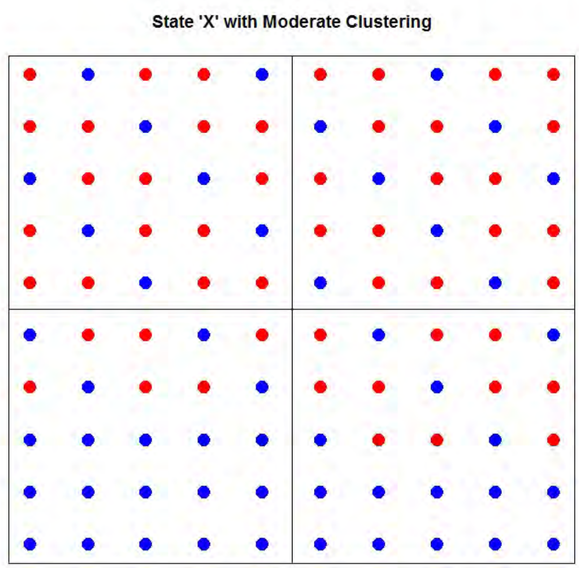
14. Note that a similar effect would occur if there were zero clustering, and every red voter lived "next door" only to blue voters. In fact, it would be very difficult to draw districts that were not evenly matched under that scenario.

15. Of course, it is still possible to draw maps to partisan advantage in this scenario. For example, the following lines would result in one district that would have 25 Democratic voters and zero Republicans, one that would have 8 Democrats and 17 Republicans, one that would have 7 Democrats and 18 Republicans, and one that would have 10 Democrats and 15 Republicans. Under this, the EG is equal to -.25, inviting court scrutiny under plaintiffs' standard.



16. At the same time, if you flipped the lines around a vertical line in the middle of the state, creating a mirror image of the above map, you would have a map with an identical Democratic advantage. In other words, in this scenario the Republicans and Democrats have equal abilities to draw lines to their advantage.

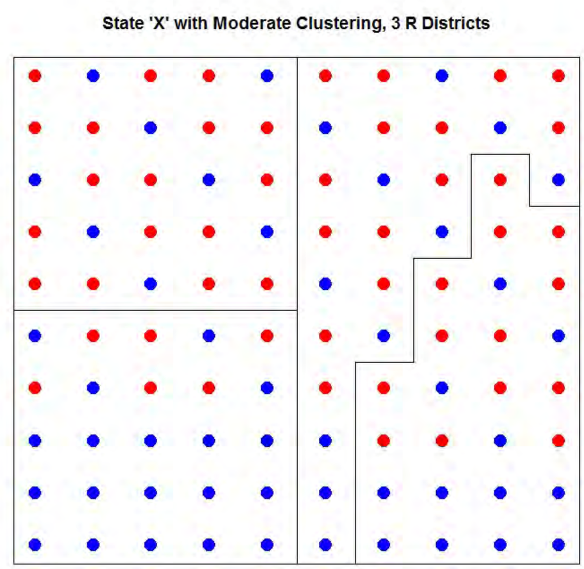
17.	If this were how partisans were actually dispersed, there might be merit to plaintiffs' approach, as we would have a baseline for what efficiency gaps should be under neutral principles. But the world is not so tidy. Imagine a slightly different scenario, where a state's Democratic voters are moderately clustered toward the southern edge of the state. The remaining voters are evenly dispersed throughout the state.



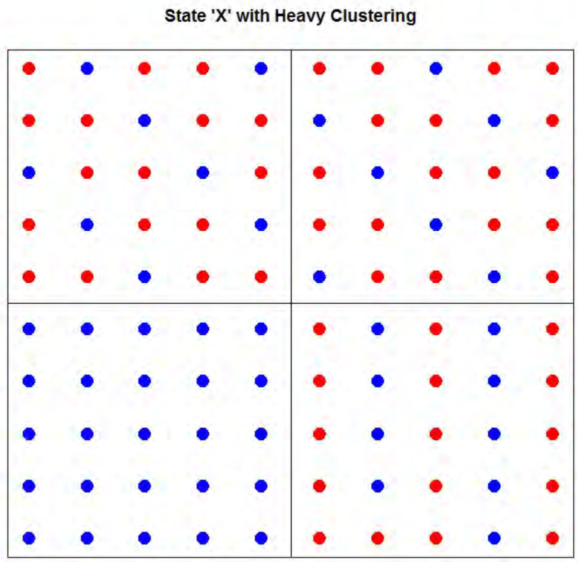
18.	In this scenario, our even division of the state into quadrants results in two Republican and two Democratic districts, but it is a closer call. Beginning in the top left quadrant, and proceeding clockwise, the districts have: 17 Republicans and 8 Democrats, 17 Republicans and 8 Democrats, 10 Republicans and 15 Democrats, and 6 Republicans and 19 Democrats. Under this scenario, the EG is zero.

19.	But note how sensitive this scenario is to slight shifts in partisanship. If three Democrats in the southeastern portion of the state vote differently, we have three Republican districts in a state that would still be evenly split. An even efficiency gap would be transformed into an efficiency gap of -.25 under the Jackman approach, and of -.19 under the Mayer approach. Court scrutiny would be invited as a result of just three percent of voters changing their underlying voting pattern.

20. The northeastern and southeastern districts can be tweaked to draw three Republican districts with relative ease, while maintaining true compactness in the western portion of the state; drawing three Democratic maps is difficult:



21. Let's imagine one final scenario to bring the point home. In this scenario the voters in the state are heavily clustered in the southwestern corner of the state, while the remaining partisans are more evenly dispersed. We again draw our familiar "grid" districts:



22. Under this scenario, utilizing our original "neutral" map drawing techniques actually results in three reliably Republican districts. Beginning in the northwestern corner and proceeding clockwise, the districts contain: 17 Republicans and 8 Democrats, 17 Republicans and 8 Democrats, 16 Republicans and 9 Democrats, and 25 Democrats. Under this scenario, the efficiency gap is -.25. Court scrutiny is invited as a result of applying neutral principles.

23. Of course, you can still draw two, or even three Democratic districts under our "clustered" scenario using relatively compact districts. But this misses the point. The point is that if significant partisan clustering occurs in a state, application of undeniably neutral redistricting principles would nevertheless result in a disproportionate number of wasted Democratic votes, and could invite court scrutiny. Moreover, it is *easy* to draw Republican-leaning districts – it takes a few minutes of effort – while drawing Democratic leaning districts requires some ingenuity.

24. In short, under a scenario where significant clustering occurs, you actually have to engage in what would traditionally be called gerrymandering in order to draw a neutral map.

25. As the report shows, this is exactly what occurred in Wisconsin. This is obvious from a simple visual inspection of maps of Wisconsin precincts and counties over time. The Democratic vote begins dispersed across the state, but becomes increasingly clustered geographically over time. The gradual consolidation of the Democratic vote into a few key Wisconsin counties coincides with the growth of wasted Democratic votes.

26. This report also measures the consolidation of the Democratic vote quantitatively, finding that heavily Democratic precincts tend to be clustered closer to other heavily Democratic precincts in Wisconsin than Republican precincts are to other Republican precincts, and that this trend has accelerated over the course of the past decade.

27. A failure to account for this and the "natural" wasted votes that occur as a result of clustering calls into question the usefulness of the wasted votes metric as a measurement of gerrymandering – at least as gerrymandering is commonly understood. When significant clustering occurs, a party can "gerrymander" while drawing lines without partisan intent.

28. This leads to the third problem with plaintiffs' approach: It is both underinclusive and overinclusive. The report examines those states that would invite court scrutiny under the metric, and finds an odd mixture of maps that were drawn with obvious partisan intent, as well as maps that could not reasonably qualify as partisan gerrymanders.

29. For example, the EG metric finds that New York and Wisconsin in the 2000s would qualify as partisan Republican gerrymanders. But Democrats drew Assembly districts in New York, while Wisconsin's map in the 2000s was drawn by a Court. Both are examples of states where there is a high degree of partisan clustering: in New York City and in Dane/Milwaukee/Rock counties respectively.

30. At the same time, almost all observers agree that Democrats gerrymandered aggressively in Illinois, at least as commonly understood, in a bid to shore up their majorities in the state. Yet those maps would not invite scrutiny under the proffered standard.

31. Because the standard does not account for the naturally occurring clustering of partisans that has grown in Wisconsin recently, and because the metric brings under its ambit maps that are clearly not partisan gerrymanders, as commonly understood, while excluding maps that were clearly drawn with heavy partisan intent, it is not a solution to the problem of identifying unconstitutional partisan gerrymanders that has flummoxed federal courts for decades.

32. Fourth, the imputation strategy employed to solve the problem of uncontested districts results in a skewing of efficiency gaps in Wisconsin.

33. Fifth, the EG metric fails to account for important effects, such as incumbency and campaign spending.

34. Sixth, the EG metric is overly sensitive to slight changes in votes.

35. Seventh, EGs do not mean that parties are effectively locked out of the political process.

EXPERT CREDENTIALS

36. I have studied and followed United States elections on both a part-time and full-time basis for almost two decades.

37. I received a B.A. from Yale University in 1995, with a double major in history and political science.

38. I received a J.D. from Duke University in 2001.

39. I also received an M.A. from Duke University in 2001, in political science.

40. I joined RealClearPolitics in January of 2009 as their Senior Elections Analyst. I assumed a fulltime position with RealClearPolitics in March of 2010.

41. RealClearPolitics is one of the most heavily trafficked political websites in the world. It serves as a one-stop shop for political analysis from all sides of the political spectrum and is recognized as a pioneer in the field of poll aggregation. It is routinely cited by the most influential voices in politics, including David Brooks of *The New York Times*, Brit Hume of *Fox News*, Michael Barone of *The Almanac of American Politics*, Paul Gigot of *The Wall Street Journal*, and Peter Beinart of *The Atlantic*.

42. My main responsibilities with RealClearPolitics consist of tracking, analyzing, and writing about elections. I also am in charge of rating the competitiveness of House of Representatives races, and collaborate in rating the competitiveness of Presidential, Senate and gubernatorial races. As a part of carrying out these responsibilities, I have studied and written extensively about demographic trends in the country, as well as the approaches that parties use to draw lines.

43. As part of familiarizing myself with how parties have drawn lines over the decades, as well as learning the political geography of the United States, I drew, using Adobe Illustrator, complete maps of every congressional district ever drawn, dating back to 1789. Examples of these maps are attached as Exhibits 3-12.

44. I am also a Senior Columnist for Dr. Larry Sabato's "Crystal Ball." I began writing for the Crystal Ball in January of 2014.

45. The overarching purpose of my writings, both at RealClearPolitics and the Crystal Ball, is to try to convey more rigorous statistical understandings of elections than are typically found in journalistic coverage of elections to a lay audience.

46. I am the author of *The Lost Majority: Why the Future of Government is up For Grabs and Who Will Take It.* The book offers a revisionist take on realignment theory. It argues that realignments are a poor concept that should be abandoned. As part of this analysis, it conducts a thorough analysis of demographic and political trends beginning around 1920 and continuing through the modern times. It was one of the first examples of the dangers the Democratic Party faced from the increased geographic concentration of its coalition.

47. I also authored a chapter in Dr. Larry Sabato's *Barack Obama and the New America: The 2012 Election and the Changing Face of Politics*, which discussed the demographic shifts accompanying the 2012 elections. I also authored a chapter in Sabato's *The Surge: 2014's Big GOP Win and What It Means for the Next Presidential Election*, which discusses demographics and Electoral College shifts.

48. I co-authored the 2014 *Almanac of American Politics*. The Almanac is considered the foundational text for understanding congressional districts and the representatives of those districts, as well as the dynamics in play behind those elections. PBS's Judy Woodruff described the book as "the oxygen of the political world," while NBC's Chuck Todd noted that "[r]eal political junkies get two *Almanacs*: one for the home and one for the office." My focus was researching the history of and writing descriptions for many of the newly-drawn districts.

49. I have spoken on these subjects before audiences from across the political spectrum, including at the Heritage Foundation, the American Enterprise Institute, the CATO Institute, the Bipartisan Policy Center, and the Brookings Institution. In 2012, I was invited to Brussels to speak about American elections to the European External Action Service, which is the European Union's diplomatic corps.

50. It is my policy to appear on any news outlet that invites me, barring scheduling conflicts, and I have appeared on both Fox News and MSNBC to discuss electoral and demographic trends. I have spoken on a diverse array of radio shows such as First Edition with Sean Yoes, the Diane Rehm Show, the Brian Lehrer Show, the John Batchelor Show, the Bill Bennett Show, and Fox News Radio. I have been cited in major news publications, including *The New York Times*, *The Washington Post*, *The Los Angeles Times*, *The Wall Street Journal*, and *USA Today*.

51. I sit on the advisory panel for the "States of Change: Demographics and Democracy" project. This three-year project is sponsored by the Hewlett Foundation and involves three premier think tanks: The Brookings Institution, the American Enterprise Institute, and the Center for American Progress. The group takes a detailed look at trends among eligible voters and the overall population, both nationally and in key states, in an attempt to explain the impact of these changes on American politics, and to create population projections, which the Census Bureau abandoned in 1995.

52. I previously authored an expert report in *Dickson v. Rucho*, No. 11-CVS-16896 (N.C. Super Ct., Wake County), in which I was asked to identify the partisanship of various districts and opine as to whether they were drawn with partisan intent. It is my understanding that my report was accepted without objection. I have also authored an expert report in a nearly identical version of this litigation, brought in federal court.

53. I also previously authored two expert reports in *NAACP v. McCrory*, No. 1:13CV658 (M.D.N.C.), which involves challenges to multiple changes to North Carolina's voter laws, including a reduction in early voting days and elimination of same-day registration. I testified at the trial phase of that litigation.

54. I also previously authored an expert report in *NAACP v. Husted*, No. 2:14-cv-404 (S.D. Ohio). There was no live testimony at the preliminary injunction phase of that litigation, but it is my understanding that my expert report was accepted by and cited to by the Court without objection. I have also authored an expert report in a later iteration of that litigation, *Ohio Democratic Party v. Husted*, No. 2:15-CV-1802 (S.D. Ohio), and testified at trial.

<u>OPINIONS</u>

I. Plaintiffs' Experts Do Not Offer A Unified Definition of the Efficiency Gap

55. It is at times difficult to critique plaintiffs' conception of the efficiency gap, because their experts offer two different formulas for measuring that gap. This difference can be consequential.

56. Dr. Jackman calculates the EG with respect to the votes-to-seats curve. For him, the EG is generated from the equation "EG=S-.5-2(V-.5)," where "S" is the share of seats a party wins in a given jurisdiction and "V" is the share of votes that a party wins. Jackman at 16.

57. Dr. Mayer, by contrast, defines the efficiency gap as "the difference between the sum of wasted votes for the two parties, divided by the total number of votes cast in the election." Mayer at 43. Dr. Mayer also expresses his metric in terms of percentages, while Dr. Jackman expresses his metric in decimal form, although in mathematical terms the scale is identical. For purposes of this report, I will express both in decimal form.

58. To see how these values can vary, consider two examples provided in Dr. Mayer's report. On page 50, Dr. Mayer estimates the results Act 43 would have produced had all seats been open. On page 48, he estimates the results from his sample plan.

59. According to Dr. Mayer's calculations, the EG for Act 43 is -.1169. But employing Dr. Jackman's formula, the EG is -.0985.

60. Similarly, according to Dr. Mayer's calculations, the EG for his demonstration plan is -.219. Under Dr. Jackman's formula, the EG is -.0077.

61. The difference in measurement with respect to Dr. Mayer's estimated Act 43 result is .0141 points. The difference in measurement with respect to Dr. Mayer's estimated demonstration plan is .0184 points. When one considers that Dr. Jackman's measurements of historic efficiency gaps stretch only from -.18 to .2, this is a substantial, meaningful amount of uncertainty. If a court adopts Dr. Jackman's approach to the efficiency gap, it will likely result in a somewhat different universe of states found presumptively unconstitutional than if it adopts Dr. Mayer's approach.

II. The Clustering of the Democratic Coalition creates "natural" packing, which the Efficiency Gap metric does not account for.

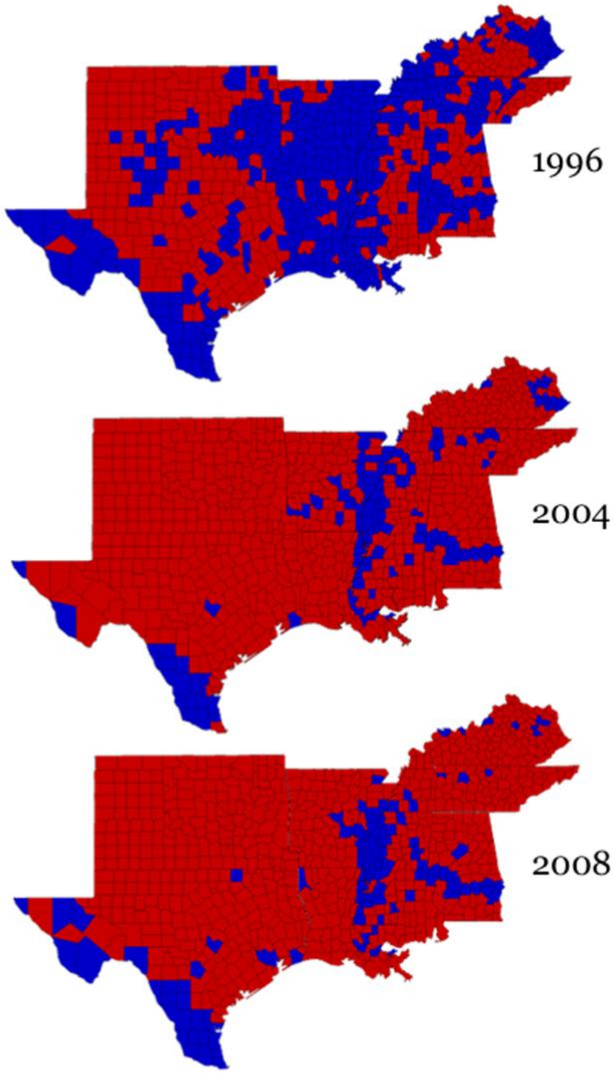
62. In 2002, John Judis and Ruy Teixeira wrote a book entitled "The Emerging Democratic Majority." In their telling, the Democratic Party of the 1990s was undergoing a transformation, and would emerge as a dominant party as a result of its coalition of minorities, women, creative class professionals and working class voters. This, they surmised, would enable Democrats to control the House, Senate and presidency into the future.

63. In 2011, I wrote a book called "The Lost Majority: Why The Future of Government is Up for Grabs, and Who Will Take It." It observed that Judis and Teixeira had been correct about a great many things, but had also overlooked the degree to which the new coalition would alienate older members of the Democratic coalition (as well as relying upon a faulty political science concept known as realignment theory). In particular, the increasingly liberal Democratic coalition alienated more conservative working class and rural voters, which Judis and Teixeira assumed would form the fourth portion of the Democrats' coalition.

64. My book argued that this trend among white working class voters and rural voters would help keep Republicans competitive at the presidential level for the foreseeable future. It also concluded that this should not have been surprising, as the story of American politics is one of ever changing coalitions, as the growth of one group pushes a group without countervailing interests into the arms of the other party.

65. But I noted that the Democrats' new coalition was uniquely problematic at the state legislative and congressional level. Because liberals, young voters, minorities, and other members of the Democrats' coalition tend to be concentrated in cities and/or placed into minority majority districts, this damaged their ability to win congressional districts, which reward parties with a wide geographic reaches (as illustrated in the introduction to this report).

66. Consider the West South Central region of the country. The following maps show the counties won by Republican and Democratic presidential candidates, utilizing the familiar red/blue color scheme.



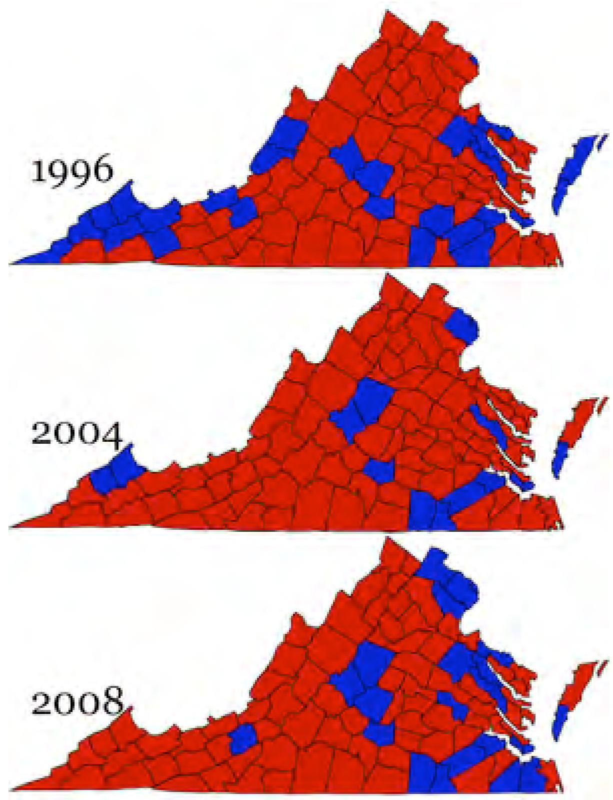
67. When Bill Clinton ran for re-election in 1996, he won nationally by about eight points. As we can see, his support in the region was geographically dispersed, which allowed him to carry around 54 percent of the Congressional districts in the region. This, in turn, helped Democrats win around 50 percent of these districts.

68. Barack Obama won nationally in 2008 by about seven points, yet this did not translate into success in the region. He ran about eight points behind Clinton's 1996 showing here. Interestingly, he actually ran about three points ahead of John Kerry in this region, yet carried fewer counties. The difference is that he carried several urban counties that neither Kerry

nor Clinton carried, such as Harris County, Texas (Houston), Jefferson County, Alabama (Birmingham) and Dallas County, Texas. But because his coalition shrank geographically, the net result was disadvantageous to Congressional Democrats; then-Senator Obama carried only 23 percent of the Congressional Districts in the region, with Democrats winning 39 percent of the seats. The latter number fell to 26 percent in 2010.

69. You can see the effects of geographic clustering in sharpest relief in a state like Virginia. Here, Barack Obama won by six points in 2008, while Bill Clinton had lost by two (despite the fact that they had won by similar margins nationally). Yet, from a geographic perspective, Obama's coalition was quite a bit narrower.

70. Obama shed voters, even from Kerry's losing coalition, in the western portion of the state, carrying only Montgomery County (Virginia Tech). He and Kerry added Albemarle County outside fast-growing Charlottesville (University of Virginia), and he performed well in the African American rural counties. He also added suburban Henrico County near Richmond, and carried some counties in the Hampton Roads area that Kerry and Clinton failed to carry. But the biggest gains are obvious, coming in northern Virginia. Obama became the first Democrat since LBJ to carry Loudoun and Prince William counties, and the second to carry Fairfax (Kerry was the first).



71. There is little doubt that the Democratic vote in Wisconsin is also increasingly concentrated in fewer counties. To understand the following analysis, we must first understand the concept of a state's Partisan Index.

72. A state's Partisan Index is computed by subtracting the share of the state that voted for the Republican presidential candidate from the share of the nation that voted for the Republican presidential candidate. For purposes of these calculations, third parties and independent candidates are excluded (i.e., we use what political scientists call the "two-party vote").

73. To illustrate the utility of the Partisan Index, consider the following example. In 1984, Ronald Reagan won 51.4 percent of the two-party vote in Massachusetts. In absolute terms, one could consider Massachusetts a swing state. But no one would have considered Massachusetts a swing state, because it had two Democratic senators, a Democratic governor,

and an overwhelmingly Democratic legislature. Ten of the state's eleven congressional districts elected Democrats, and the one Republican, Silvio Conte, was very liberal Republican.

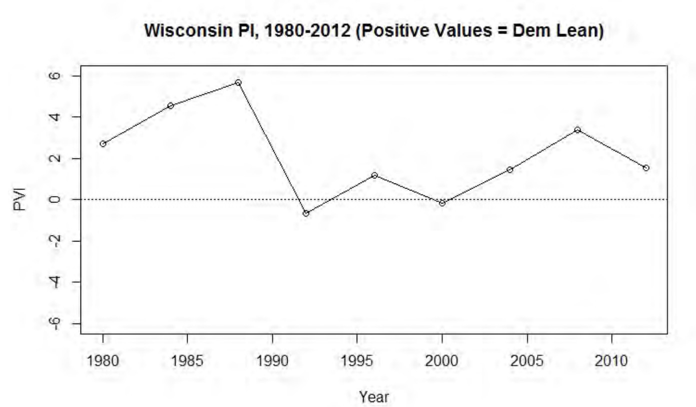
74. Moreover, one would conclude that, using absolute terms, the state has swung wildly toward Democrats in the interim, since Barack Obama won 61.8 percent of the two-party vote in the state in 2012.

75. But Reagan's 51.4 percent win in Massachusetts has to be viewed in the context of his winning 59.2 percent of the two-party vote nationally. Compared to the country as a whole, Massachusetts actually had a Democratic lean of 7.8 points in 1984.

76. Likewise, Obama's 61.7 percent win in Massachusetts has to be viewed in the context of his winning 52 percent of the two-party vote nationally. Compared to the country as a whole, Massachusetts actually had a Democratic lean of 9.8 points in 2012. Viewed in this light, Massachusetts has actually had relatively stable politics since 1984, with only a slight shift toward Democrats.

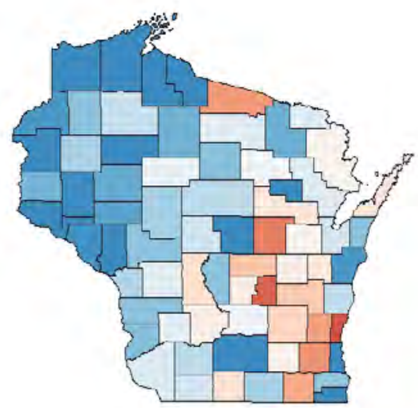
77. In short, Partisan Index allows us to control for national effects, and compare results across elections.

78. Wisconsin's PI has been mostly stable since the 1980s. After dipping to near-neutrality, during the 1990s, it shifted modestly leftward in the 00's.



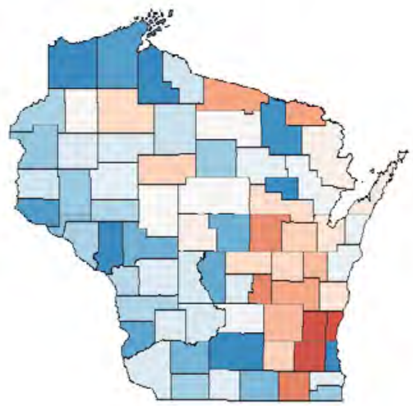
79. In this report, we begin by looking at Partisan Index on the county level across Wisconsin in a series of maps, with particular attention paid to 1996, 2004 and 2012, which represent years where the PIs of the state were similar (1.19, 1.43, and 1.54, respectively).

Wisconsin County PI 1988



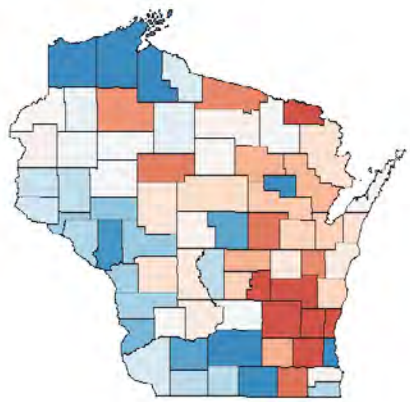
80. In 1988, the Democratic Party in Wisconsin had a broad geographic reach. It was strongest on the Menominee Indian Reservation (PI=26.86), as is the case today. The other four most Democratic counties include Douglas (22.47), Milwaukee (15.34), Ashland (14.63) and Dane (14.3). Seventy-one percent of counties had Democratic leans, and the Democratic Party covered the entire western portion of the state, particularly in the northwest. Republicans were relegated to the German-settled counties in the southeast and east-central portions of the state (note: The map caps the color-coding at PIs of -.1 and .1, in order to minimize the effect of outliers on the overall color-coding scheme).

Wisconsin County PI 1996



81. By 1996, the state as a whole had become modestly more Republican compared to the country as a whole, so it is unsurprising that the number of Republican counties increased; 45 counties (62.5 percent) had Democratic leans. But the shift was uneven. Democratic performance fell by just 4.5 points and 4.2 points in Milwaukee and Dane Counties, respectively. It fell by nine points in Douglas County, however, as the northwest became noticeably less Democratic.

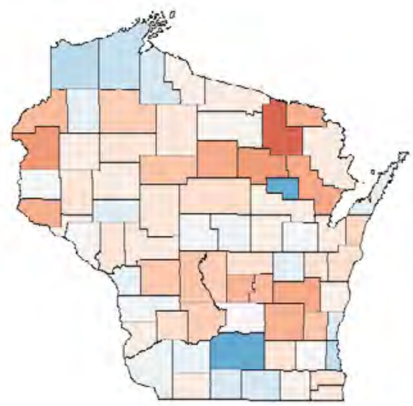
Wisconsin County PI 2004



82. In 2004, Wisconsin was once again marginally more Democratic than the country as a whole, but the political divisions looked quite different than they had in 1996. Democrats maintained their strength in the three industrial counties on the Lake Superior shoreline, as well as in the southwestern portion of the state. Milwaukee and Menominee Counties were Democratic as well. Ashland, Bayfield, and Douglas counties were 2.5 percent, 3.5 percent, and 4.2 percent more Republican than the country as a whole, respectively, than they had been in 1996. Milwaukee was 3.8 percent more Democratic. Menominee and Dane counties were both 7.9 percent more Democratic than they had been in 1996.

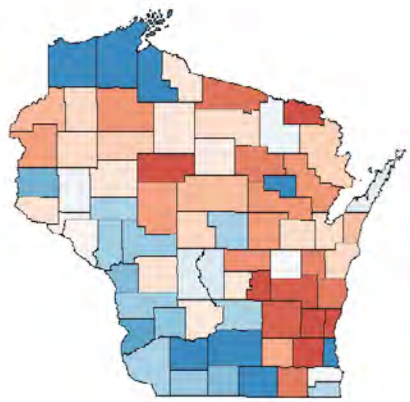
83. It was a different story in less populated counties. Forest County swung 9.2 points toward Republicans, Crawford County swung 1.2 points toward Republicans, and Adams County swung four points toward Republicans. The total number of Democratic-leaning counties dropped to 33, or just 46 percent of the counties in the state. Overall, the bluest counties tended to become bluer, while the rest of the state shifted rightward.

Wisconsin County PVI Change, 1996-2004

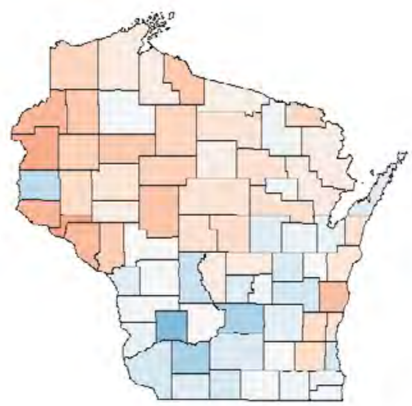


84. In 2012, the state was in roughly the same position relative to the country as a whole as it had been in 2004. But the stable orientation of the state overall masked significant internal movement. Dane and Milwaukee Counties swung a couple of points toward Democrats, along with some of the southwestern counties. Douglas and Ashland counties, along with most of the northwestern portion of the state, actually moved a touch toward Republicans. Overall, although the state was almost identically as Democratic in 2012 as it was in 1996, only 27 counties retained a Democratic lean in the latter year, or just 37.5 percent of the state. Moreover, these counties were geographically concentrated, in the southwestern portion of the state, in the far northwest, and in Milwaukee.

Wisconsin County PI 2012



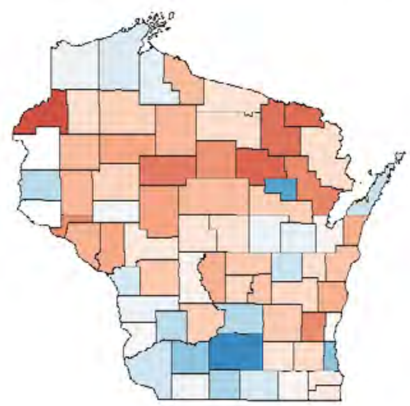
Wisconsin County PVI Change, 2004-2012



85. Overall, from 1996 to 2012, the Democratic Party became substantially less competitive in the northwestern portion of the state, as well as in the rural portions of the state outside of the southwestern corner. Its reach was limited to fewer counties, and those counties were clustered in geographically compact regions. You can see this in the map of changes

occurring across the entire time period; Democrats gained primarily in counties that already leaned Democratic at the beginning of the time period, while Republicans gained in places where they had been weak. The state didn't budge politically, but the internal movement was unmistakable. As was the case with the country as a whole, the Democrats' coalition became deeper, but narrower.

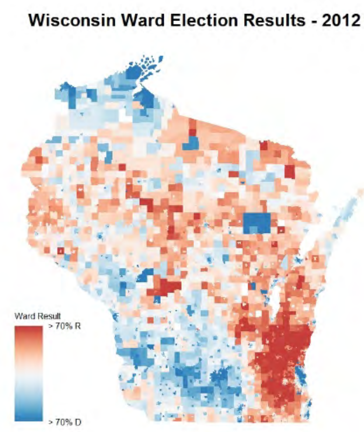
Wisconsin County PVI Change, 1996-2012



86. To put this into further perspective, Dane, Milwaukee, and Rock counties have provided Democrats with their three largest vote margins in every election since 1992 (inclusive). In 1996, Bill Clinton carried these three counties with 64 percent of the two-party vote. He also, however, carried the rest of the state with 52 percent of the vote, for a difference of twelve percent. In 2012, by contrast, even though Barack Obama was winning with a lower vote share (both in Wisconsin and nationally) than Clinton had in 1996, he carried Dane, Milwaukee and Rock counties with 69 percent of the vote. He lost the rest of the state, however, to Mitt Romney, 47 percent to 53 percent. The gap between those three counties and the rest of the state was 22 points. If we look in terms of Partisan Index, we see a similar trend; the gap

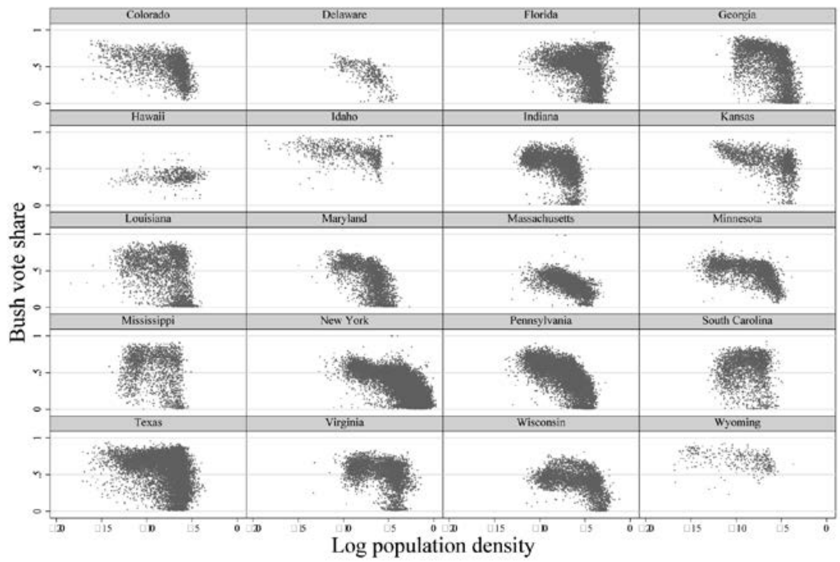
between the three counties above and the rest of the state was 12 points in 1996, 18 points in 2004, and 22 points in 2012.

87. We can also take a more rigorous approach to this. Consider the following map of Wisconsin wards in 2012, using Dr. Mayer's modified ward values.



88. This allows us to see that the clustering that is apparent at the county level filters down to the ward level, with Democrats concentrated in the northwest, southwest, and in Milwaukee County.

89. We can see this further in the following chart, reproduced from Jowei Chen and Jonathan Rodden, "Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures," 57 Quarterly Journal of Poli. Sci. 200 (2013):

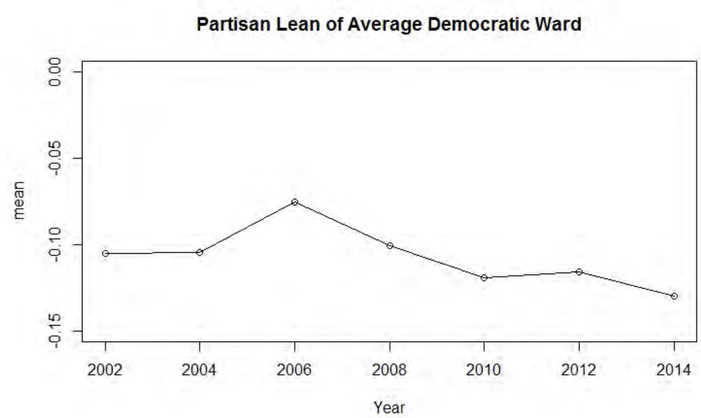


90. Each of these dots represents an estimate for voting units in each state, generated from vote files and the U.S. census. The figure charts them by partisanship (e.g., how heavily each unit voted for the Republican presidential ticket in 2000) on the vertical axis, and by population density on the horizontal axis. As you can see, in Wisconsin (as in many other states), as the units become more heavily Democratic, they also become more densely populated. This suggests that the Democratic vote is heavily concentrated in cities. Even as of 2000, as population density increased in Wisconsin, the Republican share of the vote dropped.

91. We can validate our assumption numerically through a two-step process. First, we want to see whether Wisconsin's wards have become increasingly polarized. That is, are there *more* heavily Democratic wards today than there were a decade ago? Second, we want to know whether the heavily Democratic wards are located more closely together than heavily Republican wards.

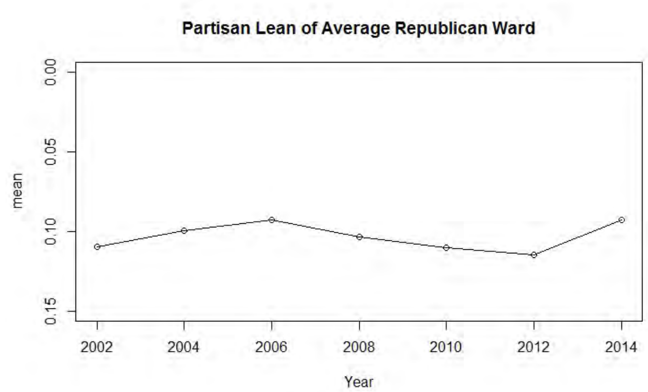
92. From 2002 to 2014, I looked at the top of the ticket race in the state (note: I tested both the "raw" LTSB data and the data recalculated under Dr. Mayer's metric for 2004, 2008 and 2012, and determined that, in this context, utilizing the raw data did not alter any conclusions).

93. To accomplish the first goal, I calculated the average Democratic lean of wards that leaned toward Democrats over the course of the past decade:



94. As you can see, the mean Democratic ward in Wisconsin has moved leftward over the course of the past decade. That is to say, the average Democratic ward in 2014 was 2.5 percent more Democratic than in 2002.

95. At the same time, we do not see any similar effect for Republican wards:

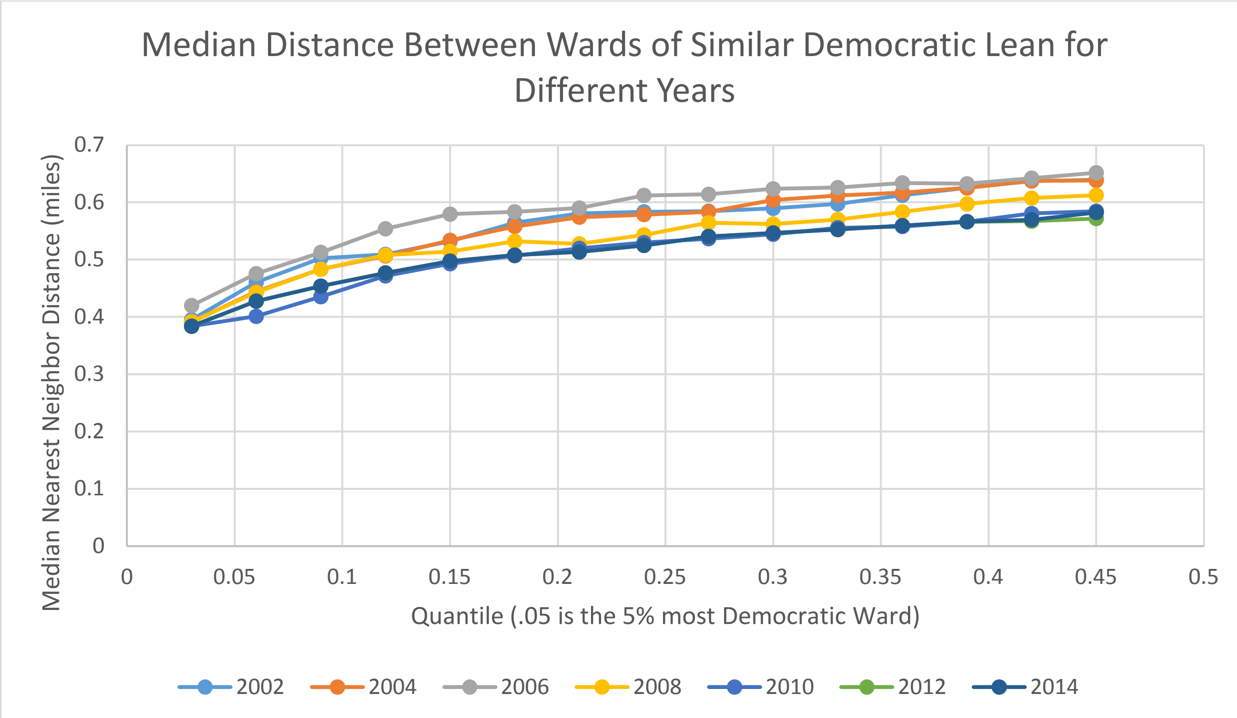


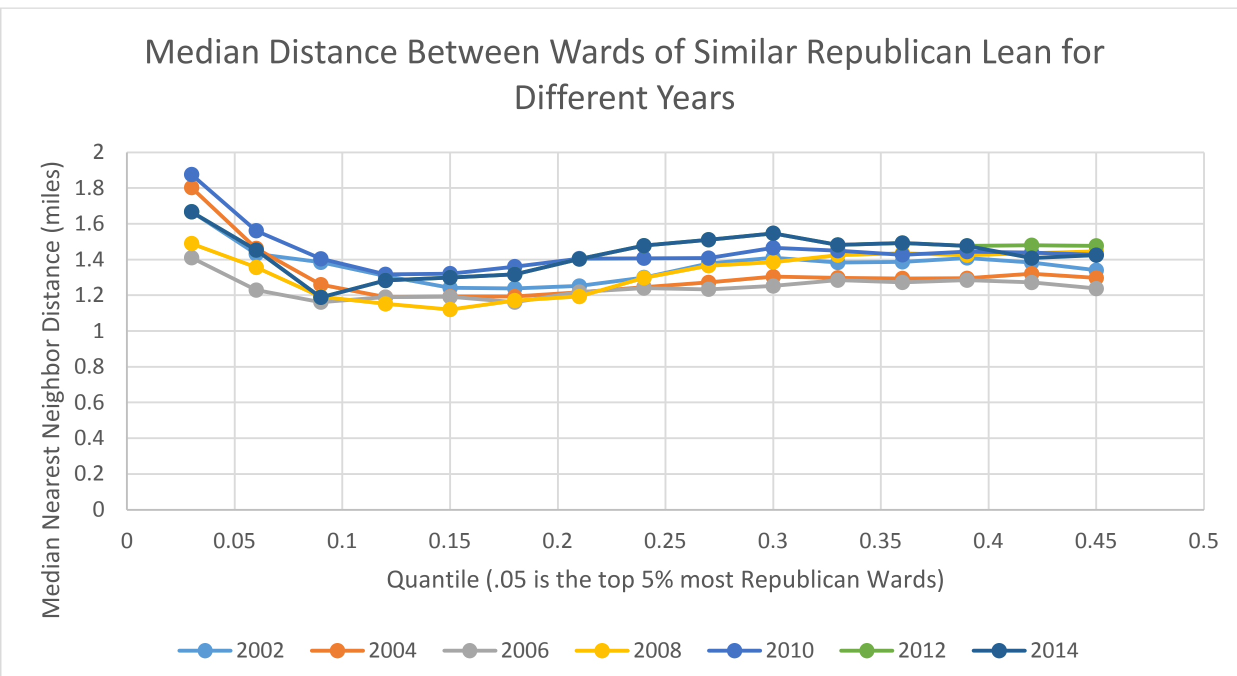
96. This answers the question of whether the Democratic-leaning wards in Wisconsin have become more heavily Democratic over time. To answer our second question, we first need

to sort the wards for each cycle into partisan-filtered maps, using the partisan index as a guide to the state's overall partisanship. That is a complicated way of saying that I took the D+1 wards as a group, the D+2 wards as a group, and so forth.

97. Next, the distance to the nearest neighbor for each ward was calculated, for each subset of partisan indices. To visualize this, imagine creating a grid with all of the D+1 wards listed both horizontally and vertically (if you prefer, an i x j matrix where both dimensions are defined as including the number of wards). The distance from the first ward to every other ward is calculated, filling in the first row of our grid. The smallest value is noted, which represents the distance from ward 1 to the nearest other ward of similar partisan index. The process then repeats for ward 2, ward 3, and so forth. At the end, the median of the smallest distances is calculated, which gives us an idea how close the D+1 wards are to each other (I utilized the median rather than the mean here because outlying wards, such as Menominee County, exert an undue amount of leverage on averages). The process is then repeated for D+2, D+3 and so forth. If Wisconsin has, in fact, become more clustered over time, then we should see the median distance decline as the partisanship of wards increases.

98. In fact, this is exactly what we see. The following charts show the wards grouped and labeled from most Democratic to least Democratic, and most Republican to least Republican. It shows the median distance for each grouping from every ward to its closest neighbor of similar partisanship. The quantiles from .45 to .55 are excluded, since they are effectively neutral.





99. As the wards become more Democratic, the distances between them shrinks. By contrast, the Republican ward distances tend to be fairly stable, until we get to the most heavily Republican wards, which are actually more spread out than the more neutral wards.

100. Taken together, these analyses demonstrate that, over the course of the past two decades, Wisconsin's Democratic vote has increasingly found itself relegated to Milwaukee County, the southwestern portion of the state, and a few counties in the northwestern portion of the state. This, in turn, shifts Wisconsin the baseline of Wisconsin maps rightward.

101. We see an example of how this plays out in Dr. Mayer's analysis. He proceeded with a mandate to "draw[] a legislative plan that has an efficiency gap as close to zero as possible while complying with federal and state requirements at least as well as the plan enacted by the Wisconsin legislature in Act 43." Mayer Report at 2. Yet after several days of mapmaking, Dr. Mayer ultimately failed to draw a map with a zero efficiency gap; the efficiency gap was actually -.022. That is almost 1/3 of the way to being a gerrymander under the standard that plaintiffs urge.

102. Plus we must remember what it means that Dr. Mayer sought to "comply[] with federal and state requirements at least as well as the plan enacted by the Wisconsin legislature." First, it is not clear that he succeeded; his districts have larger population deviations and split more localities (though they split fewer counties) than the Act 43 districts. *Id.* at 37.

103. But second, and more importantly, plaintiffs' theory is that Act 43 represents an egregious, unconstitutional gerrymander. There is something of a Hobson's choice at work here. Either Act 43 complies with traditional redistricting criteria well, which would divorce plaintiffs' metric from most understandings of gerrymandering even further, or it does not comply with traditional criteria well, in which case it is unclear that even a gerrymander (under most understandings of the term) pointing the other direction would be able to eliminate the efficiency gap entirely.

104. This is important because the efficiency gap metric assumes there is a baseline of zero – that is, if maps were drawn under neutral criteria with neutral intent, there would be no efficiency gap. But as the drawings in our introduction demonstrate, this is not necessarily the case. When natural clustering of Democrats occurs, the efficiency gap created by neutral processes drifts rightward; efficiency gaps increasingly present as a result of factors other than action by the state. This is likely one reason why, as plaintiffs' experts observe, the national trend has been toward increasingly Republican-leaning efficiency gaps, while the larger pro-Democratic efficiency gaps tend to occur in earlier decades.

105. What plaintiffs' standard does, at least in part, is force legislatures to enact "make up calls" for natural clustering of Democrats and for the clustering of Democratic-leaning groups required by the Voting Rights Act. In an odd way, by failing to account for the natural distribution of partisans, plaintiffs force legislatures to draw lines with partisan intent.

III. Plaintiffs' Standard is Both Underinclusive and Overinclusive.

106. This "natural gerrymandering" leads to an additional problem: The efficiency gap invites court scrutiny of maps that are clearly not partisan gerrymanders, while absolving maps where legislators clearly acted overwhelmingly with partisan intent.

107. While the Supreme Court has dismissed partisan intent or proportionality as a workable standard for gerrymandering, it has never intimated that gerrymanders could exist *without* partisan intent or disproportionate outcomes. The problem lies in creating workable limits determining how much partisan intent is too much partisan intent, or in constructing the counterfactual to predict disproportionate outcomes. At the same time, almost everyone's conception of gerrymandering involves intent to disadvantage a party, and to create disproportionate outcomes. If a proposed standard ignores a large number of maps drawn with

clear, overwhelming partisan intent, or includes a large number of maps that could not reasonably be argued to be gerrymanders, there is a good chance that the metric so radically alters the understanding of gerrymandering that it, in fact, is capturing something entirely different than gerrymandering.

108. Dr. Jackman identifies 17 maps with an "unambiguous history" of having a consistent efficiency gap sign over the lifespan of the plan. Jackman at 55.

109. But many of the states that would be included in the definition of a gerrymander here are poor candidates for the label, at least as most people would understand it. Table 1 shows the states on the list, as well as the party that controlled the governorship, state senate, and state house in the year prior to reapportionment.

Table 1: Partisan Control of Redistricting, Maps Id'd With "Unambiguous EGs"

State	Year	Gov	House	Sen
FL	2002	R	R	R
CA	1992	R	D	D
CO	1982	D	R	R
CO	1972	R	R	R
IL	1992	R	D	D
MI	2002	R	R	R
MI	1992	R	R	D
MO	2002	D	D	R
NY	2002	R	R	D
NY	1992	D	R	D
NY	1972	R	R	R
NY	1982	D	R	D
OH	2002	R	R	R
OH	1994	R	R	D
PA	1982	R	R	R
WI	2002	R	D	R
FL	1972	D	D	D

110. Only seven of the seventeen states included in the list of gerrymandered states feature unified partisan control of redistricting in the year where reapportionment was conducted (Ohio in 1992 drew its district lines through a Republican-controlled apportionment board). In five of those seven instances (the two Florida maps being the exception), control of at least one of the maps that produced unambiguous histories of consistent efficiency gaps switched partisan

hands at least once. The results of New York's 1972 map were particularly dramatic; by the end of the decade an 83-66 Republican lead in the state Assembly had transformed to an 85-64 Democratic lead; the 1972 elections actually marked the last election where Republicans would control the Assembly. This suggests that even enduring efficiency gaps do not necessarily translate into one side or the other being locked out of the legislative process (see below).

111. The remaining maps are poor candidates for gerrymanders, at least as the term is commonly understood. The Almanac of American Politics 1994 described the 1992 California plan (to simplify things, I refer to the year the plan was implemented, rather than the year it was actually adopted): "The key decisions for the 1990s California maps were made by the voters in 1990 and 1986. In 1990 they elected Republican Governor Pete Wilson, thus depriving Democrats of the untrammeled control they had over redistricting in 1982 and 1962 . . . Wilson held solid to his plan to appoint a redistricting commission to draw up plans for Congress and the legislature, and then handed them over to the state Supreme Court, which in January 1992 adopted them. In fact, the plan is more evenhanded than a Republican redistricter of, say, Phil Burton's abilities would have concocted. The lines are far more regular than in the ultrapartisan plan passed in Texas by the Democrats (this decade's winner of the Burton award)." Almanac of American Politics 1994 at 86.

112. In 1992, the Michigan state legislature failed to pass a reapportionment plan. The state Supreme Court appointed a panel of three special masters, which rejected the plans submitted by the state parties as excessively political. It instead implemented its own plan, which the state Supreme Court approved. *See NAACP v. Austin*, 857 F. Supp. 560 (E.D. Mich. 1994).

113. In 2002, the Missouri legislature deadlocked, and failed to pass any redistricting plan. The map was drawn by a committee of court of appeals judges.

114. The inclusion of New York's maps as potential gerrymanders is particularly perplexing. Control of redistricting has been split since the 1970 maps were drawn, and the tradition that has emerged is that the Republican-controlled senate draws the 63-member senate map, while the Democratic-controlled assembly draws the 150-member assembly map. The reason New York consistently presents as a Republican gerrymander has little to do with the lines drawn, but rather derives from the concentration of the Democratic vote. In 2012, Barack Obama carried New York state by two million votes, but carried the area outside of New York City by just 441,000 votes. These votes are also concentrated (in places like Hempstead and Islip on Long Island), which means that, even with Democrats drawing the Assembly lines and a 441,000 presidential vote advantage to work with, they are able only to split the Long Island and upstate districts evenly with Republicans.

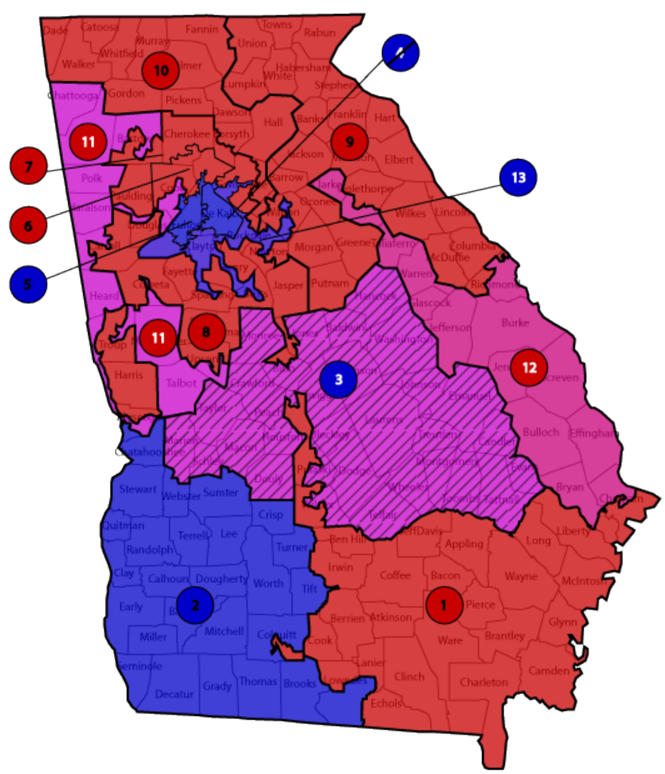
115. The standard also overlooks some of the more obvious examples of redistricting with partisan intention. For example, at the congressional level, the 2004 Almanac of American Politics describes the 2002 redistricting process in Alabama as follows: "[t]he Democrats in control of redistricting in Alabama in 2002 did a pretty good job of helping their party in drawing the boundaries of the state's seven congressional districts, but not quite good enough of a job to add to the two seats they have held since 1994." *Id.* at 54. The map the Democrats produced in a bid to shore up their majorities produces an efficiency gap of -.125, which would invite court scrutiny as a Republican gerrymander.

116. In Colorado in 2002, a court selected a Democratic-drawn map for Congress and state House; Republicans were so infuriated by this that they attempted a mid-decade

redistricting when they next controlled the legislature. *Id.* at 303-04. But the Democratic plan actually produces an efficiency gap of -.09, which would invite court scrutiny as a Republican gerrymander.

117. On the other hand, Georgia in 2002 was considered a strongly Democratic gerrymander. The Almanac describes the process: "[a]fter the 1990 and 2000 Censuses, Georgia Democrats, led by Speaker Thomas Murphy, pushed through convoluted redistricting plans – arguably the most convoluted in the nation each time – to guarantee majorities for their party in the state's House delegation." *Id*. at 454. To do saw, the Georgia legislature drew highly convoluted lines, including the new 13th, which has been liked to a "sick chicken." But the map actually had a slight Republican efficiency gap of -.01.

Georgia 2002

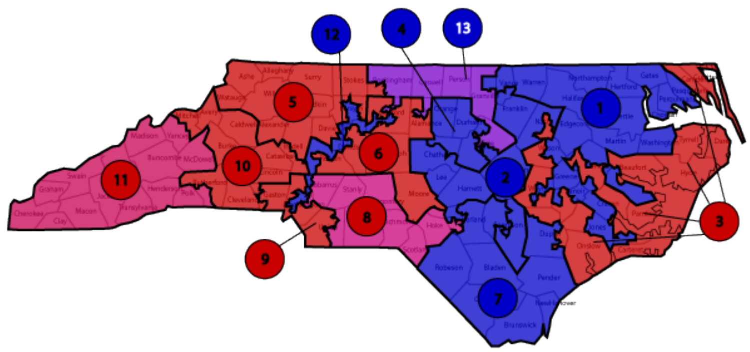


118. Illinois's congressional districts in 2002 represented a negotiated, bipartisan plan that was broadly acceptable to members of both parties. *Id.* at 528-29. Yet it presents with an efficiency gap of -.09, which would invite Court scrutiny as a Republican gerrymander.

119. Iowa's Legislative Services Bureau is often held up as an exemplar of how nonpartisan redistricting ought to work. Yet in 2002, it presents with an efficiency gap of -.2, which would invite court scrutiny as a Republican gerrymander.

120. North Carolina's 2002 redistricting was likewise controlled by Democrats, who sought to weaken Republican Robin Hayes in the 8th District while shoring up Democrat Mike McIntyre in the 7th District. It was successful in doing just that later in the decade. But in 2002, it presented a marginal Republican lean, with an EG of -.026. It is not a gerrymander under the efficiency gap metric, despite plain partisan intent and convoluted districts, including the second district, which resembles a dragon in flight:

North Carolina 2002



121. In 2012, the Arizona congressional lines were drawn by an independent redistricting commission. In 2012, it nevertheless presented with a .16 EG, which would invite court scrutiny as a Democratic gerrymander.

122. In 2012, a Colorado district court judge selected a Democratic redistricting plan for Congress. *See* Almanac of American Politics 2014 at 290-91. In 2012, it nevertheless presented with a -.099 EG, which would invite court scrutiny as a Republican gerrymander.

123. In 2011, Illinois instituted some of the most aggressive redistricting in the country. As the Almanac reported "[u]nder heavy pressure from party leaders desperate to offset Republican gains in other states, Democrats in May 2011 released a map designed to eliminate up to six Republican seats. . . . The state's Republican delegation immediately put out a joint

statement calling it 'little more than an attempt to undo the results of the elections held just six months ago' and they were largely right." *Id.* at 541. Yet the map only presented with an efficiency gap of .058, which would not trigger court scrutiny.

124. Perhaps most strikingly, the Supreme Court conceded in *Veith v. Jubelirer* that the Pennsylvania map for the 2000s was a "partisan redistricting plan;" the case failed because of the lack of a manageable standard. While it presented as a partisan redistricting plan in 2002, in 2006 the efficiency gap was only -.04, while in 2008 it was actually a *positive* .033. In other words, had the national environment been worse for Republicans in 2002, the efficiency gap might conclude that the *Veith* map was actually a modest Democratic gerrymander.

125. In Figure 36, which examines the current legislative maps, Dr. Jackman finds actionable EGs for Rhode Island and Vermont on the Democratic side, and for Florida, Michigan, Virginia, North Carolina, Kansas, Indiana, New York, and Wyoming. A majority of states overall appear to have at least one year of 2012 or 2014 outside of the actionable .07 threshold identified by Dr. Jackman.

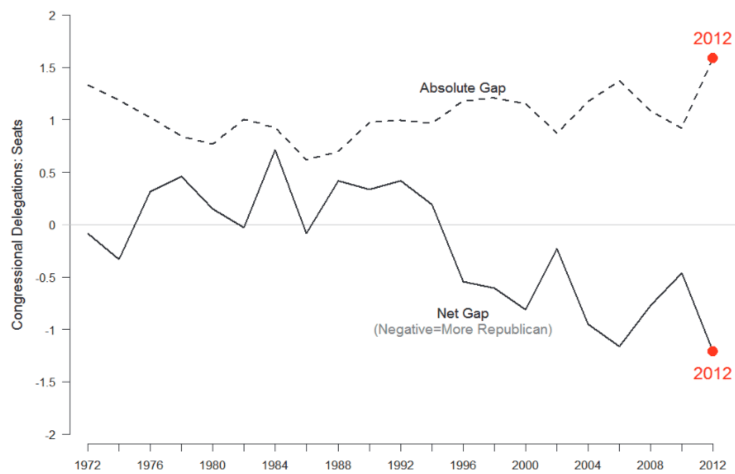
126. But as seen in the chart reproduced from Chen & Rodden above, there simply are not many precincts in Wyoming that lean Democratic; the same is likely true in Vermont and Rhode Island (oddly, efficiency gaps can present when the opposite of clustering occurs: When one party is politically dominant and partisans for the other party are so spread out that it is impossible to cluster them into districts). Democrats drew the Assembly in New York, while Kansas is a judge-drawn map. At the same time, maps that are generally thought to represent aggressive partisan maps, such as Arkansas and Illinois, appear as neutral maps under plaintiffs' standard.

127. Finally, the EG narrative is problematic for Wisconsin in particular. If the EG were a good measure of gerrymandering, we'd expect some sort of measurable difference between gaps to occur in redistricting years. In other words, we would expect that there would be natural variations over time, but overall we should see a "stepped" pattern to the chart of efficiency gaps over time, with the steps corresponding to redistricting years.

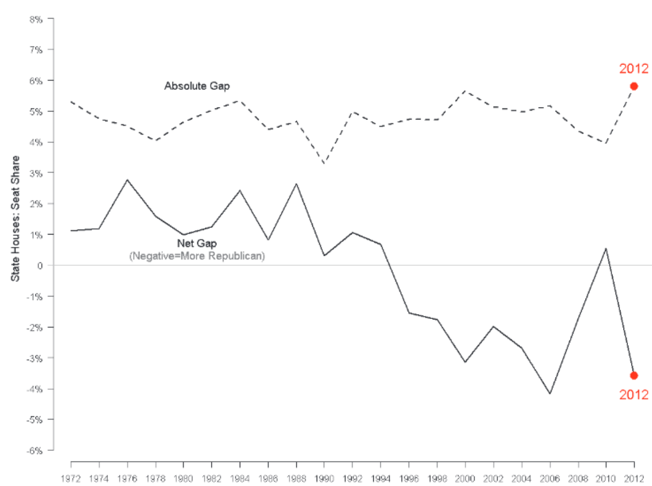
128. But this is not what we see in Wisconsin. As Dr. Jackman notes in Fig. 35, the time period from 1970 to 1996 shows relatively stable EGs in Wisconsin, regardless of who controls redistricting. But 1996 is the last year for which we see such balance. A substantial, fairly steady dropoff begins in 1998. Six of the nine post-1996 EGs appear to be large enough to be actionable under plaintiffs' theory. Worse, three of those six cases occurred under the 2001 redistricting, which resulted in a court-drawn legislative map. Indeed, it is not at all clear that the current map is appreciably different in terms of gaps from the map that was drawn by the court for the 2000s.

129. Instead, what we observe appears to ape national trends. The following two charts are taken from page 873 of the article from Drs. Eric McGhee and Nicholas Stephanopolous (which underlies this litigation). They show the average net and absolute efficiency gaps from 1972 to 2012 for Congressional and state legislative seats:

AVERAGE NET AND ABSOLUTE EFFICIENCY GAPS FOR CONGRESSIONAL PLANS, 1972–2012



AVERAGE NET AND ABSOLUTE EFFICIENCY GAPS FOR STATE HOUSE PLANS, 1972–2012



130. In both instances, we see the same thing: A clear pro-Republican trend in the overall net efficiency gap, but one that is not keyed off of redistricting years. Instead, the congressional chart begins a steady downward trajectory beginning with the 1994 elections (with the largest drop occurring in 1996), while the state house chart shows a dropoff beginning in 1990 (with a similar acceleration occurring in 1996). The EGs demonstrated in 2012 in both maps are similar to EGs that manifested in 2006, and the large drop-offs tend not to occur in

redistricting years. This suggests that the efficiency gaps we see are in large part due to exogenous forces, such as natural partisan clustering, rather than gerrymandering.

131. Efficiency gaps are growing in ways that gerrymandering has difficulty explaining, and are present in maps drawn by courts, by independent commissions, and by members of the opposing party. Given this, it is unclear why the existence of an efficiency gap would provide prima facie evidence that members of a party have had their right to vote diminished by state action.

IV. **Dr. Jackman's Imputation Strategy is Problematic**.

132. One of the great challenges of utilizing the efficiency gap is dealing with the problem of uncontested districts. Unopposed candidates will artificially inflate a party's popular vote total, and can skew the efficiency gap if they are disproportionally allocated to one party or the other.

133. Dr. Jackman's solution, when the data are available, is to use presidential vote share in the district (he has a different solution when presidential votes are not available). He notes that there is a tight correlation between the presidential vote share and state house vote share. Therefore, when state house vote shares are missing because of an uncontested election, Dr. Jackman substitutes presidential vote share from a similar district.

134. But there are two interrelated problems with this. First, we are not simply concerned with the r-square here (which, in lay terms, tells us how well knowing the value of variable A helps us to predict the value of variable B). We are also concerned with the coefficient, or the slope of the best fit line. If every percent increase in presidential vote share yielded a .5 percent increase in state house vote share, we would have a very high r-square, but we would not want to use this as a substitute.

135. Second, plaintiffs' own experts provide some good evidence suggesting that there may, in fact, be a systemic bias involved in imputing presidential results to state House results. Dr. Mayer demonstrates that there were many fewer unconstested Republican districts in 2012 than uncontested Democratic districts. Mayer at 40. Therefore, Dr. Jackman is imputing votes for far more Democratic districts than Republican districts.

136. In and of itself, this is not a problem if the imputation strategy is correct. But on page 15, Dr. Mayer plots a line that represents a 1:1 ratio between presidential and assembly votes for Republicans and Democrats. That is, if every ward showed the same number of votes for president and assembly, every dot would fall on the line.

137. Figure 2 demonstrates that imputation is acceptable for Republican wards in Wisconsin, since the dots appear to fall more-or-less on the line.

138. For Democrats, however, the dots systematically fall below the line, often creating differences on the order of 10 percent.

139. The net effect of this will be to skew the imputation. It suggests that too many votes are being imputed in wards reporting a high number of Democratic votes, which will skew popular vote totals. In other words, a ward with 100 votes for Romney and 900 votes for Obama probably should not be reported as a 90 percent Democratic ward with 1,000 votes cast. It should probably be reported as an 89 percent Democratic ward with 900 votes cast. The impact of this will be particularly pronounced, given that there are more imputations being performed for Democratic districts than Republican districts.

V. The Efficiency Gap Metric Ignores Important Factors, Such as Incumbency, Candidate Quality, Campaign Spending, and Recruiting Advantages.

140. When Dr. Mayer models his efficiency gaps, he notes that incumbency has a statistically significant impact on vote totals (this is one reason why he ultimately models results

without any incumbents). Other factors, such as candidate quality, campaign spending, and recruiting advantages are acknowledged as having positive effects on turnout. *E.g.*, Eric McGhee & John Sides, "Do Campaigns Drive Partisan Turnout?" 33 Polit. Behav. 313-333 (2010).

141. In other words, if one party has a disproportionately strong get-out-the-vote effort in place, or better candidates, or fewer incumbents, it can alter the popular vote totals and alter the efficiency gap.

142. In other words, there are important factors in addition to clustering that can alter the efficiency gap, and which the presented EG metric does not account for.

VI. **Efficiency Gaps Are Sensitive To Slight Changes.**

143. This might not be a problem if the Efficiency Gap was not sensitive to slight changes in turnout or voting behavior. But it is. Consider the following scenario: A Republican legislature redistricts a Democratic-leaning state. It creates five 90% Democratic districts, a 60% Democratic district, four 90% Republican districts, six 55% Republican districts, a 53% Republican district, and three 49% Democratic districts.

Table 2: Redistricting in Hypothetical State

District	D %	R %
1	10	90
2	10	90
3	10	90
4	10	90
5	45	55
6	45	55
7	45	55
8	45	55
9	45	55
10	45	55
11	47	53
12	51	49
13	51	49
14	51	49
15	60	40
16	90	10
17	90	10
18	90	10
19	90	10
20	90	10

144. In the first year after redistricting, if everyone votes as expected, we would see a -.06 efficiency gap, suggesting that the map was not a Republican gerrymander, under the plaintiffs' proposed standard.

145. But assume that we saw a national Republican wave in the first year, and Republicans fared two points better across-the-board. The map would result in a -.19 efficiency gap, which would constitute a gross "gerrymander."

146. The result would not have to be that dramatic, however. Assume instead that Republicans ran a slightly stronger candidate in district 12, and carried it. The efficiency gap would be -.109, and the map would be presumed unconstitutional.

147. This is not a wholly hypothetical concern. As discussed above, Dr. Mayer measures Act 43, sans incumbents, of having an EG of 11.69. But assume that through a modestly better GOTV effort, Democrats win 400 more votes in District 1, and 200 more votes in District 94 in the 2012 election. The EG falls by more than two points off these modest shifts, to 9.466.

148. In other word, the EG metric is sensitive enough that relatively small differences in the electoral outcome can make a difference between whether a map is presumptively unconstitutional or not. While this shift would not make a difference in terms of whether the Wisconsin map invited Court scrutiny, as a national standard, it almost certainly would in other states.

VI. Efficiency gaps do not mean that stability is created or that parties are locked out of the process.

149. Finally, it is worth noting that EGs do not correlate to partisan outcomes. That is to say, to the extent an equal protection violation derives from foreclosing a party from adequately participating in the political process, the EG does not reveal such a pattern.

150. For example, as noted above, even though New York has consistently had a pro-Republican efficiency gap, Republicans have never claimed control of the Assembly. The most severe Republican gerrymander, under the EG standard, came in 2002. Yet despite the fact that the EG never rises above -.078 under that map –every election results in an actionable Republican gerrymander—Democrats always controlled the Assembly by a large margin.

151. The Michigan 2002 map is counted as a Republican gerrymander, yet Democrats won the state House in 2006 and 2008. Likewise, the Michigan 1992 map is counted as a Republican gerrymander, yet Democrats controlled the state House throughout the decade.

152. The Colorado 1972 map is counted as a Republican gerrymander, yet Democrats won the state House twice under the map (in what was then considered a Republican state).

153. Likewise, even though California's 1992 map is counted as a Republican gerrymander, Democrats managed to win unified control of the legislature in 1996, 1998 and 2000.

154. This is not to say that partisan outcome provides a workable legal standard for analyzing gerrymanders. If anything, the foregoing merely proves the point that *forecasting* actual partisan outcomes over the course of a decade can be difficult. But when a standard for gerrymandering does not align with outcomes in a backward-looking analysis, it calls into question the utility of the metric as a standard overall.

CONCLUSION

155. The EG is a clever metric, propounded by some of the political scientists I hold in the highest regard. But as a legal standard, it is highly problematic. For a variety of reasons described above, it casts its net both too widely and not widely enough. Moreover, it effectively forces mapmakers to gerrymander to "fix" things that do not result from state action.

This the 2nd day of December, 2015.

Sean P. Trende

Rebuttal Report: Response to Expert Reports of Sean Trende and Nicholas Goedert

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Department of Political Science
University of Wisconsin-Madison
December 21, 2015

This report presents my responses to the criticisms that Sean Trende and Professor Nicholas Goedert make of my report.[1]

I. Summary

A. Both Trende and Goedert erroneously argue that Democrats are more geographically concentrated than Republicans in Wisconsin, which creates a natural pro-Republican bias even under a neutrally-drawn district plan. Both arguments are based on unreliable methodologies, flawed measures, and lead to inaccurate conclusions. Trende's methodology for measuring partisan concentration relies on an unorthodox method (the PVI) far more common among political commentators than academics who study spatial patterns of concentration and isolation. Moreover, as he applies it here, Trende relies on fundamentally inaccurate measures of geography that are guaranteed to demonstrate that Democratic wards are closer to one another than are Republican wards.

Goedert's arguments about geographic concentration are analogous to Trende's, and suffer from the same flaws in that they are based on superficial claims that do not rely on actual measures of spatial concentration or isolation. Moreover, Goedert's claims here contradict his own research, in which he finds that even after controlling for urbanization (a proxy for concentration), Republican control of the redistricting process has a large and statistically significant impact on a plan's bias. A model in one of his papers (Goedert 2015) also shows that a court-drawn or bipartisan map in Wisconsin would be expected to produce a *pro-Democratic bias*. The model generates the same expectation for a court-drawn or bipartisan map in a state that resembles the country as a whole. Accordingly, based on Goedert's own analysis, there is no natural pro-Republican tilt in either Wisconsin or the typical U.S. state.

In contrast to Trende's and Goedert's unorthodox techniques, widely (even universally) accepted measures of spatial distributions, such as Global Moran's I (Cho 2003) and the Isolation Index (Reardon 2004), show that Wisconsin's Republicans and Democrats are equally spatially concentrated and equally spatially isolated from each other, and that in some election years *Republicans are more concentrated* than Democrats.

B. Trende criticizes my method of estimating the partisanship of uncontested Assembly districts as biased. But his criticism stems from a superficial and erroneous discussion of a single figure in my report (Figure 2), and he erroneously believes that I set the Assembly votes in uncontested districts to the presidential vote in those districts. He does not take notice of the fact that my analysis was based on a comprehensive multiple regression model that controlled for the very factors that he claims create bias, nor that my model produces extraordinarily accurate forecasts of the actual data, using multiple methods.

[1] "Analysis of the Efficiency Gaps of Wisconsin's Current Legislative District Plan and Plaintiff's Demonstration Plan," July 3, 2015.

C. Trende criticizes my baseline measure of partisanship for not taking into account factors such as incumbency, candidate quality, and spending. This is an inaccurate criticism, because estimating baseline partisanship is *designed* to control for incumbency, campaign spending, and candidate quality. This is the method preferred in the academic literature on redistricting, which seeks to understand the consequences of hypothetical plans (in which candidate quality, spending, and incumbency are unknown). My approach is *identical* to the method used by Professor Gaddie, who produced the baseline partisan estimates used by Wisconsin's map drawers in 2011.

D. Goedert challenges my model for estimating baseline partisanship in 2012, contending that I took into account information that the authors of Act 43 did not have (the 2012 election results). However, my baseline estimates of partisanship are nearly identical to those generated by Gaddie in 2011, indicating the same conclusions follow whether 2012 or pre-2012 data are used in the analysis. In addition, pre-2012 election results are highly correlated with 2012 election results, indicating that it would make no difference if I had used earlier election results. Goedert dismisses the convergence between my estimates and Gaddie's estimates as "mostly coincidental," but offers no evidence or data to support his assertion.

E. Geodert also challenges my efficiency gap calculations for ignoring the effects of incumbency, which he asserts that any author of a redistricting plan would incorporate. His criticism fails to acknowledge that controlling for incumbency is the standard methodology for estimating the partisan consequences of a hypothetical district plan. Nevertheless, I recalculated efficiency gap estimates for both Act 43 and my Demonstration Plan, taking incumbency into account. The substantive conclusions are identical: the efficiency gap for my plan increases slightly (but is still well within acceptable limits), as does the efficiency gap for Act 43. The *difference* between the two plans' efficiency gaps remains enormous.

F. Goedert criticizes my efficiency gap calculations for not including any sensitivity testing to determine whether my results are robust to changes in the statewide electoral environment. I conducted a uniform swing analysis over the range of plausible election results, based on the maximum and minimum statewide Democratic Assembly vote since 1992. This analysis shows that the efficiency gaps of both Act 43 and the Demonstration Plan are robust: Act 43's efficiency gap remains very high across this range, always significantly above the plaintiffs' suggested 7% threshold, and the Demonstration Plan's efficiency gap remains very low, and is always well below the threshold. Goedert is simply incorrect in asserting that the plans' respective efficiency gaps are not robust, and, again, offers no data or evidence to support his claim.

G. Throughout their reports, neither Trende nor Goedert has actually done any analysis that identifies problems with my analysis, or that specifically shows where my analysis is incorrect. Trende and Goedert merely offer speculative and unsubstantiated criticism, but never offer any substantive data or evidence that supports their arguments. And, as I will show, when they attempt to analyze Wisconsin's political geography, their conclusions are utterly wrong.

II. The Claim that Wisconsin's Political Geography Has a Pro Republican Bias

While I will go into more detail on the specific points each report makes, I focus first on a central argument both Trende and Goedert make: that Wisconsin has a natural distribution of Republicans and Democrats that produces an intrinsic pro-Republican bias in a neutrally-drawn redistricting plan. They claim that because Democrats in Wisconsin happen to be (allegedly) naturally concentrated in small pockets of overwhelming Democratic strength, even a neutrally-drawn map would produce a large pro-Republican efficiency gap. As a result, they conclude, it is not possible to consider a large pro-Republican efficiency gap as evidence of gerrymandering.

I begin by noting that both Trende and Goedert ignore the role that political geography already plays in plaintiffs' proposed test. Under the test's first prong, if the state's motive in enacting its plan was simply to follow the contours of the state's geography, then partisan intent would not be present and plaintiffs would proceed no further in their claim. Similarly, under the test's third prong, if the state can show that its plan's large efficiency gap was necessitated by the geographic distribution of the state's voters, then the plan would be upheld. These points mean that geography is already properly incorporated into plaintiffs' proposal.

There are, additionally, two points that fundamentally negate the utility of this line of attack. First, the geographic concentration argument is predicated on the foundational assumption that a *neutrally-drawn map* would have produced a pro-Republican bias. Even if Trende and Goedert are correct in this assumption (which they are not), they take no position on whether the process in Wisconsin was, in fact, neutral. The record of the federal redistricting trial clearly shows that Act 43 was designed with the predominant purpose of benefiting Republicans and disadvantaging Democrats, and neither Trende nor Goedert contradicts the findings in my report of examples of blatant packing and cracking that are the very DNA of a partisan gerrymander.

And second, even if the state's experts are correct that political geography has produced the pro-Republican bias in Wisconsin's state legislative district plan (which they are not), it is impossible for them to quantify *how much* of an effect geography has had: is it 5%? 10%? 90%? 100%? Neither Trende nor Goedert have actually done any analysis that *demonstrates* that the alleged concentration of Democrats *in Wisconsin* will produce a pro-Republican efficiency gap, or any work that quantifies how concentration is related to efficiency gap calculations. They simply assert (incorrectly) that Democrats are more concentrated than Republicans, and therefore that even a neutral map will produce a pro-Republican bias.

But they are also wrong on the facts. Their argument about geographic concentration is based on flawed data and measures, and has no basis in accepted methods of measuring geographic concentration and isolation. Trende, in particular, uses an unorthodox method with no support in the peer-reviewed literature, and one that is guaranteed to produce a biased result that shows Democrats far more concentrated than they actually are. Goedert's argument contradicts his own published work, which shows that partisan control of redistricting generates a substantial bias even after partisan concentration is taken into account. His argument, further, falls victim to the Modified Areal Unit Problem, in that it is based entirely on the analysis of wards, ignoring the fact that wards are aggregated into districts. As I demonstrate, this aggregation process completely changes the applicability of Goedert's conclusions.

When I analyze the geographic distribution of Wisconsin's Democrats and Republicans using widely accepted measures of spatial concentration and isolation (Global Moran's I and the Isolation Index), I find that there is very little evidence of significant disparities in how the parties' voters have been distributed in recent election cycles. Republicans are in fact *more concentrated* than Democrats when measured by the 2012 Assembly vote.

A. Trende

Trende spends nearly half of his report (paragraphs 62-105) arguing that Democrats are naturally more concentrated ("clustered") than Republicans in Wisconsin, which creates a natural packing effect. Much of this discussion is entirely irrelevant to Wisconsin (Trende's discussion of patterns in the southern United States, Virginia, and differences between the 1996 and 2008 Democratic coalitions; see paragraphs 62-77). Trende also simply asserts that "there is little doubt that the Democratic vote in Wisconsin is also increasingly concentrated in fewer counties" (paragraph 71). He neither explains the relevance of the *county* vote to the issue of geographic distribution and legislative redistricting, nor why the county vote pattern in 1988 or 1996 is germane to the environment in 2012.

1. The PVI (partisan vote index) is the wrong quantity of interest

As applied to Wisconsin, Trende attempts to demonstrate that over the last 20 years Democrats have become more concentrated. His method relies on a quantity he calls the Partisan Lean Index, which is the party's county or ward vote share minus the party's statewide vote share, and appears to be analogous to the Cook PVI, which is the same quantity calculated using the congressional district vote and the national presidential vote. Trende argues that Democratic wards are closer together than Republican wards, which to him is evidence of geographic clustering that produces a natural pro-Republican redistricting bias.

The PVI (which is how Trende abbreviates the measure) is a quantity that is not commonly used in the academic literature, and when it is, it is used largely as a simple descriptive statistic. What this index does is simply redistribute the ward vote around the statewide average, and thus tells us which areas are more Democratic (or Republican) than the state as a whole, and which areas are less so.[2] It tells us little about overall partisan strength, and

[2] The Cook Political Report notes that it "introduced the Partisan Vote Index (PVI) as a means of providing a more accurate picture of the competitiveness of each of the 435 congressional districts." http://cookpolitical.com/story/5604

is useful only in comparing elections at one level (here, counties or wards) to elections at another (the state).

The PVI is used almost exclusively by political commentators to describe congressional districts (the most widely known is the Cook PVI, which compares the average congressional district vote split over two consecutive elections to the average national presidential vote over those same elections). It is used less frequently in academic research, and then largely as a basic descriptive statistic used to classify districts as competitive or not. It is not used in the context of state legislative redistricting (Trende did not cite any studies that support the use of his measure, and could not identify any in his deposition).

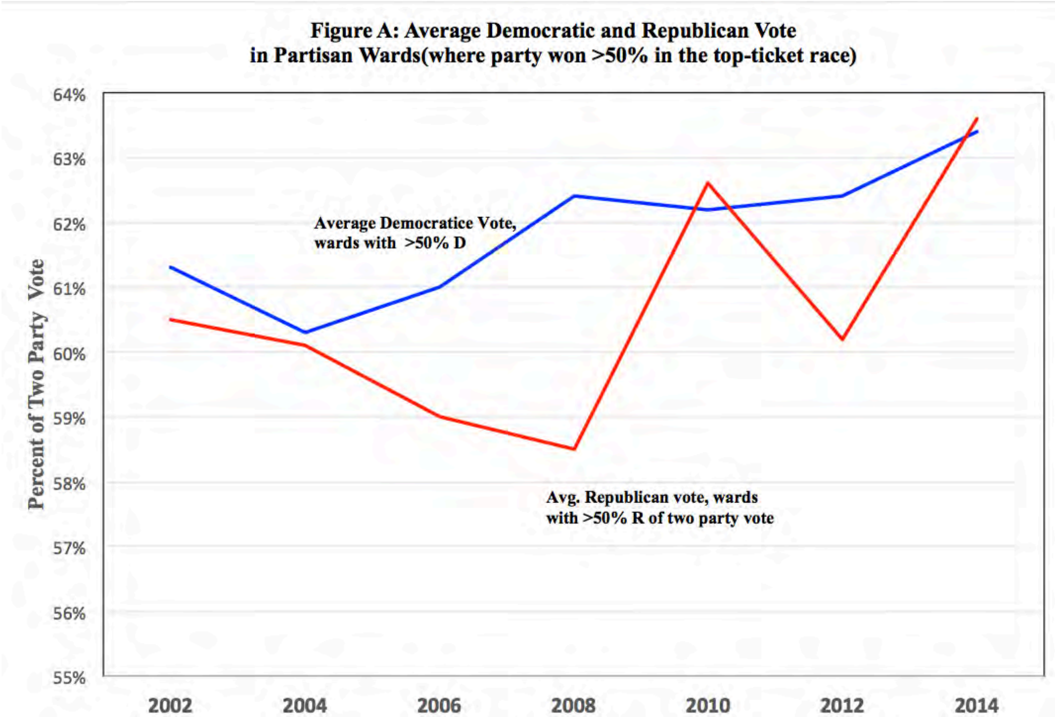
Moreover, Trende appears to have made two errors in his calculation of the PVI.[3] First, while he states that his PVI is based on the top-of-the-ticket race in each year, he uses the gubernatorial elections as his top-of-the-ticket race in 2002, 2010, and 2014, but the U.S. Senate race in 2006, even though there was a gubernatorial race that year. While scholars may differ on whether a gubernatorial or U.S. Senate election is the correct top-ticket race, there is no justification whatsoever for being inconsistent.[4]

Second, in calculating his 2014 PVI, Trende mistakenly subtracted the *2014* statewide percentages from the *2012* ward totals (this is the code he used to generate the PVI for 2014; the error is highlighted, and "map_2012$r_share" is the ward vote for 2012):

```
map_2014=readOGR("Wards_Final_Geo_111312_2014_ED.shp",
"Wards_Final_Geo_111312_2014_ED")
map_2014=spTransform(map_2014, CRS("+proj=longlat +datum=WGS84"))
map_2014$r_share=map_2014$GOVREP14/(map_2014$GOVREP14 + map_2014$GOVDEM14)
map_2014$pvi=map_2012$r_share -
sum(map_2014$GOVREP14)/(sum(map_2014$GOVREP14) + sum(map_2014$GOVDEM14))
map_2014$pvi[which(is.nan(map_2014$pvi))]=0
```

Instead of the PVI, the actual ward level vote (or party vote share) is a much more direct measure of ward partisanship. I used LTSB ward level data from 2002 to 2014 to calculate the average Democratic percentage of the vote in a Democratic ward (all wards that were more than 50% Democratic in the top-ticket race), and the average Republican vote in wards where Republicans won more than 50% of the top-ticket vote. A graph of this data shows a very different pattern from what Trende claims (Republicans are in red; Democrats in blue):

[3] These occurred in the R file "Wisconsin_clustering_computation.R" that Trende disclosed.
[4] This inconsistency could well affect Trende's results, as the vote percentages were vastly different in the two races in Wisconsin. Democrats garnered 53.8% of the two-party vote in the gubernatorial election, but 60.5% in the Senate race (GAB data).



Here, we see that Democrats and Republicans have moved in almost identical fashion between 2002 and 2014. In 2002, Democrat wards were about 60.8% Democratic, and Republican wards were about 60.5% Republican in the top-ticket races. In 2014, similarly, both Democratic and Republican wards became more partisan: Democratic wards were 63.3% Democratic, and Republican wards 63.6% Republican.

Trende's claim that Democratic wards have become more Democratic, while Republican wards have not become more Republican (paragraphs 91-95), is simply false.

Trende offers no justification or support for why he is relying on the PVI measure rather than more direct indicators of ward partisanship; he merely asserts that it is a relevant quantity. Given that there are far more widely used and relevant measures of district level partisanship, his reliance on it in this context is unsupportable.

2. Trende's "Nearest Neighbor" Method is Inappropriate and Inaccurate

After introducing the PVI, Trende attempts to use it to demonstrate that Democrats have become more closely packed than Republicans (which, he asserts, produces a natural pro-Republican gerrymander). Apart from the irrelevance of the PVI, Trende's analysis uses a fundamentally flawed measure that is guaranteed to exaggerate the extent of Democratic concentrations. Instead of his measure, widely used and academically accepted metrics of concentration and isolation show that Democrats and Republicans are *both* highly segregated, and to about the same extent. Just as there are core areas of high Democratic strength in Milwaukee and Madison, there are similar Republican core areas in the "collar counties" of Waukesha, Ozaukee, and Washington.

The premise of Trende's argument is that pro-Democratic wards are closer to other pro-Democratic wards than are pro-Republican wards to other pro-Republican wards. His method, which I infer from his description, is to identify a pro-Democratic or pro-Republican ward of a certain percentage lean, and then to find the distance to the nearest ward with the *same* partisan lean. He determines the *median* distance between similar wards, and presents two graphs (about paragraph 98 in his report) showing that the median distance between similar Democratic wards is smaller than for Republican wards, and that as Democratic wards become more Democratic, they become closer to one another.

This is reminiscent of the nearest neighbor method used in the study of populations, but it bears little resemblance to how the concept is actually used in the literature, even in its earliest form (Clark and Evans (1954) used it to study the distribution of plant and animal populations).[5] His application of this method is highly unorthodox, unsuited to the study of redistricting, and not based on any accepted peer-reviewed academic work (he does not cite a single study in support of his method).

Trende's method is to start with a ward (call it *i*), calculate its PVI and assign it to a quantile, and then locate the closest ward that shares this PVI quantile (call it *j*). The geographic distance between wards *i and j* (presumably calculated using the ward centroids, although Trende fails to specify this key detail) is then recorded (paragraph 97). The process is repeated for every ward over every election from 2002 to 2014, producing for each election a matrix consisting of every ward and the distance to the nearest ward with the same PVI quantile. He then calculates median distances between wards of the same PVI quantiles, which he claims shows that Democratic wards are, and have been continuing to move, closer together than Republican wards.

There are several problems with this approach. First, and most fundamentally, the proximity of similar wards is simply not a measure of geographic concentration or clustering. Trende's method tells us nothing about which wards are actually *adjacent* to wards of a certain PVI. It only tells us how far these wards tend to be from other wards of the same partisan lean. It is entirely possible for wards of the same partisan makeup to be far apart but still easy to join in the same district (think of a sparsely populated but uniformly partisan area). Likewise, it is entirely possible that wards of the same partisan makeup are close together but quite difficult to combine in the same district (think of a densely populated but politically heterogeneous area). Trende's method cannot distinguish between these scenarios, and as a result it cannot tell us anything about the geographic patterns that actually matter for redistricting.

Second, Trende does not explicitly define in his report what a "similar partisan index" (paragraph 97) means. Clearly, Trende is classifying them in some way, defining "similar" as within some range, as his vague discussion of quantiles indicates (paragraph 98). But without specifying the range, it is impossible to know whether his measure has any meaning. Different

[5] Byers and Raferty (1998) use a near neighbor method to estimate the statistical relationship between points in space and how they differ from random distributions, or "clutter," in the context of distinguishing landmines from other objects during aerial reconnaissance. Neither their work nor Clark and Evans (1954) supports Trende's use of the method.

classification methods -- requiring a match of, say, within 0.1 percentage points, or classifying according to deciles or some other method -- are likely to yield very different results than requiring a match of within 0.5 or 1.0 percentage points or using a larger number of categories. His graphs suggest he is using some type of percentile distribution (the x axis label refers to "(.05% is the most Democratic [or Republican] Ward)," but he does not explicitly define why he chose this particular scheme or how he calculated the quantiles. On this point alone, his method lacks validity or replicability.

But there are two additional serious – fatal, in fact – flaws in this method. First, in treating the geographic distances between wards as his quantity of interest, Trende does not take into account the fact that wards in Wisconsin are not uniform in area. Ward areas actually vary widely: some are very small, others are moderate in size, and still others are very large (wards are drawn within specified population limits, but their geographic areas are not similarly constrained).

Table A shows the mean and median areas (in square miles) of Wisconsin wards. The average is 8.41 mi^2, but the range is huge: the smallest ward with a nontrivial population is in the City of Middleton: ward 19, with 690 people in an area of 0.0071 mi^2. The largest ward in the state is in the Town of Winter: ward 2 (in Sawyer County), with 565 people in an area of 227.7 $mi^{2.}$

Geographic distances between ward centroids will, obviously, depend on how large the wards are. Although centroid-to-centroid distances will not map perfectly onto area differences (because the distances will vary with the shape and orientation of wards), two large wards – even if they are adjacent – will show up as much farther apart than two smaller wards that might be separated by numerous other wards and municipal boundaries.

The problem is magnified when we observe that ward sizes are correlated with other relevant variables, particularly whether a ward is in a city, and most crucially, whether it is a Democratic or Republican ward:

Table A 2012 Ward Sizes (square miles)[6]	Mean	Median
Statewide Average	8.41	1.12
City of Milwaukee	0.29	0.20
Rest of State	8.83	1.27
Democratic Wards	5.91	0.56
Republican Wards	10.96	3.45

Wards in the city of Milwaukee have a mean area of only 0.29 mi^2, which is 3% of the size of the mean area statewide. Democratic wards (measured by whether the 2012 Democratic presidential vote was above 50%) are, on average, only about half the size of Republican wards (5.91 mi^2 vs. 10.96 mi^2).

In relying on the distance between wards, Trende is thus putting his thumb on the scale; all other things equal, this method will *always* show Democratic wards to be much closer than Republican wards, irrespective of whether this concentration is real or merely an artifact of ward area. To put it most simply, smaller Democratic wards will *always* appear closer than larger Republican wards.

But a second and equally serious problem lurks. Trende does not use the *mean* distance between wards as his quantity of interest, but rather the *median*. He justifies this choice "because outlying wards, such as Menominee County, exert an undue amount of leverage on averages" (paragraph 97).

This is the wrong measure, because the "nearest neighbor" approach is unlikely to pair, say, a ward in Milwaukee with a ward in northwest Wisconsin. Menominee County will not exercise "an undue amount of leverage" because it is an outlying ward. It will exercise an undue amount of leverage because it *has a very large area* (222.8 mi^2), which is something Trende should, but does not, correct for.

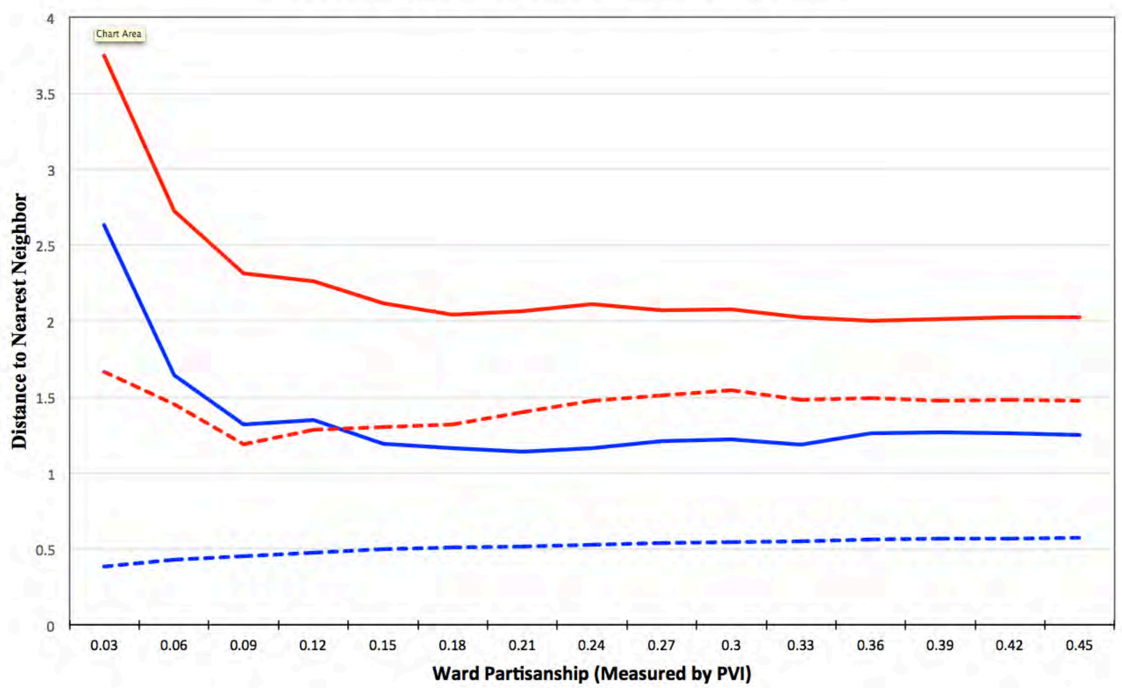
His use of the median rather than the mean further exaggerates the difference between Republican ward distances and Democratic ward distances. The average Republican ward area is 1.9 times larger than the average Democratic ward area (10.96 vs. 5.91 mi^2). But the *median* Republican ward is *6.2* times larger than the median Democratic ward (3.45 mi^2 vs. 0.56 mi^2).

[6] Calculated directly from the LTSB shape files of 2012 wards, obtained from http://legis.wisconsin.gov/gis/data.

Because the disparity is three times larger for the median versus the mean area, Trende is further stacking the deck in favor of his preferred hypothesis.

I was able to replicate Trende's analysis, using LTSB data and the R code he disclosed. When the mean distances between similar wards are included, Figure B is the result for the 2012 Election:[7]

Figure B
Nearest Neighbor Analysis: Mean vs. Median Distance



In this graph, the dotted lines are the median nearest neighbor distances for Democratic (blue) and Republican (red) wards, replicating what Trende did in his median distance graphs around paragraph 98 in his report. Wards become more partisan as we move from right to left.

The *mean* distances are shown with solid lines. While Republican wards remain farther apart than Democratic wards, the mean distances for both parties are much larger than the median distances. Proportionally, Republican and Democratic wards are much closer together in mean than in median distances (which is what one would expect, given the exaggerated difference between median Democratic and Republican ward sizes). Specifically, the mean distance between Republican wards is only about 70% larger than the mean distance between Democratic wards, compared to a 180% difference between the median Republican and Democratic distance.

[7] The pattern Trende identifies is largely constant across all elections; adding the additional cycles will not change the results.

More relevant is the shape of the mean distance lines. They show that Republican and Democratic distances move precisely in parallel, and that strongly Democratic wards are significantly *farther apart* than weaker Democratic wards (as are strongly Republican wards). This is the complete opposite of Trende's claim that stronger Democratic wards are closer together than weaker Democratic wards, and it obliterates the core of Trende's report: the assertion that the pro-Republican bias evident in Act 43 is the natural result of Democrats being more geographically concentrated.

To conclude, Trende's argument about Democratic concentration is based on an irrelevant measure of partisanship (PVI) that is incorrectly calculated, applies a methodology that bears no relationship to any scholarship or actual research on spatial distribution, ignores a key feature of Wisconsin's actual political geography (ward area), relies on an improper distance measure that is enormously biased in favor of his hypothesis, and produces a result that fundamentally misrepresents what the data actually shows. Because of his use of a questionable method and fundamentally flawed measures, Trende's opinions should be regarded as uninformative.

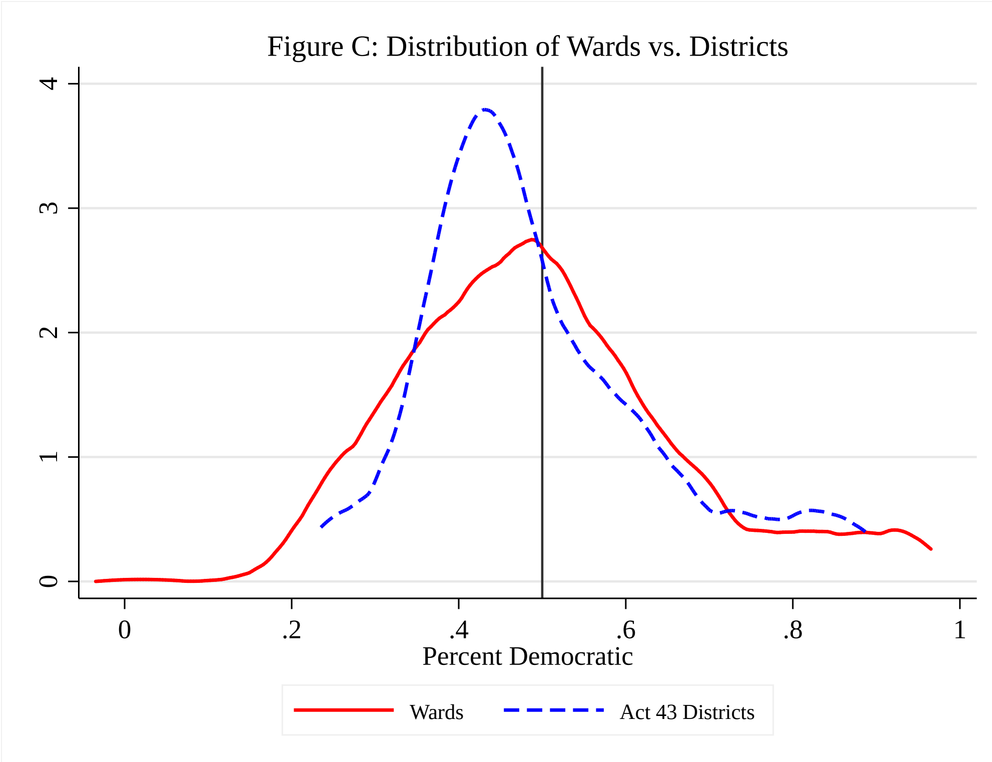
B. Goedert

Goedert, like Trende, asserts that Wisconsin's natural geography creates an intrinsic pro-Republican bias in redistricting (p. 17). He cites his own research that geography produced a pro-Republican bias in the 2012 congressional election (p. 19).

The only analysis Goedert conducts as to Wisconsin is an examination of wards, which he claims shows "the bias inherent in Wisconsin's geography" (p. 21). His analysis is a simple "uniform swing" study of wards in 2012, adjusting the Democratic presidential vote in each ward downward by 3.5% to determine the overall ward distribution in the event of a tied election (Figure 1, p. 22). He asserts that based on this analysis, "Republicans would win 60.2% of wards, comprising 54.4% of the voting population" in a tied election (p. 22). This is the extent of his analysis.

This analysis, however, is a non sequitur, because it fails to aggregate wards to the relevant geographic level, which is *districts*. Goedert's failure to take this into account is an example of the Modified Areal Unit Problem, in which inferences at one level of geography frequently do not hold at other levels of aggregation; see King (1996). In this example, the ward level vote is far less relevant than the district level vote, because it is entirely possible that wards will be aggregated in such a way that the pattern he observes either disappears (or even reverses).

When we examine the distribution of *districts*, which have a population deviation small enough that we can consider them equal (the deviation under Act 43 is 0.76%), we in fact see almost the reverse pattern. The following graph (Figure C) displays Goedert's adjusted ward level presidential vote in a simulated 50-50 election, along with an adjusted baseline forecast for Act 43 districts, using my baseline open seat model, in a simulated tied election. Both wards and districts are weighted based on the number of votes cast in each unit. This allows me to directly compare ward level results to district level results:



What this figure demonstrates is that as wards are aggregated into districts, the distribution substantially changes. The red line is a kernel density plot of the ward Democratic vote percentage in a simulated tied election; it is a continuous version of the histogram Goedert presents in his Figure 1. The dotted blue line shows the predicted Democratic vote in Act 43 districts in a simulated tied election – or, what occurs after the wards are aggregated into Assembly districts. The overall shape of the curves, the mode of each distribution, and even the mean vote percentage vary as we aggregate from wards up to districts. Knowing the ward distribution ultimately does not tell us much about what the distribution of districts will look like; the process of aggregation is crucial.

More significantly, the district distribution is much more tilted in a Republican direction than is the ward distribution. The ward distribution is nearly normal in shape, and has a peak very close to 50% Democratic. In contrast, the *district* distribution is skewed to the right, and has a much higher peak around 42% Democratic, meaning that there are many more districts that Republicans win by relatively small margins (indicating that Democrats are cracked), and many more districts where Democrats win by much larger margins (indicating packing). Accordingly, the district distribution does *not* mirror the underlying distribution of wards. Rather, it reveals that Act 43's designers were able to distort a fairly neutral ward distribution into a far more advantageous district distribution, through gerrymandering.

1. Goedert's Published Work Contradicts His Report

Goedert's own prior work indicates that unified party control of state government has an independent and significant effect on the bias of redistricting plans, even after controlling for population concentration. This work also indicates that if Wisconsin, or a state resembling the country as a whole, had a court-drawn or bipartisan map in 2012, this map would have had a slight *pro-Democratic* bias. These findings further obliterate the claim that Act 43's extreme partisan tilt resulted from Wisconsin's natural political geography.

In a 2014 article, Goedert analyzes the consequences of different redistricting processes, looking for evidence that partisanship and geography each have an independent effect on the partisan bias of redistricting plans.[8] Using an unorthodox definition of gerrymandering – Goedert defines *any* redistricting plan created in a state with unified party control of state government as a partisan gerrymander – he finds that in states with more than six congressional districts, both urbanization (a proxy for Democratic concentration) and unified party control have a strong and statistically significant effect on the bias of a district plan (2014, 6). Goedert interprets his results as indicating that geography matters, and that higher urban concentration leads to more bias against Democrats (2014, 6). But what his results also show is that *even after taking urbanization into account*, the partisanship of the map drawers introduces a separate and significant bias: Republican-drawn maps are associated with an additional *13.6%* pro-Republican bias.

Geodert updated his 2014 article in a more recent manuscript, which incorporated the results of the 2014 midterm elections. Here, he finds that urbanization *no longer has a statistically significant effect* on the bias of district plans (2015, 6). Yet he stills finds evidence that the partisanship of map-drawers has a significant effect on district plans' bias (in 2014, a Republican-drawn plan adds 12.4% bias, or roughly the same as the 13.6% estimate for 2012).

So, on the one hand, Goedert's own work comes to different conclusions about the impact of urbanization (or Democratic concentration): sometimes it matters, other times it does not. But his work is consistent about the effect of partisan control: when partisans draw maps, they *always* do so in ways that dramatically bias plans in their favor. The clear inference is that geography matters much *less* than partisan control in explaining plans' electoral consequences.

Furthermore, we can use Goedert's regression model to generate a forecast of what would have occurred in 2012 in Wisconsin – as well as in a state resembling the country as a whole – under a neutral process (i.e., a court-drawn or bipartisan plan). His regression model includes the following variables (2015, 11):

1. Whether a district plan was drawn by Democrats or Republicans (court-drawn and bipartisan plans are the excluded category)
2. A state's African American population percentage
3. A state's Hispanic population percentage

[8] Goedert's definition of bias is essentially identical to the efficiency gap. He "compare[s] the mean vote share with the expected seat share under a 'fair' map with zero bias and a historically average seats-votes curve" (2014, 3). In the "historically average seats-votes curve," "a 1% increase in vote share will produce about a 2% increase in seat share," which is the same seat-vote relationship implied by a zero efficiency gap (2014, 3). Goedert's bias estimates are thus largely indistinguishable from the efficiency gap calculations of Stephanopoulos and McGhee (2015).

4. The percentage of a state that is urbanized (according to the Census)
5. The statewide Democratic vote
6. The number of congressional seats.

With the coefficients of this model, and the appropriate data for Wisconsin (or any other state), we can calculate what the expected bias would be for a plan in 2012.[9] The dependent variable here is a measure of bias almost identical to the efficiency gap, with positive values indicating a pro-Democratic bias, and negative values a pro-Republican bias. Because this is a linear regression, we can multiply each coefficient by the value of the independent variable, and then sum the results to generate a forecast from any set of data values. In Table B, I set both Democratic and Republic Gerrymanders to 0, simulating a neutrally-drawn plan:

[9] Goedert generated two models, one for states with fewer than 6 congressional districts, and another for states with more than six. As Wisconsin has 8 districts, I use the latter.

Table B Goedert's Regression Model for 2012 Dependent Variable: Pro-Democratic Bias in a District Plan			
Variable Name	**(a) Coefficient Value**	**(b) Variable value for Wisconsin**	**Value (a) x (b)**
Democratic Gerrymander	16.6	0	0
Republican Gerrymander	-13.6	0	0
% Black	-0..29	6.6	-1.914
% Hispanic	0.77	6.5	5.005
% Urbanized	-0.72	70.2	-50.544
Statewide Democratic Congressional Vote	0.11	50.8 (2012)	5.588
Number of Seats	-0.16	8	-1.28
Constant	45.0	1	45
Total	**(sum of all values)**		**1.855**

Goedert's regression model thus predicts that if Wisconsin had a neutrally drawn plan in 2012, the resulting map would have had a *pro-Democratic* bias of 1.855%. In other words, in the absence of unified Republican control over the redistricting process, Wisconsin's demographic, geographic, and political characteristics would have resulted in a small natural *Democratic* advantage. And this is no fluke of the state or the election year. We can also use Goedert's model to predict what would happen in a state resembling the United States as a whole (i.e., a state that is 13.2% black, 17.4% Hispanic, 80.7% urbanized, 51% Democratic, and with

8.7 congressional seats[10]). Substituting these values into the regression model shows that in an "average" state, a neutrally-drawn map would have had a *pro-Democratic bias* of 0.684% in 2012.

Goedert's 2014 variant of the model (2015, 13) further predicts that Wisconsin would have had a *pro-Democratic bias* of 4.392% in 2014, and that the average state would have had a *pro-Democratic bias* of 1.589%. At this point, it is hard to see what is left of the thesis that political geography inherently favors Republicans. If anything, Goedert's own published analysis shows that Wisconsin's political geography slightly favors *Democrats*.

C. Accepted Measures of Geographic Concentration and Isolation Show that Democrats and Republicans are Equally Dispersed

In arguing that Republicans in Wisconsin enjoy a natural geographic advantage, both Trende and Geodert use ad hoc, unorthodox measures of concentration that are neither relevant nor accepted by the academic literature. In fact, there exist widely accepted metrics of geographic concentration and dispersion, used by geographers and demographers to study spatial patterns. Two of the most common are Global Moran's I (Anseln 1995; Cho 2003), and the Isolation Index (Glaeser and Vigdor 2012; Reardon 2004). I use these metrics to determine how Democrats and Republicans in Wisconsin are actually distributed.

Moran's I is a measure of spatial autocorrelation, or how values of a variable in space correlate with values in nearby space. It can be calculated for an entire geographic system (Global Moran's I), or for any specific point in space (Local Moran's I). The Isolation Index indicates, for the average member of a group residing in a certain geographic unit (such as a ward), what share of the member's neighbors in the unit belong to the same group (Iceland and Weinberg 2002, 120). It measures how geographically isolated a group is (Reardon 2004, 153), and it can easily be adjusted, by deducting a group's share of the statewide population, to show how much *more* isolated a group is than we would expect given its statewide size (Glaeser and Vigdor 2012, 2). Both Moran's I and the Isolation Index are widely used in studies of residential segregation and sorting (Chung and Brown 2007; Massey and Denton 1989; Glaeser and Vigdor 2012; Dawkins 2007; Reardon 2004; Iceland and Weinberg 2002), epidemiology (Moore and Carpenter 1999), network effects (Cho 2003), and political geography (Glaeser and Ward 2005). The measures are also used by the U.S. Census Bureau itself (Iceland and Weinberg 2002).

Both Moran's I and the Isolation Index are directly applicable to the issue of measuring the geographic distribution of Democrats and Republicans in Wisconsin. In this context, Global Moran's I tells us how likely Democrats are to live clustered next to other Democrats (and Republicans to Republicans), and the Isolation Index, adjusted as noted above, tells us to what extent the average Democrat (or Republican) lives in a ward that is more heavily Democratic (or Republican) than the state as a whole. I use these indices to directly assess the geographic distribution of Democrats, and, more importantly, to compare it to the geographic distribution of Republicans.

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[10] Calculated as 435/50.

Global Moran's I is analogous to a correlation coefficient, and ranges from -1 to 1; scores close to 1 indicate a very high spatial correlation (i.e., clustering) of Democrats (or Republicans). The Isolation Index ranges from 0 to 1, and, adjusted as noted above, indicates to what extent the average Democrat or Republican lives in a ward that is more heavily Democratic or Republican than Wisconsin as a whole. In calculating both measures, I use the ward as the basic unit of geography and actual Assembly votes.[11] Because I only have geodata for the current wards, I only estimate Global Moran's I for 2012 and 2014. For the Isolation Index, I compute scores dating back to 2004. Both Global Moran's I and the Isolation Index are asymmetrical, and so must be calculated separately for Democrats and Republicans.

Table C shows the values of the Isolation Index, adjusted as noted above, for Democrats and Republicans in Wisconsin from 2004 to 2014:

	Table C Isolation Index	
	Dem-Rep	**Rep-Dem**
2014	0.23	0.20
2012	0.14	0.12
2010	0.15	0.17
2008	0.15	0.14
2006	0.16	0.17
2004	0.20	0.21

As is evident from Table C, Democrats were slightly less isolated than Republicans in 2004, 2006, and 2010, and slightly more so in 2008, 2012, and 2014. In all cases, the differences in isolation were very small, amounting to only one to three percentage points (out of a scale extending from 0% to 100%). In the 2012 election, for instance, the average Democrat lived in a ward whose Democratic vote share was 14% more Democratic than the state as a whole; analogously, the average Republican lived in a ward whose Republican vote share was 12% more Republican than the entire state. In the previous election, it was Republican voters who were more isolated than Democratic voters (17% versus 15%). This analysis in no way supports the claim that Republicans are more advantageously distributed than Democrats; on the contrary, both parties' supporters are almost identical in their geographic isolation over the last decade, and there is no clear temporal pattern. In some years, Democrats are marginally more isolated than Republicans, and in other years Republicans are marginally more isolated than Democrats.

[11] I calculated Global Moran's I using the method in Bivand and Piras (2015) and the R module spdep available at https://cran.r-project.org/web/packages/spdep/index.html. I calculated the isolation index using a Stata module (seg), available at http://econpapers.repec.org/software/bocbocode/s375001.htm.

The results are very similar with the Global Moran's I, again calculated for Democrats and Republicans in Wisconsin, although only for the two elections (2012 and 2014) for which the geodata is readily available:

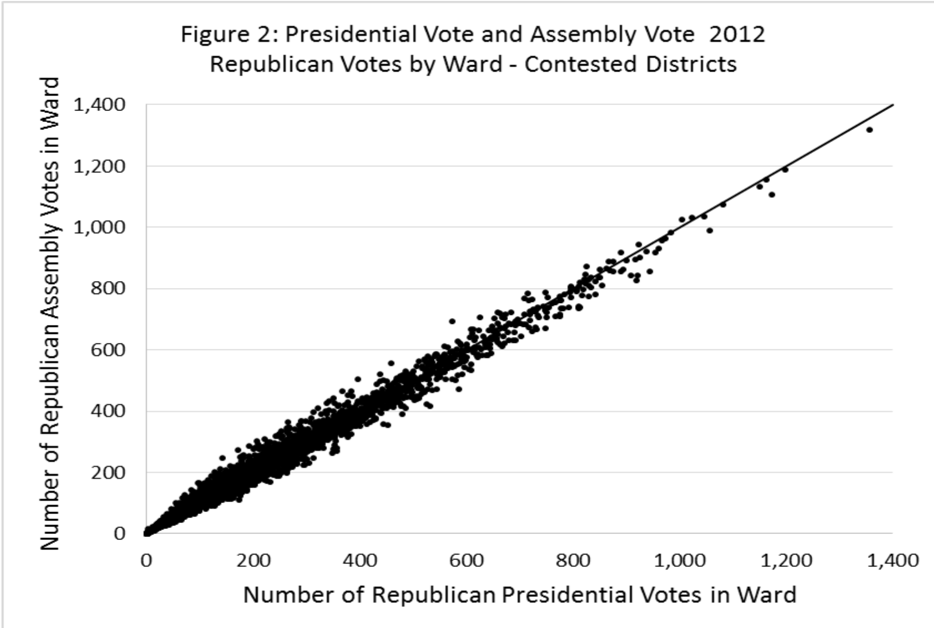
	Table D Global Moran's I	
	Democrats	**Republicans**
2014	0.75	0.68
2012	0.68	0.69

Here, we see that Democrats were slightly less spatially concentrated than Republicans in 2012, but slightly more spatially concentrated in 2014. The differences in both cases are tiny: 0.01 in 2012 and 0.07 in 2014, on a scale that stretches from -1 to 1. The message is quite clear: *both* Democrats and Republicans in Wisconsin tend to live near one another in distinct clusters, but there is no evidence that Democrats are *more* geographically clustered than Republicans.

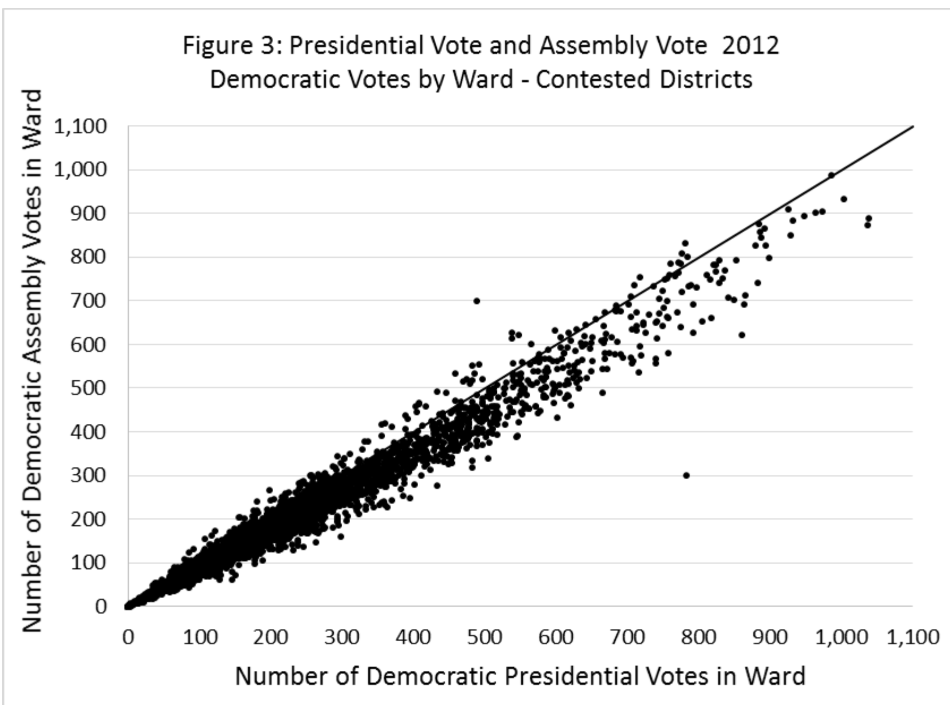
Accordingly, two widely used and accepted measures of geographic distribution show no consistent pattern, and no material difference in how Wisconsin's Democrats and Republicans are dispersed spatially. In no sense, therefore, is it an accurate statement that Democrats are much more concentrated than Republicans – the unsubstantiated claim that comprised the core of both Trende's and Geodert's arguments about natural gerrymanders.

III. Trende's Claim That My Vote Model Is Biased Is Incorrect

Trende claims that there may be "a systematic bias involved in imputing presidential results to state House results" (paragraph 135). As evidence he points to Figures 2 and 3 in my original report, which display the relationship between the ward level presidential vote and the ward level Assembly vote. Trende notes that Figure 2 shows that there is close to a 1:1 relationship between Republican presidential and Assembly votes, as the dots on the graph are distributed around the 45-degree line:



However, Trende claims that the relationship is different for Democratic votes (Figure 3 in my original report):

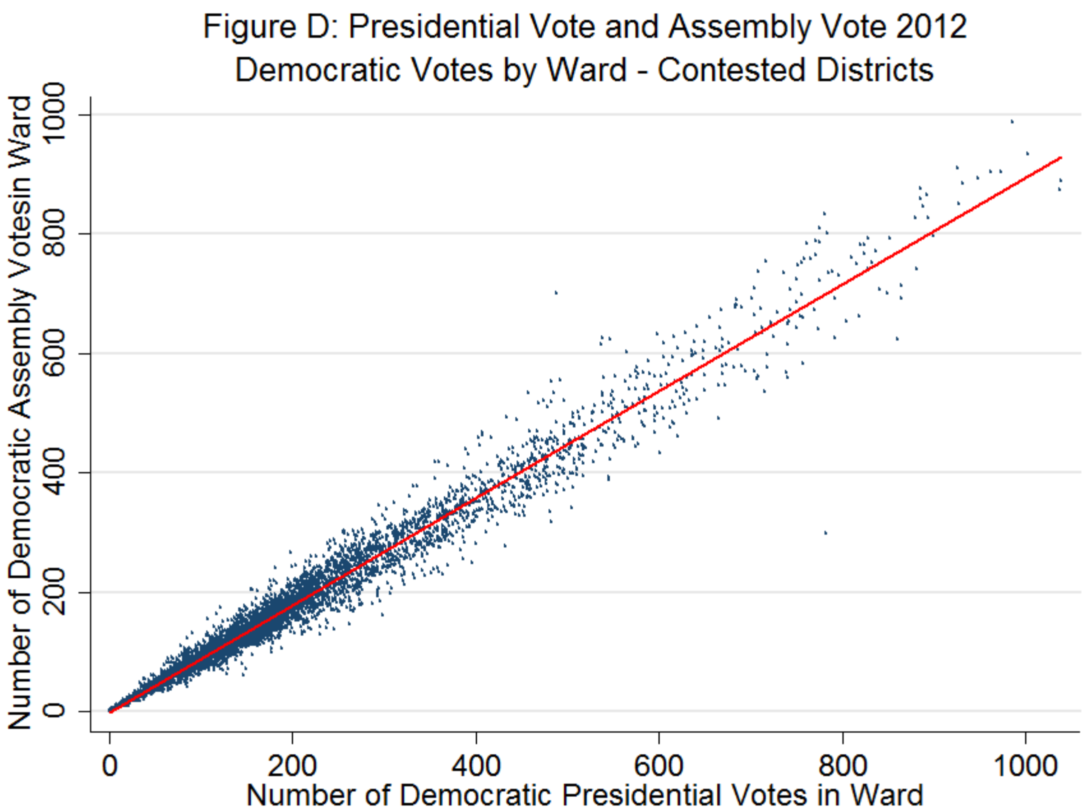


Here, Trende argues, the "dots systematically fall below the line, often creating differences on the order of 10 percent" (paragraph 138). This pattern, he asserts, will "skew the imputation" of votes, resulting in "too many votes [being] imputed in wards reporting a high number of Democratic votes" (paragraph 139).

Trende is completely and unambiguously wrong in this claim, which belies a fundamental lack of understanding of multiple regression and the causes of bias in statistical models. Trende appears to believe that I simply assumed that ward level Democratic Assembly votes are actually *equal* to ward level Democratic presidential votes, or that in estimating the Assembly vote in uncontested wards I merely used the value of the presidential vote (presumably because that is how he imputes the vote in uncontested districts in his own analysis; deposition page 83).

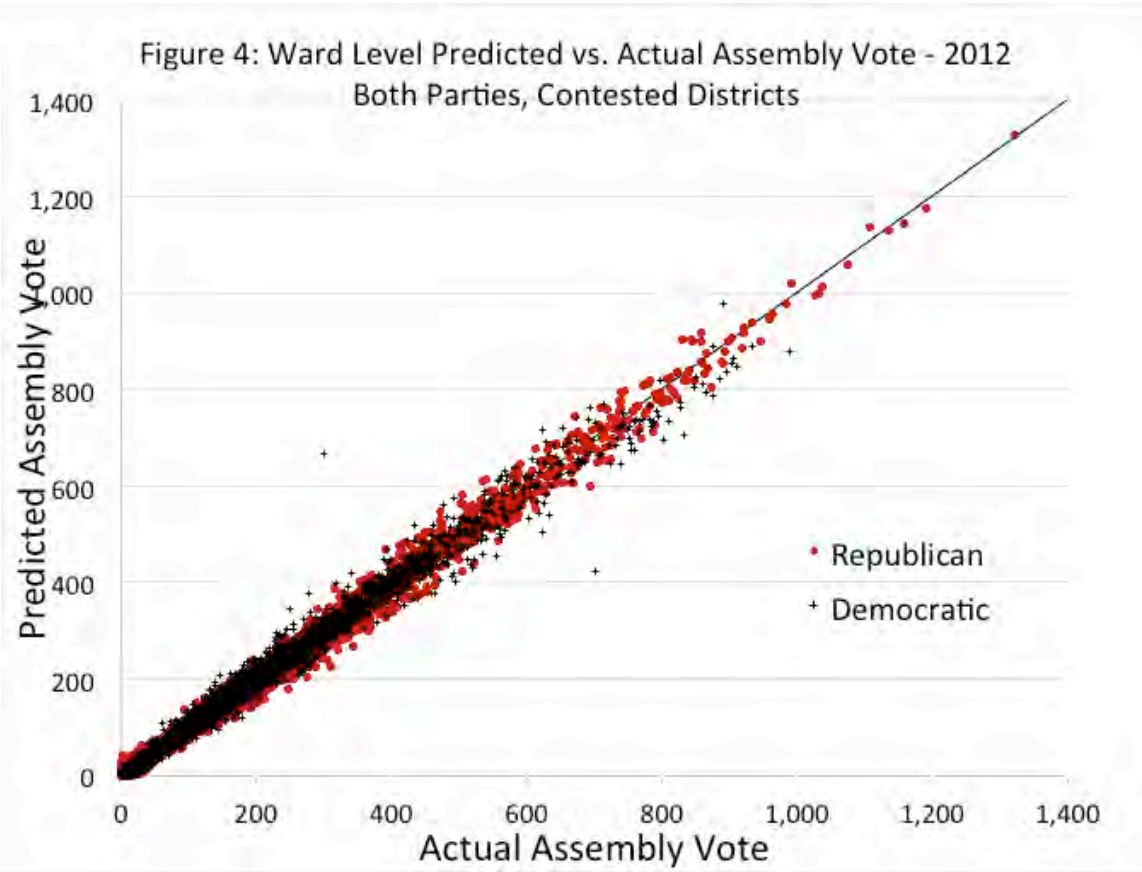
That is wrong. I displayed this graph merely to show that there is in fact a strong relationship between the two variables. The fact that the Democratic Assembly vote tends to fall below the presidential vote is completely irrelevant to any possible bias. In fact, regression analysis estimates the relationship between the two quantities by identifying the *slope* of the line that relates them, not how the relationship varies across a 45-degree line.

Below (Figure D) is a graph that plots the data in Figure 3 of my original report along with a fitted line of predicted values from a bivariate regression of the Democratic Assembly vote on the Democratic presidential vote. The red line consists of the predicted values of the Democratic Assembly vote in each ward:



Here, we see that the fitted line runs *exactly* down the middle of the plotted points. My regression analysis of the Democratic Assembly vote (Table 1 in my original report) shows that the coefficient for the Democratic presidential vote is 0.931 ($p<0.0001$), which is precisely the pattern than we see in the bivariate relationship above. In a linear model, this coefficient is the slope of the line that relates the presidential vote to the assembly vote. It is less than 1 (a 45-degree line), indicating that the Assembly vote rises more slowly than the presidential vote; i.e., the predicted Assembly vote will lie below the 45-degree line in Figure 2.

And, as is immediately apparent from the actual results of my regression (Figure 4 in my original report, which plots the actual vs. predicted ward level votes), there is no bias in the results. In this graph, the 45-degree line is where the *predicted* Assembly vote would fall if it were exactly equal to the actual Assembly vote:



Trende's criticism on this point is utterly misinformed. No one with a solid understanding of quantitative methods or regression analysis would have made it.

IV. Trende's Claim That My Efficiency Gap Calculations Ignore Incumbency, Candidate Quality, and Campaign Spending

In paragraphs 140-143, Trende criticizes my efficiency gap calculations for failing to take into account factors that can affect election results, such as get-out-the vote drives, candidate quality, recruitment, and campaign spending.

Trende offers no evidence that these factors would actually have a material effect on my estimates if I had more directly taken them into account. And he ignores the fact that any estimation of the results of a hypothetical district plan utilizes baseline estimates that, in effect, average out the effects of these factors (Gelman and King 1990; 1994). That is to say, my regression model *does* implicitly incorporate these factors, in its analysis of the relationship between the presidential vote (where none of these variables will affect the vote) and the Assembly vote (where they are all incorporated into the estimates).

Moreover, Trende's criticism overlooks the point that my model is based on precisely the same information that the authors of Act 43 considered in estimating the likely partisan effects of the new districts. In particular, Gaddie's analysis of the partisan effects in the new Act 43 districts was functionally equivalent to mine and based on exactly the same considerations.

Like his complaints about alleged bias in the regression analysis that I discuss above, Trende's criticism is uninformed and betrays a lack of knowledge of how hypothetical district plans are evaluated.

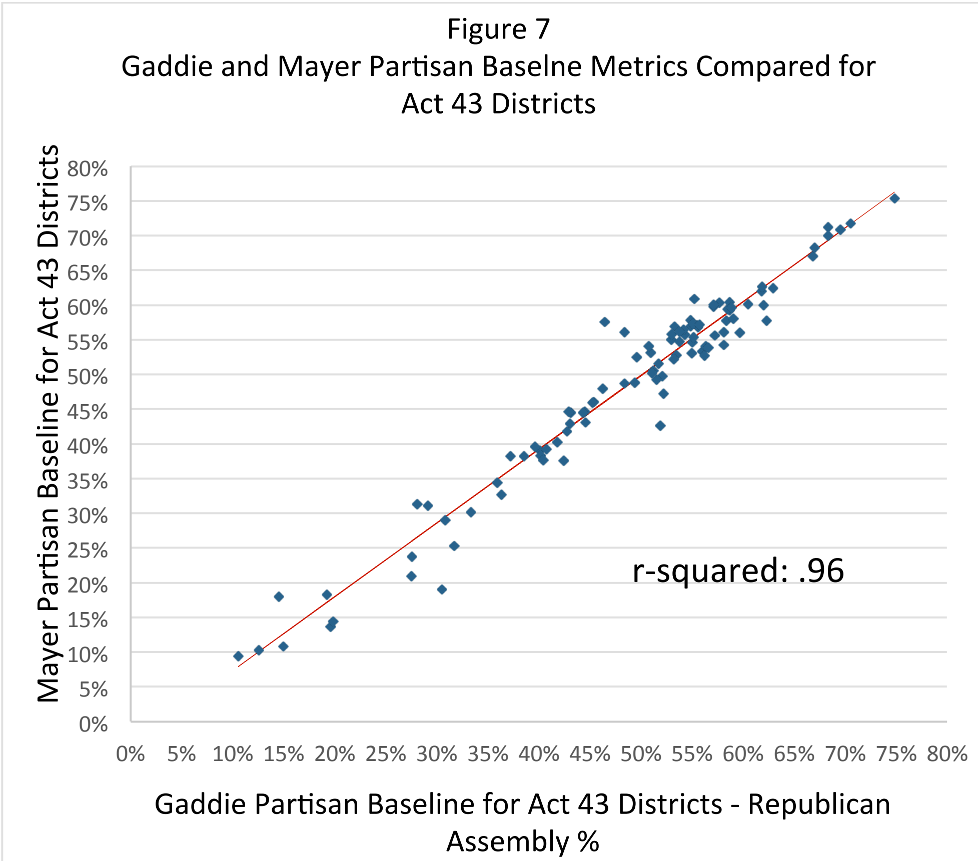
V. Goedert's Claim That My Efficiency Gap Calculations Incorporate Information Not Available to Act 43's Designers, and Ignore the Effects of Incumbency

Goedert criticizes my analysis for incorporating information that map drawers did not have (2012 election results), and for ignoring information that map drawers would have taken into account (incumbency in particular).

The first criticism is incorrect, as Act 43's designers in fact had information functionally equivalent to the 2012 election results in their possession, in the form of Gaddie's Act 43 district level estimates. These estimates, like my own, are baseline measures of partisanship, and they correlate almost perfectly with my results (r^2=0.96). In his deposition, Gaddie described in detail his method, which like mine assumed that all seats would be contested and that no incumbents would run (Gaddie Deposition, pp. 197, 198, 201, 202, 204):

> Let's suppose we have a seat with an incumbent and a seat without an incumbent and each one has an Assembly election. The party of the incumbent is presumably going to do a little stronger in the district where they have an incumbent than in an open seat. So I can't really take -- Let's suppose I move precincts from the open seat into that incumbent seat. I can't really take those open seat Assembly votes, add them, compare them to the percentage for the incumbent running for the same party, get an accurate estimation of the partisanship and the competitiveness of the district. So we attempt to create a substitute measure. Statewide elections are held in all precincts, they're held in all constituencies, so one thing that we often do is we do what we call reconstituted elections, or proxy elections, where we'll take one election or a composite of elections, like I described previously, and attempt to create some measure of partisan competitiveness, an expected vote or what we call a normal vote, what the vote would usually do without an incumbent in the district." (Gaddie Deposition, pp. 204-5)

To highlight the similarity between Gaddie's pre-2012 estimates and my own estimates using 2012 election results, below is a graph plotting the two sets of data (Figure 7 in my original report, p. 30):



This graph shows that the information the Act 43 authors relied on when drawing their map (the Gaddie estimates) and my estimates, are nearly identical. This is largely because they are both estimates of the same underlying quantity – the baseline partisanship of a hypothetical Assembly district. Goedert dismisses the nearly perfect correlation as "mostly coincidental" (p. 17), but offers no analysis or data to support this conclusion. It is simply an assertion offered without evidence.

And it is an entirely unpersuasive assertion for the additional reason that election results in Wisconsin (and in most states) are extremely highly correlated from one election to the next. For example, Wisconsin's counties remained geographically constant between 2008 and 2012, and Trende supplied information about the presidential vote in each county in each of these years. The 2008 county level presidential vote and the 2012 county level presidential vote are almost perfectly correlated (r^2=0.96), indicating that it would make no difference whether Act 43 was assessed using the former or the latter.[12] Either way, the same conclusion would follow: that

[12] Ward level 2008 and 2012 results cannot easily be compared because ward boundaries were redrawn after the 2010 Census.

the map is an extreme Republican gerrymander, and that the authors of Act 43 had information in their possession that predicted it.

Second, Goedert claims that map drawers do not ignore incumbency when drawing maps. That will generally be true when map drawers are trying to figure out which incumbent should be included in which district. But when it comes to estimating the likely partisanship of the new districts, ignoring incumbency (that is, controlling for it) is precisely what the drawers of Act 43 did, as Gaddie noted in his description of his methods. This approach is sensible since incumbents can be defeated, retire, run for higher office, or switch parties over a plan's decade-long lifespan. A map's authors will typically want to ensure that their projections do not depend on particular incumbents continuing to run in particular districts.

In any event, *including* incumbency in no way changes my substantive conclusions about Act 43 or the Demonstration Plan. I recalculated the efficiency gap for both maps, using my baseline partisan estimate and then incorporating incumbency into the model. For Act 43, I used the actual incumbents who ran in the plan's districts, with the adjustments noted in my report to account for paired incumbents and those who lost in primaries (p. 18, footnote 14).[13] For my plan, I geocoded incumbents' home addresses[14] and then identified which districts had incumbents residing in them using Maptitude for Redistricting. Table E shows the resulting efficiency gap calculations, and compares them to the open seat baseline I generated in my report:

Table E

Efficiency Gap Calculations

with Incumbents

	Demonstration Plan	**Act 43**
Baseline Efficiency Gap	2.20%	11.69%
Efficiency Gap with Incumbency	3.71%	13.04%

The efficiency gap increases marginally for both plans (by 1.5% for the Demonstration Plan and 1.4% for Act 43), in large part because there were more Republican (50) than

[13] I recalculated vote estimates using predicted values of Democratic and Republican Assembly votes when one of the parties had an incumbent running.
[14] This information was provided to me by counsel.

Democratic (24) incumbents running in 2012. With twice as many incumbents, Republicans will win more seats than in the open seat baseline even though the Republican vote percentage remains below 50% in both cases. It is thus apparent that taking incumbency into account has no effect on my conclusion that Act 43 was an egregious partisan gerrymander; the substantive inferences are identical, with or without incumbency.[15]

VI. Goedert's Claim That I Did Not Perform Sensitivity Testing for Act 43's or the Demonstration Plan's Efficiency Gaps

Goedert criticizes the efficiency gap calculations for both Act 43 and the Demonstration Plan, arguing that I "provide no estimates for the efficiency gap of the demonstration plan under the range of plausible election outcomes facing legislators at the time they were drawing the map" (p. 16), and that I conduct no "sensitivity testing" of my calculations of Act 43's efficiency gap.

I note that Goedert has not provided any actual analysis showing that this sensitivity testing would have materially altered my conclusions, or even any citations showing that such testing is necessary to evaluate the adequacy of my calculations.

Still, it is possible to show that my calculations are robust to significant changes in the electoral environment. Using Jackman's historical estimates of the statewide Assembly vote in Wisconsin, I can determine the plausible variation of the overall vote over the course of a decade. Since 1992, the statewide Democratic percentage of the Assembly vote has ranged from a high of 54.6% (in 2006) to a low of 46.4% (in 2010). The Democratic share of the statewide vote in 2012 was 51.2% in my baseline calculations, which suggests a plausible range of -5% to +3% in conducting a sensitivity analysis. In effect, this approach asks whether Act 43's and the Demonstration Plan's efficiency gaps would be durable in the face of massive Democratic *or* Republican waves – an extremely rigorous test that exceeds what is normally found in the literature.

Following Goedert's method of applying a uniform swing (p.21), I can estimate the effects that these swings will have on the efficiency gap, both for Act 43 and for the Demonstration Plan. To maintain consistency and to address his concern that I did not incorporate incumbency in my baseline, I estimate the effects using the incumbent baseline (that is, including the incumbents who ran in 2012).

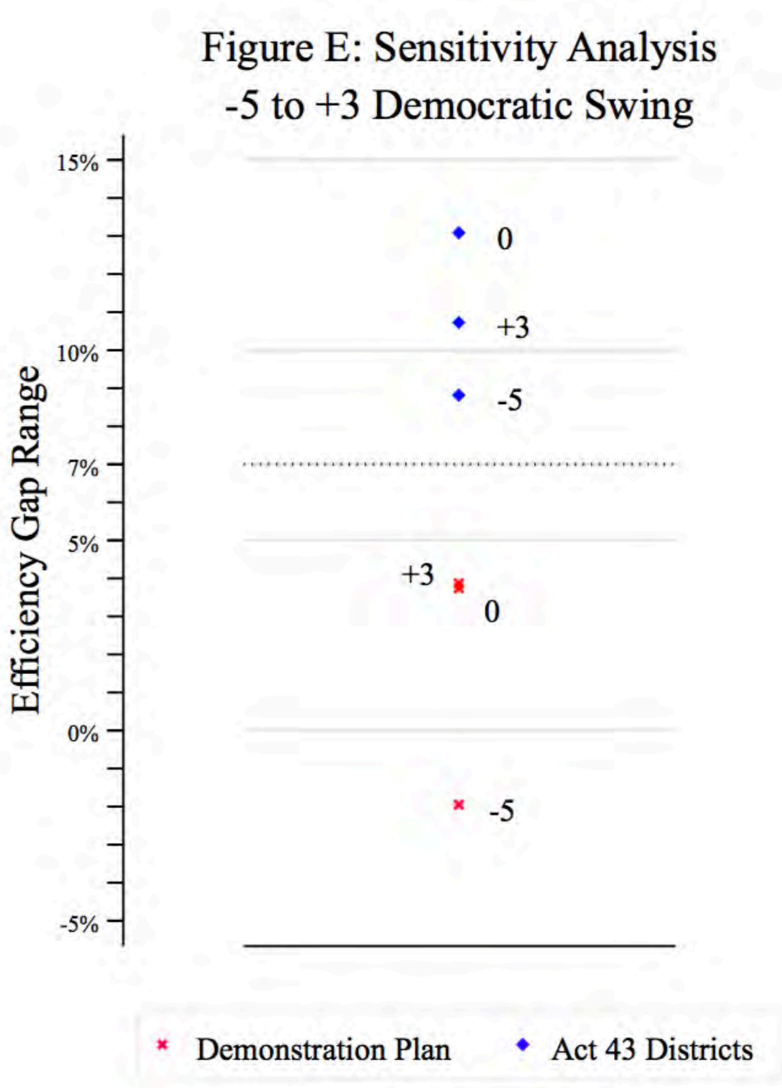
[15] We can use these calculations to determine how many more Democratic legislators would have been elected in 2012 if either the Demonstration Plan, or a plan with an efficiency gap of exactly zero, had been in place. Under the open-seat baseline, 9.49% more Democrats would have been elected under the Demonstration Plan (11.69% - 2.20%), and 11.69% more under a plan with an efficiency gap of exactly zero. Similarly, under the incumbent baseline, 9.33% more Democrats would have been elected under the Demonstration Plan (13.04% - 3.71%), and 13.04% more under a plan with an efficiency gap of exactly zero. In all cases, these are very large differences, amounting to anywhere from nine to thirteen Assembly seats.

The results are shown in the following two tables, the first for the Demonstration Plan (Table F), and the second for Act 43 (Table G). For the Demonstration Plan, the efficiency gap remains well below the plaintiffs' suggested 7% threshold, even when the statewide vote reaches the most extreme values either party has seen over the last three decades. Specifically, the efficiency gap goes to 3.9% in the event of a Democratic wave akin to that of 2006, and to -2.0% if a Republican wave like that of 2010 occurs. For Act 43, however, the efficiency gap remains extremely large and above the threshold at all times, ranging from 10.7% in a Democratic wave to 8.8% in a Republican wave. Moreover, the sensitivity testing shows that even if the Democrats obtained over *54%* of the statewide Assembly vote – equal to their best performance in a generation – they *still* would not capture a majority of the Assembly, gaining only 48 seats. Act 43's gerrymandering thus effectively insulates the Republican Assembly majority from all plausible shifts in voter sentiment.

	Table F Efficiency Gap Estimates, Uniform Swing Demonstration Plan		
	D Minus 5	**My Plan Incumbent Baseline**	**D Plus 3**
party split (R-D)	51-48	48-51	43-56
Rep share of Seats	52%	48%	43%
Wasted Republican Votes	737,557	659,821	659,390
Wasted Democratic Votes	681,900	765,561	769,546
Gap	(55,657)	105,740	110,156
Total Democratic Votes	1,336,168	1,484,631	1,573,709
Total Republican Votes	1,502,745	1,366,132	1,284,164
Total Votes	2,838,913	2,850,763	2,857,873
Efficiency Gap (gap/total votes)	**-1.96%**	**3.71%**	**3.85%**

	Table G Efficiency Gap Estimates, Uniform Swing Act 43 Districts		
	D Minus 5	**Act 43 Actual**	**D Plus 3**
Party Split (R-D)	64-35	60-39	51-48
Rep share of Seats	65%	61%	52%
Wasted Republican Votes	585,668	504,553	560,840
Wasted Democratic Votes	835,968	876,153	866,725
Gap	250,300	371,600	305,885
Total Democratic Votes	1,316,158	1,462,397	1,550,141
Total Republican Votes	1,527,115	1,388,286	1,304,989
Total Votes	2,843,273	2,850,684	2,855,130
Efficiency Gap (gap/total votes)	**8.80%**	**13.04%**	**10.71%**

Figure E below shows these results graphically: the red x's are the efficiency gap estimates for the Demonstration Plan, and the blue diamonds the estimates for Act 43. The dotted line is at plaintiffs' suggested threshold of 7%. The figure clearly demonstrates that even across huge partisan swings, the efficiency gap under Act 43 remains very large, and the efficiency gap for the Demonstration Plan remains very small. This is further powerful confirmation of the durability of Act 43's bias – and the durable *lack* of bias of the Demonstration Plan.



VII. **Conclusion**

In their criticism of my report, both Trende and Goedert offer nothing but supposition, speculation, irrelevant discourse about Wisconsin political history, extraneous discussion of congressional redistricting in other parts of the United States, wildly inapposite and inaccurate conjecture about the geographic concentration of Democrats as a possible source of the pro-Republican bias of Act 43, unreliable methodologies, and minor quibbles that have no consequences for my conclusions. Neither Trende nor Goedert has conducted any valid analysis of either Act 43 or the Demonstration Plan – in fact, they make no mention at all of the specifics of the Demonstration plan.

Most significantly, nothing in their reports undercuts my fundamental conclusion that Act 43 constituted an egregious and durable gerrymander, and that it was entirely possible to draw a neutral map that met or exceeded Act 43 on all legal dimensions. If anything, the sensitivity testing substantially bolsters this conclusion, since it shows that Act 43's large efficiency gap and the Demonstration Plan's small one are durable in the face of enormous changes in Wisconsin's electoral environment.

Dated: December 21, 2015

/s/ Kenneth R. Mayer

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Department of Political Science

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Assessing the Current Wisconsin State Legislative Districting Plan

Simon Jackman

July 7, 2015

Contents

1 Introduction

My name is Simon Jackman. I am currently a Professor of Political Science at Stanford University, and, by courtesy, a Professor of Statistics. I joined the Stanford faculty in 1996. I teach classes on American politics and statistical methods in the social sciences.

I have been asked by counsel representing the plaintiffs in this lawsuit (the "Plaintiffs") to analyze relevant data and provide expert opinions in the case titled above. More specifically, I have been asked

- to determine if the current Wisconsin legislative districting plan constitutes a partisan gerrymander;
- to explain a summary measure of a districting plan known as "the efficiency gap" (Stephanopolous and McGhee, 2015), what it measures, how it is calculated, and to assess how well it measures partisan gerrymandering;
- to compare the efficiency gap to extant summary measures of districting plans such as partisan bias;
- to analyze data from state legislative elections in recent decades, so as to assess the properties of the efficiency gap and to identify plans with high values of the efficiency gap;
- to suggest a threshold or other measure that can be used to determine if a districting plan is an extreme partisan gerrymander;
- to describe how the efficiency gap for the Wisconsin districting plan compares to the values of the efficiency gap observed in recent decades elsewhere in the United States;
- to describe where the efficiency gap for the current Wisconsin districting plan lies in comparison with the threshold for determining if a districting plan constitutes an extreme partisan gerrymander.

My opinions are based on the knowledge I have amassed over my education, training and experience, and follow from statistical analysis of the following data:

- a large, canonical data set on candidacies and results in state legislative elections, 1967 to the present available from the Inter-University Consortium for Political and Social Research (ICPSR study number 34297); I use a release of the data updated through 2014, maintained by Karl Klarner (Indiana State University and Harvard University).
- presidential election returns, 2000-2012, aggregated to state legislative districts.

2 Qualifications, Publications and Compensation

My Ph.D. is in Political Science, from the University of Rochester, where my graduate training included courses in econometrics and statistics. My curriculum vitae is attached to this report.

All publications that I have authored and published in the past ten years appear in my curriculum vitae. Those publications include peer-reviewed journals such as: *The Journal of Politics*, *Electoral Studies*, *The American Journal of Political Science*, *Legislative Studies Quarterly*, *Election Law Journal*, *Public Opinion Quarterly*, *Journal of Elections, Public Opinion and Parties*, and *PS: Political Science and Politics*.

I have published on properties of electoral systems and election administration in *Legislative Studies Quarterly*, the *Australian Journal of Political Science*, the *British Journal of Political Science*, and the *Democratic Audit of Australia*. I am a Fellow of the Society for Political Methodology and a member of the American Academy of Arts and Sciences.

I am being compensated at a rate of $250 per hour.

3 Summary

1. **Partisan gerrymandering and wasted votes**. In two-party, single-member district electoral systems, a partisan gerrymander operates by effectively "wasting" more votes cast for one party than for the other. Wasted votes are votes for a party in excess of what the party needed to win a given district or votes cast for a party in districts that the party doesn't win. Differences

in wasted vote rates between political parties measure the extent of partisan gerrymandering.

2. **The efficiency gap** (*EG*) is a relative, wasted vote measure, the ratio of one party's wasted vote rate to the other party's wasted vote rate. *EG* can be computed directly from a given election's results, without recourse to extensive statistical modeling or assumptions about counter-factual or hypothetical election outcomes, unlike other extant measures of the fairness of an electoral system (e.g., partisan bias).

3. The efficiency gap is an "excess seats" measure, reflecting the nature of a partisan gerrymander. An efficiency gap in favor one party sees it wasting fewer votes than its opponent, thus translating its votes across the jurisdiction into seats more efficiently than its opponent. This results in the party winning more seats than we'd expect given its vote share (V) and if wasted vote rates were the same between the parties. $EG = 0$ corresponds to no efficiency gap between the parties, or no partisan difference in wasted vote rates. In this analysis (but without loss of generality) *EG* is normed such that negative *EG* values indicate higher wasted vote rates for Democrats relative to Republicans, and $EG > 0$ the converse.

4. A districting plan in which *EG* is consistently observed to be positive is evidence that the plan embodies a pro-Democratic gerrymander; the magnitudes of the *EG* measures speak to the severity of the gerrymander. Conversely, a districting plan with consistently negative values of the efficiency gap is consistent with the plan embodying a pro-Republican gerrymander.

5. **Performance of the efficiency gap in 786 state legislative elections**. My analysis of 786 state legislative elections (1972-2014) examines properties of the efficiency gap. *EG* is estimated with some uncertainty in the presence of uncontested districts (and uncontested districts are quite prevalent in state legislative elections), but this source of uncertainty is small relative to differences in the *EG* across states and across districting plans.

6. **Stability of the efficiency gap**. *EG* is stable in pairs of temporally adjacent elections held under the same districting plan. In 580 pairs of consecutive

EG measures, the probability that each *EG* measure has the same sign is 74%. In 141 districting plans with three or more elections, 35% have a better than 95% probability of *EG* being negative or positive for the entire duration of the plan; in about half of the districting plans the probability that *EG* doesn't change sign is above 75%.

7. **Recent decades show more pro-Republican gerrymandering, as measured by the efficiency gap.** Efficiency gap measures in recent decades show a pronounced shift in a negative direction, indicative of an increased prevalence of districting plans favoring Republicans. Among the 10 most pro-Democratic *EG* measures in my analysis, *none* were recorded after 2000.

8. **The current Wisconsin state legislative districting plan** (the "Current Wisconsin Plan"). In Wisconsin in 2012, the average Democratic share of district-level, two-party vote (V) is estimated to be 51.4% ($\pm$0.6, the uncertainty stemming from imputations for uncontested seats); recall that Obama won 53.5% of the two-party presidential vote in Wisconsin in 2012. Yet Democrats won only 39 seats in the 99 seat legislature (S = 39.4%), making Wisconsin one of 7 states in 2012 where we estimate $V > 50\%$ but $S < 50\%$. In Wisconsin in 2014, V is estimated to be 48.0% ($\pm$0.8) and Democrats won 36 of 99 seats (S = 36.4%).

9. Accordingly, Wisconsin's *EG* measures in 2012 and 2014 are large and negative: -.13 and -.10 (to two digits of precision). The 2012 estimate is the largest *EG* estimate in Wisconsin over the 42 year period spanned by this analysis (1972-2014).

10. Among 79 *EG* measures generated from state legislative elections after the 2010 round of redistricting, Wisconsin's *EG* scores rank 9th (2012, 95% CI 4 to 13) and 18th (2014, 95% CI 14 to 21). Among 786 *EG* measures in the 1972-2014 analysis, the magnitude of Wisconsin's 2012 *EG* measure is surpassed by only 27 (3.4%) other cases.

11. Analysis of efficiency gaps measures in the post-1990 era indicates that conditional on the magnitude of the Wisconsin 2012 efficiency gap (the first election under the Current Wisconsin Plan), there is a 100% probability

that *all subsequent elections* held under that plan will also have efficiency gaps disadvantageous to Democrats.

12. **The Current Wisconsin Plan presents overwhelming evidence of being a pro-Republican gerrymander**. In the entire set of 786 state legislative elections and their accompanying *EG* measures, there are *no precedents* prior to this cycle in which a districting plan generates an initial two-election sequence of *EG* scores that are each as large as those observed in *WI*.

13. The Current Wisconsin Plan is generating *EG* measures that make it *extremely likely* that it has a systematic, historically large and enduring, pro-Republican advantage in the translation of votes into seats in Wisconsin's state legislative elections.

14. **An actionable threshold based on the efficiency gap.** Historical analysis of the relationship between the first *EG* measure we observe under a new districting plan and the subsequent *EG* measures lets us assess the extent to which that first *EG* estimate is a *reliable* indicators of a *durable* and hence *systematic* feature of the plan. In turn, this let us assess the *confidence* associated with a range of possible *actionable EG thresholds*.

15. My analysis suggests that *EG* greater than .07 in absolute value be used as an actionable threshold. Relatively few plans produce a first election with an *EG* measure in excess of this threshold, and of those that do, the historical analysis suggests that most go on to produce a sequence of *EG* estimates indicative of systematic, partisan advantage consistent with the first election *EG* estimates, At the 0.07 threshold, 95% of plans would be either (a) undisturbed by the courts, or (b) struck down because we are sufficiently confident that the plan, if left undisturbed, would go on to produce a one-sided sequence of *EG* estimates, consistent with the plan being a partisan gerrymander. In short, our "confidence level" in the 0.07 threshold is 95%.

16. **The Current Wisconsin Plan is generating estimates of the efficiency gap far in excess of this proposed, actionable threshold**. In 2012 elections to the Wisconsin state legislature, the efficiency gap is estimated to be -.13; in

2014, the efficiency gap is estimated to be -.10. Both measures are separately well beyond the conservative .07 threshold suggested by the analysis of efficiency gap measures observed from 1972 to the present.

A vivid, graphical summary of my analysis appears in Figure 1, showing the average value of the efficiency gap in 206 districting plans, spanning 41 states and 786 state legislative elections from 1972 to 2014. The Current Wisconsin Plan has been in place for two elections (2012 and 2014), with an average efficiency gap of -.115. Details on the interpretation and calculation of the efficiency gap come later in my report, but for now note that negative values of the efficiency gap indicate a districting plan favoring Republicans, while positive values indicate a plan favoring Democrats. Note that *only four other districting plans have lower average efficiency gap scores than the Current Wisconsin Plan*, and these are also from the post-2010 round of redistricting. That is, Wisconsin's current plan is generating the 5th lowest average efficiency gap observed in over 200 other districting plans used in state legislative elections throughout the United States over the last 40 years. The analysis I report here documents why the efficiency gap is a valid and reliable measure of partian gerrymandering and why are confident that the current Wisconsin plan exceeds even a conservative definition of partisan gerrymandering.

4 Redistricting plans

A districting plan is an exercise in map drawing, partitioning a jurisdiction into districts, typically required to be contiguous, mutually exclusive and exhaustive regions, and — at least in the contemporary United States — of approximately the same population size. In a single-member, simple plurality (SMSP) electoral system, the highest vote getter in each district is declared the winner of the election. Partisan gerrymandering is the process of drawing districts that favor one party, typically by creating a set of districts that help the party win an excess of seats (districts) relative to its jurisdiction-wide level of support.

What might constitute evidence of partisan gerrymandering? One indication might be a series of elections conducted under the same districting plan in which a party's seat share (S) is unusually large (or small) relative to its vote share (V).

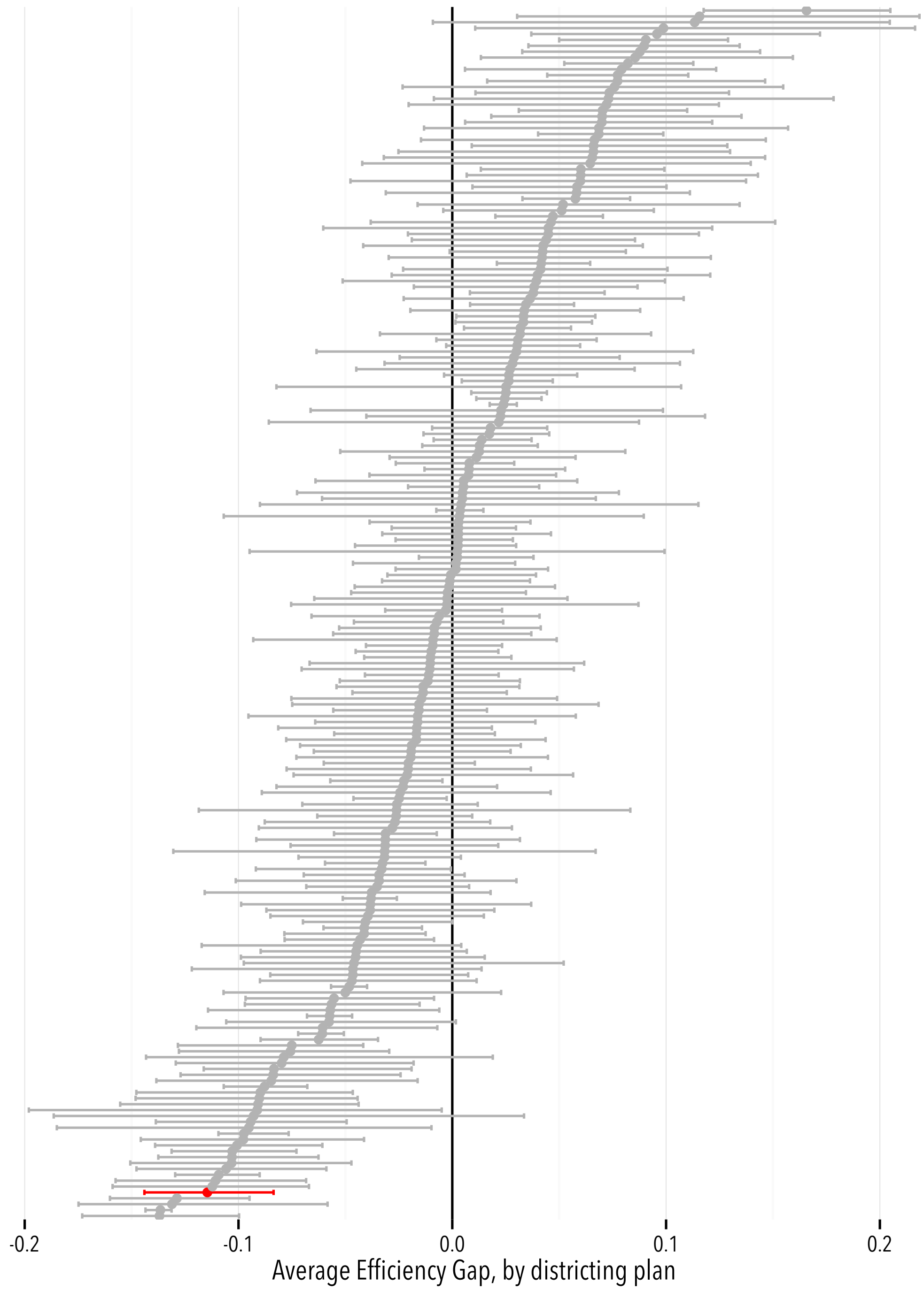

Figure 1: Average efficiency gap score, 206 districting plans, 1972-2014. Plans have been sorted from low average *EG* scores to high. Horizontal lines cover 95% confidence intervals. Negative efficiency gap scores are plans that disadvantage Democrats; positive efficiency gap scores favor Democrats. The Current Wisconsin Plan is shown in red. See also Figure 36.

There may be elections where a party wins a majority of seats (and control of the jurisdiction's legislature) despite not winning a majority of votes: $S > .5$ while $V < .5$ and vice-versa. In fact, there are numerous instances of mismatches between the party winning the statewide vote and the party controlling the state legislature in recent decades. I estimate that since 1972 there have been 63 cases of Democrats winning a majority of the vote in state legislative elections, while not winning a majority of the seats, and 23 cases of the reverse phenomenon, where Democrats won a majority of the seats with less than 50% of the statewide, two-party vote.

Geographic clustering of partisans is typically a prerequisite for partisan gerrymandering. This is nothing other than partisan "packing": a gerrymandered districting plan creates a relatively small number of districts that have unusually large proportions of partisans from party *B*. The geographic concentration of party *B* partisans might make creating these districts a straightforward task. In other districts in the jurisdiction, party *B* supporters never (or seldom) constitute a majority (or a plurality), making those districts "safe" for party *A*. This districting plan helps ensure party *A* wins a majority of seats even though party *B* has a majority of support across the jurisdiction, or at the very least, the districting plan helps ensures that party *A*'s seat share exceeds its vote share in any given election.

It is conventional in political science to say that such a plan allows party *A* to "more efficiently" translate its votes into seats, relative to the way the plan translates party *B*'s votes into seats. This nomenclature is telling, as we will see when we consider the *efficiency gap* measure, below.

Assessing the partisan fairness of a districting plan is fundamentally about measuring a party's excess (or deficit) in its seat share relative to its vote share. The efficiency gap is such a summary measure. To assess the properties of the efficiency gap, I first review some core concepts in the analysis of districting plans: vote shares, seat shares, and the relationship between the two quantities in single-member districts.

4.1 Seats-Votes Curves

Electoral systems translate parties' vote shares (V) into seat shares (S). Both V and S are proportions. Plotting the two quantities V and S against one another yields the "seats-votes" curve, a staple in the analysis of electoral systems and districting plans. Two seats-votes curves are shown in Figure 2, one showing a non-linear relationship between seats and votes typical of single-member district systems,[1] the other showing a linear relationship between seats and votes observed under proportional representation systems.

In pure proportional representation (PR) voting systems, seats-votes curves are 45 degree lines by design, crossing the $(V, S) = (.5, .5)$ point: i.e., under PR, $S = V$ and a party that wins 50% of the vote will be allocated 50% of the seats. Absent a deterministic allocation rule like pure PR, seats-votes curves are most usefully thought of in probabilistic terms, due to the fact that there are many possible configurations of district-specific outcomes corresponding to a given jurisdiction-wide V, and hence uncertainty — represented by a probability *distribution* — over possible values of S given V.

In single-member, simple plurality (SMSP) systems, we often see non-linear, "S"-shaped seats-votes curves. With an approximately symmetric mix of districts (in terms of partisan leanings), large changes in seat shares (S) can result from relatively small changes in votes shares (V) at the middle of the distribution of district types. This presumes a districting plan such that both parties have a small number of "strongholds," with extremely large changes in vote shares needed to threaten these districts, and so the seats-votes curve tends to "flatten out" as jurisdiction-wide vote share (V) takes on relatively large or small values. Other shapes are possible too: e.g., bipartisan, incumbent-protection plans generate seats-votes curves that are largely flat for most values of V, save for the constraint that the curve run through the points $(V, S) = (0, 0)$ and $(1, 1)$; i.e., relatively large movements in V generates relatively little change in seats shares.

[1] The curve labeled "Cube Law" in Figure 2 is generated assuming that $S/(1-S) = [V/(1-V)]^3$, an approximation for the lack of proportionality we observe in single-member district systems, though hardly a "law."

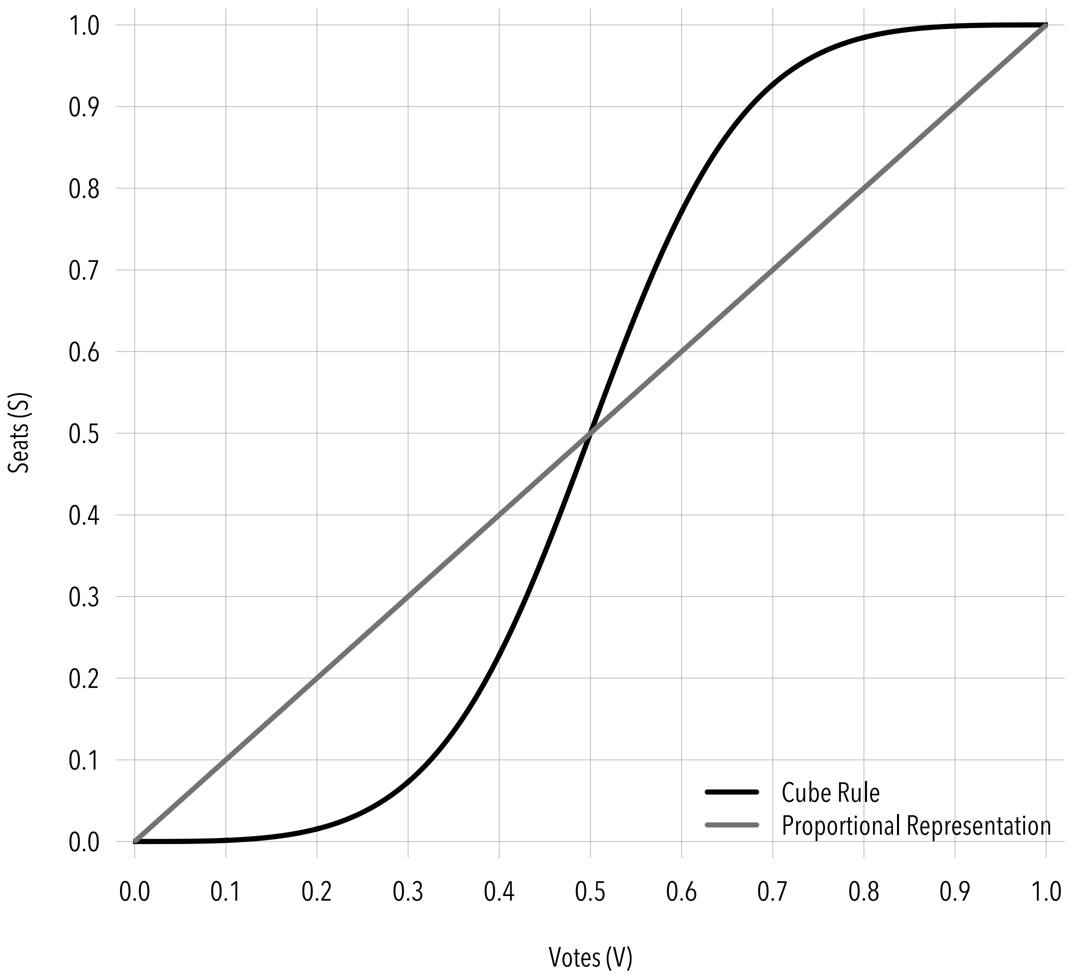

Figure 2: Two Theoretical Seats-Votes Curves

5 Partisan bias

Both of the hypothetical seats-votes curves in Figure 2 run through the "50-50" point, where $V = .5$ and $S = .5$. An interesting empirical question is whether *actual* seats-votes curves run through this point, or more generally, whether the seats-votes curve is symmetric about $V = .5$. Formally, symmetry of the seats-vote curve is the condition that $E(S|V) = 1 - E(S|1 - V)$, where E is the expectation operator, averaging over the uncertainty with respect to S given V. The vertical offset from the $(.5, .5)$ point for a seats-votes curve is known as *partisan bias*: the extent to which a party's expected seat share lies above or below 50%, conditional on that party winning 50% of the jurisdiction-wide vote.

Figure 3 shows three seats-votes curves, with the graph clipped to the region $V \in [.4, 6.]$ and $S \in [.4, .6]$ so as to emphasize the nature of partisan bias. The blue, positive bias curve "lifts" the seats-votes curve; it crosses $S = .5$ with $V < .5$ and passes through the upper-left quadrant of the graph. That is, with positive bias, a party can win a majority of the seats with *less* then a majority of the jurisdiction-wide or average vote; equivalently, if the party wins $V = .5$, it can expect to win *more* than 50% of the seats. Conversely, with negative bias, the opposite phenomenon occurs: the party can't expect to win a majority of the seats until it wins more than a majority of the jurisdiction-wide or average vote.

5.1 Multi-year method

With data from multiple elections under the same district plan, partisan bias can be estimated by fitting a seats-votes curve to the observed seat and vote shares, typically via a simple statistical technique such as linear regression; this approach has a long and distinguished lineage in both political science and statistics (e.g., Edgeworth, 1898; Kendall and Stuart, 1950; Tufte, 1973). Niemi and Fett (1986) referred to this method of estimating the partisan bias of an electoral system as the "multi-year" method, reflecting the fact that the underlying data comes from a sequence of elections.

This approach is of limited utility when assessing a new or proposed districting plan. More generally, it is of no great help to insist that a sequence of elections must be conducted under a redistricting plan before the plan can be properly assessed. Indeed, few plans stay intact long enough to permit reliable analysis in

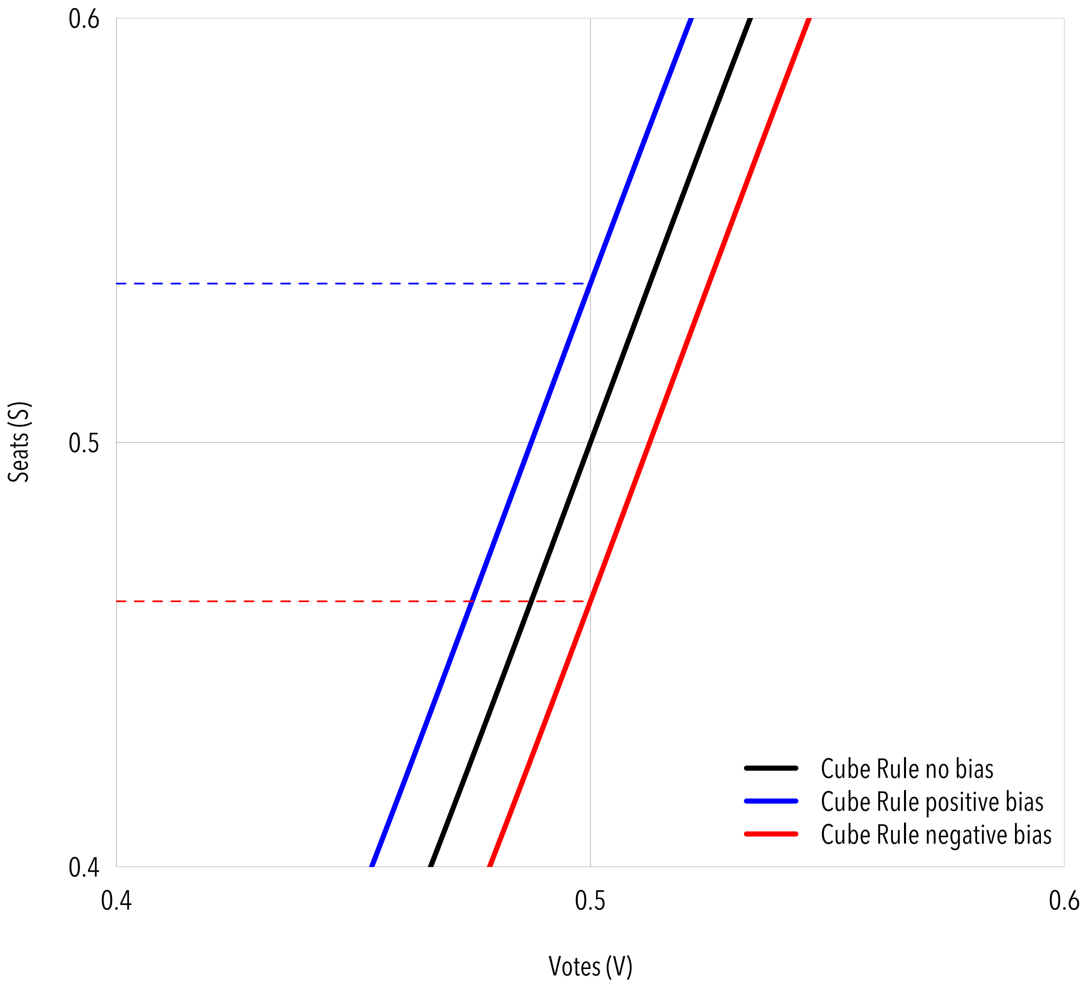

Figure 3: Theoretical seats-votes curves, with different levels of partisan bias. This graph is "zoomed in" on the region $V \in [.4, .6]$ and $S \in [.4, .6]$; the seats-votes "curves" are approximately linear in this region.

this way. State-level plans in the United States might generate as many five elections between decennial censuses. Accordingly, many uses of the "multi-year" method pool multiple plans and/or across jurisdictions, so as to estimate average partisan bias. For instance, Niemi and Jackman (1991) estimated average levels of partisan bias in state legislative districting plans, collecting data spanning multiple decades and multiple states, and grouping districting plans by the partisanship of the plan's authors (e.g., plans drawn under Republican control, Democratic control, mixed, or independent).

Assessing the properties of a districting plan after a tiny number of elections — or *no* elections — requires some assumptions and/or modeling. A single election yields just a single (V, S) data point, through which no unique seats-vote curve can be fitted and so partisan bias can't be estimated without further assumptions. Absent *any* actual elections under the plan, we might examine votes from a previous election, say, with precinct level results re-aggregated to the new districts.

5.2 Uniform swing

One approach—dating back to Sir David Butler's (1974) pioneering work on British elections—is the uniform partisan swing approach. Let $\mathbf{v} = (v_1, \ldots, v_n)'$ be the set of vote shares for party A observed in an election with n districts. Party A wins seat i if $v_i > .5$, assuming just two parties (or defining v as the share of two-party vote); i.e., $s_i = 1$ if $v_i > .5$) and otherwise $s_i = 0$. Party A's seat share is $S = \frac{1}{n} \sum_{i=1}^{n} s_i$. V is the jurisdiction-wide vote share for party A, and if each district had the same number of voters $V = \bar{v} = \frac{1}{n} \sum_{i=1}^{n} v_i$, the average of the district-level v_i. Districts are never *exactly* equal sized, in which case we can define V as follows: let t_i be the number of voters in district i, and $V = \sum_{i=1}^{n} t_i v_i / \sum_{i=1}^{n} t_i$.

The uniform swing approach perturbs the observed district-level results $\mathbf{v}$ by a constant factor δ, corresponding to a hypothetical amount of *uniform swing* across all districts. For a given δ, let $v_i^* = v_i + \delta$ which in turn generates $V^* = V + \delta$ and an implied seat share S^*. Now let δ vary over a grid of values ranging from $-V$ to $1 - V$; then V^* varies from 0 to 1 and a corresponding value of S^* can also be computed at every grid point. The resulting set of (V^*, S^*) points are then plotted to form a seats-vote curve (actually, a step function). Partisan bias is simply "read off" this set of results, computed as $S^*|(V^* = .5) - .5$.

There is an elegant simplicity to this approach, taking an observed set of district-level vote shares $\mathbf{v}$ and shifting them by the constant δ. The observed distribution of district level vote shares observed in a given election is presumed to hold under *any* election we might observe under the redistricting plan, save for the shift given by the uniform swing term δ.

5.3 Critiques of partisan bias

Among political scientists, the uniform swing approach was criticized for its determinism. Swings are never exactly uniform across districts. There are many permutations of observed vote shares that generate a statewide vote share of 50% other than simply shifting observed district-level results by a constant factor. A less deterministic approach to assessing partisan bias was developed over a series of papers by Gary King and Andrew Gelman in the early 1990s (e.g., Gelman and King, 1990). This approach fits a statistical model to district-level vote shares — and, optionally, utilizing available predictors of district-level vote shares — to model the way particular districts might exhibit bigger or smaller swings than a given level of state-wide swing. Perhaps one way to think about the approach is that it is "approximate" uniform swing, with statistical models fit to historical election results to predict and bound variation around a state-wide average swing. The result is a seats-vote curve and an estimate of partisan bias that comes equipped with uncertainty measures, reflecting uncertainty in the way that individual districts might plausibly deviate from the state-wide average swing yet still produce a state-wide average vote of 50%.

The King and Gelman model-based simulation approaches remain the most sophisticated methods of generating seats-votes curves, extrapolating from as little as one election to estimate a seats-votes curve and hence an estimate of partisan bias. Despite the technical sophistication with which we can estimate partisan bias, legal debate has centered on a more fundamental issue, the *hypothetical* character of partisan bias itself. Recall that partisan bias is defined as "seats in excess of 50% *had the jurisdiction-wide vote split 50-50.*" The premise that $V = .5$ is the problem, since this will almost always be a counter-factual or hypothetical scenario. The further V is away from .5 in a given election, the counter-factual we must contemplate (when assessing the partisan bias of a districting plan) becomes all the more speculative.

In no small measure this is a marketing failure, of sorts. Partisan bias (at least under the uniform swing assumption) is essentially a measure of skew or asymmetry in *actual* vote shares. Partisan bias garners great rhetorical and normative appeal by directing attention to what happens at $V = .5$; it seems only "fair" that if a party wins 50% or more of the vote it should expect to win a majority of the districts.

Yet this distracts us from the fact that *asymmetry* in the distribution of vote shares across districts is the key, operative feature of a districting plan, and the extent to which it advantages one party or the other. Critically, we need not make appeals to counter-factual, hypothetical elections in order to assess this asymmetry.

6 The Efficiency Gap

The efficiency gap (*EG*) is also an asymmetry measure, as we see below. But unlike partisan bias, the interpretation of the efficiency gap is *not* explicitly tied to any counter-factual election outcome. In this way, the efficiency gap provides a way to assess districting plans that is free of the criticisms that have stymied the partisan bias measure.

Stephanopoulos and McGhee (2015) derive the *EG* measure with the concept of wasted votes. A party only needs v_i = 50% + 1 of the votes to win district i. Anything more are votes that could have been deployed in other districts. Conversely, votes in districts where the party doesn't win are "wasted," from the perspective of generating seats: any districts with $v_i < .5$ generate no seats.

Wasted votes get at the core of what partisan gerrymandering is, and how it operates. A gerrymander against party A creates a relatively small number of districts that "lock up" a lot of its votes ("packing" with $v_i > .5$) and a larger number of districts that disperse votes through districts won by party B ("cracking" with $v_i < .5$). To be sure, both parties are wasting votes. But partisan advantage ensues when one party is wasting fewer votes than the other, or, equivalently, more efficiently translating votes into seats. Note also how the efficiency gap measure is also closely tied to asymmetry in the distribution of v_i.

Some notation will help make the point more clearly. If $v_i > .5$ then party A wins the district and $s_i = 1$; otherwise $s_i = 0$. The efficiency gap is defined by McGhee (2014, 68) as "relative wasted votes" or

$$EG = \frac{W_B}{n} - \frac{W_A}{n}$$

where

$$W_A = \sum_{i=1}^{n} s_i(v_i - .5) + (1 - s_i)v_i$$

is the sum of wasted vote proportions for party A and

$$W_B = \sum_{i=1}^{n} (1 - s_i)(.5 - v_i) + s_i(1 - v_i)$$

is the sum of wasted vote proportions for party B and n is the number of districts in the jurisdiction. If $EG > 0$ then party B is wasting more votes than A, or A is translating votes into seats more efficiently than B; if $EG < 0$ then the converse, party A is wasting more votes than B and B is translating votes into seats more efficiently than A.

6.1 The efficiency gap when districts are of equal size

Under the assumption of equally sized districts McGhee (2014, 80) re-expresses the efficiency gap as:

$$EG = S - .5 - 2(V - .5) \tag{1}$$

recalling that $S = n^{-1} \sum_{i=1}^{n} s_i$ is the proportion of seats won by party A and $V = n^{-1} \sum_{i=1}^{n} v_i$ is the proportion of votes won by party A.

The assumption of equally-sized districts is especially helpful for the analysis reported below, since the calculation of EG in a given election then reduces to using the jurisdiction-level quantities S and V as in equation 1. For the analysis of historical election results reported below, it isn't possible to obtain measures of district populations, meaning that we really have no option other than to rely on the jurisdiction-level quantities S and V when estimating the EG.

I operationalize V as the average (over districts) of the Democratic share of the two-party vote, in seats won by either a Democratic or Republican candidate;

this set of seats includes uncontested seats, where I will use imputation procedures to estimate two-party vote share. If districts are of equal size (and ignoring seats won by independents and minor party candidates) then this average over districts will correspond to the Democratic share of the state-wide, two-party vote.

6.2 The seats-vote curve when the efficiency gap is zero

This simple expression for the efficiency gap implies that *if the efficiency gap is zero*, we obtain a particular type of seats-votes curve, shown in Figure 4:

1. the seats-votes curve runs through the 50-50 point. If the jurisdiction wide vote is split 50-50 between party A and party B then with an efficiency gap of zero, $S = .5$.

2. conditional on $V = .5$ (an even split of the vote), the efficiency gap is the same as partisan bias: $V = .5 \iff EG = S - .5$, the seat share for party A in excess of 50%. That is, the efficiency gap reduces to partisan bias *under the counter-factual scenario* $V = .5$ that the partisan bias measure requires us to contemplate. On the other hand, the efficiency gap is not premised on that counter-factual holding, or any other counter-factual for that matter; the efficiency gap summarizes the distribution of observed district-level vote shares v_i.

3. the seats-votes curve is linear through the 50-50 point with a slope of 2. That is, with $EG = 0$, $S = 2V - .5$. Or, with a zero efficiency gap, each additional percentage point of vote share for party A generates *two* additional percentage points of seat share. A zero efficiency gap does not imply proportional representation (a seats-votes that is simply a 45 degree line).

4. a party winning 25% or less of the jurisdiction-wide vote should win zero seats under a plan with a zero efficiency gap; a party winning 75% or more of the jurisdiction-wide vote should win all of the seats under a plan with a zero efficiency gap. This is a consequence of the “2-to-1” seats/vote ratio and the symmetry implied by a zero efficiency gap. A party that wins an extremely low share of the vote ($V < .25$) can only be winning any seats if it enjoys an efficiency advantage over its opponent.

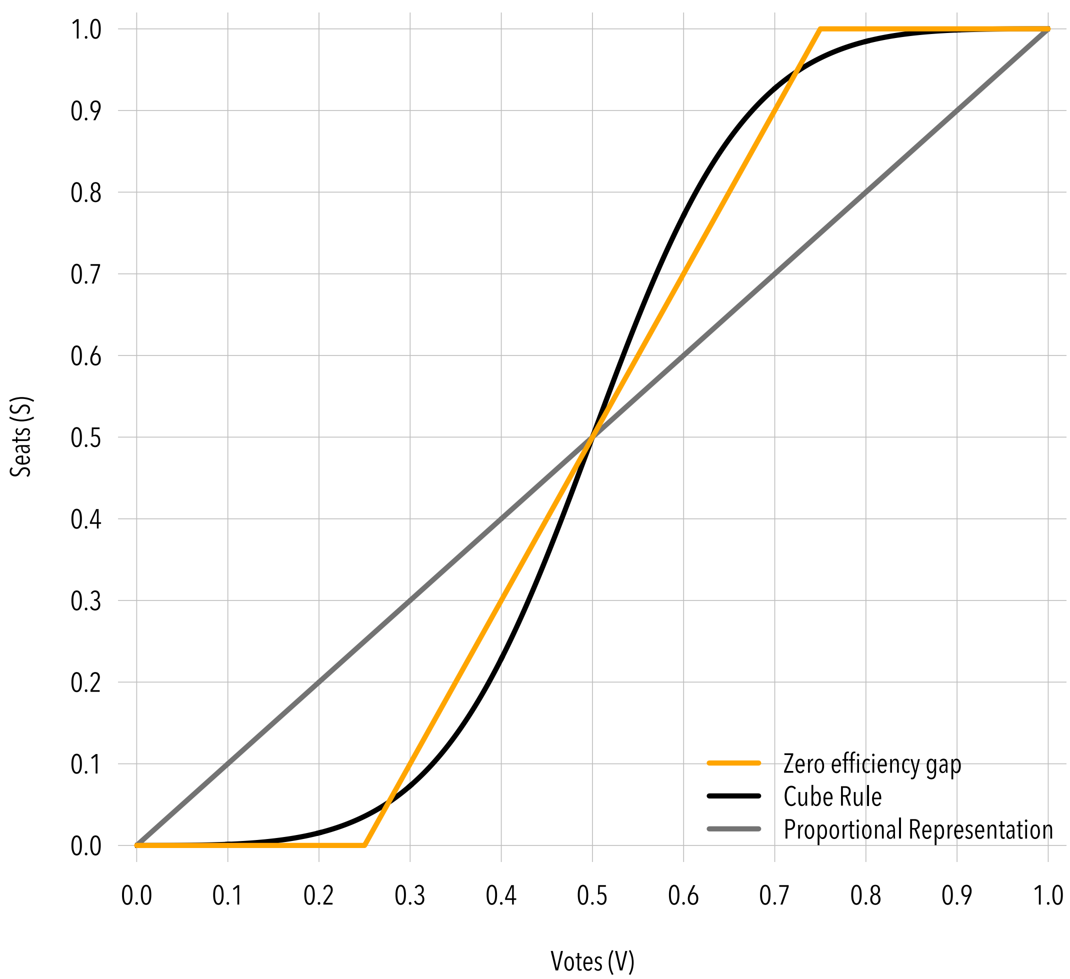

Figure 4: Theoretical seats-votes curves. The $EG = 0$ curve implies that (a) a party winning less than $V = .25$ jurisdiction-wide should not win any seats; (b) symmetrically, a party winning more than $V = .75$ jurisdistion-wide should win all the seats; and (c) the relationship between seat shares S and vote shares V over the interval $V \in [.25, .75]$ is a linear function with slope two (i.e., for every one percentage point gain in vote share, seat share should go up by two percentage points).

Moreover, the efficiency gap is trivial to compute once we have V and S for a given election. We don't need a sequence of elections under a plan in order to compute EG, nor do we need to anchor ourselves to a counter-factual scenario such as $V = .5$ as we do when computing partisan bias. For any given observed V, the hypothesis of zero efficiency gap tells us what level of S to expect.

6.3 The efficiency gap as an excess seats measure

In this sense the efficiency gap can be interpreted even more simply as an "excess seats" measure. Recall that $EG = 0 \iff S = 2V - .5$. In a given election we observe $EG = S - .5 - 2(V - .5)$. The efficiency gap can be computed by noting how far the observed S lies above or below the orange line in Figure 4.

A positive EG means "excess" seats for party A relative to a zero efficiency gap standard given the observed V in that election; conversely, a negative EG mean a deficit in seats for party A relative to a zero efficiency gap standard given the observed V.

7 State legislative elections, 1972-2014

We estimate the efficiency gap in state legislative elections over a large set of states and districting plans, covering the period 1972 to 2014. We begin the analysis in 1972 for two primary reasons: (a) state legislative election returns are harder to acquire prior to the mid-1960s, and not part of the large, canonical data collection we rely on (see below); and (b) districting plans and sequences of elections from 1972 onwards can be reasonably considered to be from the post-malapportionment era.

For each election we recover an estimate of the efficiency gap based on the election results actually observed in that election. To do this, I compute two quantities for each election:

1. V, the statewide share of the two-party vote for Democratic candidates, formed by averaging the district-level election results v_i (the Democratic share of the two-party vote in district i) in seats won by major party candidates, including uncontested seats, and

2. *S*, the Democratic share of seats won by major parties.

Recall that these quantities are the inputs required when computing the efficiency gap (equation 1).

The analysis that follows relies on a data set widely used in political science and freely available from the Inter-University Consortium for Political and Social Research (ICPSR study number 34297). The release of the data I utilize covers state legislative election results from 1967 to 2014, updated by Karl Klarner (Indiana State University and Harvard University). I subset the original data set to general election results since 1972 in states whose lower houses are elected via single-member districts, or where single-member districts are the norm. Multi-member districts "with positions" are treated as if they are single-member districts.

Figure 5 provides a graphical depiction of the elections that satisfy the selection criteria described above.

- Arizona, Idaho, Louisiana, Maryland, Nebraska, New Hampshire, New Jersey, North Dakota and South Dakota all drop out of the analysis entirely, because of exceedingly high rates of uncontested races, using multi-member districts, non-partisan elections, or the use of a run-off system (Louisiana).

- Alaska, Hawaii, Illinois, Indiana, Kentucky, Maine, Minnesota, Montana, North Carolina, Vermont, Virginia, West Virginia and Wyoming do not supply data over the entire 1972-2014 span; this is sometimes due to earlier elections being subject to exceedingly high rates of uncontestedness, the use of multi-member districts or non-partisan elections.

- Alabama and Mississippi have four-year terms in their lower houses, contributing data at only half the rate of the vast bulk of states with two-year legislative terms.

- Twenty-three states supply data every two years from 1972 to 2014, including Michigan and Wisconsin.

- Data is more abundant in recent decades. For the period 2000 to 2014, 41 states contribute data to the analysis at two or four year intervals.

In summary, the data available for analysis span 83,269 district-level state legislative contests, from 786 elections across 41 states.

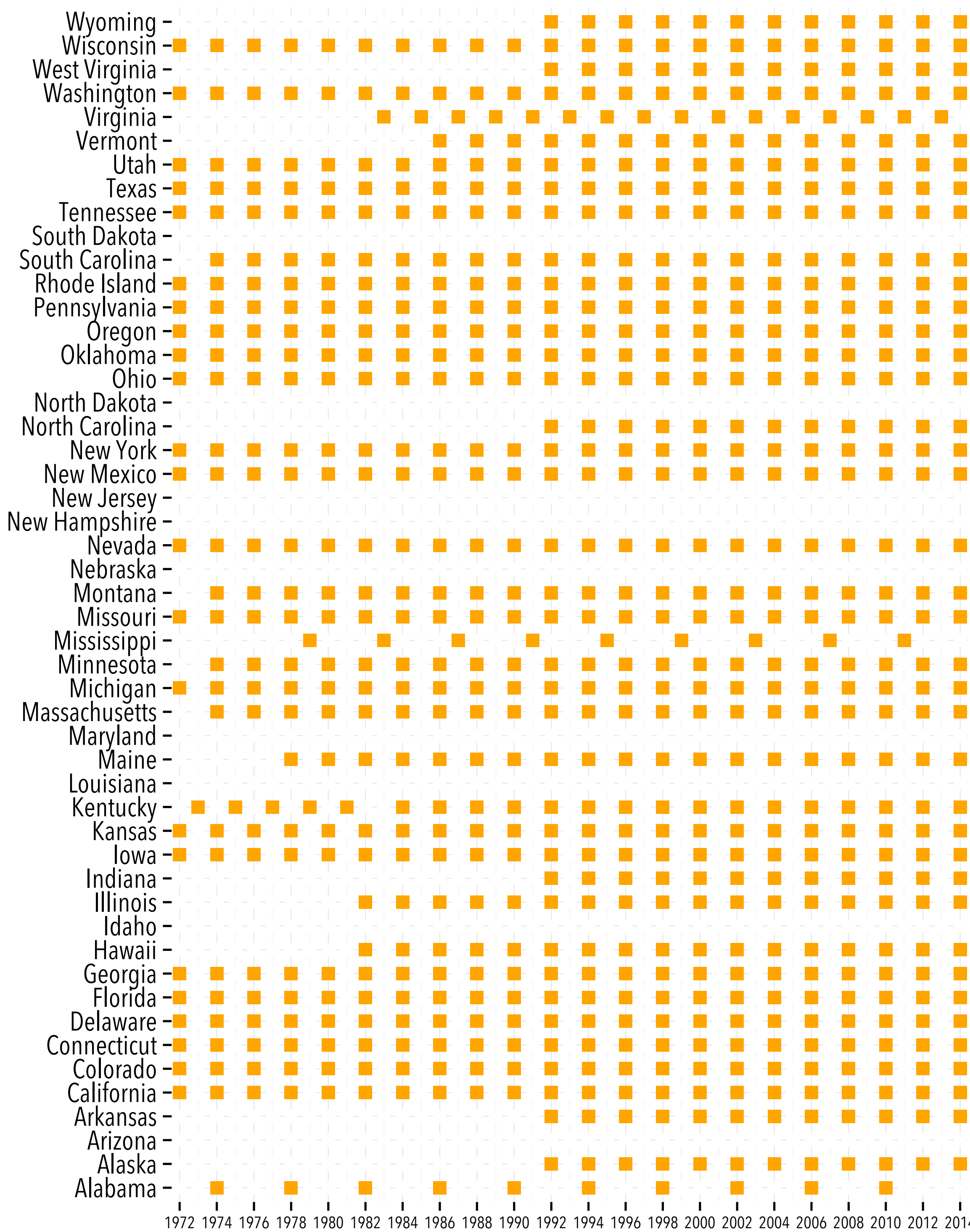

Figure 5: 786 state legislative elections available for analysis, 1972-2014, by state.

7.1 Grouping elections into redistricting plans

Districting plans remain in place for sequences of elections. An important component of my analysis involves tracking the efficiency gap across a series of elections held under the same districting plan. A key question is how much variation in the *EG* do we observe *within* districting plans, versus variation in the *EG* *between* districting plans.

To the extent that the *EG* is a feature of a districting plan per se, we should observe a small amount of within-plan variation relative to between plan variation. To perform this analysis we must group sequences of elections within states by the districting plan in place at the time.

Stephanopolous and McGhee (2015) provide a unique identifier for the districting plan in place for each state legislative election, for which I adopt here.

Figure 6 displays how the elections available for analysis group by districting plan. Districts are typically redrawn after each decennial census; the first election conducted under new district boundaries is often the "2" election (1982, 1992, etc). Occasionally we see just one election under a plan: examples include Alabama 1982, California, Hawaii 1982, Tennessee 1982, Ohio 1992, South Carolina 1992, North Carolina 2002, and South Carolina 2002.

Alaska, Kentucky, Pennsylvania and Texas held just one election under their respective districting plans adopted after the 2010 Census. In each of those states a different plan was in place for 2014 state legislative elections. Alabama's state legislature has a four year term and we observe only the 2014 election under its post-2010 plan. The last election from Mississippi was in 2011 and was held under the plan in place for its 2003 and 2007 elections.

7.2 Uncontested races

Uncontested races are common in state legislative elections, and are even the norm in some states. For 38.7% of the district-level results in this analysis, it isn't possible to directly compute a two-party vote share (v_i), either because the seat was uncontested or not contested by both a Democratic and Republican candidate, or (in a tiny handful of cases) the data are missing.

In some states, for some elections, the proportion of uncontested races is so high that we drop the election from the analysis. As noted earlier, examples

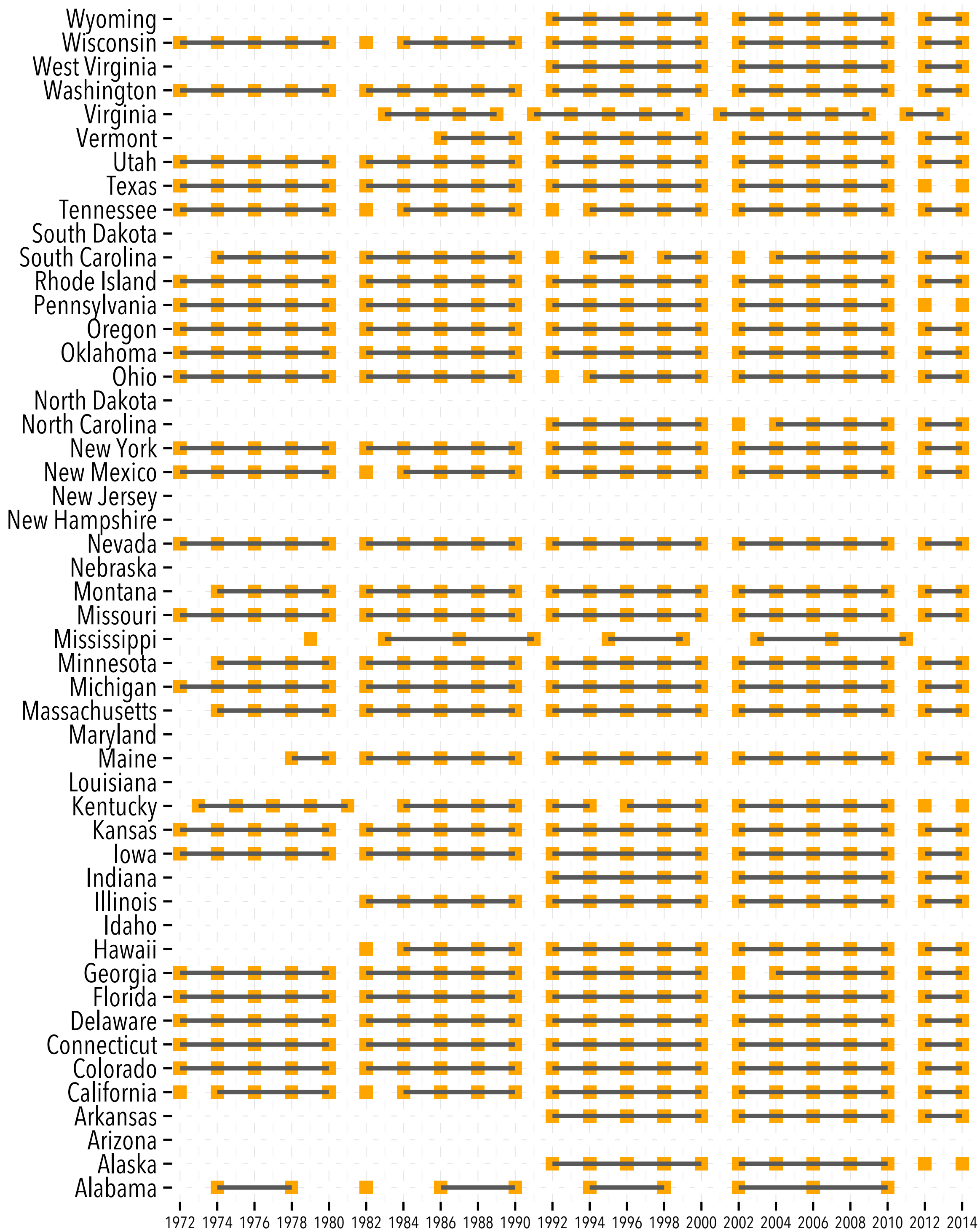

Figure 6: 786 state legislative elections available for analysis, 1972-2014, by state, grouped by districting plan (horizontal line).

include Arkansas elections prior to 1992 and South Carolina in 1972.

Even with these elections dropped from the analysis, the extent of uncontestedness in the remaining set of state legislative election results is too large to be ignored. Of the remaining elections, 31% have missing two-party results in at least half of the districts.

A graphical summary of the prevalence of uncontested districts appears in Figure 7, showing the percentage of districts without Democratic and Republican vote counts, by election and by state. Uncontested races are the norm in a number of Southern states: e.g., Georgia, South Carolina, Mississippi, Arkansas, Texas, Alabama, Virginia, Kentucky and Tennessee record rates of uncontestedness that seldom, if ever, drop below 50% for the period covered by this analysis. Wyoming also records a high proportion of districts that do not have Democratic versus Republican contests. States that lean Democratic also have high levels of uncontestedness too: see Rhode Island, Massachusetts, Illinois and, in recent decades, Pennsylvania.

Michigan and Minnesota are among the states with the lowest levels of uncontested districts in their state legislative elections. Over the set of 786 state legislative elections we examine, there are just *three* instances of elections with Democrats and Republicans running candidates in every district: Michigan supplies two of these cases (2014 and 1996) and Minnesota the other (2008).

8 Imputations for Uncontested Races

Stephanopolous and McGhee (2015) note the prevalence of uncontested races and report using a statistical model to impute vote shares to uncontested districts. They write:

> We strongly discourage analysts from either dropping uncontested races from the computation or treating them as if they produced unanimous support for a party. The former approach eliminates important information about a plan, while the latter assumes that coerced votes accurately reflect political support.

I concur with this advice, utilizing an imputation strategy for uncontested districts with *two* distinct statistical models, predicting Democratic, two-party

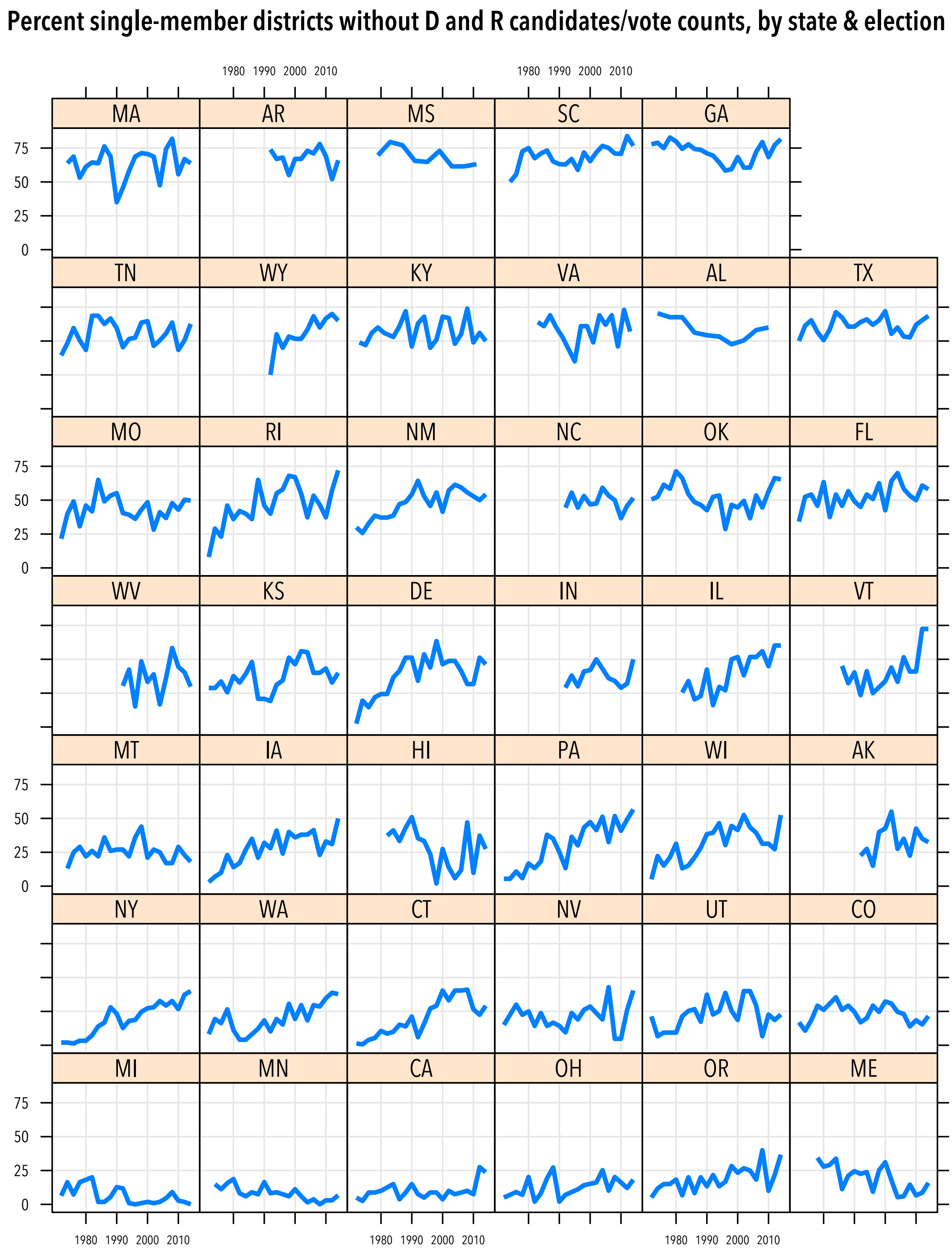

Figure 7: Percentage of districts missing two-party vote shares, by election, in 786 state legislative elections, 1972-2014. Missing data is almost always due to districts being uncontested by both major parties.

vote share in state legislative districts (v_i).

8.1 Imputation model 1: presidential vote shares

The first imputation model relies on presidential election returns reported at the level of state legislative districts. Presidential election returns are excellent predictors of state legislative election outcomes and observed even when state legislative elections are uncontested. I fit a series of linear regressions of v_i on the Democratic share of the two-party vote for president in district i, as recorded in the most temporally-proximate presidential election for which data is available and for which the current election's districting plan was in place; separate slopes and intercepts are estimated depending on the incumbency status of district i (Democratic, Open/Other, Republican).

The model also embodies the following assumptions in generating imputations for unobserved vote shares in uncontested districts. In districts where a Republican incumbent ran unopposed, we assume that the Democratic share of the two-party vote would have been less than 50%; conversely, where Democratic incumbents ran unopposed, we assume that the Democratic share of the vote would have been greater than 50%.

In most states the analysis predicts 2014 and 2012 state legislative election results v_i using 2012 presidential vote shares; 2006, 2008 and 2010 v_i is regressed on 2008 presidential vote shares, and so on. Some care is needed matching state and presidential election results in states that hold their state legislative elections in odd-numbered years, or where redistricting intervenes. In a small number of cases, presidential election returns are not available, or are recorded with district identifiers that can't be matched in the state legislative elections data. We lack data on presidential election results by state legislative district prior to 2000, so 1992 is the earliest election with which we can match state legislative election results to presidential election results at the district level.

The imputation model generally fits well. Across the 447 elections, the median r^2 statistic is 0.82. The cases fitting less well include Vermont in 2012 ($r^2 = 0.29$), with relatively few contested seats and multi-member districts with positions.

We examine the performance of the imputation model in a series of graphs, below, for six sets of elections: Wisconsin in 2012 and 2014, Michigan in 2014

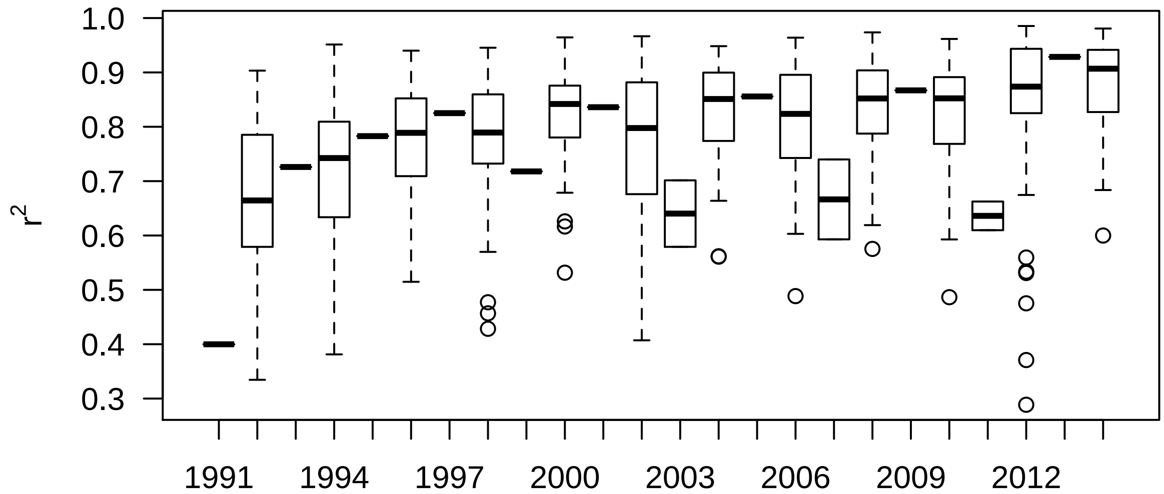

Figure 8: Distribution of r^2 statistics, regressions of Democratic share of two-party vote in state legislative election outcomes on Democratic share of the two-party for president.

(with no uncontested districts), South Carolina in 2012 (with the highest proportion of uncontested seats in the 2012 data), Virginia in 2013 and Wyoming in 2012 (the latter two generating extremely large, negative values of the efficiency gap). Vertical lines indicate 95% confidence intervals around imputed values for the Democratic share of the two-party vote in state legislative elections (vertical axis). Separate slopes and intercepts are fit for each incumbency type. Note also that the imputed data almost always lie on the regression lines.

Imputations for uncontested districts are accompanied by uncertainty. Although the imputation models generally fit well, like any realistic model they provides less than a perfect fit to the data. Note too that in any given election, there is only a finite amount of data and hence a limit to the precision with which we can make inferences about unobserved vote shares based on the relationship between observed vote shares and presidential vote shares.

Uncertainty in the imputations for v in uncontested districts generates uncertainty in "downstream" quantities of interest such as statewide Democratic vote share V and the efficiency gap measure EG. This is key, given the fact that uncontestedness is so pervasive in these data. We want any conclusions about the efficiency gap's properties or inferences about particular levels of the efficiency gap to reflect the uncertainty resulting from imputing vote shares in uncontested districts.

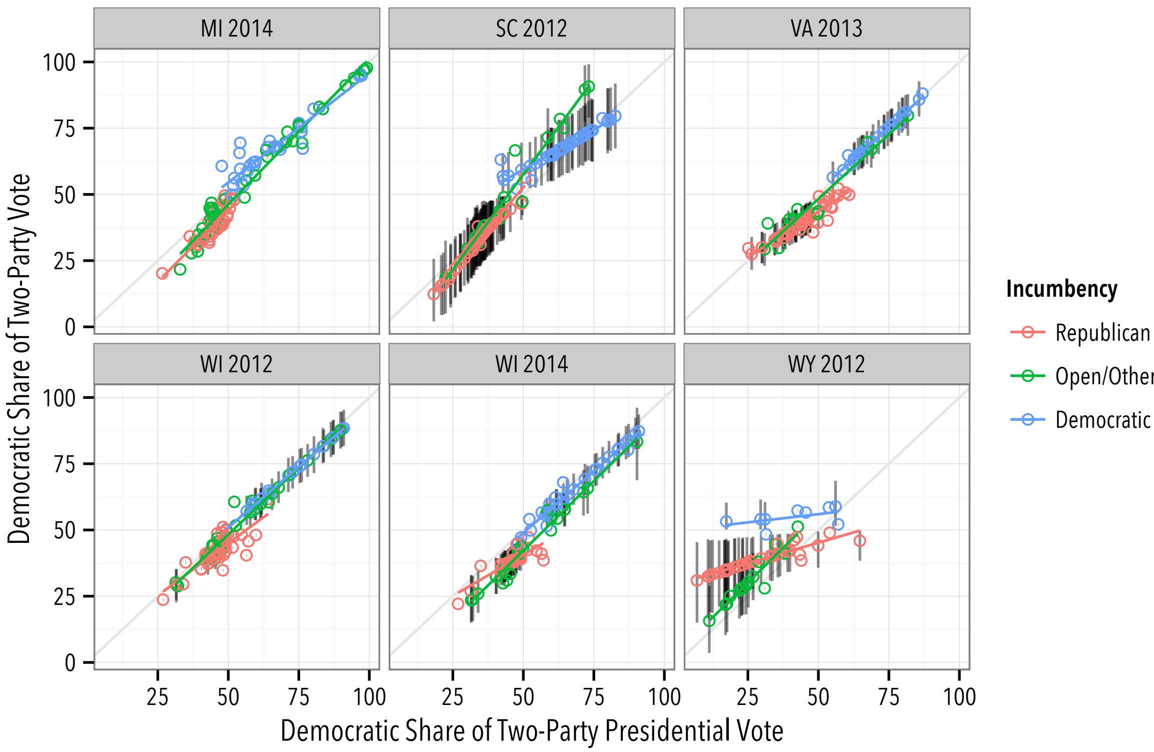

Figure 9: Regression model for imputing unobserved vote shares in 6 selected elections. Vertical lines indicate 95% confidence intervals around imputed values for the Democratic share of the two-party vote in state legislative elections (vertical axis). Separate slopes and intercepts are fit for each incumbency type. Note also that the imputed data almost always lie on the regression lines.

8.2 Imputation model 2

We rely on imputations based on presidential election returns when they are available. But presidential vote isn't always available at the level of state legislative districts (not before 1992, in this analysis). To handle these cases, we rely on a second imputation procedure, one that models sequences of election results observed under a redistricting plan, interpolating unobserved Democratic vote shares given (1) previous and future results for a given district; (2) statewide swing in a given state election; and (3) change in the incumbency status of a given district. This model also embodies the assumption that unobserved vote shares would nonetheless be consistent with what we *did* observe in a given seat: where a Democrat wins in an uncontested district, any imputation for v in that district must lie above 50%, and where a Republican wins an uncontested district, any imputation for v must lie below 50%.

8.3 Combining the two sets of imputations

We now have two sets of imputations for uncontested districts: (1) using presidential vote as a basis for imputation, where available (447 state legislative elections from 1992 to 2014); and (2) the imputation model that relies on the trajectory of district results over the history of a districting plan, including incumbency and estimates of swing, which supplies imputations for uncontested districts in all years.

When there are no uncontested districts, obviously the two imputations must agree, for the trivial reason that are no imputations to perform. As the number of uncontested districts rises, the imputations from the two models have room to diverge. Where the two sets of imputations are available for a given election (elections where presidential vote shares by state legislative districts are available) we generally see a high level of agreement between the two methods.

The two sets of imputations for V correlate at .99. With only a few exceptions (see Figure 10), the discrepancies are generally small relative to the uncertainty in the imputations themselves. As the proportion of districts with missing data increases, clearly the scope for divergence between the two models increases.

To re-iterate, we prefer the imputations from "Model 1" based on the regressions utilizing presidential vote shares in state legislative districts, and use them whenever available (i.e., for most states in the analysis, the period 1992-2014). We only rely on "Model 2" when presidential vote shares are not available. We model the difference between the two sets of imputations, adjusting the "Model 2" imputations of V to better match what we have obtained from "Model 1", had the necessary presidential vote shares by state legislative district been available.

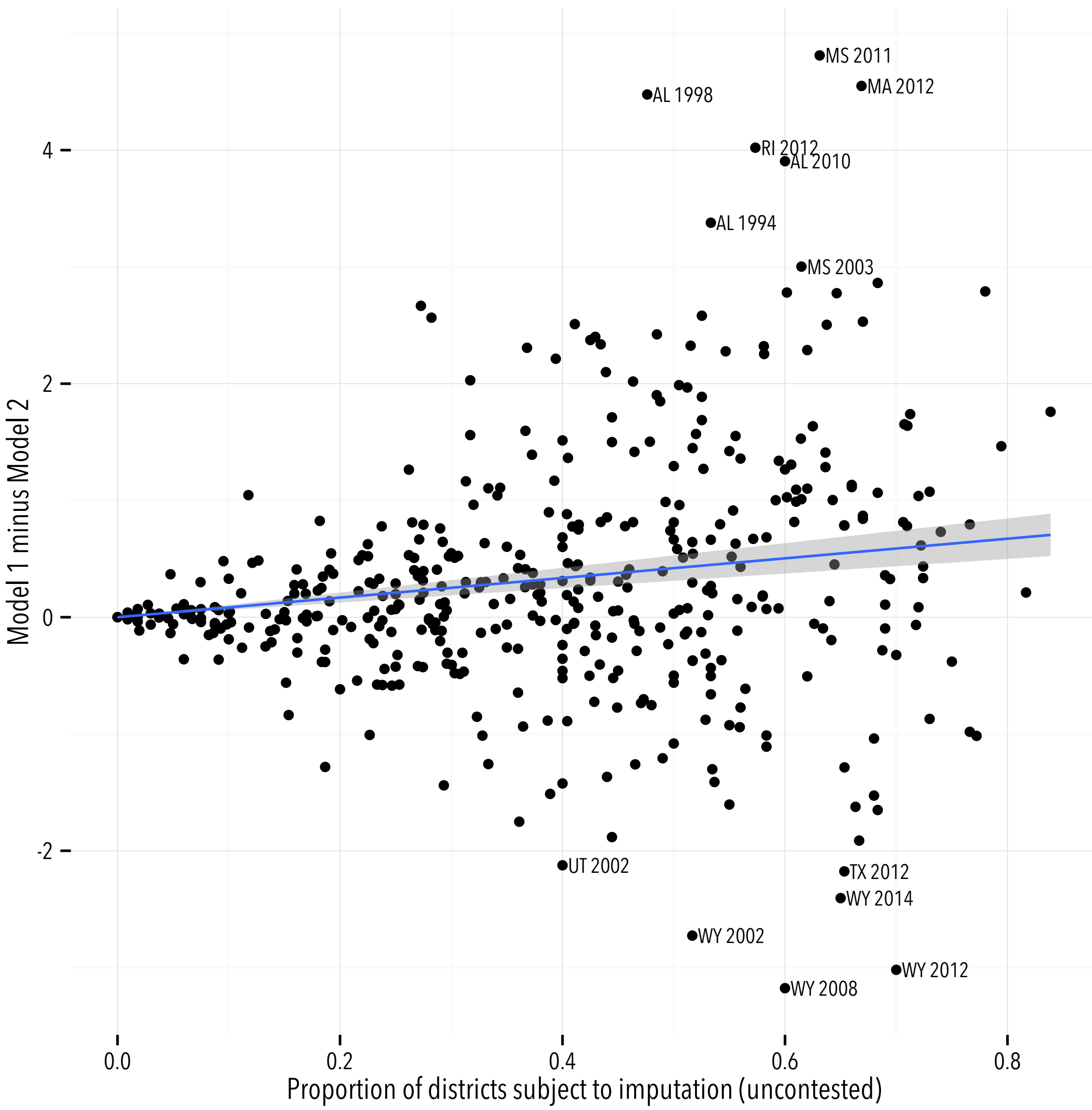

Figure 10: Difference between imputations for V by proportion of uncontested seats. The fitted regression line is constrained to respect the constraint that the imputations must coincide when there are no uncontested seats.

8.4 Seat and vote shares in 786 state legislative elections

After imputations for missing data, each election generates a seats-votes (V, S) pair. In Figure 11 we plot *all* of the V and S combinations over the 786 state elections in the analysis. We also overlay the seats-vote curve corresponding to an efficiency gap of zero. This provides us with a crude, visual sense of how often we see large departures from the zero EG benchmark.

The horizontal lines around each plotted point show the uncertainty associated with each estimate of V (statewide, Democratic, two-party vote share), given the imputations made for uncontested and missing district-level vote shares. Uncontested seats do not generate uncertainty with respect to the party winning the seat, and so the resulting uncertainty is with respect to vote shares, on the horizontal axis in Figure 11.

The efficiency gap in each election is the vertical displacement of each plotted (V, S) point from the orange, zero-efficiency gap line in Figure 11. Uncertainty as to the horizontal co-ordinate V (due to imputations for uncontested races) generates uncertainty in determining how far each point lies above or below the orange, zero efficiency gap benchmark.

9 The efficiency gap, by state and election

We now turn to the centerpiece of the analysis: assessing variation in the efficiency gap across districting plans.

We have 786 efficiency gap measures in 41 states, spanning 43 election years. These are computed by substituting each state election's estimate of V and the corresponding, observed seat share S into equation 1.

Figure 12 shows the efficiency gap estimates for each state election, grouped by state and ordered by year; vertical lines indicate 95% credible intervals arising from the fact that the imputation model for uncontested seats induces uncertainty in V and any quantity depending on V such as EG (recall equation 1). In many cases the uncertainty in EG stemming from imputation for uncontested seats is small relative to variation in EG both between and within districting plans.

We observe considerable variation in the EG estimates across states and elections. Some highlights:

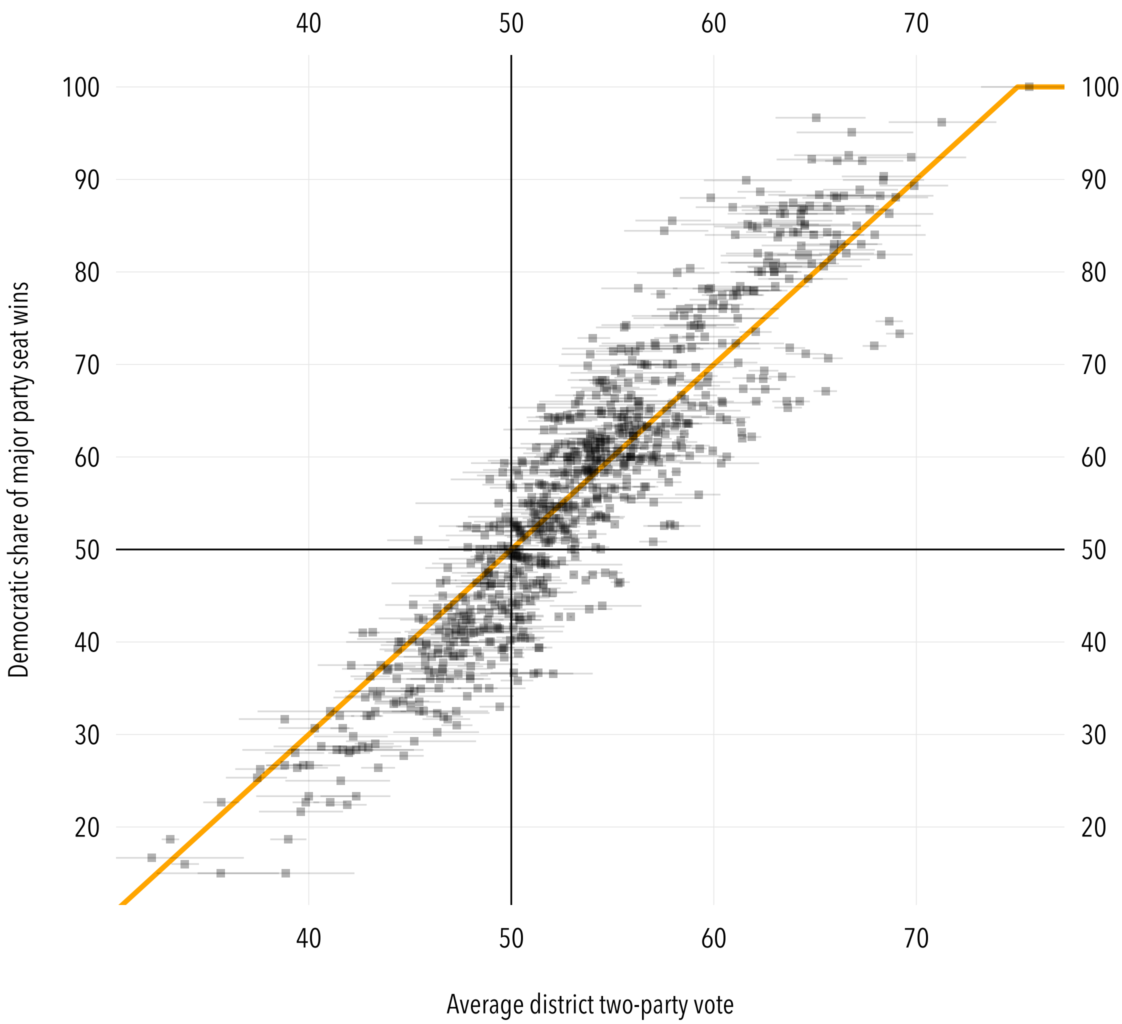

Figure 11: Democratic seat shares (S) and vote shares (V) in 786 state legislative elections, 1972-2014, in 41 states. Seat shares are defined with respect to single-member districts won by either a Republican or a Democratic candidate, including uncontested districts. Vote shares are defined as the average of district-level, Democratic share of the two-party vote, in the same set of districts used in defining seat shares. Horizontal lines indicate 95% credible intervals with respect to V, due to uncertainty arising from imputations for district-level vote shares in uncontested seats. The orange line shows the seats-votes relationship we expect if the efficiency gap were zero. Elections below the orange line have $EG < 0$ (Democratic disadvantage); points above the orange line have $EG > 0$ (Democratic advantage).

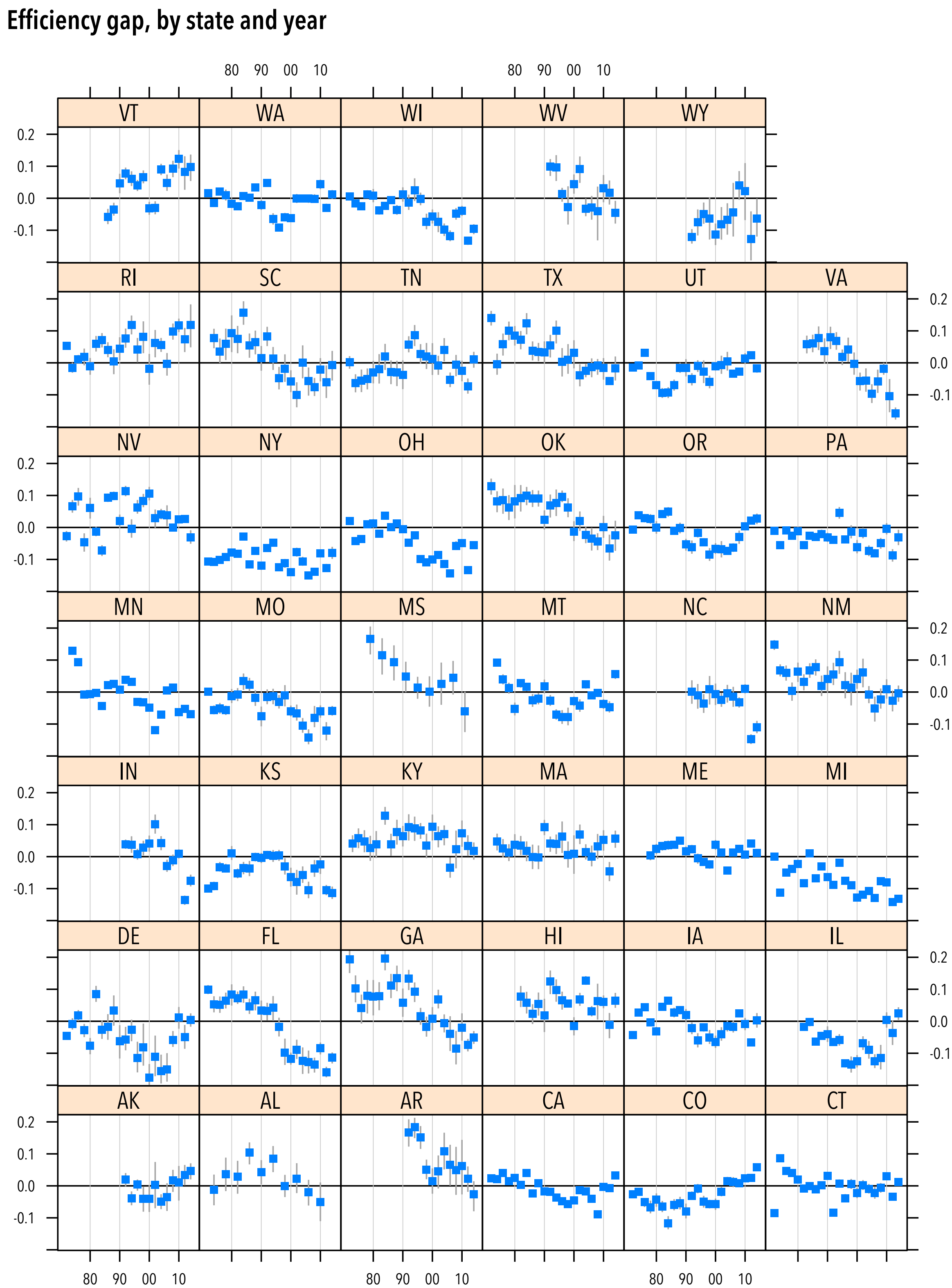

Figure 12: Efficiency gap estimates in 786 state legislative elections, 1972-2014. Vertical lines cover 95% credible intervals.

1. estimates of EG range from -0.18 to 0.20 with an average value of -0.005.

2. The lowest value, -0.18 is from Delaware in 2000. There were 19 uncontested seats in the election to the 41 seat state legislature. Democrats won 15 seats ($S = 15/41 = 36.6\%$). I estimate V to be 52.1%. Via equation 1, this generates $EG = -0.18$. Considerable uncertainty accompanies this estimate, given the large number of uncontested seats. The 95% credible interval for V is $\pm$ 2.03 percentage points, and the 95% credible interval for the accompanying EG estimate is $\pm$ 0.04.

3. The highest value of EG is 0.20 is from Georgia in 1984. There were 140 uncontested seats in the election to the 180 seat state legislature. Democrats won 154 seats ($S = 154/180 = 85.6\%$). I estimate V to be 57.9%. Again, using equation 1, this generates $EG = 0.2$. Considerable uncertainty also accompanies this estimate, given the large number of uncontested seats. The 95% credible interval for V is $\pm$ 1.89 percentage points, and the 95% credible interval for the accompanying EG estimate is $\pm$ 0.04. Figure 13 contrasts the seats and votes recorded in Georgia against those for the entire data set, putting Georgia's large EG estimates in context.

4. New York has the lowest median EG estimates, ranging from -.15 (2006) to -.028 (1984). Statewide V ranges from 53.7% to 69.2%, but Democrats only win 70 (1972) to 112 (2012) seats in the 150 seat state legislature, so S ranges from .47 to .75, considerably below that we'd expect to see given the vote shares recorded by Democrats if the efficiency gap were zero. See Figure 15.

5. Arkansas has the highest median EG score by state, .10; see Figure 14.

6. Connecticut has the median, within-state median EG score of approximately zero; Figure 16 shows Connecticut's seats and votes have generally stayed close to the $EG = 0$ benchmark.

7. Michigan has the third lowest median EG scores by state, surpassed only by New York and Wyoming. Michigan's EG scores range from -.14 (2012) to .01 (1984). V ranges from 50.3% to 60.6%, a figure we estimate confidently given low and occasionally even zero levels of uncontested districts

in Michigan state legislative elections. Yet *S* ranges from 42.7% (Democrats won 47 out of 110 seats in 2002, 2010 and 2014) to 63.6% (Democrats won 70 out of 110 seats in 1978). See Figure 17.

8. Wisconsin's *EG* estimates range from -.14 (2012) to .02 (1994). Although the *EG* estimates for WI are not very large relative to other states in other years, Wisconsin has recorded an unbroken run of negative *EG* estimates from 1998 to 2014 and records two very large estimates of the efficiency gap in elections held under its current plan: -.13 (2012) and -.10 (2014). In short, Democrats are underperforming in state legislative elections in Wisconsin, winning fewer seats than a zero efficiency gap benchmark would imply, given, their statewide level of support. See Figure 18.

9.1 Are efficiency gap estimates statistically significant?

Recall that $EG < 0$ means that Democrats are disadvantaged, with relatively more wasted votes than Republicans; conversely $EG > 0$ means that Democrats are the beneficiaries of an efficiency gap, in that Democrats have fewer wasted votes than Republicans. But *EG* does vary from election to election, even with the same districting plan in place and *EG* is almost always not measured perfectly, but is estimated with imputations for uncontested seats.

In Figure 19 we plot the imprecision of each efficiency gap estimate (the half-width of its 95% credible interval) against the estimated *EG* value itself. Points lying inside the cones have *EG* estimates that are small relative to their credible intervals, such that we would not distinguish them from zero at conventional levels of statistical significance. Not all *EG* estimates can be distinguished from zero at conventional levels of statistical significance, nor should they. But many estimates of the *EG* *are* unambiguously non-zero. Critically, the two most recent Wisconsin *EG* estimates (-.13 in 2012, -.10 in 2014) are clearly non-negative, lying far away from the "cone of ambiguity" shown in Figure 19; the 95% credible interval for the 2012 estimates runs from -.146 to -.121 and from -.113 to -.081 for the 2014 estimate.

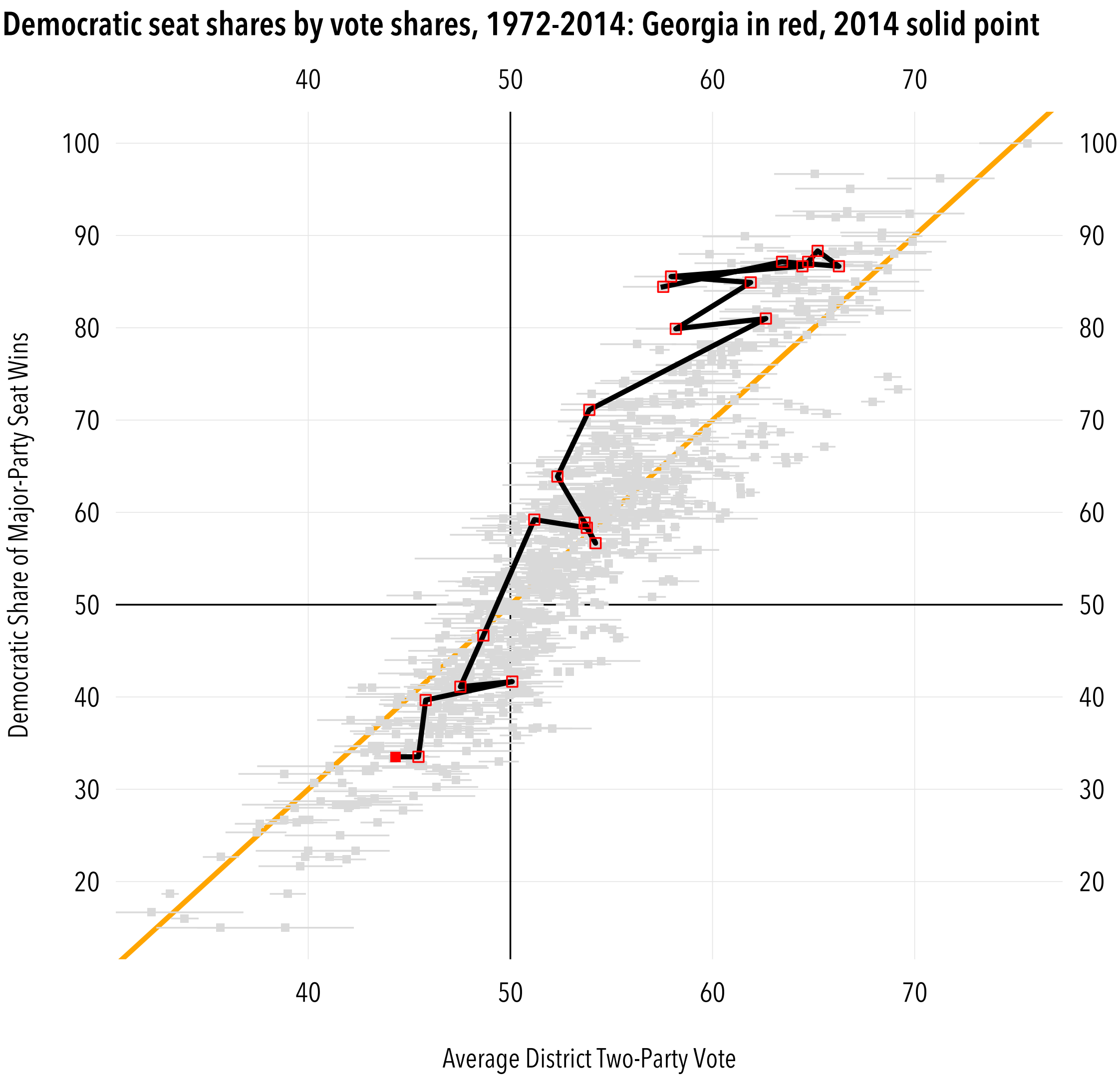

Figure 13: Georgia, Democratic seat share and average district two-party vote share, 1972-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

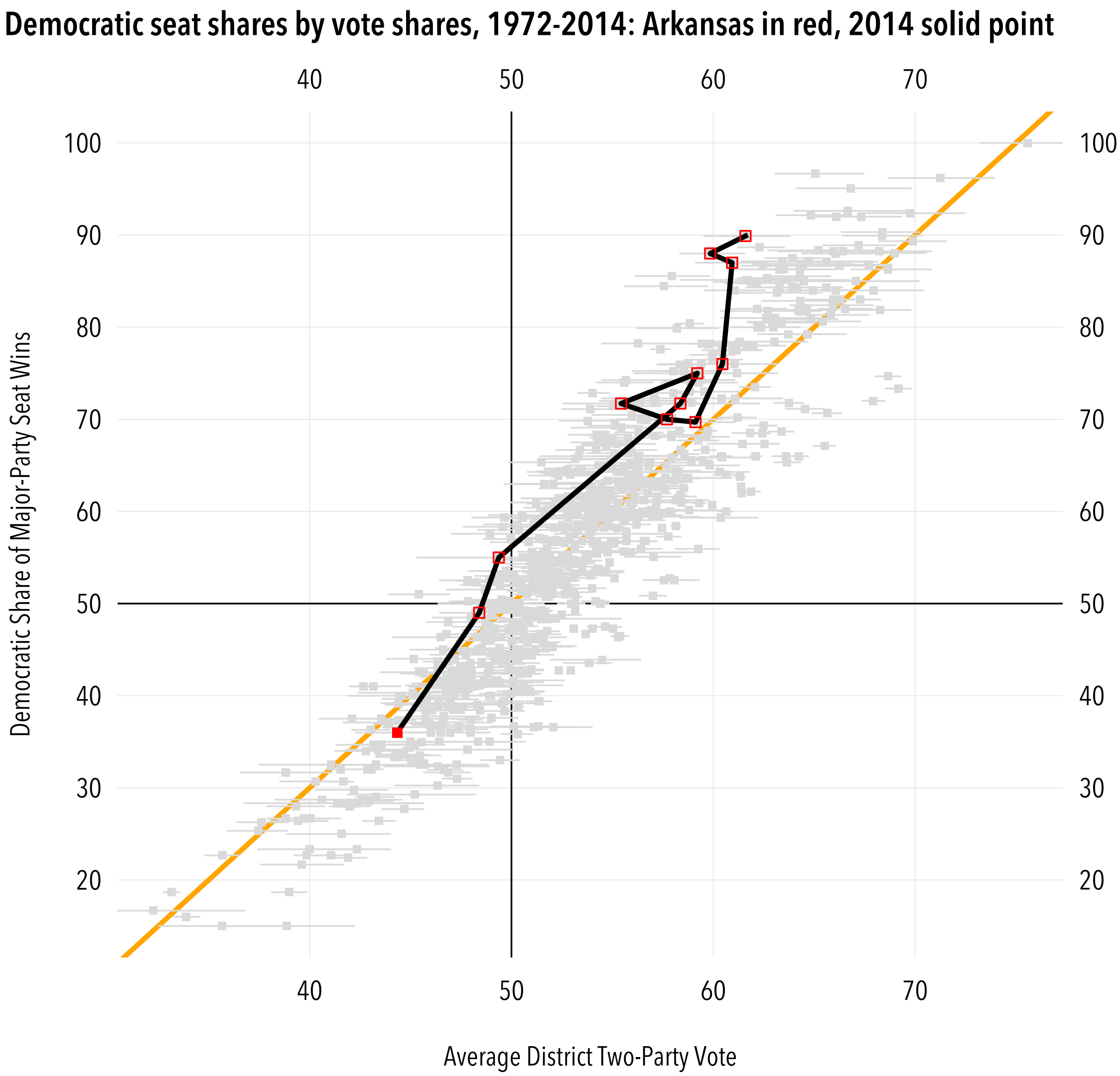

Figure 14: Arkansas, Democratic seat share and average district two-party vote share, 1992-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

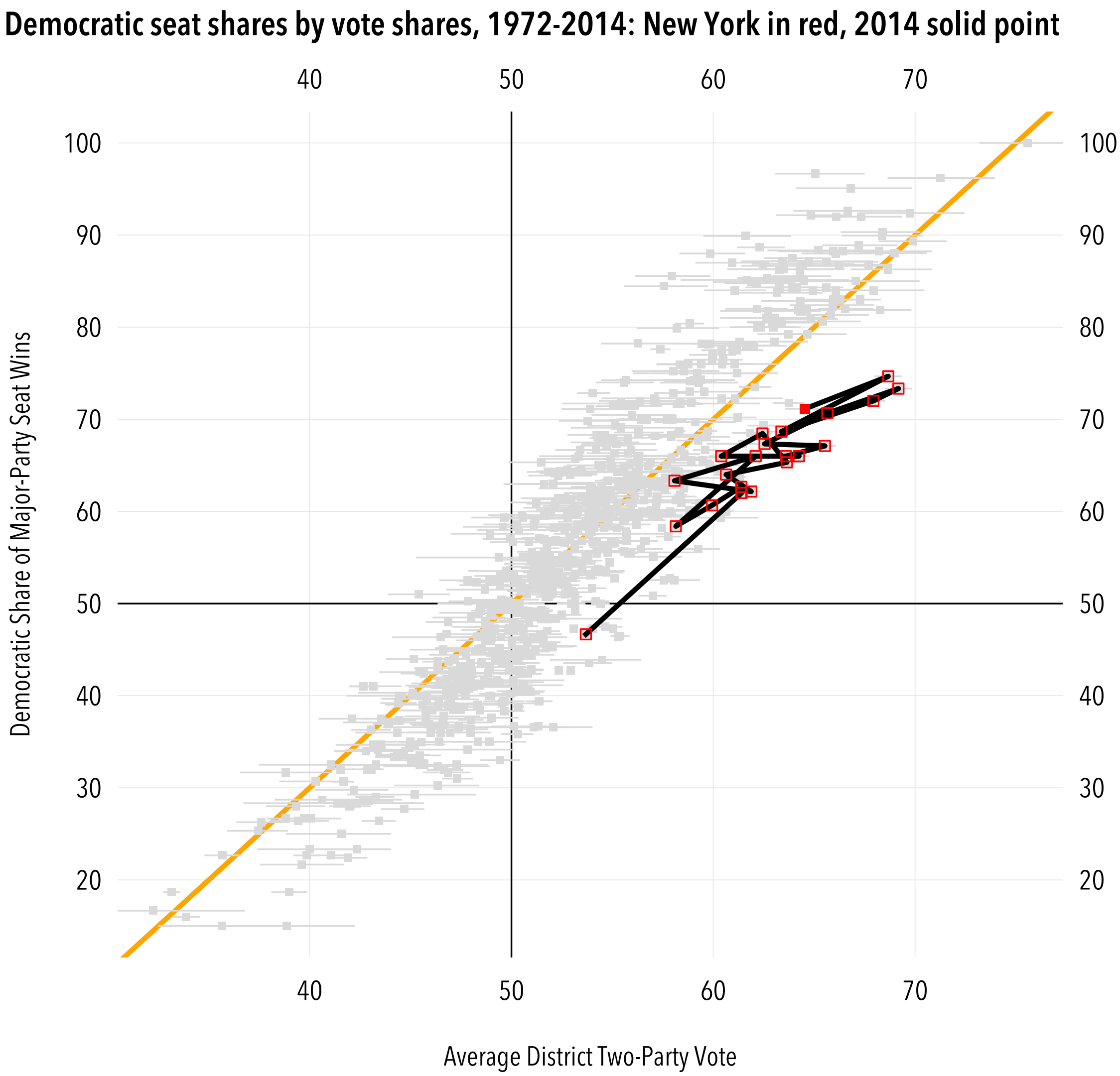

Figure 15: New York, Democratic seat share and average district two-party vote share, 1972-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

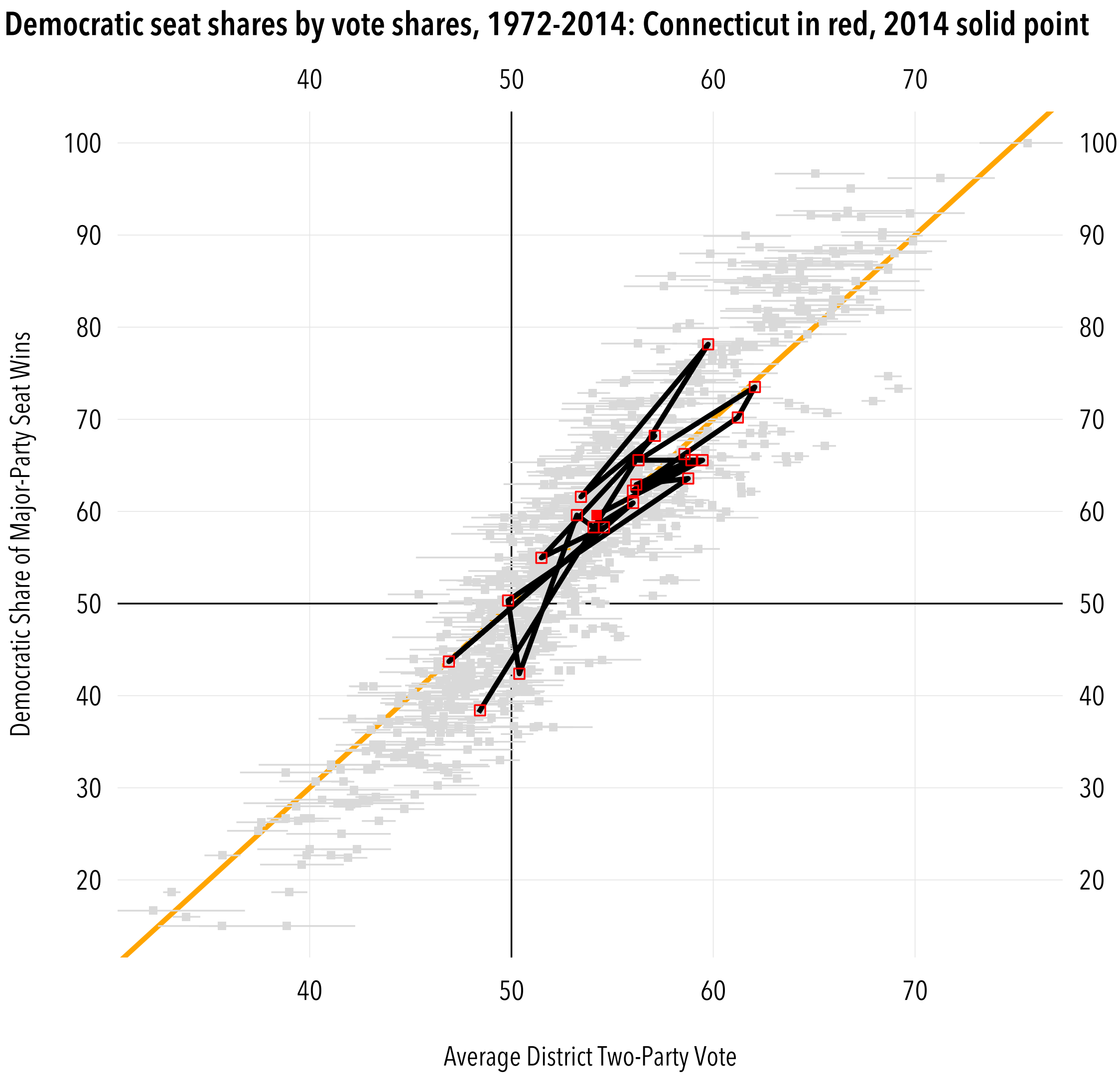

Figure 16: Connecticut, Democratic seat share and average district two-party vote share, 1972-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

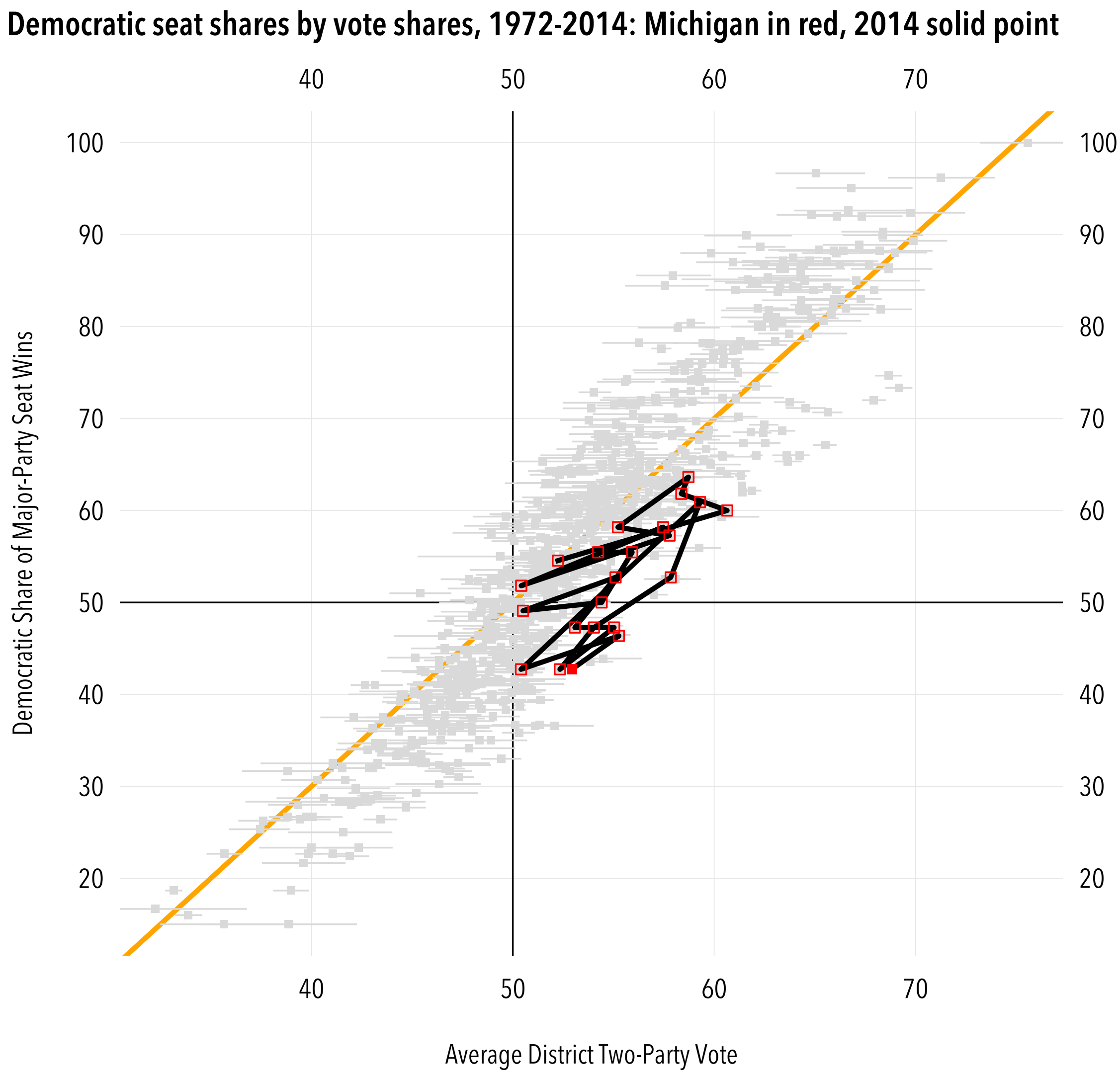

Figure 17: Michigan, Democratic seat share and average district two-party vote share, 1972-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

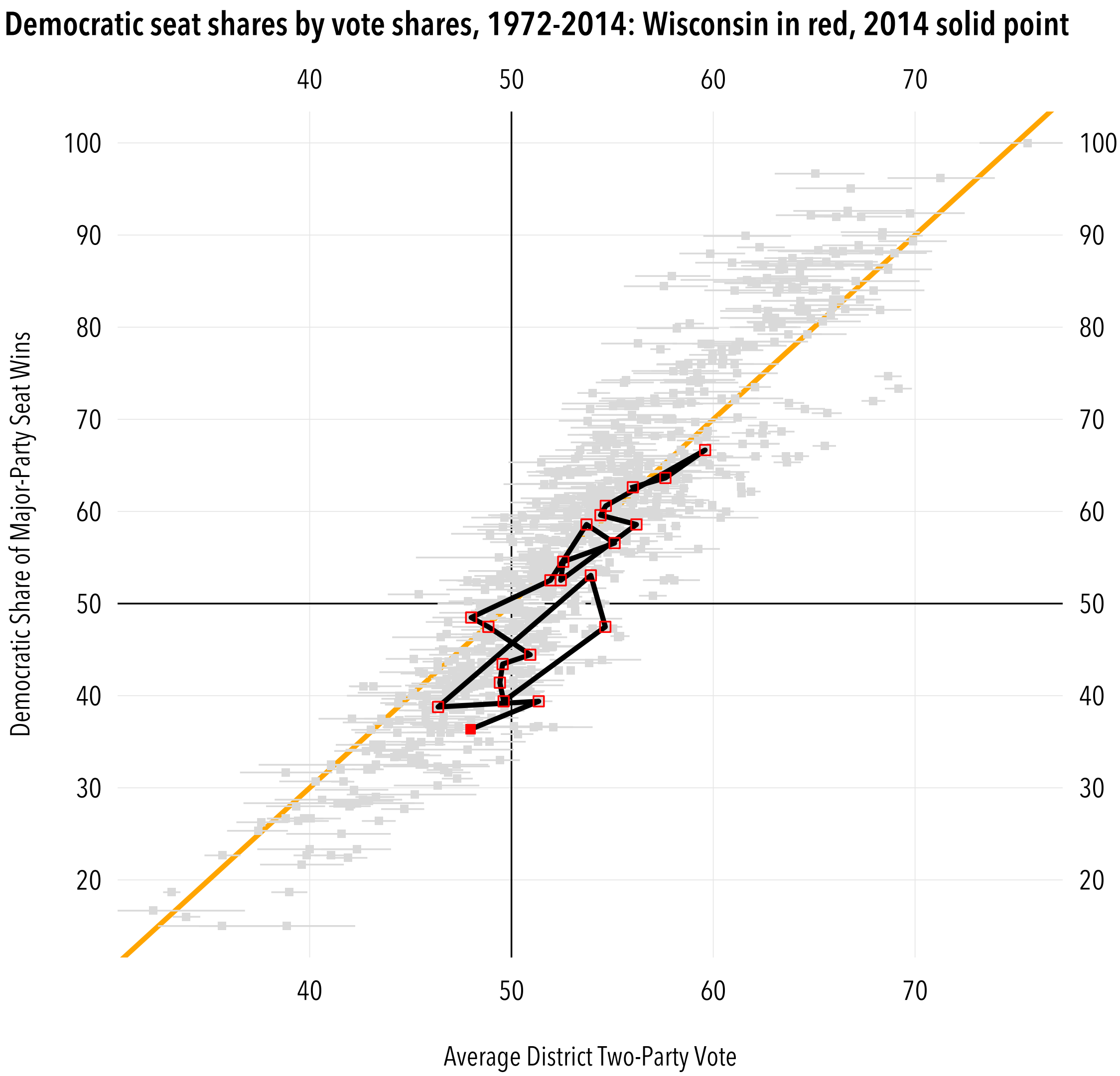

Figure 18: Wisconsin, Democratic seat share and average district two-party vote share, 1972-2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts.

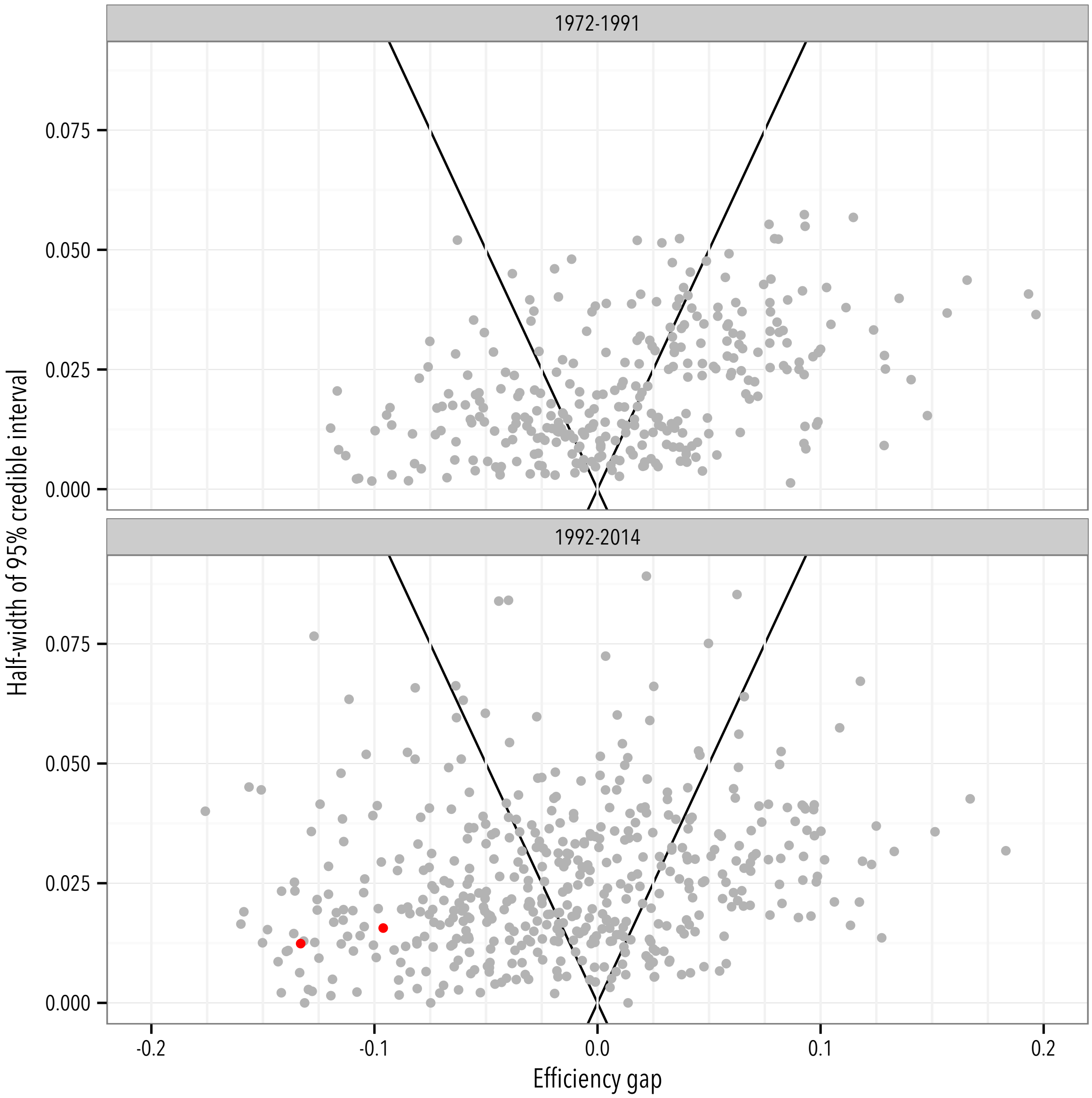

Figure 19: Uncertainty in the efficiency gap, against the *EG* estimate itself. The vertical axis is the half-width of the 95% credible interval for each *EG* estimate (plotted against the horizontal axis); points lying inside the cones have *EG* estimates that are small relative to their credible intervals, such that we would not distinguish them from zero at conventional levels of statistical significance. *EG* estimates from Wisconsin in 2012 and 2014 are shown as red points in the lower panel. Note the greater prevalence of large, negative and precisely estimated *EG* measures in recent decades.

9.2 Over-time change in the efficiency gap

Are large values of the efficiency gap less likely to be observed in recent decades? This is relevant to any discussion of a standard by which to assess redistricting plans. If recent decades have generally seen smaller values of the efficiency gap relative to past decades, then this might be informative as to how we should assess contemporary districting plans and their corresponding values of the *EG*.

Figure 20 plots *EG* estimates over time, overlaying estimates of the smoothed, weighted quantiles (25th, 50th and 75th) of the *EG* measures (the weights capture the uncertainty accompanying each estimate of the *EG*). The distribution of *EG* measures in the 1970s and 1980s appeared to slightly favor Democrats; about two-thirds of all *EG* measures in this period were positive. The distribution of *EG* measures trends in a pro-Republican direction through the 1990s, such that by the 2000s, *EG* measures were more likely to be negative (Republican efficiency advantage over Democrats); see Figure 21.

There is some evidence that the 2010 round of redistricting has generated an increase in the magnitude of the efficiency gap in state legislative elections. For most of the period under study, there seems to be no distinct trend in the magnitudes of the efficiency gap over time; see Figure 22. The median, absolute value of the efficiency gap has stayed around 0.04 over much of the period spanned by this analysis; elections since 2010 are producing higher levels of *EG* in magnitude.

It is also interesting to note that the estimate of the 75th percentile of the distribution of *EG* magnitudes jumps markedly after 2010, suggesting that districting plans enacted after the 2010 census are systematically more gerrymandered than in previous decades. Of the almost 800 *EG* estimates in the analysis, spanning 42 years of elections, the largest, negative estimates (an efficiency gap disadvantaging Democrats) are more likely to be recorded in the short series of elections after 2010. These include Alabama in 2014 (-.18), Florida in 2012 (-.16), Virginia in 2013 (-.16), North Carolina in 2012 (-.15) and Michigan in 2012 (-.14); these five elections are among the 10 least favorable to Democrats we observe in the entire set of elections. Among the 10 most pro-Democratic *EG* scores, *none* were recorded after 2000. The most favorable election to Democrats in terms of *EG* since 2010 is the 2014 election in Rhode Island (*EG* = .12), which is only the 20th largest (pro-Democratic) *EG* in the entire analysis.

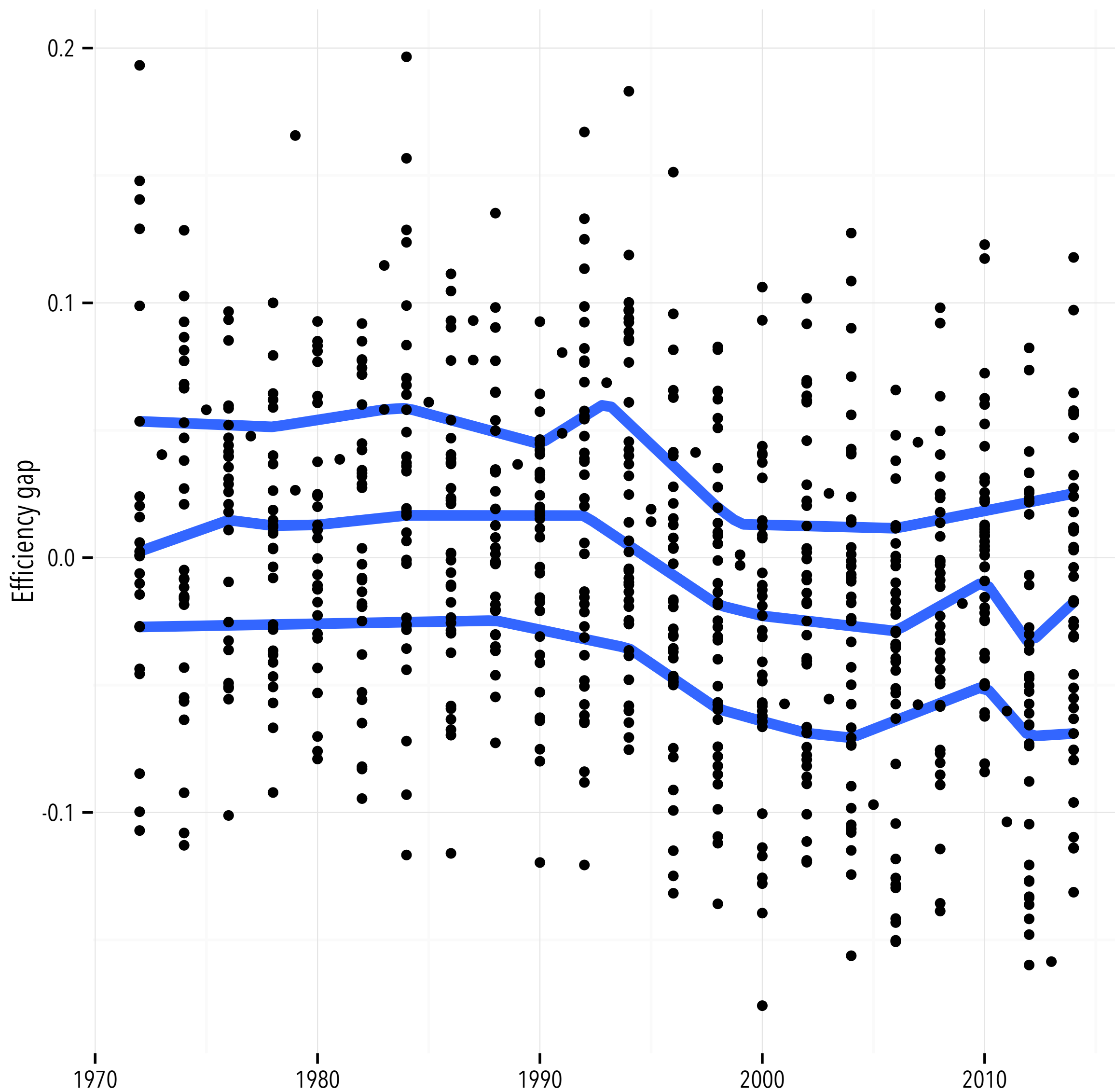

Figure 20: Efficiency gap estimates, over time. The lines are smoothed estimates of the 25th, 50th and 75th quantiles of the efficiency gap measures, weighted by the precision of each *EG* measure.

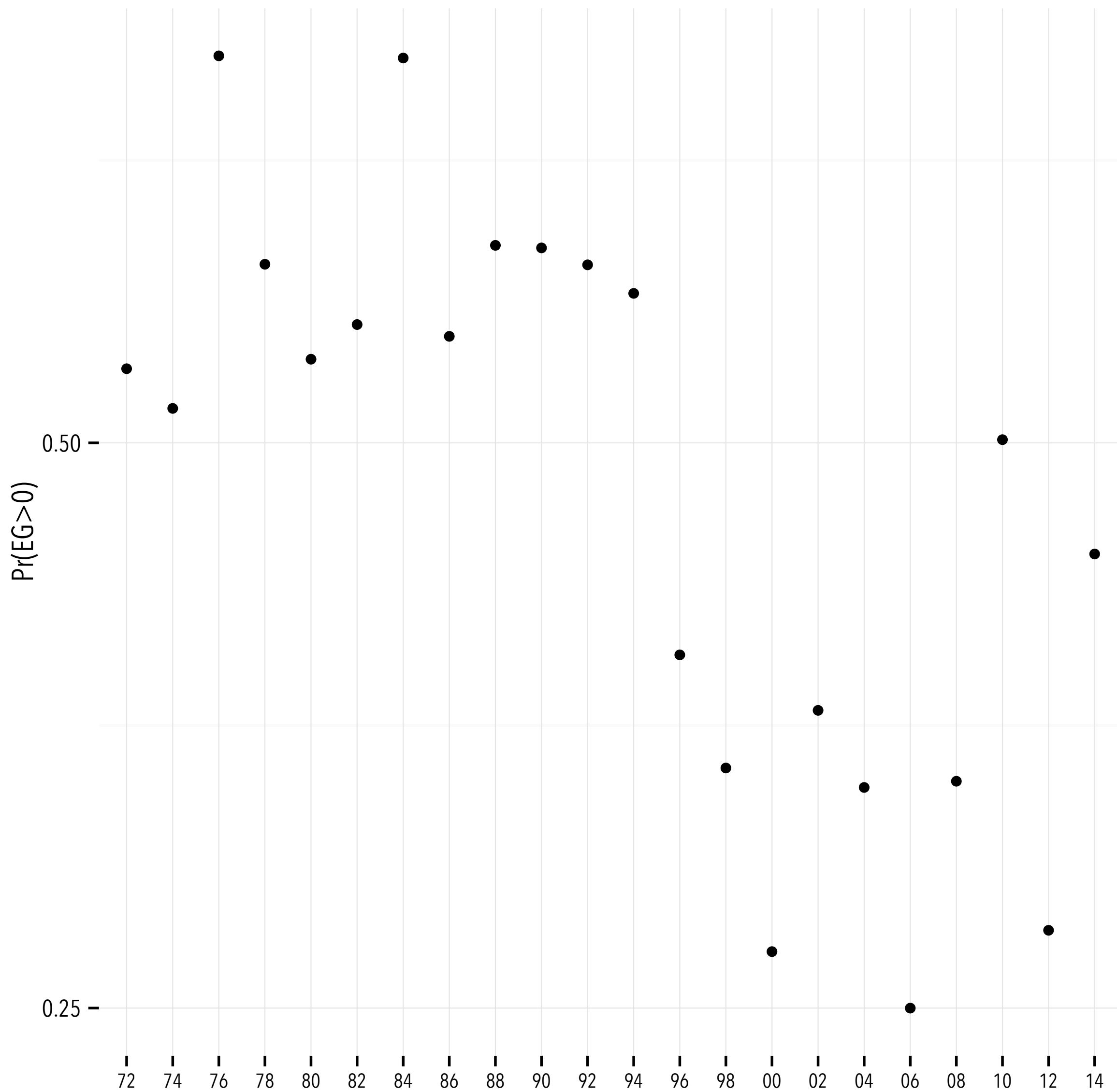

Figure 21: Proportion of efficiency gap measures that are positive, by two year intervals.

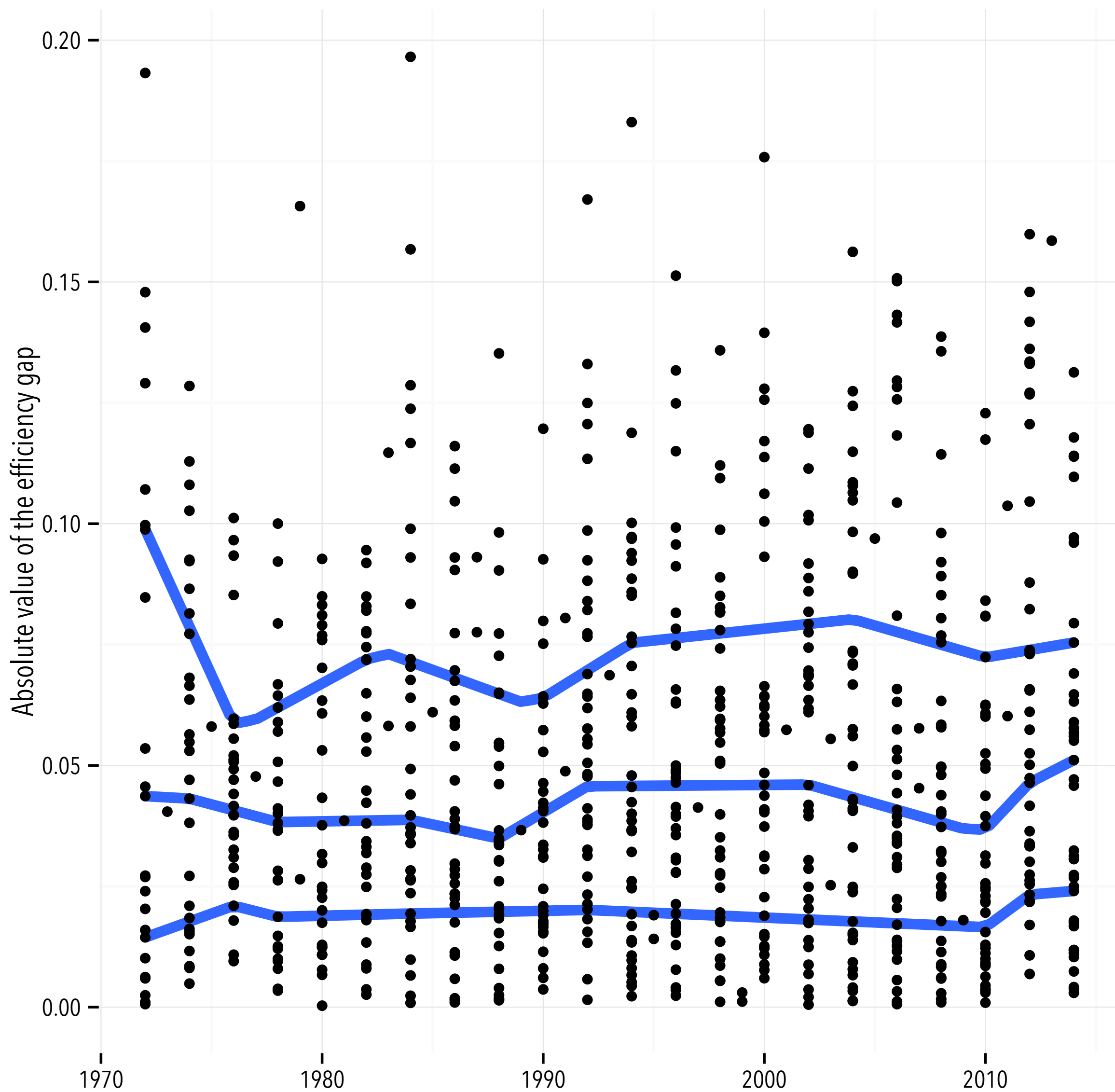

Figure 22: Absolute value of efficiency gap measures, over time. The lines are smoothed estimates of the 25th, 50th and 75th quantiles of the absolute value of the efficiency gap measure, weighted by the precision of each *EG* measure.

9.3 Within-plan variation in the efficiency gap

The efficiency gap is measured at each election, with a given districting plan typically generating up to five elections and hence five efficiency gap measures. Efficiency gap measures will change from election to election as the distribution of district-level vote shares varies over elections. Some of this variation is to be expected. Even with the same districting plan in place, districts will display "demographic drift," gradually changing the political complexion of those districts. Incumbents lose, retire or die in office; sometimes incumbents face major opposition, sometimes they don't. Variation in turnout — most prominently, from on-year to off-year — will also cause the distribution of vote shares to vary from election to election, even with the districting plan unchanged. All these election-specific factors will contribute to election-to-election variation in the efficiency gap.

Precisely because we expect a reasonable degree of election-to-election variation in the efficiency gap, we assess the magnitude of this "within-plan" variability in the measure. If a plan is a partisan gerrymander — with a systematic advantage for one party over the other — then the "between-plan" variation in *EG* should be relatively large relative to the "within-plan" variation in *EG*.

About 76% of the variation in the *EG* estimates is between-plan variation. The *EG* measure does vary election-to-election, but there is a moderate to strong "plan-specific" component to variation in the *EG* scores. We conclude that the efficiency gap *is* measuring an enduring feature of a districting plan.

We examine some particular districting plans. The 786 elections in this analysis span 150 districting plans. For plans with more than one election, we compute the standard deviation of the sequence of election-specific *EG* measures observed under the plan. These standard deviations range from .011 (Kentucky's plan in place for just two elections in 1992 and 1994, or Indiana's plan 1992-2000) to .079 (Delaware's plan between 2002 and 2010).

A highly variable plan: Deleware 2002-2010. Figure 23 shows the seats, votes and *EG* estimates produced under the Delaware 2002-2010 plan. This is among the most variable plans we observe with respect to the *EG* measure. An efficiency gap running against the Democrats for 2002, 2004 and 2006 (the latter election saw Democrats win only 18 seats out of 41 with 54.5% of the state wide vote) falls to a small gap in 2008 ($V = 0.584, S = 25/41 = .61, EG = -0.058$) and

Delaware ends the decade with a positive efficiency gap in 2010. The Democratic district-average two-party vote share fell to $V = 0.561$ in 2010, but translated into $S = 26/41 = .63, EG = 0.012$.

A plan with moderate variability in the EG. The median, within-plan standard deviation of the EG is about .03. This roughly corresponds to the within-plan standard deviation of the EG observed under the plan in place for five Wisconsin state legislative elections 1992-2000, presented in Figure 24. This was a plan that generated relatively small values of EG that alternated sign over the life of the plan: negative in 1992, positive in 1994 and 1996, and negative in 1998 and 2000.

A low variance plan, Indiana 1992-2000. See Figure 25. The EG measures recorded under this plan are all relatively small and positive, ranging from 0.008 to 0.041 and correspond to an interesting period in Indiana state politics. Democrats won 55 of the 100 seats in the Indiana state house in the 1992 election with what I estimate to be just over 50% of the district-average vote (29 of 100 seats were uncontested). Democratic vote share fell to about 45% in the 1994 election (38 uncontested seats), and Democrats lost control of the legislature. The 1996 election resulted in a 50-50 split in the legislature. Democrats won legislative majorities in the 1998 and 2000 elections, while the last election might have been won by Democrats with just less than 50% of the district-vote; I estimate $V = 0.495 \pm .012$ and $EG = 0.041$.

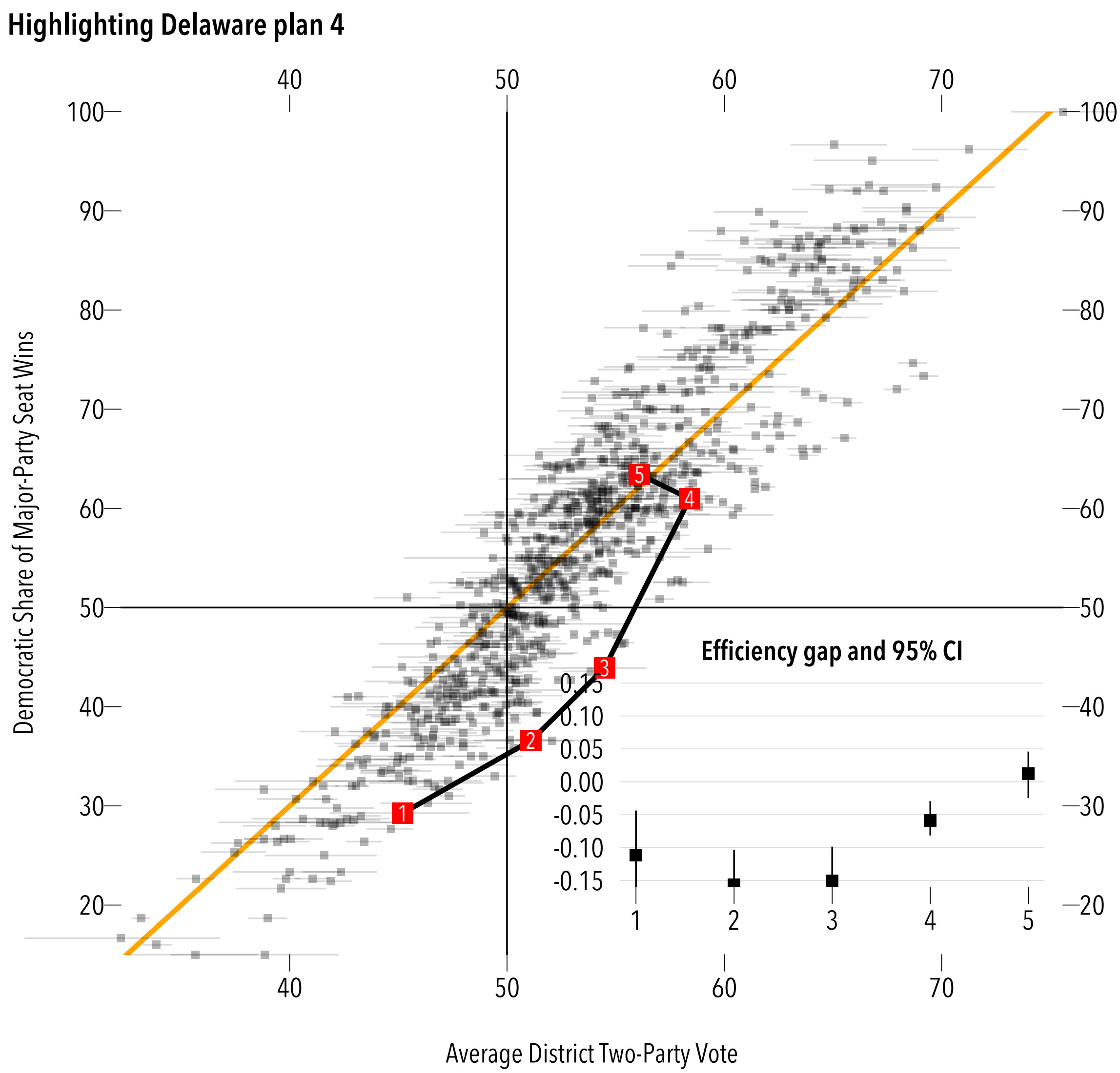

Figure 23: Seats, votes and the efficiency gap recorded under the Delaware plan, 2002-2010. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts. The inset in the lower right shows the sequence of efficiency gap measures recorded under the plan; vertical lines are 95% credible intervals.

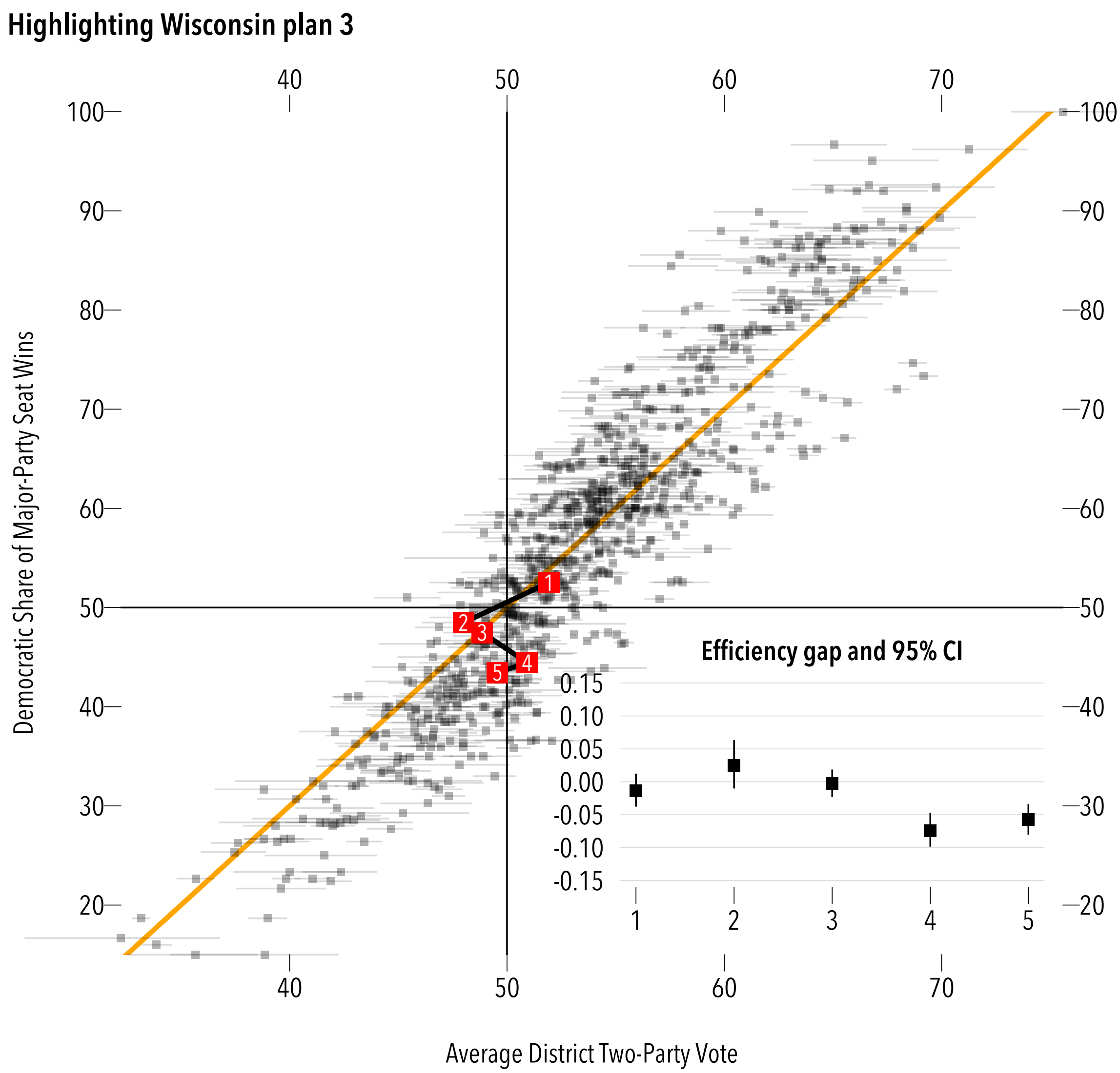

Figure 24: Seats, votes and the efficiency gap recorded under the Wisconsin plan, 1992-2000. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts. The inset in the lower right shows the sequence of efficiency gap measures recorded under the plan; vertical lines are 95% credible intervals.

Highlighting Indiana plan 3

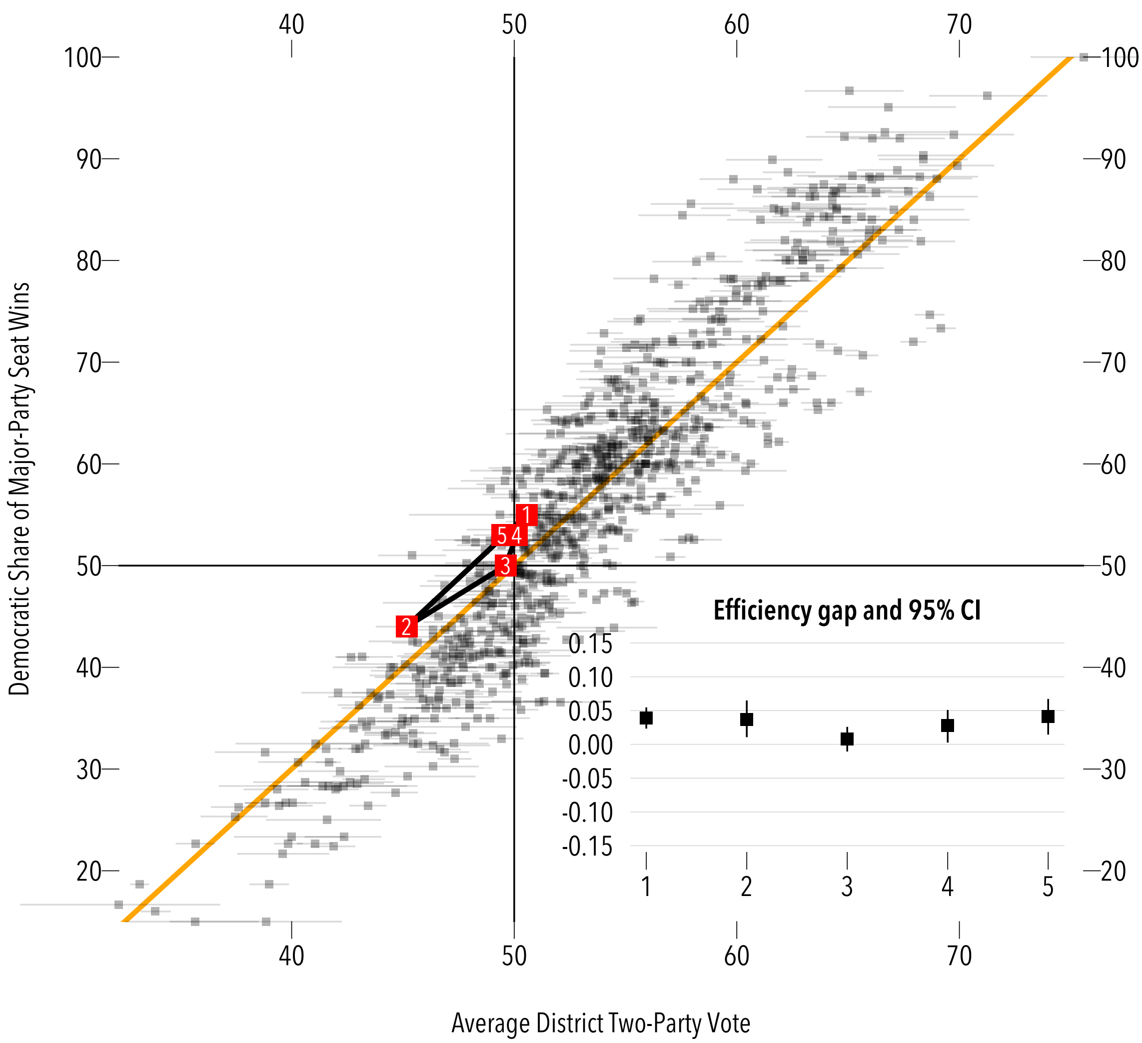

Figure 25: Seats, votes and the efficiency gap recorded under the Indiana plan, 1992-2000. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts. The inset in the lower right shows the sequence of efficiency gap measures recorded under the plan; vertical lines are 95% credible intervals.

9.4 How often does the efficiency gap change sign?

Having observed a particular value of *EG*, how confident are we that:

- the *EG* measure is distinguishable from zero at conventional levels of statistical significance? That is, how sure are we as to the sign of any particular *EG* estimate? We addressed this question in section 9.1.

- it will be followed by one or more estimates of *EG* that are of the same sign?

- over the life of a districting plan, *EG* remains on one side of zero or the other?

The latter two questions are key. It is especially important that we assess the *durability* of the sign of the *EG* measure under a districting plan, if we seek to assert that a districting plan is a partisan gerrymander. We will see that *magnitude* and *durability* of the efficiency gap go together: *large* values of the efficiency gap don't seem to be capricious, but likely to be repeated over the life of a districting plan, consistent with partisan disadvantage being a systematic feature of the plan.

We begin this part of the analysis by considering temporally adjacent *pairs* of *EG* estimates. Can we be confident that these have the same sign? In general, yes. Of the full set of 786 elections for which we compute an efficiency gap estimate, 580 are temporally adjacent, within state and districting plan. Figure 26 shows that we usually see efficiency gap measures with the same sign; this probability exceeds 90% for almost half of the temporally adjacent pairs of efficiency gap measures. Averaged over all pairs, this "same sign" probability is 74%. While the efficiency gap does vary election to election, these fluctuations are not so large that the *sign* of the efficiency gap is likely to change election to election.

What about over the life of an entire redistricting plan? How likely is it that the efficiency gap retains the same sign over, say, three to five elections in a given state, taking into account election-to-election variation *and* uncertainty arising from the imputation procedures used for uncontested districts?

We have 141 plans that supply three or more elections with estimate of the efficiency gap. Of these, 17 plans are *utterly unambiguous* with respect to the sign of the efficiency gap estimates recorded over the life of the plan: for each of these plans we estimate the probability that the *EG* has the same sign over the life of the plan to be 100%. These plans are listed below in Table 1.

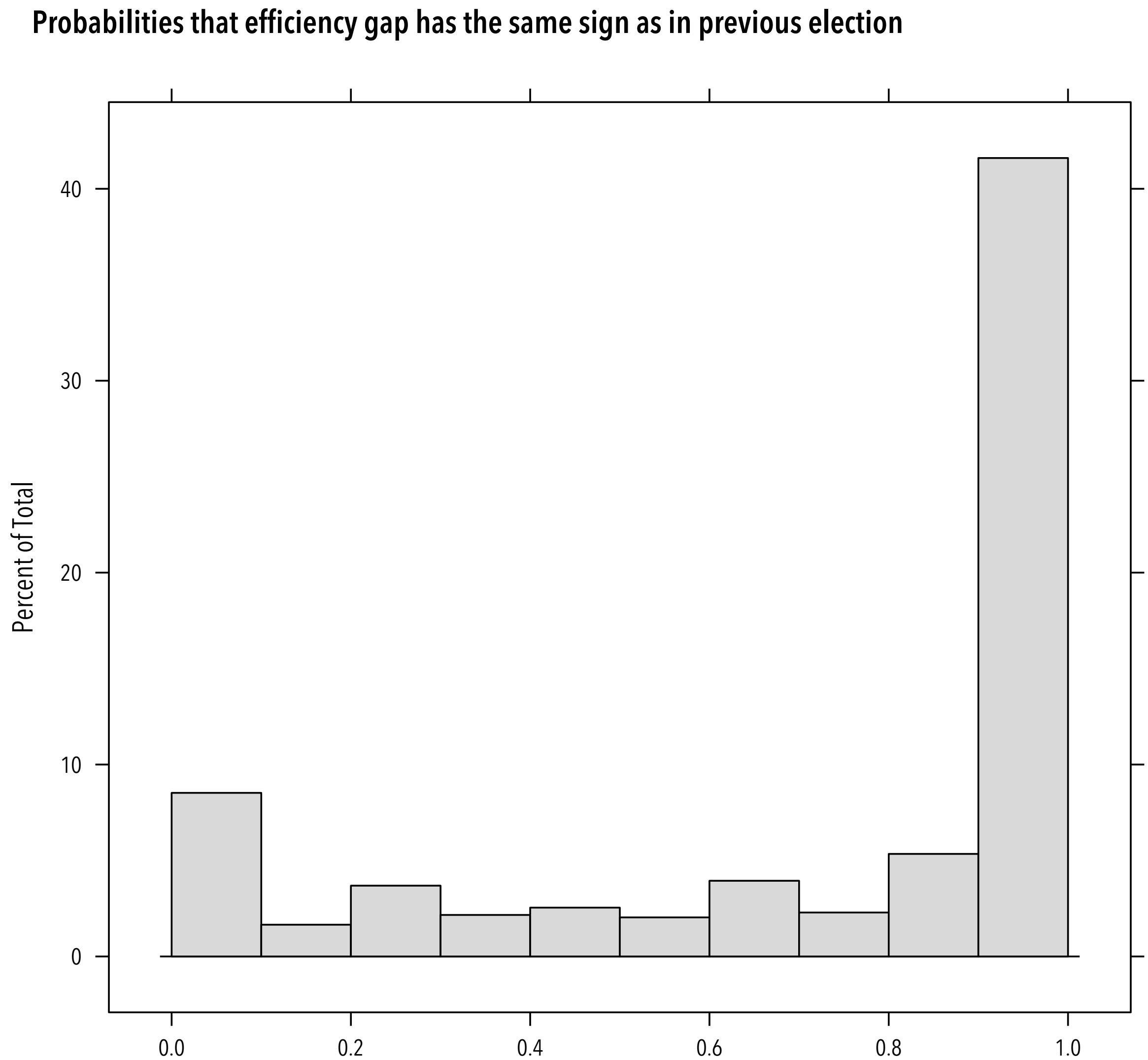

Figure 26: Stability in 580 successive pairs of efficiency gap measures

State	Plan	Start	End	EG avg	EG min	EG max
Florida	4	2002	2010	-0.112	-0.136	-0.084
New York	4	2002	2010	-0.111	-0.150	-0.078
Illinois	3	1992	2000	-0.103	-0.136	-0.058
Michigan	4	2002	2010	-0.103	-0.130	-0.077
New York	3	1992	2000	-0.098	-0.139	-0.048
New York	1	1972	1980	-0.097	-0.108	-0.079
Missouri	4	2002	2010	-0.091	-0.142	-0.061
Ohio	4	2002	2010	-0.090	-0.143	-0.049
New York	2	1982	1990	-0.084	-0.120	-0.028
Ohio	3	1994	2000	-0.083	-0.109	-0.025
Michigan	3	1992	2000	-0.080	-0.128	-0.019
Wisconsin	4	2002	2010	-0.076	-0.118	-0.039
Colorado	2	1982	1990	-0.075	-0.117	-0.055
Colorado	1	1972	1980	-0.041	-0.067	-0.018
California	3	1992	2000	-0.041	-0.057	-0.018
Pennsylvania	2	1982	1990	-0.033	-0.056	-0.020
Florida	1	1972	1980	0.070	0.052	0.099

Table 1: Plans with no doubt as to the sign of the efficiency gap over the life of the plan (3+ elections).

Interestingly, these plans with an utterly unambiguous history of one-sided *EG* measures are almost all plans with efficiency gaps that are disadvantagous to Democrats. Michigan's 2002-2010 plan is on this list, as is the plan in place in Wisconsin 2002-2010 (average *EG* of -.076).

We examine this probability of "3+ consecutive *EG* measures with the same sign" for all of the plans with 3 or more elections in this analysis. 35% of 141 plans with 3 or more elections have at least a 95% probability of recording plans with *EG* measures with the same sign. If we relax this threshold to 75%, then 46% of plans with 3 or more elections exhibit *EG* measures with the same sign. Again, there is a reasonable amount of within-plan movement in *EG*, but in a large proportion of plans the efficiency gap appears to be a stable attribute of the plan.

10 A threshold for the efficiency gap

We now turn to the question of what might determine a threshold for determining if the EG is a *large and enduring* characteristic of a plan. We pose the problem as follows:

> for a given threshold $EG^* > 0$, what is the probability that having observed a value of $EG \geq EG^*$ we then see $EG < 0$ in the remainder of the plan?

To answer this we compute

- if (and optionally, when) a plan has $EG \geq EG^*$;
- conditional on seeing $EG \geq EG^*$, do we also observe $EG < 0$ (a sign flip) in the same districting plan?

For $EG < 0$, the computations are reversed: conditional on seeing $EG < EG^*$, do we also see $EG > 0$ under the same plan?

Figure 27 displays two proportions, plotted against a series of potential thresholds on the horizontal axis. The two plotted proportions are:

- the proportion of plans in which we observe an EG more extreme than the specified threshold EG^* (on the horizontal axis);
- among the plans that trip the specified threshold, the proportion in which we see a EG in the same plan with a different sign to EG^*.

Plans with at least one election with $|EG| > .07$ are reasonably common: over the entire set of plans analyzed here — and again, with the uncertainty in EG estimates taken into account — there is about a 20% chance that a plan will have at least one election with $|EG| < .07$.

Observing $EG > .07$ is not a particularly informative signal with respect to the other elections in the plan. Conditional on observing an election with $EG > .07$ (an efficency gap favoring Democrats), there is an a 45% chance that *under the same plan* we will observe $EG < 0$. That is, making an inference about a plan on the basis of one election with $EG > .07$ would be quite risky. Estimates

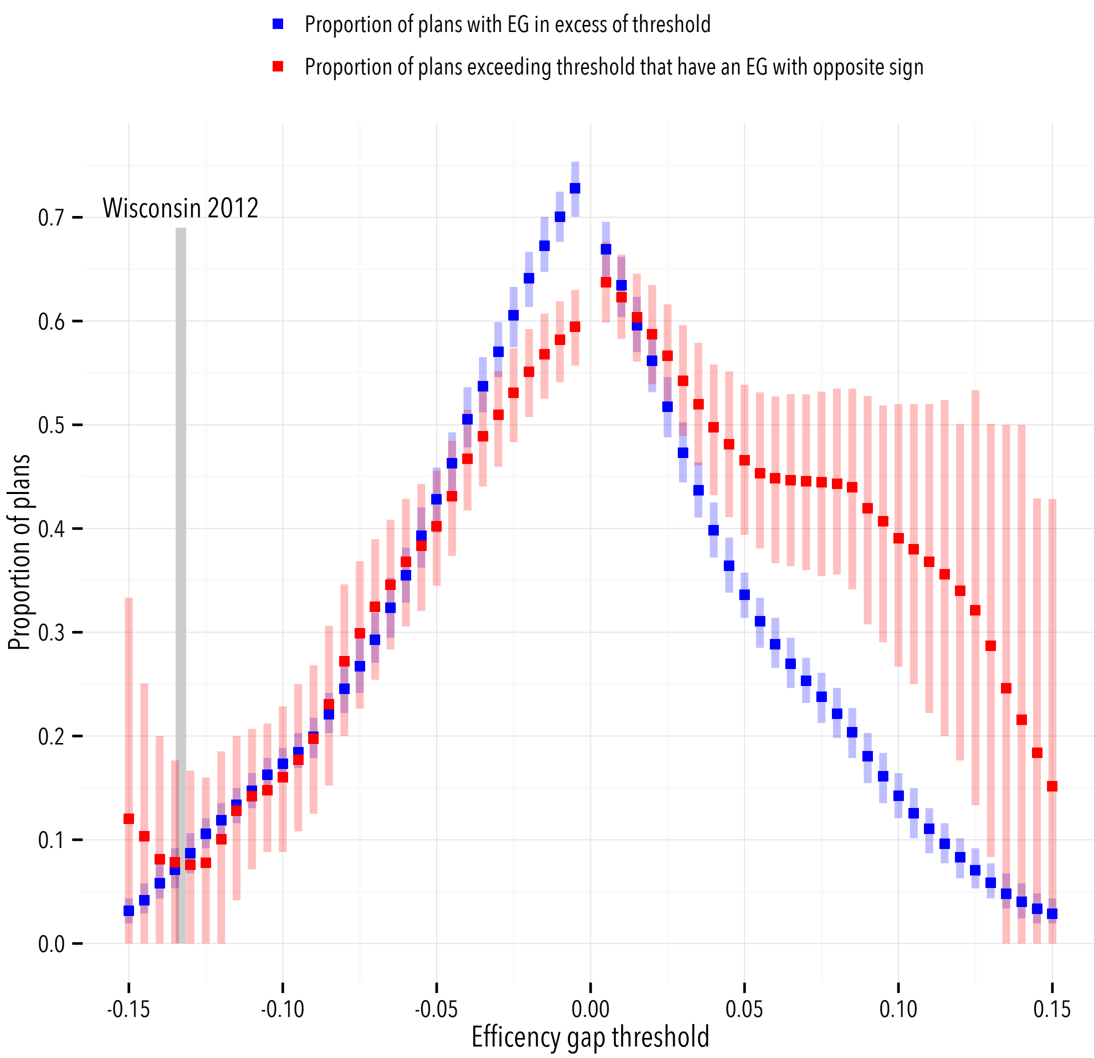

Figure 27: Proportion of plans that (a) record an efficiency gap measure at least as extreme as the value on the horizontal axis; and (b) conditional on at least one election with *EG* in excess of this threshold (not necessarily the first election), the proportion of plans where there is another election in the plan with an *EG* of the opposite sign.

of the "sign flip" rate conditional on a plan generating a relatively large, pro-Democratic EG estimates are quite unreliable because there are so few plans generating large, pro-Democratic EG estimates to begin with; note the confidence intervals on the "sign flip" rate get very wide as the data become more scarce on the right hand side of the graph.

This finding is not symmetric. The "signal" $EG < -.07$ (an efficiency gap disadvantageous to Democrats) is much more informative about other elections in the plan than the opposite signal $EG > .10$ (a pro-Democratic efficiency gap). If any single election in the plan has $EG < -.07$ then the probability that *all* elections in the plan have $EG < 0$ is about .80. That is, there is a smaller degree of within-plan volatility in plans that disadvantage Democrats. Observing a relatively low value of the EG such as $EG < -.07$ is much more presumptive of a systematic and enduring feature of a redistricting plan than the opposite signal $EG > .07$. Efficiency gap measures that appear to indicate a disadvantage for Democrats are thus more reliable signals about the respective districting plan than efficiency gap measures indicating an advantage for Democrats.

We repeat this previous exercise, but restricting attention to more recent elections and plans, with the results displayed in Figure 28. Again we see that plans with pro-Democratic EG measures are quite likely to also generate an election with $EG < 0$; and again, note that estimates of the "sign flip" rate are quite unreliable because there are so few plans generating large, pro-Democratic EG estimates to begin with.

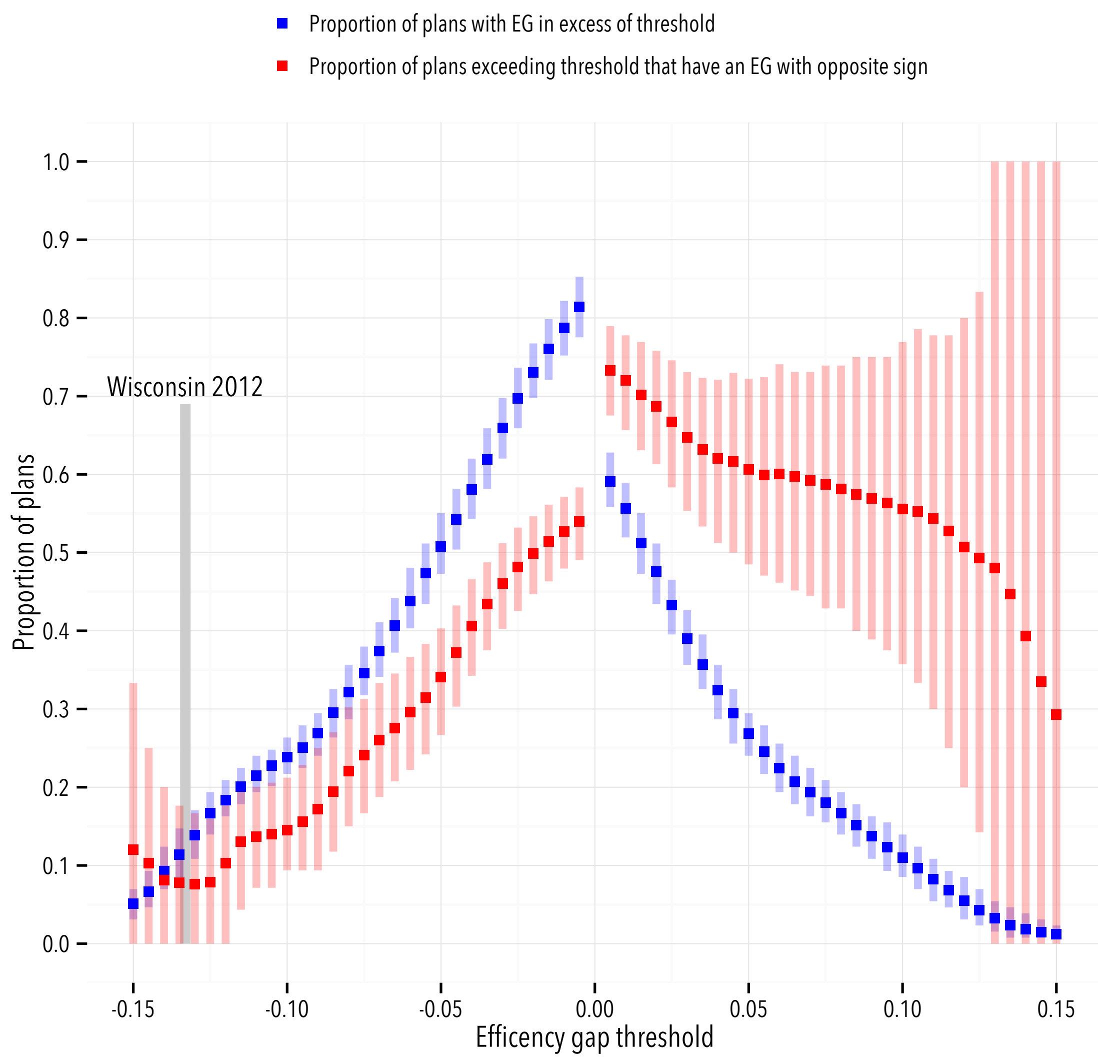

Figure 28: Proportion of plans in which (a) the efficiency gap measure is at least as extreme as the value on the horizontal axis; and (b) of these plans with at least one election with *EG* in excess of this threshold (not necessarily the first election), the proportion of plans in which there is another election in the plan with an *EG* of the *opposite* sign. Analysis of state legislative elections in 129 plans, 1991-present.

10.1 Conditioning on the first election in a districting plan

We also compute this probability of a sign flip in *EG* conditional on the magnitude of the *EG* observed with the *first* election under a districting plan. We perform this analysis twice: (1) for all elections in the data set and (2) for elections held under plans adopted in 1991 or later.

Figures 29 and 30 display the results of these analyses. First, over the full set of data (Figure 29) we observe a roughly symmetric set of *EG* scores in the first election under a plan. But we seldom see plans in the 1990s or later that commence with a large, pro-Democratic efficiency gap; the probability of a first election having $EG > .10$ is zero and the probability of a first election having $EG > .05$ (historically, not a large *EG*) is only about 11%. Negative efficiency gaps (not favoring Democrats) are much more likely under the first election in the post-1990 plans: almost 40% of plans open with $EG < -.05$ and about 20% of plans open with $EG < -.10$.

As noted earlier, pro-Democratic efficiency gaps seem much more fleeting than pro-Republican efficiency gaps. Conditional on a pro-Republican estimate of $EG > 0$ in the first election under a plan, the probability of seeing *EG* change sign over the life of the plan is almost always around 40% (1972-2014, Figure 29) or 50% (1991-present, Figure 30).

A very different conclusion holds if the first election observed under a plan indicates a sizeable efficiency gap working to disadvantage Democrats. In fact, the more negative the initial *EG* observed under a plan, the more confident we can be that we will continue to observe $EG < 0$ over the sequence of elections to follow under the plan. Conditional on a first election with $EG < -.10$, the probability of *all subsequent* efficiency gaps being negative is about 85%. Indeed, it is more likely than not that if the first election has $EG < 0$ (no matter how small), then so too will all subsequent elections (a 60% chance of this event).

Note that the Current Wisconsin Plan opens with $EG = -.13$ in the 2012 election. Analysis of efficiency gap measures in the post-1990 era (Figure 30) indicates that conditional on an *EG* measure of this size and sign, there is a 100% probability that *all subsequent elections* held under that plan will also have efficiency gaps disadvantageous to Democrats. That is, in the post-1990 era, if a plan's first election yields $EG \leq -.13$, we *never* see a subsequent election under that plan yielding a pro-Democratic efficiency gap. In short, a signal such as

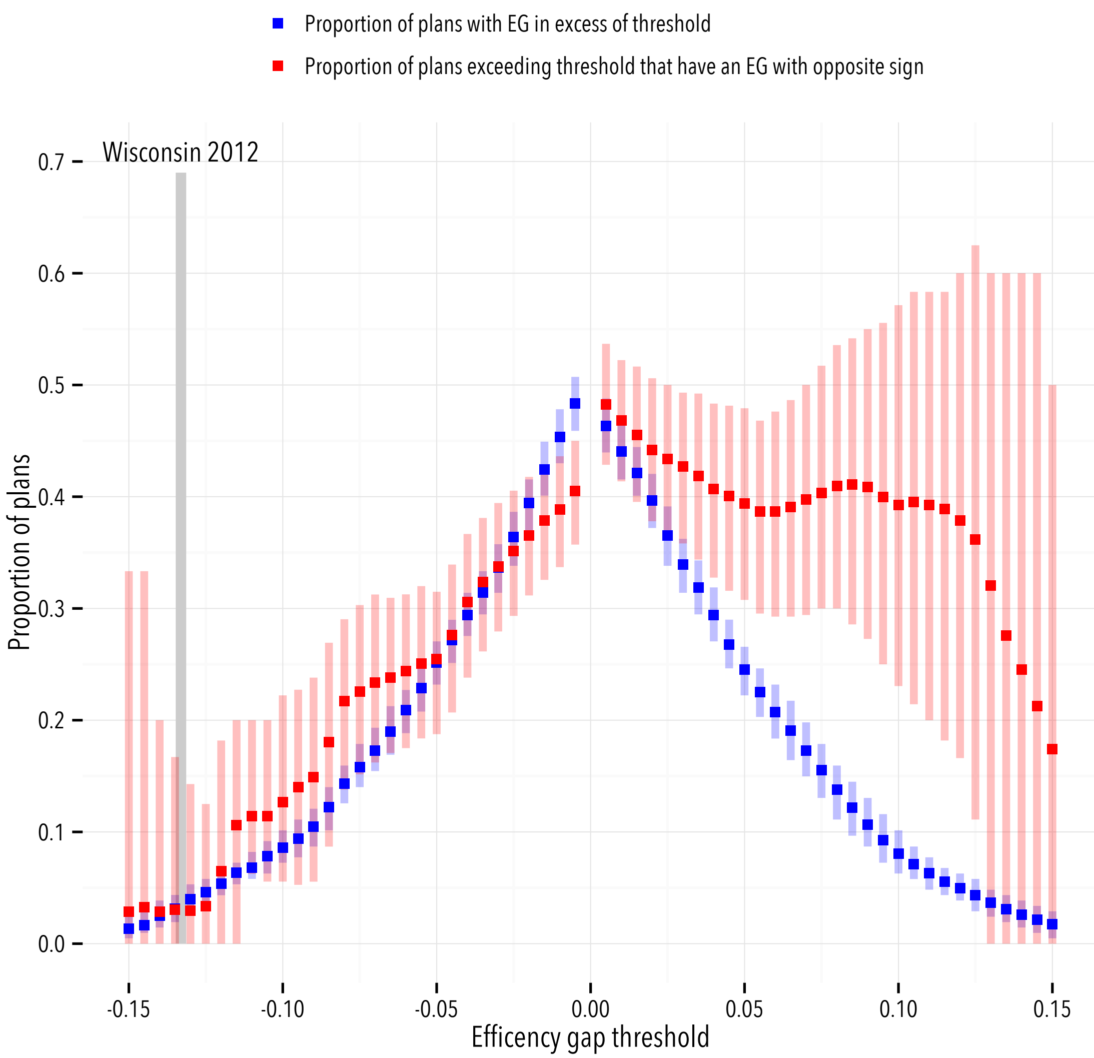

Figure 29: Proportion of plans in which the *first election* (a) has an efficiency gap measure at least as extreme as the value on the horizontal axis; and (b) conditional on the first election having an *EG* in excess of this threshold, the proportion of those plans in which a *subsequent election* has an *EG* of the *opposite* sign. Analysis of all state legislative elections in all plans with more than one election, 1972-present.

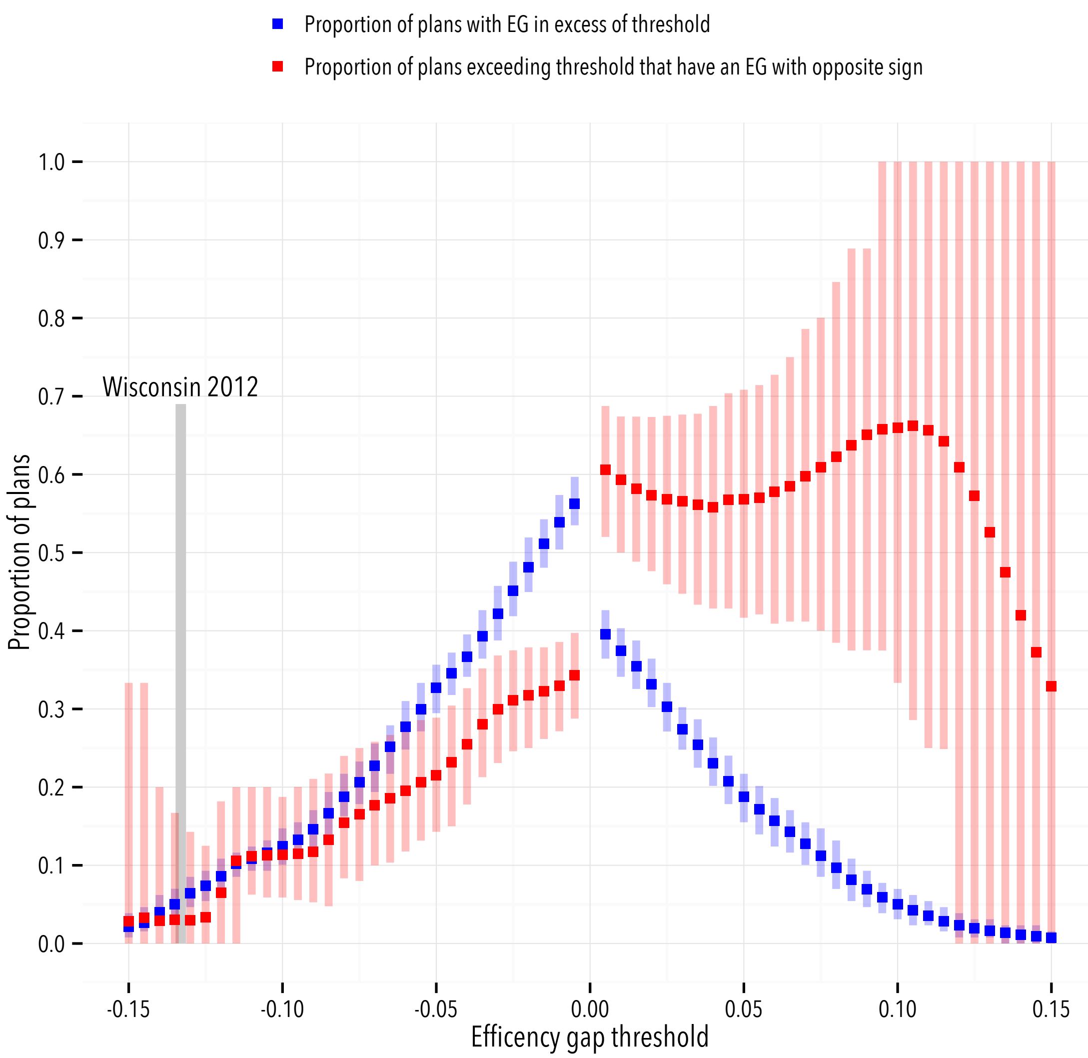

Figure 30: Proportion of plans in which the *first election* (a) has an efficiency gap measure at least as extreme as the value on the horizontal axis; (b) conditional on the first election having an *EG* in excess of this threshold, the proportion of those plans in which a *subsequent election* has an *EG* of the *opposite* sign. Analysis of state legislative elections in 129 plans, 1991-present.

$EG \leq -.13$ is extremely reliable with respect to the districting plan that generated it, at least given the post-1990 record.

10.2 Conditioning on the first two elections in a districting plan

The difficulty with conditioning on the first two elections of a districting plan is that the data start to thin out. In the entire data set there simply aren't many districting plans that equal or surpass the two, relatively large values of *EG* observed in Wisconsin in the first two elections of the current plan. Indeed, the only cases with a similar history of *EG* measures like Wisconsin's in 2012 and 2014 are contemporaneous cases: Florida, Michigan, and North Carolina in 2012 and 2014.

We relax the threshold of what counts as a similar case to encompass plans whose first two efficiency gap measures are within 75% of the magnitude of Wisconsin's 2012 and 2014 *EG* measures; we now pick up 11 roughly comparable cases, 4 of which date from earlier decades. Again, this is testament to how recent decades have seen an increase in the prevalence of larger, negative values of the efficiency gap.

For the four prior cases we plot the sequence of *EG* estimates in Figure 31. With the exception of the last election in the highly unusual Delaware sequence (among the most volatile observed in the data set; see section 9.3), the other proximate cases all go on to record efficiency gap measures that are below zero over the balance of the plan. We stress that four cases doesn't provide much basis for comparison, but this only speaks to the fact that the sequence of two large, negative values of the efficiency gap in Wisconsin in 2012 and 2014 are virtually without historical precedent. We have little guidence from the historical record as to what to expect given an opening sequence of *EG* measures like the ones observed in Wisconsin. But the little evidence we do have suggests that a stream of similarly sized, negative values of the efficiency gap are quite likely over the balance of the districting plan.

10.3 An actionable EG threshold?

We now consider a more general question: what is an actionable threshold for the efficiency gap?

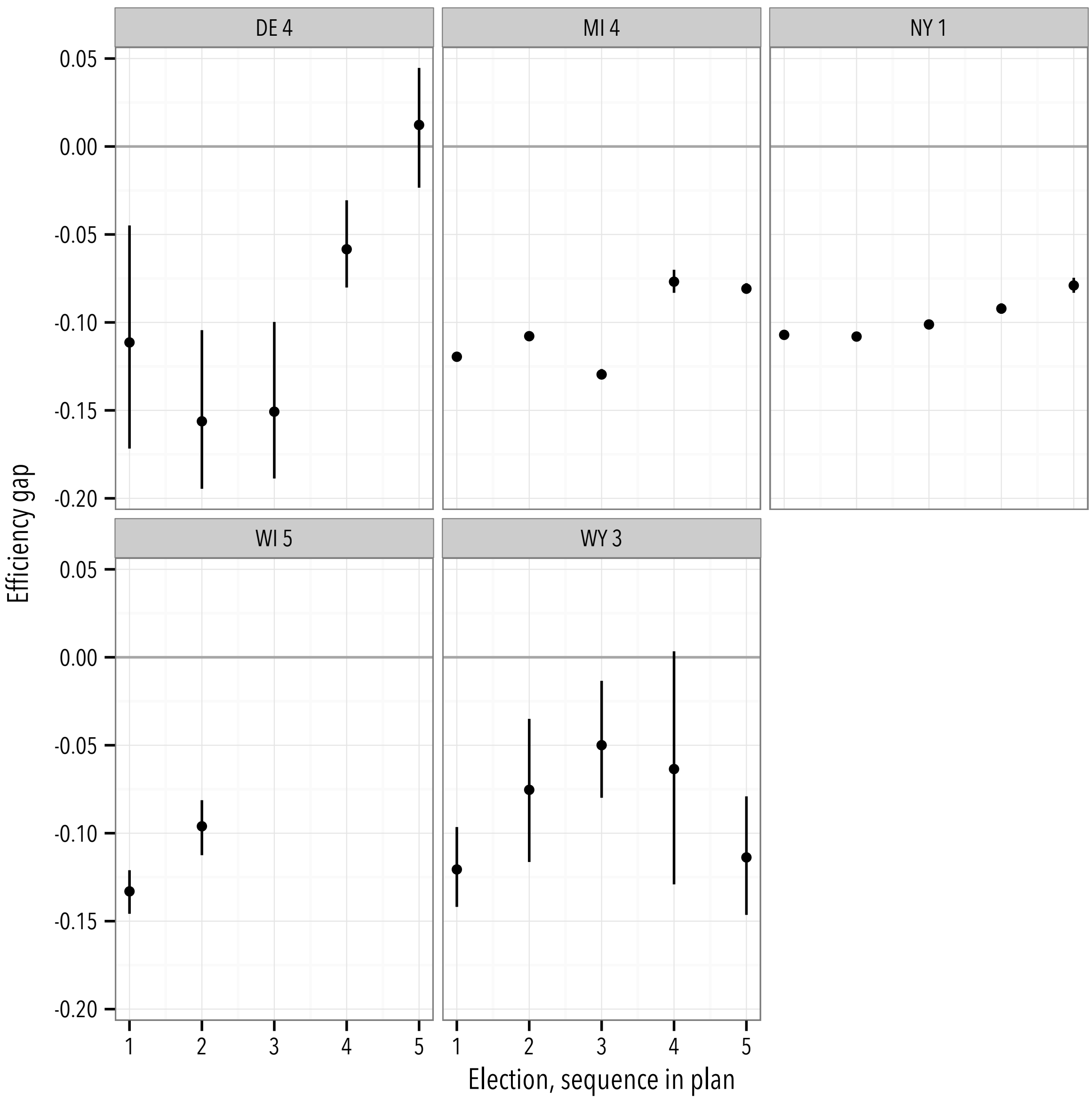

Figure 31: Sequence of *EG* estimates observed over the life of districting plans, for pre-2010 plans with first two *EG* scores within 75% of the magnitude of the *EG* scores observed in Wisconsin in 2012 and 2014.

First, recall that relatively small *EG* estimates are likely to be swamped by their estimation uncertainty, depending on the proportion of uncontested districts in the given election and the statistical procedures. In every instance though, this is an empirical question; at least in the approach I present here, each *EG* estimate I generate is accompanied with uncertainty bounds, letting us assess the *probability* that a given estimate is positive or negative. Figure 19 provides a summary of the relationship between the size of the *EG* estimate and the "statistical significance" of the estimate (in the sense that the 95% credible interval for each estimate does not overlap zero).

Second, the distribution of *EG* statistics in the 1972-2014 period is roughly symmetric around zero. Reference to this empirical distribution might also be helpful in setting actionable thresholds, and answering the question "is the *EG* measure at issues large relative to those observed in the previous 40 years of state legislative elections?" Double digit *EG* measures (-.10 or below; .10 or above) are pushing out into the extremes of the observed distribution of *EG* estimates: *EG* estimates of this magnitude are comfortably past the question of "statistical significance." Just 15% of the 786 *EG* measures generated in this analysis are below -.07; fewer than 12% are greater than .07.

We do need to be careful when making these kinds of *relative* assessments about the magnitude of the efficiency gap. If pro-Republican gerrymandering is widespread, then it will be less unusual to see a large, negative *EG* estimate, at least contemporaneously; in fact this appears to the case in the post-2010 set of elections, where the longer-term distinctiveness of the Wisconsin numbers is matched and in some cases exceeded by other states also recording unusually large, negative *EG* estimates (e.g., Florida, Michigan, Virginia and North Carolina). This speaks to the utility of the longer-term, historical analysis in both Stephanopolous and McGhee (2015) and in this report. It it is important to remember that $EG = 0$ corresponds to a partisan symmetry in wasted vote rates; we should be wary of arguments that would lead us to tolerate small to moderate levels of the efficiency gap because they appear to be the norm in some period of time, or in some set of jurisdictions.

In any litigation, much will turn on the question of *durability* in the efficiency gap, and this concern motivates much of the preceeding analysis. We cannot wait until three, four, or more elections have transpired under a plan in order to assess its properties. Courts will be asked to assess a plan based on only one *EG* estimate, or two. Analysis of the sort I provide here will be informative in these cases, assessing whether the estimate is so large that the historical record suggests that the first election's *EG* estimate is a reliable indicator as an enduring feature of the plan, and not an election-specific aberration.

10.4 Confidence in a given threshold

Figures 32 and 33 present my estimate of a "confidence rate" associated with a range of possible "actionabale thresholds" for the efficiency gap. These figures essentially re-package the information shown in Figures 29 and 30. Suppose a court rejects or amends every plan with a first election *EG* more extreme (further away from zero) than the proposed threshold shown on the horizontal axis of these graphs. A certain number of plans fail to trip this threshold, and so are upheld by the courts if they are challenged. Of those that do trip the threshold and are rejected by a court, what is our confidence that the plan, if left undisturbed, would go on to produce a sequence of *EG* measures that lie on the same side of zero as the threshold? Combining these two proportions gives us an overall confidence measure associated with a particular threshold.

This analysis points to a benchmark of about -.06 or -.07 as the actionable threshold given a first election with $EG < 0$ (Democratic disadvantage) or .08 or .09 when we observe $EG > 0$ in the first election under a redistricting plan (Democratic advantage); the asymmetry here reflects the fact that districting plans evincing apparent Democratic advantages are not as durable or as common (in recent decades) as plans presenting evidence of pro-Republican gerrymanders. At these proposed benchmarks the overall confidence rates are estimated to be 95%, with this confidence rate corresponding to a benchmark used widely in statistical decision-making in many fields of science.

Figures 32 and 33 also highlight that $EG < -.07$ or $EG > .07$ would be an extremely conservative threshold. On the pro-Democratic side, $EG > .07$ is a rare event. Districting plans unfavorable to Democrats, with $EG < -.07$ are not unusual; about 10% of post-1990 plans generate *EG* measures below -.07; the proportion of these plans that then record a sign flip is only about 10%; see Figure 30. If the presumption was that any plan with a first election showing

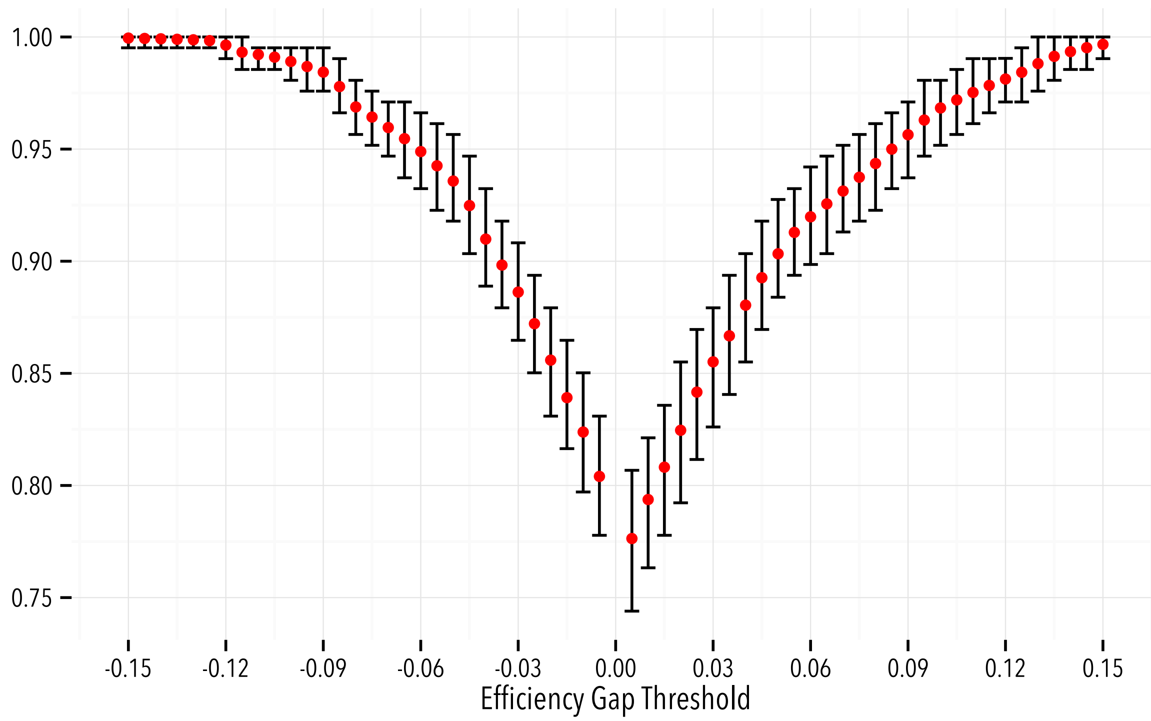

Figure 32: Proportion of plans being either (a) undisturbed or (b) if left undisturbed, would continue to produce one-sided partisan advantage (no sign change in subsequent *EG* measures), as a function of the proposed "first election," efficiency gap threshold (horizontal axis), based on analysis of all multi-election districting plans, 1972-2014. The proportion on the vertical axis is thus interpretable as the "confidence level" associated with intervention at a given first election, *EG* threshold. Vertical lines indicate 95% credible intervals.

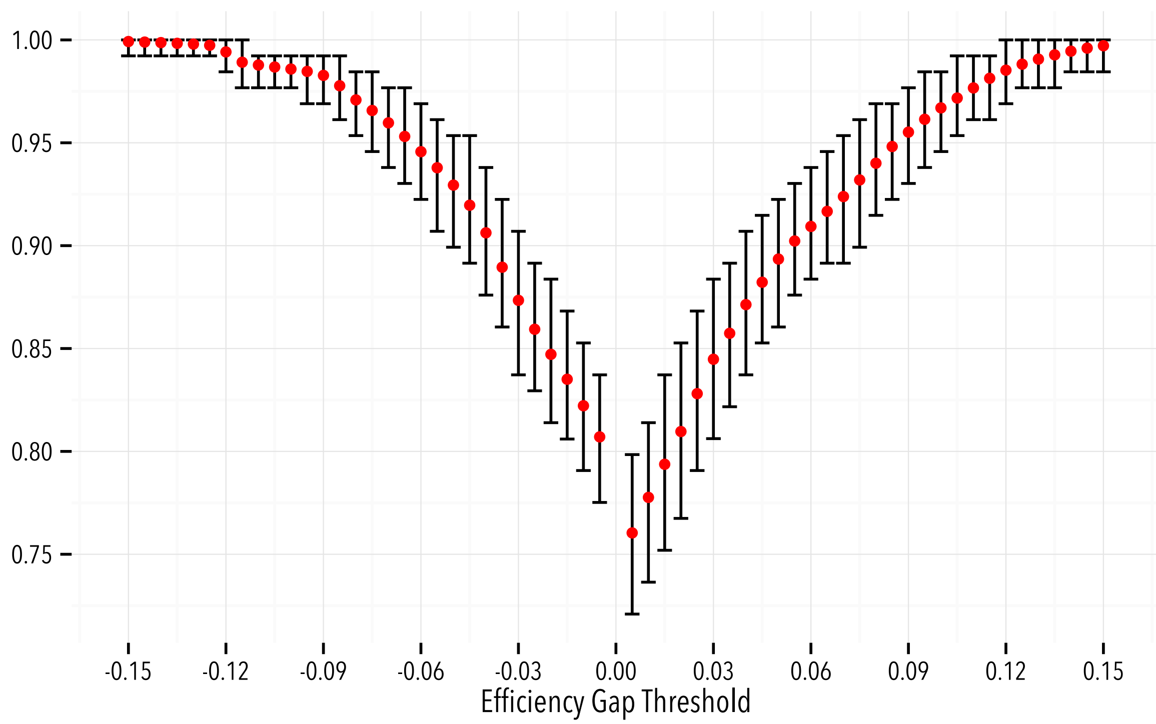

Figure 33: Proportion of plans being either (a) undisturbed or (b) if left undisturbed, would continue to produce one-sided partisan advantage (no sign change in subsequent *EG* measures), as a function of the efficiency gap threshold (horizontal axis), based on analysis of post-1990 plans and elections. The proportion on the vertical axis is thus interpretable as the "confidence level" associated with intervention at a given first election, *EG* threshold. Vertical lines indicate 95% credible intervals.

$EG < -.07$ would be rejected, then we'd be "wrong" to do so in about 10% of those cases (in the sense that if left in place, the plan would go on to produce at least one election with $EG > 0$). The total error rate in this case would be *1% of all plans*. Equivalently, 99% of all plans would be either left undisturbed or appropriately struck down or amended by a court, given the historical relationship between "first election" *EG* measures and the sequence of *EG* measures that follow.

11 Conclusion: the Wisconsin plan

Wisconsin has had two elections for its legislature under the plan currently in place, in 2012 and 2014. Both elections were subject to considerable rates of uncontestedness (27 of 99 seats in 2012 and 52 of 99 seats in 2014), but these rates are hardly unusual; Wisconsin's rates of uncontested districts in these two elections are low to moderate compared to other states. We use the relationship between state legislative election results and presidential election results in state legislative districts (and incumbency) to impute two-party vote shares in uncontested seats (see section 7.2). With a complete set of vote shares, we then compute average district-level Democratic two-party vote share (V) and note the share of seats (contested and uncontested) won by Democratic candidates (S).

In Wisconsin in 2012, and after imputations for uncontested seats, V is estimated to be 51.4% (± 0.6); recall that Obama won 53.5% of the two-party presidential vote in Wisconsin in 2012. Yet Democrats won only 39 seats in the 99 seat legislature (S = 39.4%), making Wisconsin one of 7 states in 2012 where we estimate $V > 50\%$ but $S < 50\%$ and where Democrats failed to win a majority of legislative seats despite $V > 50$ (the other states are Florida, Iowa, Michigan, North Carolina and Pennsylvania). In 2014, V is estimated to be 48.0% (± 0.8) and Democrats won 36 of 99 seats (S = 36.4%).

This provides the raw ingredients for computing the efficiency gap (*EG*) for these two elections (recalling equation 1). Repeating these calculations across a large set of state elections provides a basis for assessing whether the efficiency gap estimates for Wisconsin in 2012 and 2014 are noteworthy.

Wisconsin's efficiency gap measures in 2012 and 2014 are -.13 and -.10 (to two digits of precision). These negative estimates indicate the disparity between

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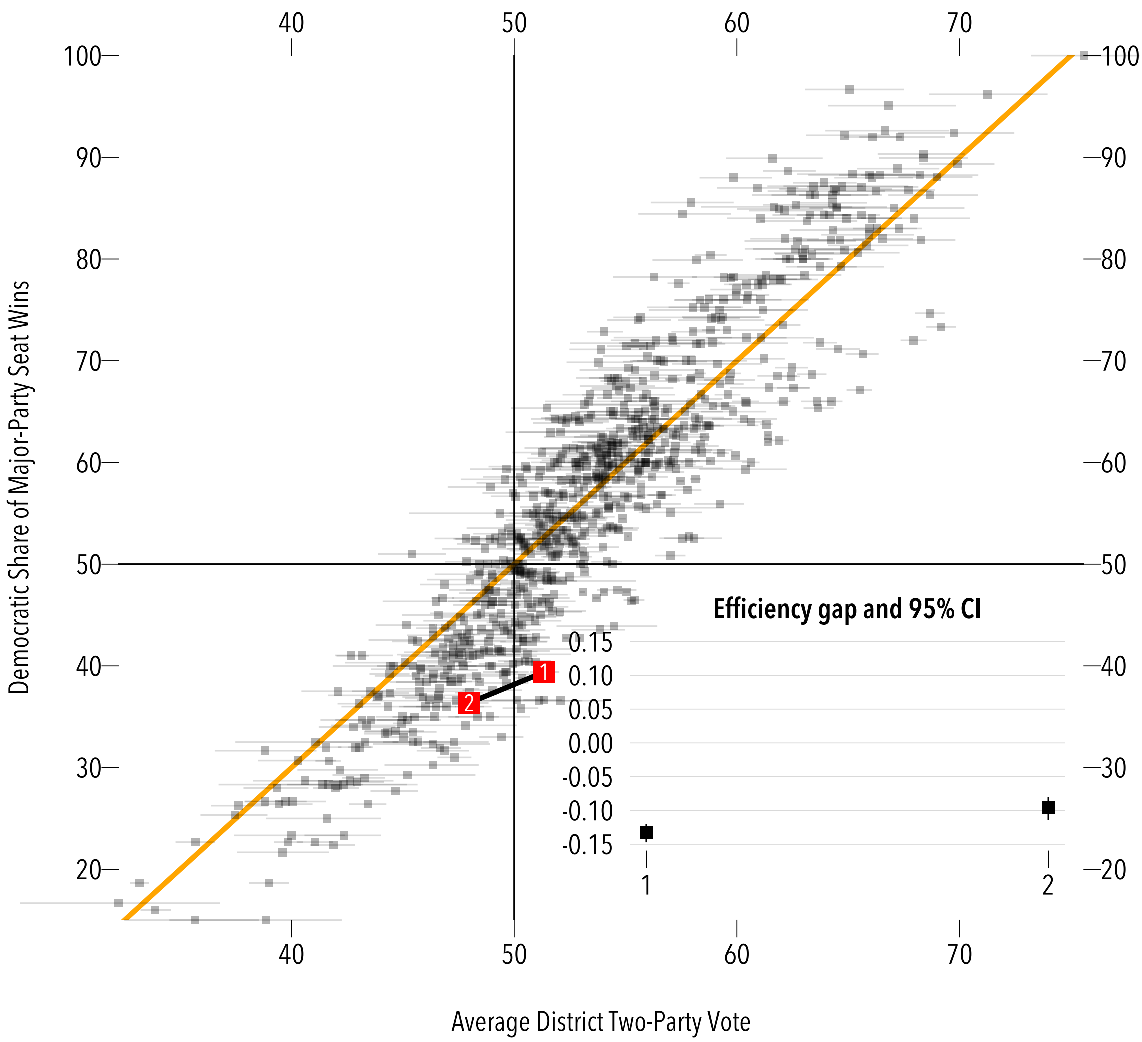

Figure 34: Seats, votes and the efficiency gap recorded under the Wisconsin plan, 2012 and 2014. Orange line shows the seats-votes curve if the efficiency gap were zero; the efficiency gap in any election is the vertical distance from the corresponding data point to the orange line. Gray points indicate elections from other states and elections (1972-2014). Horizontal lines cover a 95% credible interval for Democratic average district two-party vote share, given imputations in uncontested districts. The inset in the lower right shows the sequence of efficiency gap measures recorded under the plan; vertical lines are 95% credible intervals.

vote shares and seat shares in these elections, which in turn, is consistent with partisan gerrymandering. The negative *EG* estimates generated in 2012 and 2014 are unusual relative to Wisconsin's political history (see Figure 35). The 2012 estimate is the largest *EG* estimate in Wisconsin over the 42 year period spanned by this analysis (1972-2014); the 2014 estimate is the fourth largest (behind 2012, 2006 and 2004, although it is essentially indistinguishable from the 2004 estimate). The jump from the *EG* values being recorded towards the end of the previous districting plan in Wisconsin (2002-2010) to the 2012 and 2014 values strongly suggests that the districting plan adopted in 2011 is a driver of the change, systematically degrading the efficiency with which Democratic votes translate into Democratic seats in the Wisconsin state legislature.

Wisconsin's 2012 and 2014 *EG* estimates are also large relative to the *EG* scores being generated contemporaneously in other state legislative elections. Figure 36 shows *EG* estimates recorded under plans in place since the post-2010 census round of redistricting; the *EG* estimates are grouped by state and ordered, with Wisconsin highlighted. We have 78 *EG* scores from elections held since the last round of redistricting. Among these 79 scores, Wisconsin's *EG* scores rank eigth (2012, 95% CI 3 to 12) and seventeenth (2014, 95% CI 13 to 20).

The historical analysis reported above supports the proposition that Wisconsin's *EG* scores are likely to endure over the course of the plan. Few states ever record *EG* scores as large as those observed in Wisconsin; indeed, there is virtually no precedent for the lop-sided, two election sequence of *EG* scores generated in Wisconsin in 2012 and 2014 in the data I analyze here (1972-2014). The closest historical analogs suggest that a districting plan that generates an opening, two-election sequence of *EG* scores like those from Wisconsin will continue to do so, generating seat shares for Democrats that are well below those we would expect from a neutral plan.

The Current Wisconsin Plan is generating estimates of the efficiency gap far in excess of the proposed, actionable threshold (see section 10). In 2012 elections to the Wisconsin state legislature, the efficiency gap is estimated to be -.13; in 2014, the efficiency gap is estimated to be - .10. Both measures are separately well beyond the conservative .07 threshold suggested by the analysis of efficiency gap measures observed from 1972 to the present.

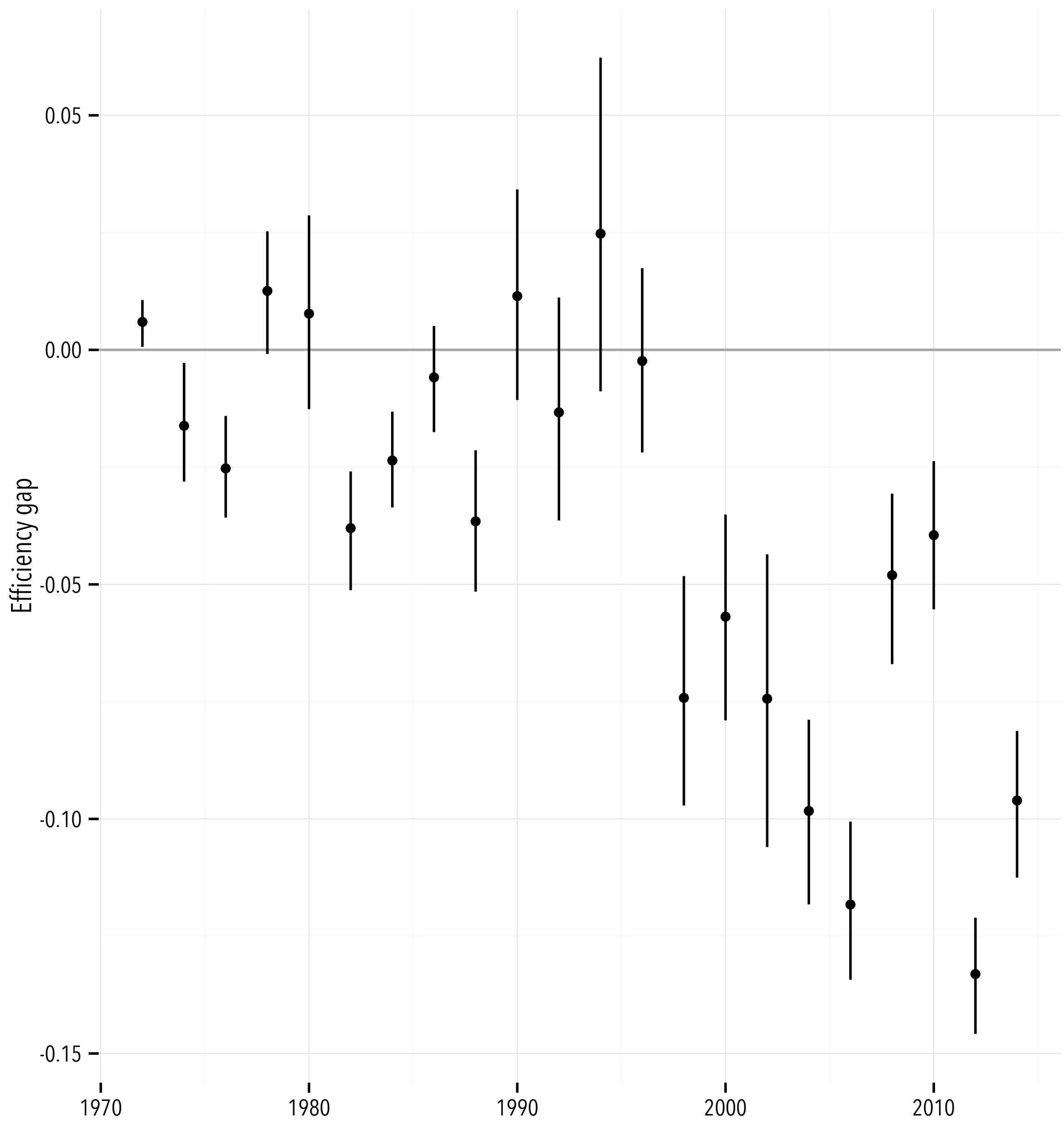

Figure 35: History of efficiency gap estimates in Wisconsin, 1972-2014. Vertical lines indicate 95% credible intervals.

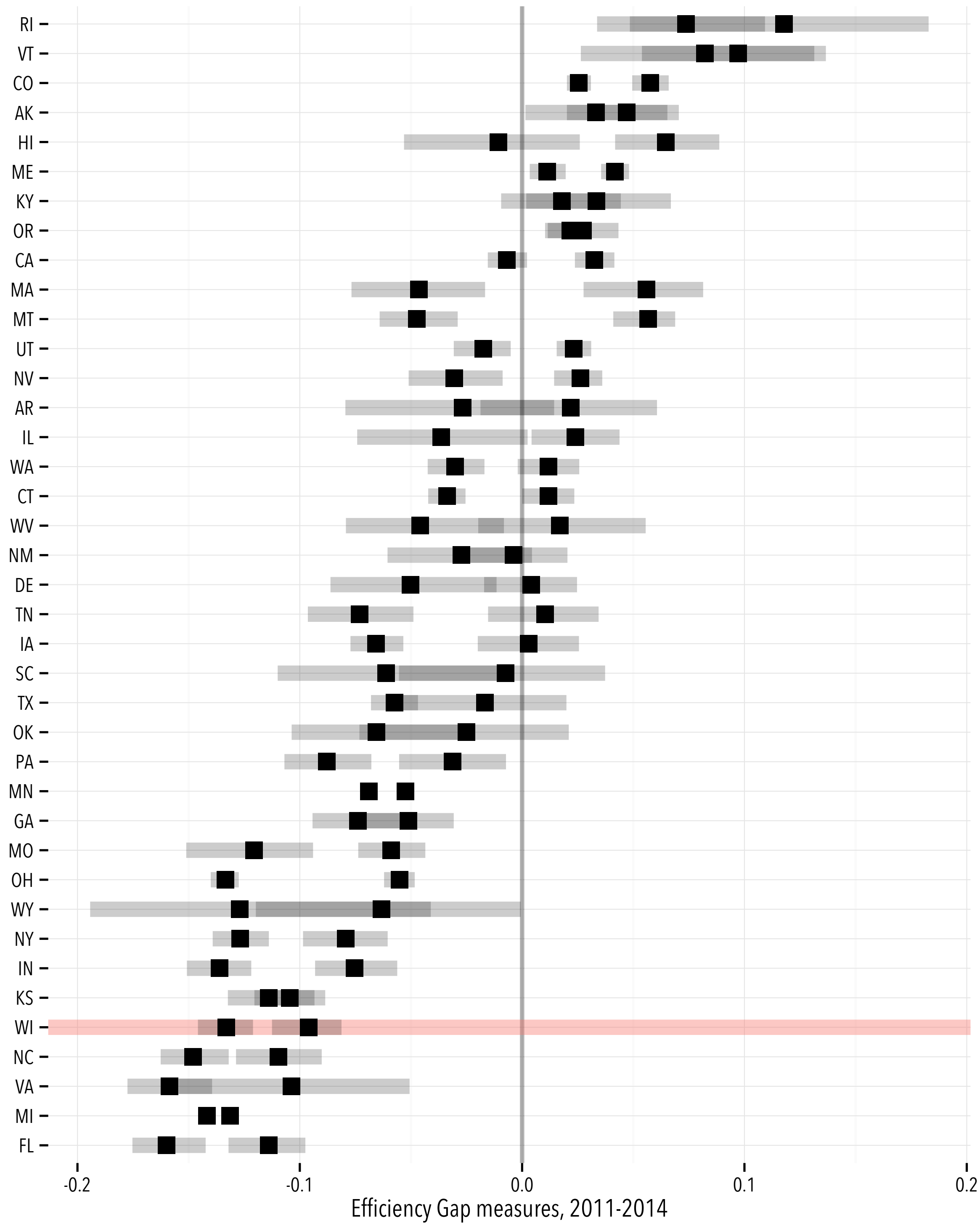

Figure 36: *EG* estimates in 2012 and 2014, grouped by state and ordered. Horizontal bars indicate 95% credible intervals.

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Rebuttal Report

Simon Jackman

December 21, 2015

Introduction

In this rebuttal report, I respond to criticisms made by Sean P. Trende and Professor Nicholas Goedert in their respective expert reports. I also conduct new empirical analyses further confirming the validity of the efficiency gap as a measure of partisan gerrymandering and the reasonableness of the proposed 0.07 threshold. More specifically, my principal contributions are the following:

- *First*, I respond to Goedert's various critiques of the efficiency gap and of the proposed efficiency gap threshold. Among other things, he misunderstands the relevance of efficiency gap data, cherry-picks information from my initial report while ignoring its broader context, and wrongly claims that plaintiffs' test would mandate "hyper-responsiveness" or prevent states from pursuing goals such as competitiveness or proportional representation.

- *Second*, I calculate several widely accepted prognostic measures—all based on the rates of true positives, false positives, true negatives, and false negatives—with respect to the odds of a district plan's efficiency gap changing signs over the plan's lifetime given a certain efficiency gap value in the plan's first election. Based on these measures, I conclude that the proposed 0.07 threshold is highly conservative. In fact, this threshold *sacrifices* some accuracy (which would be maximized at a lower threshold) in order to reduce the proportion of false positives.

- *Third*, I calculate the same prognostic measures with respect to the odds of a district plan's *average* efficiency gap, over its lifetime, having a different sign than that observed in the first election under a plan, given a certain efficiency gap value in this first election. Under this method, the proposed 0.07 threshold appears even more conservative, driving down the share of false positives to below 5%.

- *Fourth*, I compare the values of the efficiency gap in the *first* election under a plan and *on average* over the plan's lifetime. This relationship is impressively tight (r^2=0.73), indicating that a plan's initial bias is a very good predictor of its overall lifetime bias. For Act 43, this analysis allows us to predict that it will *average* a pro-Republican efficiency gap of almost 10% over the 2010 cycle as a whole.

- *Fifth*, I examine to what extent changes in party control over redistricting are responsible for the pro-Republican trend in the efficiency gap since the 1990s. In the current cycle, about *four times* more state house plans were designed by Republicans in full control of state government than in the 1990s. Had the distribution of party control over redistricting remained unchanged, essentially *all* of the pro-Republican movement in the efficiency gap over the last two decades would not have occurred. It is thus changes in party control, and *not* changes in the country's political geography, that primarily account for Republicans' growing redistricting advantage over the last generation.

- *Sixth*, I address recent work by Chen and Rodden (2013), cited by both Trende and Goedert for the proposition that Republicans enjoy a natural geographic advantage over Democrats. Chen and Rodden's simulated maps are not *lawful* because they ignore the Voting Rights Act and state redistricting criteria; they are based on presidential election results rather than more relevant state legislative election results; they do not constitute a representative sample of the entire plan solution space; and they are contradicted by other recent work (Fryer & Holden 2011) finding that randomly drawn plans *reduce* bias and *increase* electoral responsiveness.
- *Lastly*, I comment on Trende's analysis of particular state legislative and congressional plans. This analysis is marked by conceptual and methodological errors severe enough to render it useless. For example, Trende ignores two of the three prongs of plaintiffs' proposed test; he calculates congressional efficiency gaps without converting them from percentage points to House seats and for House delegations too small to generate reliable estimates; and he simply *substitutes* presidential election results for congressional election results whenever the latter are missing due to uncontested races. None of this work meets accepted standards of social science rigor.

1 Responses to Goedert's criticisms

In his report, Goedert offers several critiques of the efficiency gap and of the 0.07 threshold I recommended in my initial report, based primarily on the alleged instability of the efficiency gap. None of these critiques have merit. In this section, I respond to Goedert's points relying only on the analysis of my initial report and on the existing literature. My new empirical analyses appear in subsequent sections.

First, Goedert appears to believe that a plan's efficiency gap is only relevant to the extent that it sheds light on the partisan intent (or lack thereof) underlying the plan. He writes that "such intent cannot be inferred" from a large efficiency gap, that "a durable bias . . . is not even a sign of deliberate partisan intent," and that the "efficiency gap [is] a standard to measure partisan intent" (pp. 11, 13, 19). But this is not at all the legal function of the efficiency gap in plaintiffs' proposed test. Rather, partisan intent is its own independent inquiry, and the efficiency gap then comes into play at the *second* stage of the test, to determine if a plan's electoral *consequences* are sufficiently severe that it should be deemed presumptively unconstitutional. To put it simply, the efficiency gap is plaintiffs' measure of partisan *effect*, not of partisan *intent*. Goedert's misunderstanding of this basic point infects all of his discussion.

Second, Goedert observes that of *all* plans, anytime in the decade, with a *pro-Democratic* efficiency gap of greater than 0.07, a substantial proportion of them switch signs over their lifetimes (p. 11). In making this observation, Goedert cherry-picks a single bit of data from my initial report, and an irrelevant piece of data at that. This fact is irrelevant because it applies to plans no matter when their elections were held, while the appropriate universe for plaintiffs, defendants, and courts is limited to the *first* elections held under plans. It is the first elections that typically will be used in litigation, given Justice Kennedy's admonition in *Vieth* that plans should not be struck down based on a "hypothetical state of affairs," but rather "if and when the feared inequity arose" (*Vieth v. Jubelirer* (2004), p. 420). And the fact is misleading because it applies only to pro-Democratic efficiency gaps above 0.07, and not to the larger set of pro-Republican efficiency gaps above this threshold.

If we consider only plans that exhibit a pro-Democratic efficiency gap above 0.07 in their *first* elections, the probability that they will switch signs over their lifetimes drops by about five percentage points (Jackman Report, p. 61). And if we then turn to plans that exhibit a *pro-Republican* efficiency gap above 0.07 in their first elections—a more sizeable set, for which more accurate estimates are possible—this probability drops all the way to about 15% (Jackman Report, p. 61). In other words, of plans that open with large pro-Republican efficiency gaps, close to 85% of them continue to favor Republicans in every election for the remainder of the cycle. *This* is the most pertinent data point in my report, not the one cherry-picked by Goedert, and it reveals the persistence of many gerrymanders.

Third, Goedert discusses *congressional* district plans throughout his report, even though this case is exclusively about state legislative redistricting (pp. 7-8, 10, 12, 20). In doing so, he makes some of the same errors as does Trende: namely, not converting the efficiency gap from percentage points to House seats, and improperly handling uncontested races (in his case, by not adjusting for the uncontestedness *at all*, and simply treating the races as if all of the vote went to one party and none to the other). I discuss these errors in more detail later in this report.

Fourth, Goedert claims that it is "arbitrary" to focus on the first election after redistricting, and that doing so "biases toward a finding of *EG* durability" by ignoring wave elections (p. 14). As noted above, the first election after redistricting is the critical one for purposes of litigation, since under *Vieth*, it is after this election that a lawsuit will typically commence and have to be decided by the courts. Later elections are largely irrelevant for litigation purposes, since it is unreasonable to expect suits to be brought six or eight or even ten years into a cycle. Moreover, my analysis in no way ignored wave elections; to the contrary, I determined the odds that a plan's efficiency gap would switch signs by examining *all* elections held under the plan, waves and non-waves alike. If anything, the fact that most wave elections over the last forty years have not taken place in the first election after redistricting biases *against* a finding of durability, since these elections may well cause the efficiency gap to flip signs.

Fifth, Goedert is wrong that an efficiency gap of zero represents "'hyper-responsive' representation" (p. 2). In fact, as he has recognized in his own prior work, an efficiency gap of zero corresponds almost exactly to the responsiveness actually displayed by American elections over the course of the twentieth century, under which "a 1% increase in vote share will produce about a 2% increase in seat share" (Goedert 2014, p. 3). Indeed, this correspondence is one of the efficiency gap's most attractive properties, and it explains why Goedert himself calculated a quantity nearly identical to the efficiency gap in his work (Goedert 2014; Goedert 2015).

And sixth, Goedert is wrong as well that plaintiffs' proposed test might discourage states from pursuing worthwhile goals such as competitiveness or proportional representation (pp. 6-10). If a state's aim in redrawing districts was to make them more competitive or to produce more proportional representation, then the partisan intent required by the first prong of plaintiffs' test would not be present. Even if partisan intent were somehow found, the state would likely be able to show that its plan's large efficiency gap was necessitated by its pursuit of competitiveness or proportional representation. And in any event, competitiveness and proportional representation are extremely rare objectives in American redistricting. Only *one* state, Arizona, has a competitiveness requirement, and not a *single* state has a proportional representation criterion. (And needless to say, line-drawers do not tend to seek out either of these goals on their own.)

2 Reliability of a district plan's first efficiency gap

Having rebutted Goedert's criticisms using preexisting data, I now provide further analysis of the reliability of the first efficiency gap (*EG*) observed in the life of a district plan. This played a key role in the determination of the threshold *EG* value in my initial report. In that report, I focused on the probability of a "sign-flip": that is, given the magnitude of the efficiency gap observed in the first election under a district plan, what can we infer about the likelihood that all subsequent efficiency gaps observed under that plan will have the same sign as that from the first election.

Under this approach, just one election that produces an efficiency gap with a different sign from the efficiency gap in the first election will generate a "failure," in the sense we would say that the plan has generated an efficiency gap that conflicts with that from the first election. In short, the "constant sign" analysis in my original report considers the most extreme set of efficiency gap estimates produced under a plan and insists that they have the same sign. In this sense, the "constant sign" analysis I performed is a quite stringent and conservative test of what we can or ought to infer from the efficiency gap observed in the first election under the district plan. Another approach would be to inquire as to the *average* efficiency gap over the life of the district plan. A summary statistic such as the average is—by definition—less sensitive to extreme values. At the same time—and again, by definition—the average measures central tendency or typicality, and is the most widely used summary statistic in existence. I thus consider how well the first *EG* observed under a district plan predicts the average *EG* observed over the life of the plan.

But I first provide some additional analysis of the prognostic properties of the first efficiency gap observed under a district plan. In each instance the test is whether the first *EG* observed under a plan exceeds a given threshold value. The outcome of interest is whether the plan's remaining efficiency gaps have the same sign as the *EG* from the first election. For purposes of this exercise, plans are classified as "positive" (all *EG* scores under the plan have the same sign) or "negative" (*EG* scores differ in sign). With these definitions in place, we can then classify plans according to the accuracy of the prediction implicit in the first *EG* observed under the plan:

	Actual	
Test	Positive	Negative
Positive	True Positive	False Positive
Negative	False Negative	True Negative

The prognostic measures I rely on are conventional measures of predictive or classification accuracy used throughout the quantitative sciences:

1. sensitivity, or the *true positive rate*: proportion of positives that test positive, TP/(TP + FN)
2. specificity, or the *true negative rate*: proportion of negatives that test negative, TN/(TN + FP)

3. *balanced accuracy*, the average of the sensitivity and the specificity

4. *accuracy*, the proportion of cases that are true positives or true negatives, (TP + TN)/(TP + FP + FN + TN).

5. the *false positive rate*; proportion of negative cases that test positive, 1 minus the specificity or FP/(TN + FP).

6. the *false discovery rate*; proportion of cases testing positive that are actually negative, FP/(TP + FP).

7. the *false omission rate*; proportion of cases that test negative that are actually positive, FN/(FN + TN).

Figure 1 shows how these prognostic performance indicators vary as a function of the absolute *EG* threshold (on the horizontal axis in the figure). That is, as we move to the right in each panel of the graph, the test is becoming increasingly stringent: larger absolute values of the efficiency gap in the first election under a district plan are required to trip the increasingly higher threshold. When the threshold is set to zero, all plans trip the threshold (all first-election *EG*s are greater than zero in magnitude, by definition) and so all cases test positive; in this case the sensitivity is 1, while conversely the specificity is 0 and the false positive rate is 1 (all negatives test positive).

The test has better properties as the threshold grows, with the accuracy measures maximized around absolute values of .03 to .04. Yet accuracy is not all in this context. The rate of false positives is quite high at thresholds where the accuracy is high, as is the false discovery rate. At a threshold of .03, for example, over half of plans that would go on to exhibit sign flips in their *EG*s would test positive and be flagged for inspection; of the plans selected for scrutiny, more than a third would turn out to have *EG* sign flips over the life of the plan. The .07 threshold is thus a conservative standard, the point at which the rate of false positives is becoming reasonably low (25%), without letting the false omission rate go above 50%.

It is worth noting the weight being put on false discoveries or false alarms versus the weight on false omissions in this context, which in turn reflects the conservatism and caution of the thinking underlying the .07 threshold. We propose accepting *twice* the rate of false omissions (plans that should have been scrutinized but were not) than the rate of false discoveries (plans that would be flagged for scrutiny given the *EG* observed in the first election, but would then go on to display sign flips). To reiterate: the proposed standard for judicial scrutiny is cautious and conservative, erring on the side of letting even durably skewed plans stand.

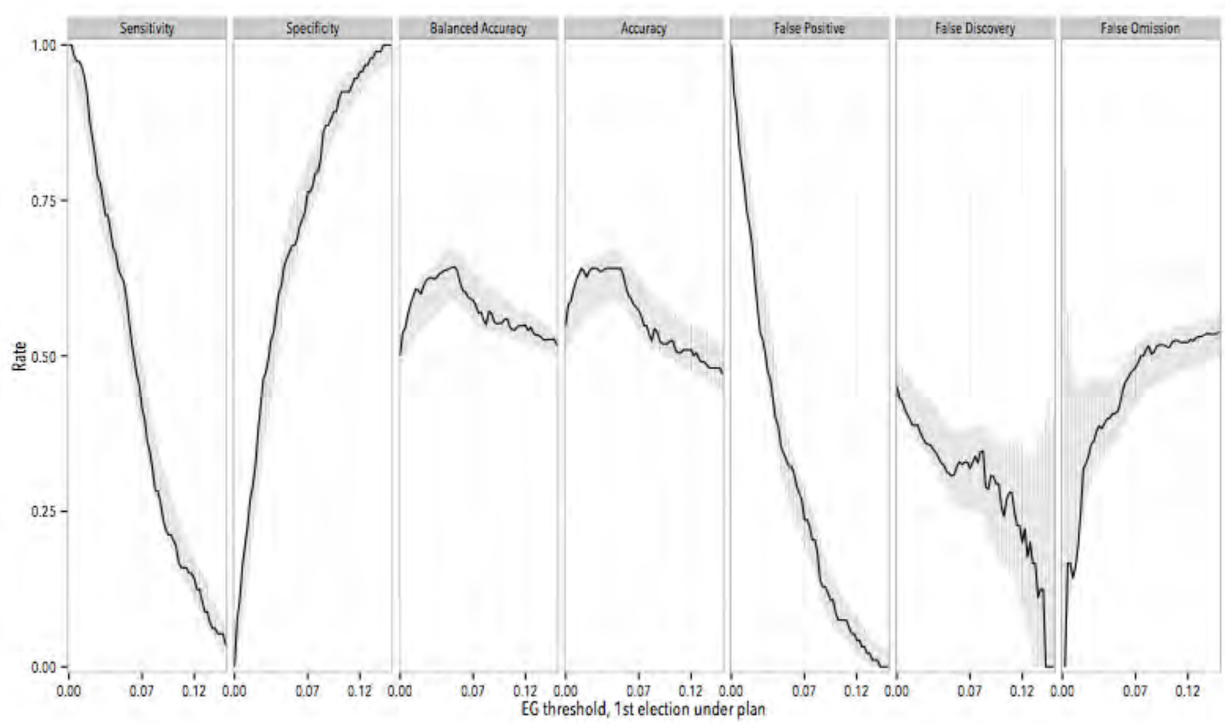

Figure 1: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the subsequent efficiency gaps recorded under the district plan all have the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis spans all state legislative elections and district plans as per my initial report, 1972-2014.

Figure 2 repeats this analysis, but only considering the performance of *negative* values of the first-election efficiency gap threshold, consistent with Republican advantage (and more relevant to the Wisconsin plan at issue). Here the threshold becomes less stringent as we move across the horizontal axis from left to right, from larger negative thresholds to closer to zero at the right hand edge of each panel. With a large negative threshold (left hand edge of each panel), almost all plans test negative and so the sensitivity is close to zero, the specificity is 1, and the false positive rate is zero. The accuracy measures increase as the threshold becomes less stringent, attaining maxima in the range -.05 to -.02. Again—and consistent with the cautious approach we take—we emphasize that accuracy is not the sole criterion we use to evaluate a decision rule. At low values of the threshold, where accuracy is maximized, the false positive and false discovery rates are relatively high. On the other hand, at the proposed threshold value of -.07, the false positive rate is under 10% (fewer than 10% of plans with efficiency gaps changing signs would be scrutinized), and the false omission rate is about 35% (close to

35% of plans would not be flagged despite having *EG*s of the same sign over their lifetimes). The proposed threshold again errs on the side of restraint, tolerating a higher rate of false omissions than false discoveries.

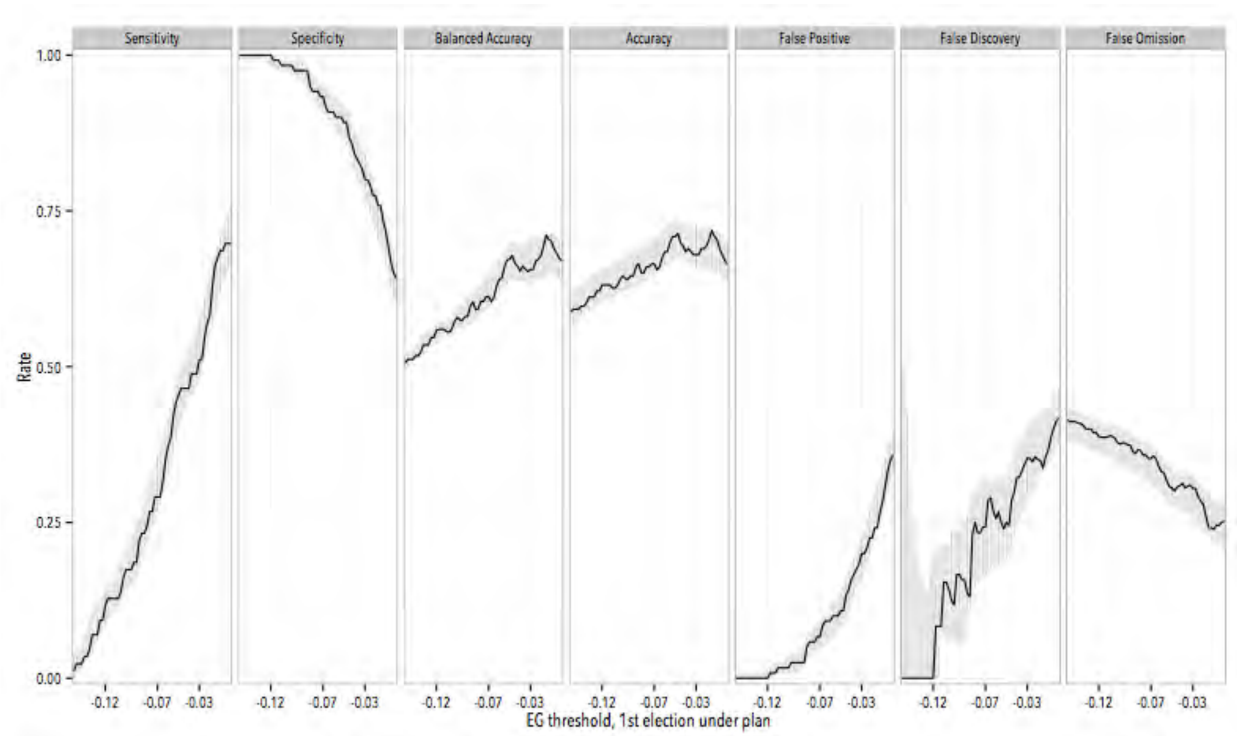

Figure 2: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the subsequent efficiency gaps recorded under the district plan all have the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis examines negative, first-election threshold values of the efficiency gap, consistent with Republican advantage.

Figure 3 presents the corresponding analysis of *positive* values of the first-election *EG* threshold, consistent with Democratic advantage. Here the proposed threshold becomes more stringent as we move to the right of each panel, in the sense that fewer plans trip the threshold. At high values of the threshold (the right hand edge of each panel), no plans trip the threshold and all are classified as "negatives," leading to a specificity of 1, and false positive and false discovery rates of zero. Once again, accuracy is maximized at a less stringent threshold than the proposed .07 standard, around .03. The false positive rate is much lower at the proposed threshold of .07 than at the accuracy-maximizing threshold of .03. Note that the false discovery rates are moderately large but unstable and estimated with considerable imprecision; this is because there are so few plans exhibiting high (pro-Democratic) levels of *EG* in their first election. Moreover, of the few plans that do trip a given pro-Democratic threshold in their first election, it is reasonably likely that they will record efficiency gaps that will change sign over the life of the plan; this sign-flip or "false discovery" probability is about 35% at the proposed threshold of .07.

Comparing the analyses in Figures 2 and 3, we see an asymmetry in the results. The .07 threshold is more permissive with respect to plans that begin life exhibiting Democratic advantage than it is for plans that initially exhibit Republican advantage. At a +/- .07 threshold, the false discovery rate for plans initially exhibiting Republican advantage is under 10%, but around 35% for plans initially exhibiting Democratic advantage. As Figure 3 shows, it is difficult to find a threshold for apparently pro-Democratic plans that drives the false discovery rate to reliably low levels, if only because the historical record has relatively few instances of these types. We also note that the .07 threshold generates false omission rates of about 30% for both sets of plans.

Because the preceding discussion is somewhat technical, it is worth restating its principal conclusion: It is that an efficiency gap threshold of 0.07 is quite conservative, in that it sacrifices some accuracy (which would be maximized at a threshold of around 0.03) in order to drive down the false positive and false discovery rates. At a threshold of 0.07, in fact, the false positive and false discovery rates are about *half* of the false omission rate, indicating that there are about twice as many plans that are *not* being flagged even though their *EG* signs would remain one-sided throughout the cycle, than there are plans that *are* being flagged even though their *EG* signs would flip. This is further powerful confirmation of the reasonableness of the 0.07 efficiency gap threshold.

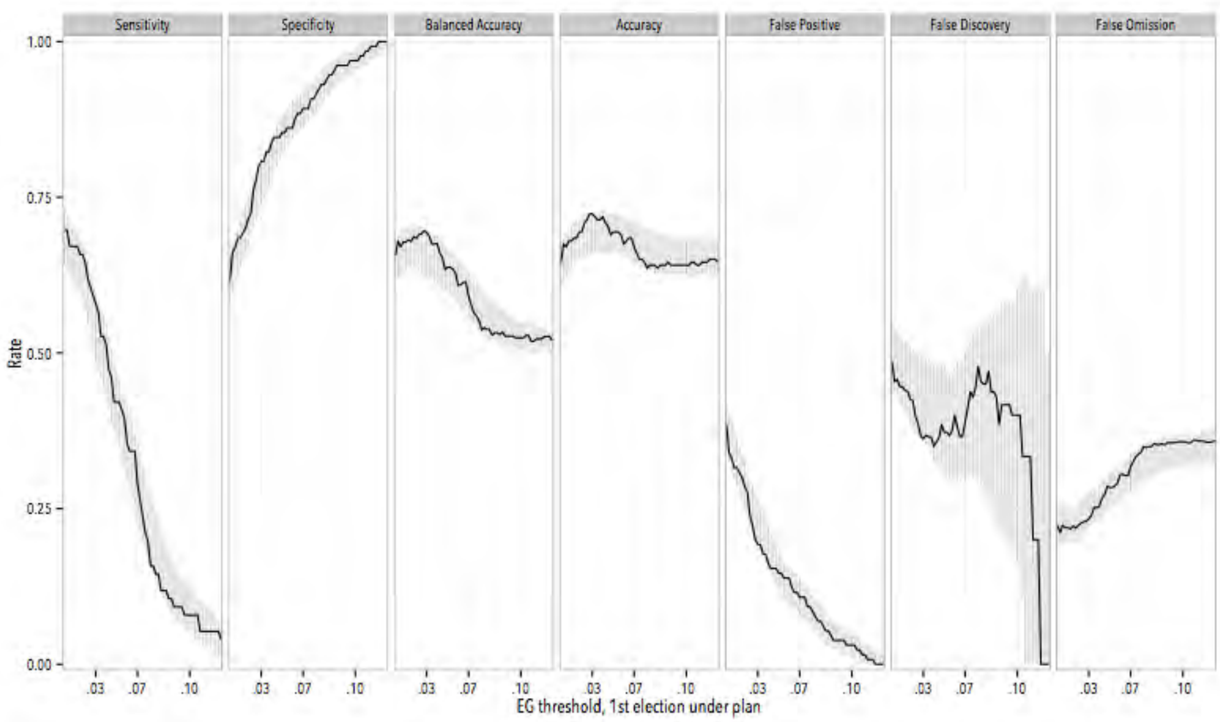

Figure 3: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the subsequent efficiency gaps recorded under the district plan all have the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis examines positive, first-election threshold values of the efficiency gap, consistent with Democratic advantage.

3 First-election efficiency gap reliability with respect to the plan-average efficiency gap sign

Next we consider a slightly different kind of test; given that the first election under a district plan produces a value of the efficiency gap above or below a given threshold, how likely is it that the *average* value of the efficiency gap produced over the life of the plan lies on the same side of zero as that of the first election? Recall that the sign of the efficiency gap speaks to the corresponding direction of partisan advantage ($EG < 0$ is consistent with Republican advantage; conversely for $EG > 0$). We expect that this will be a less strenuous test than asking if *any EG* has an opposite sign to the first *EG* observed under a district plan.

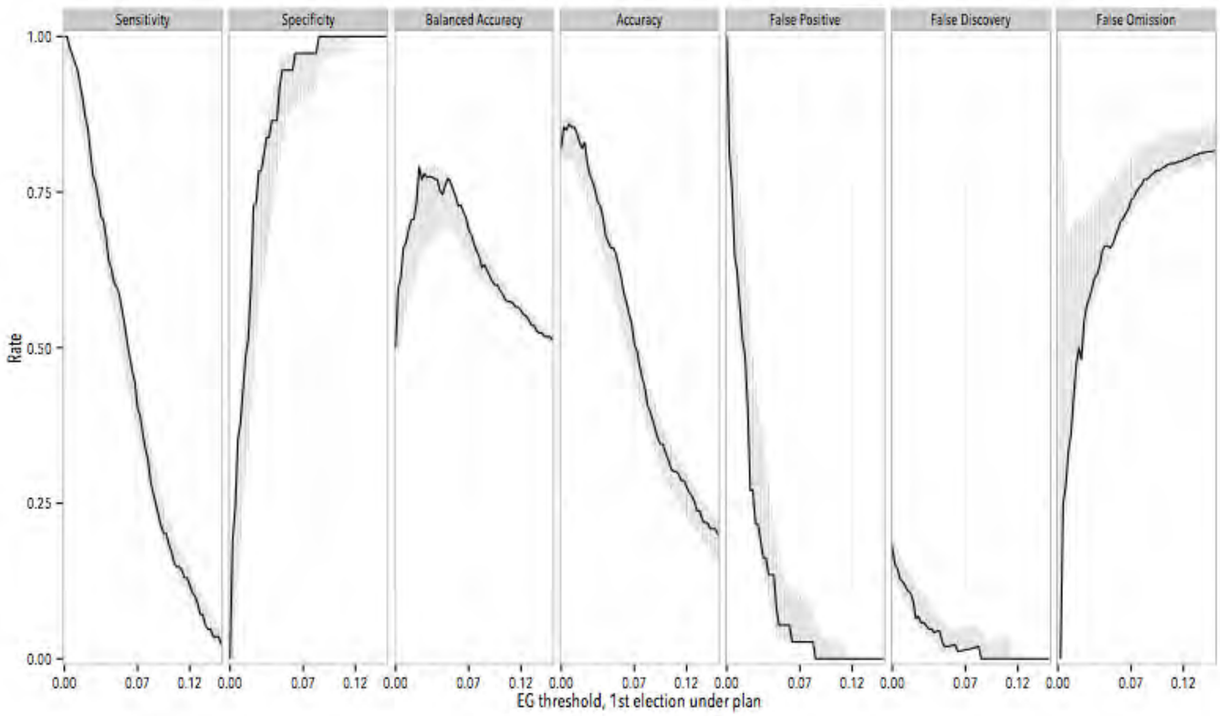

Figure 4: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the average efficiency gap recorded under the district plan has the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis spans all state legislative elections and district plans as per my initial report, 1972-2014.

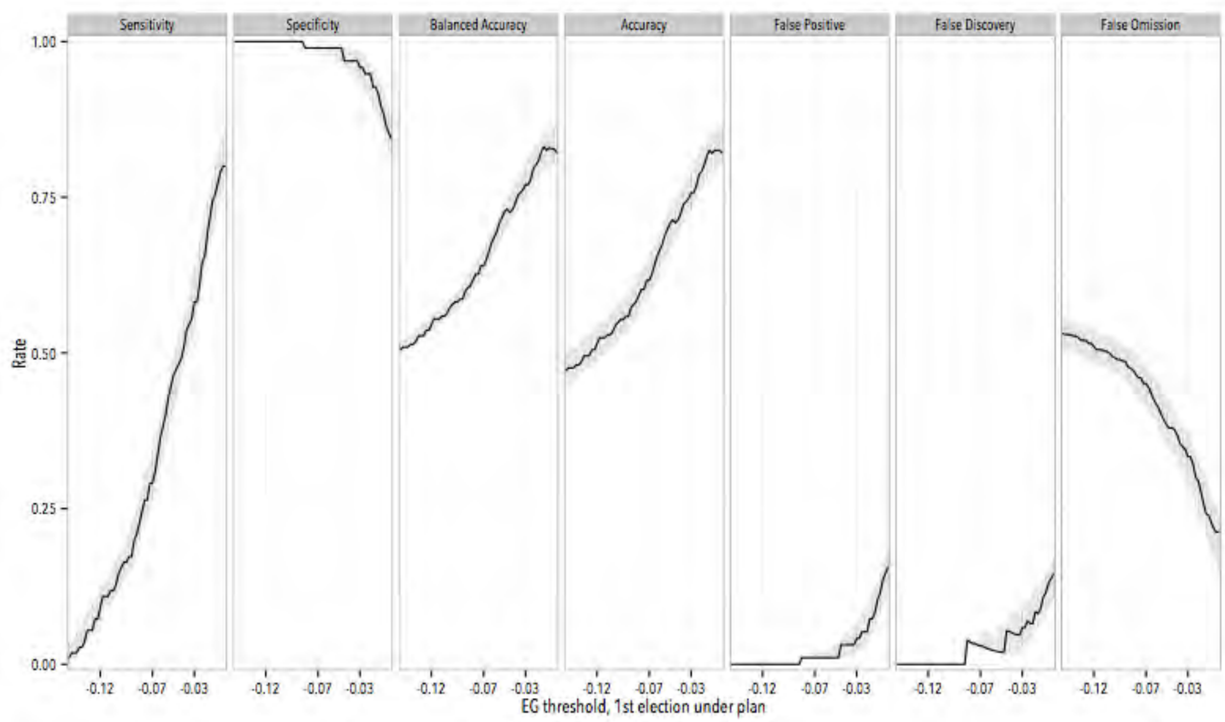

Figure 5: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the average efficiency gap recorded under the district plan has the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis examines negative, first-election threshold values of the efficiency gap, consistent with Republican advantage.

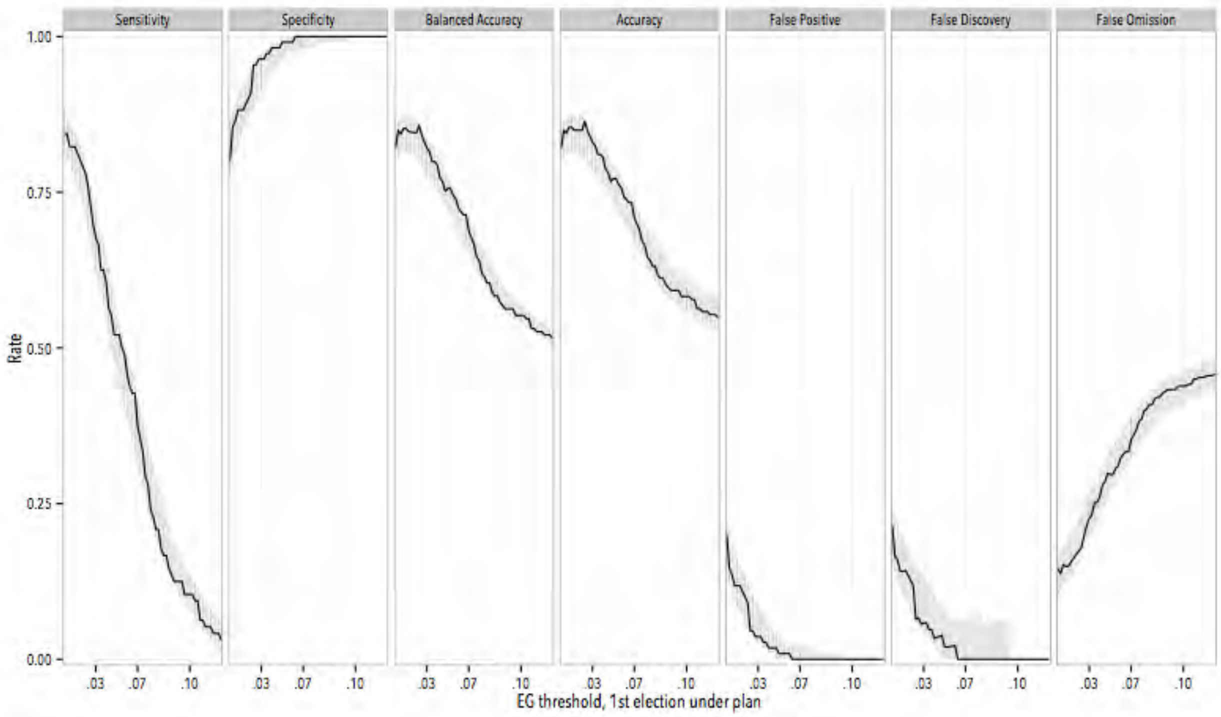

Figure 6: Prognostic performance measures, first efficiency gap under a district plan more extreme than threshold (horizontal axis) as a predictor of whether the average efficiency gap recorded under the district plan has the same sign as the first efficiency gap. Vertical lines indicate 95% confidence intervals. Analysis examines positive, first-election threshold values of the efficiency gap, consistent with Democratic advantage.

Figures 4, 5 and 6 show the prognostic performance of the first-election *EG* with respect to the sign of the corresponding plan's average *EG*, looking at the absolute value of the first-election *EG* (Figure 4), negative first-election efficiency gaps (Figure 5) and positive first-election efficiency gaps (Figure 6). The first thing to observe is the generally superior prognostic performance when it comes to forecasting the sign of the *plan-average* efficiency gap, relative to the prognostic performance with respect to *all* of the plan's efficiency gaps having the same sign. As anticipated, the former is better predicted by the plan's first-election efficiency gap than the latter. Second, the accuracy-versus-caution tradeoff noted earlier is also apparent. The proposed threshold of +/- 0.07 trades away accuracy for very low false positive and false discovery rates, below 5%, at the cost of higher false omission rates, a pattern we observed earlier. Finally, note that at the proposed threshold of +/- 0.07, almost one-half of all plans with a negative (pro-Republican) average *EG* would *not* be candidates for scrutiny (right-hand panel of Figure 5); about one-third of plans with a positive (pro-Democratic) average *EG* also would not trigger the threshold for scrutiny.

4 Relationship between the first-election efficiency gap and the plan-average efficiency gap

I next present analysis on a related issue, the relationship between the magnitudes of the *first* efficiency gap observed under a plan and the *average* efficiency gap we observe over the life of the plan. Does a larger or smaller first-election efficiency gap portend anything for the average value of the efficiency gap generated over the life of a district plan?

Clearly the first value of the efficiency gap and the plan-average efficiency gap are related; the former contributes to the calculation of the latter, and after the first election under a district plan we observe at most four more elections under the plan (given elections every two years in most states and redistricting once a decade). Accordingly we expect a positive correlation between the two quantities. The interesting empirical question—and one with considerable substantive implications for the issue at hand—is *how strong* the relationship is between the first-election efficiency gap and the corresponding plan-average efficiency gap. This speaks to the reliability of the first-election *EG* measure as a predictor of *EG* over the life of the plan.

Figure 7 shows the relationship between the first-election *EG* and the average *EG* observed over the entire plan. Note that we restrict this analysis to plans with at least three elections, so that the first election does not unduly contribute to the calculation of the average; this restriction has the consequence of omitting elections from the most recent round of redistricting after the 2010 Census, which have contributed at most two elections. The black diagonal line on the graph is a 45-degree line: if the relationship between first-election *EG* and plan-average *EG* were perfect, the data would all lie on this line. Instead we see a classic "regression-to-the-mean" pattern, with a positive regression slope of less than one (as indeed we should, given that the first-election *EG* on the horizontal axis contributes to the average plotted on the vertical axis). But the relationship here is especially strong. The variation in plan-average efficiency gaps explained by this regression is quite large, about 73%; after taking into account the uncertainty in the *EG* scores (stemming from the imputation procedures used for uncontested districts; see my initial report) a 95% confidence interval on the variance explained measure ranges from 67% to 74% (the uncertainty has the consequence of tending to make the regression fit slightly less well). That is, even given the uncertainty that accompanies *EG* measures due to uncontestedness, the relationship between first-election *EG* and plan-average *EG* is quite strong.

In particular, at the threshold values of +/- 0.07 there is very little doubt as to the plan-average value of the efficiency gap. The historical relationship between first-election *EG* and plan-average *EG* shown in Figure 7 indicates that a first-election *EG* of -.07 is typically associated with a plan-average *EG* of about -0.053 (95% CI -0.111 to 0.004); the probability that the resulting, expected plan-average *EG* is negative is 96.5%. Conditional on a first-election *EG* of .07 we typically see a plan-average *EG* of about 0.037 (95% CI -0.021 to 0.093); the probability that the resulting, expected plan-average *EG* is positive is 89.8%. This constitutes additional, powerful evidence that (a) first-election *EG* estimates are predictive with respect to the *EG* estimates that will be observed over the life of the plan; and (b) the threshold values of +/- 0.07 are conservative, generating high-confidence predictions as to the behavior of the district plan in successive elections.

In the particular case of Wisconsin in 2012—the first election under the plan in question—I estimated the efficiency gap to be -0.133 (95% CI -0.146 to -0.121). The analysis of historical data discussed above—and graphed in Figure 7—indicates that the plan-average *EG* for this plan will be -0.095 (95% CI -0.152 to -0.032)[1], a quite large value by historical standards, placing the current Wisconsin district plan among the five to ten most disadvantageous district plans for Democrats in the data available for analysis. The probability that the Wisconsin plan—if left undisturbed—will turn out to have a positive, pro-Democratic, average efficiency gap is for all practical purposes zero (less than 0.1%).

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1 It is also worth stressing that the confidence interval is computed so as to take into account uncertainty from all known sources: in the underlying efficiency gap scores themselves, the fact that the 2012 *EG* scores for Wisconsin are large by historical standards, and in the regression relationship between first-election *EG* and plan-average *EG*.

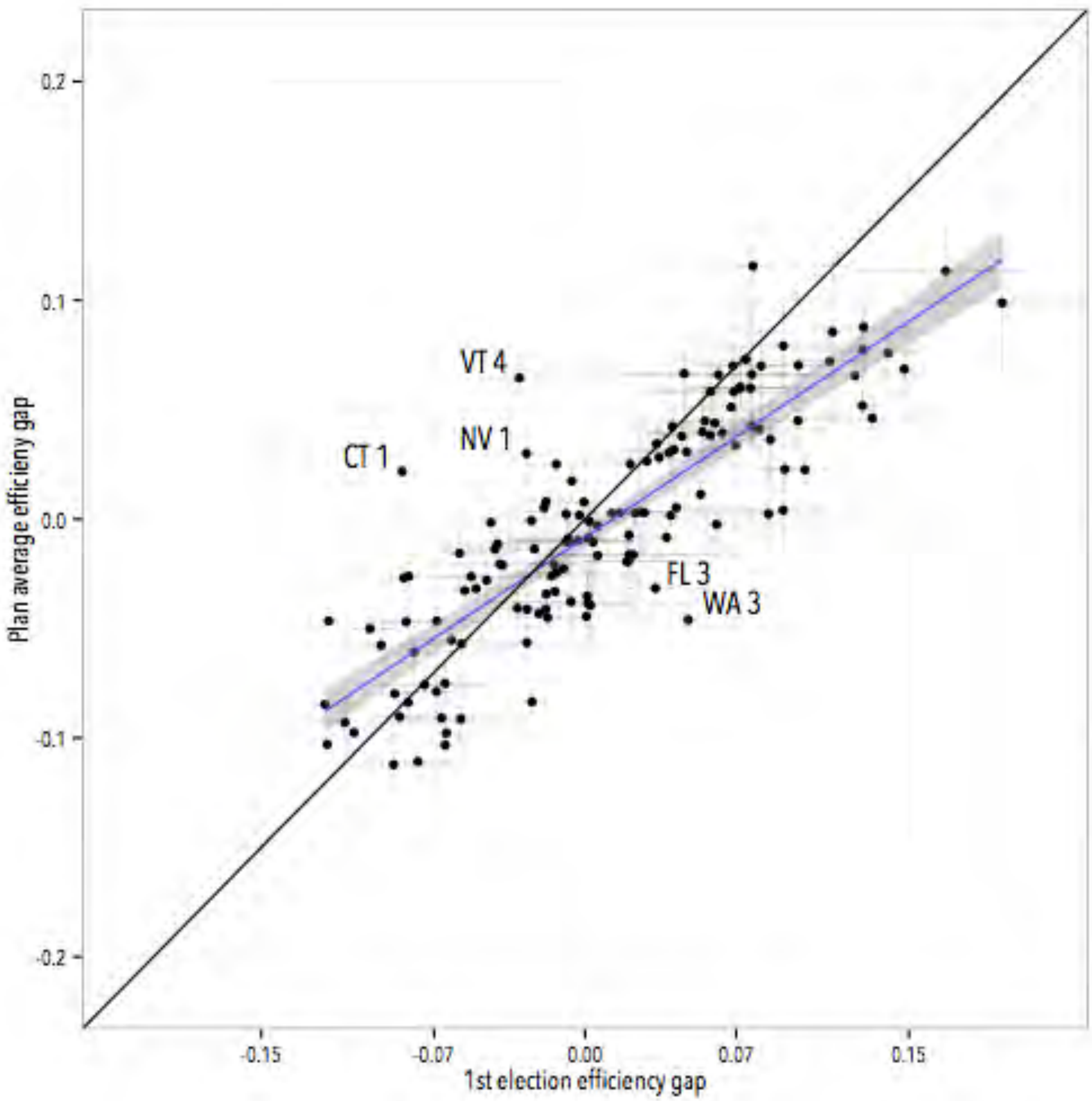

Figure 7: Scatterplot of first-election efficiency gap scores (horizontal axis) and plan-average efficiency gap scores (vertical axis). The diagonal black line is a 45-degree line; the data would lie on this line if first-election efficiency gaps coincided with plan-average efficiency gaps. The solid blue line is a linear regression with slope .64 (95% CI 0.57 to 0.72); the shaded region around the blue line is a 95% confidence interval for the regression line. Vertical and horizontal lines extending from each data point cover 95% confidence intervals in either direction, summarizing the uncertainty in both first-election *EG* and plan-average *EG*, stemming from imputations for uncontested districts. Outliers are labeled (state, plan). Analysis restricted to plans with at least three elections (1972-2010), omitting plans adopted after the 2010 Census. The first-election *EG* for the current Wisconsin plan is -0.133 (95% CI -0.146 to -0.121).

5 Party control as an explanation for change in the efficiency gap

Both Trende and Goedert point out that, on average, state house plans have exhibited pro-Republican efficiency gaps in recent years (Trende, paragraphs 129-30; Goedert p. 19). They then argue that this pro-Republican mean is attributable to a natural pro-Republican political geography in many states. However, as I found in my initial report, the *overall* efficiency gap average, over the entire 1972-2014 period, is very close to zero (Jackman Report, p. 35, 45, 57). There is thus no sign of a natural pro-Republican advantage in the dataset as a whole, nor any evidence (despite Trende and Goedert's unsupported assertions to the contrary) that states' political geography is changing in ways that favor Republicans.

In fact, the one historical change that *is* undeniable is the trend toward unified Republican control over redistricting. As Figure 8 displays, only about 10% of all state house plans were designed by Republicans in full control of the state government in the 1990s, compared to about 30% by Democrats in full control and about 60% by another institution (divided government, a commission, or a court). But in the 2000s, Republicans were fully responsible for slightly *more* plans than were Democrats (about 20% versus about 15%). And in the 2010s, the partisan gap jumped again, to about *40%* of plans designed entirely by Republicans, versus less than 20% designed entirely by Democrats.

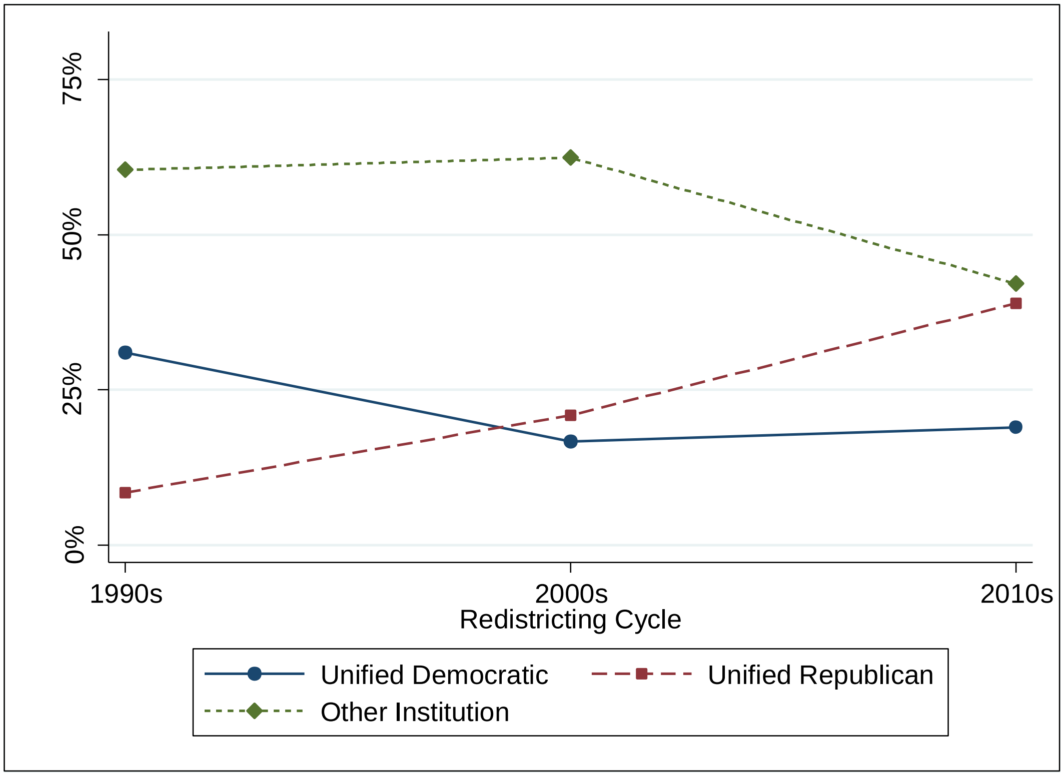

Figure 8: Share of all state house plans, by cycle, designed by Democrats in unified control of state government, by Republicans in unified control of state government, or by another institution (divided state government, commission, or court).

To determine the impact of this change in party control on the change in the efficiency gap over the last generation, I carry out three regressions, one for the 1990 redistricting cycle, one for the 2000 cycle, and one for the 2010 cycle. In each case, state house plans' efficiency gaps are the dependent variable, and unified Democratic control over redistricting and unified Republican control over redistricting are the independent variables. (The omitted category is any other institution responsible for redistricting, such as divided government, a court, or a commission.) Figure 9 then displays the *actual* average efficiency gap for each cycle, as well as the *predicted* average efficiency gap if the distribution of party control over redistricting had remained unchanged since the 1990s.

As is evident from the chart, state house plans' average efficiency gap in the 2000 cycle would have been substantially less pro-Republican (by about 0.5 percentage points) had Republicans not gained control of more state governments in this cycle relative to the 1990s. And in the current cycle, *all* of the efficiency gap's movement in a Republican direction would have been erased had the distribution of party control over redistricting not changed since the 1990s. That is, if the same distribution of party control had existed in this cycle as in the 1990s, state house plans' average efficiency gap would have been very close to zero, not over 3% in a Republican direction. Accordingly, it is the change in party control that appears to account for essentially all of the pro-Republican trend in the efficiency gap over the past two decades—and not, as claimed by Trende and Goedert, a dramatic alteration of the country's political geography.

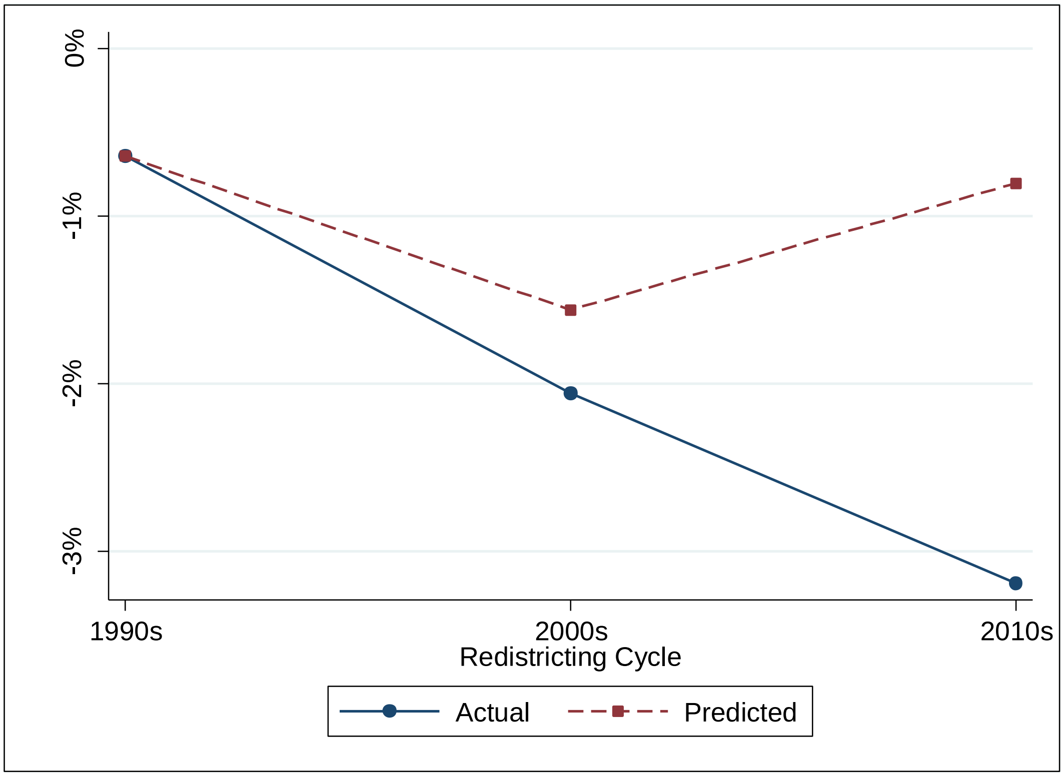

Figure 9: Actual and predicted values of state house plans' average efficiency gaps by cycle. Predicted values calculated assuming that the 1990s distribution of party control over redistricting remained constant in subsequent cycles.

6 Response to the Chen and Rodden map simulations

Both Trende and Goedert cite a recent article by Chen and Rodden (2013) that purports to find, based on simulations of hypothetical district maps, that random redistricting would benefit Republicans because of their more efficient spatial allocation (Trende, paragraphs 89, 126; Goedert, pp. 13, 18, 21). While I respect Chen and Rodden's contribution, there are several issues with their work that make it inapplicable here.

First, Chen and Rodden do not even attempt to simulate *lawful* plans. Rather, they simulate plans "using only the traditional districting criteria of equal apportionment and geographic contiguity and compactness" (Chen and Rodden, 248). They do not take into account Section 2 of the Voting Rights Act, which often requires majority-minority districts to be constructed. They also do not take into account Section 5 of the VRA, which until 2013 meant that existing majority-minority districts could not be eliminated in certain states. And they do not take into account state-level criteria such as respect for political subdivisions and respect for communities of interest, which are in effect in a majority of states (NCSL 2010, pp. 125-27).

Second, Chen and Rodden only use *presidential* election results in their analysis, but these outcomes may diverge from *state legislative* election results due to voter roll-off as well as voter preferences that vary by election level. As Stephanopoulos and McGhee have noted, "If certain voters consistently support Republicans at the presidential level and Democrats at the legislative level, then presidential data may produce more pro-Republican estimates than legislative data" (Stephanopoulos & McGhee, 870). In fact, this is exactly what seems to be occurring; at the congressional level, efficiency gaps are about 6% more Republican when they are calculating using presidential data than when they are computed on the basis of congressional election results.

Third, Chen and Rodden's simulated maps do not constitute a representative sample of the entire plan solution space. Their simulation algorithm has "no theoretical justification," is "best described as ad-hoc," and is not "designed to yield a representative sample of redistricting plans" (Fifield et al. 2015, pp. 2-3; Altman & McDonald 2010, p. 108). The explanation for this lack of representativeness is highly technical and involves the details of the particular simulation approach adopted by Chen and Rodden. But its implication is clear: that no conclusions can yet be drawn about the partisan consequences of randomly drawn maps.

Lastly, Chen and Rodden's results are directly contradicted by Fryer and Holden, who also simulated contiguous, compact, and equipopulous districts for multiple states. Unlike Chen and Rodden, Fryer and Holden found that, "[u]nder maximally compact districting, measures of Bias are slightly *smaller* in all states except [one]" (Fryer & Holden 2011, p. 514). Fryer and Holden also found that "[i]n terms of responsiveness . . . there are large and statistically significant" *increases* in all states, sometimes on the order of a fivefold rise (p. 514). Their analysis thus leads to the opposite inference from Chen and Rodden's: that randomly drawn contiguous and compact districts favor *neither* party and substantially boost electoral responsiveness.

7 Trende's analysis of particular plans

Trende devotes a large portion of his report (paragraphs 106-31) to analyzing the efficiency gaps of particular state legislative and congressional plans. He first examines a set of seventeen state legislative plans that had efficiency gaps favoring the same party over their entire lifespans, arguing that not all of these plans were gerrymanders (paragraphs 106-14). He then cites a series of congressional plans, some of which he claims had large efficiency gaps despite not being gerrymanders, and others of which allegedly had small efficiency gaps despite being gerrymanders (paragraphs 115-24). All of this analysis is riddled with conceptual and methodological errors that, in my judgment, renders it unreliable and unhelpful to the court.

Beginning with the set of seventeen state legislative plans that had efficiency gaps of the same sign throughout their lifespans, Trende asserts that they "would be included in the definition of a gerrymander," and are a "list of gerrymandered states" (paragraphs 109-10). But neither plaintiffs nor I argue that these plans should have been held unconstitutional. That is, neither plaintiffs nor I argue that these plans were designed with partisan intent (the first element of plaintiffs' proposed test), that their initial efficiency gaps exceeded a reasonable threshold (the second element), or that their efficiency gaps could have been avoided (the third element). To the contrary, I simply included these plans in my report to illuminate historical cases in which the efficiency gap's direction did not change over the course of a decade. I never stated or implied that these plans should have been deemed unlawful.

However, if we focus on the plans among the seventeen that likely *would* have failed plaintiffs' proposed test (at least the first two elements), we see that both the test and the efficiency gap perform exceptionally well. Five of the seventeen plans featured unified control by a single party over redistricting (from which, like Goedert (2014) and Goedert (2015), we can infer partisan intent) as well as an initial efficiency gap above 7% (the threshold I recommended in my initial report): Florida in the 1970s, Florida in the 2000s, Michigan in the 2000s, New York in the 1970s, and Ohio in the 2000s. Assuming that these plans' large efficiency gaps were avoidable (a granular inquiry that cannot be carried out here), it would have been quite reasonable for all of these maps to attract heightened judicial scrutiny. In particular:

- Florida's plan in the 1970s was designed exclusively by Democrats, opened with a 9.9% pro-Democratic efficiency gap, averaged a 7.0% pro-Democratic efficiency gap over its lifespan, and never once favored Republicans.

- Florida's plan in the 2000s was designed exclusively by Republicans, opened with a 8.9% pro-Republican efficiency gap, averaged a 11.2% pro-Republican efficiency gap over its lifespan, and never once favored Democrats.
- Michigan's plan in the 2000s was designed exclusively by Republicans, opened with a 12.0% pro-Republican efficiency gap, averaged a 10.3% pro-Republican efficiency gap over its lifespan, and never once favored Democrats.
- New York's plan in the 1970s was designed exclusively by Republicans, opened with a 10.7% pro-Republican efficiency gap, averaged a 9.7% pro-Republican efficiency gap over its lifespan, and never once favored Democrats.
- Ohio's plan in the 2000s was designed exclusively by Republicans, opened with a 8.6% pro-Republican efficiency gap, averaged a 9.0% pro-Republican efficiency gap over its lifespan, and never once favored Democrats.

Accordingly, we see that if my report's set of seventeen plans is analyzed properly, the opposite conclusion emerges from the one advocated by Trende. Only a subset of the seventeen plans likely would have failed plaintiffs' proposed test. But *every member* of this subset turns out to have been an exceptionally severe and durable gerrymander, featuring a very large and consistent efficiency gap over its lifespan. These are *precisely* the historical cases in which judicial intervention may have been advisable.

After commenting on these seventeen state legislative plans, Trende discusses a series of *congressional* plans, all from the 2000 and 2010 redistricting cycles. These congressional plans are entirely irrelevant to this case, which deals only with state legislative redistricting. Neither in their complaint nor in their subsequent filings do plaintiffs ever argue that their approach should be applied to congressional plans. And neither Mayer nor I provide any empirical analysis of congressional plans. In my initial report, in particular, I examined state legislative plans from 1972 to the present, but no congressional plans at all.

This state legislative focus has two explanations. First, and more importantly, each congressional delegation is *not* a legislative chamber in its own right, but rather a portion (often a very small portion) of the U.S. House of Representatives. Methods applicable to entire chambers cannot simply be transferred wholesale to delegations that make up only fractions of Congress. Second, most congressional delegations have many fewer seats than most state houses. The efficiency gap becomes lumpier when there are fewer seats, because each seat accounts for a larger proportion of the seat total, and the efficiency gap thus shifts more as each seat changes hands. This lumpiness is entirely avoided when state legislative plans, which typically have dozens or even hundreds of districts, are at issue.

For these reasons, Stephanopoulos and McGhee make two adjustments when analyzing congressional plans in their work on the efficiency gap. First, they convert the efficiency gap from percentage points to *seats* by multiplying the raw efficiency gap by each state's number of congressional districts. As they explain their method, "What matters in congressional plans is their impact on the total number of *seats* held by each party at the national level. Conversely, state houses are self-contained bodies of varying sizes, for which *seat shares* reveal the scale of parties' advantages and enable temporal and spatial comparability" (Stephanopoulos & McGhee, 869). Second, they only calculate efficiency gaps for states with at least eight congressional districts. Efficiency gaps are lumpier for states with fewer than eight districts, and additionally, congressional "redistricting in smaller states has only a minor influence on the national balance of power" (Stephanopoulos & McGhee, 868).

In his report, Trende fails to make either of these necessary adjustments when examining congressional plans. That is, he does not convert the efficiency gap from percentage points to seats, and he calculates the efficiency gap for small congressional delegations with fewer than eight seats. There is no authority in the literature for his methodological choices, and he is unable to cite any. And his flawed methods have serious substantive consequences that render his results entirely untrustworthy.

Take Trende's failure to convert the efficiency gap from percentage points to House seats. He claims that Alabama's congressional plan had an efficiency gap of -12.5% in 2002, that Arizona's congressional plan had an efficiency gap of 16% in 2012, that Colorado's congressional plan had an efficiency gap of -9% in 2002 and -10% in 2012, that Illinois's congressional plan had an efficiency gap of -9% in 2002, and that Iowa's congressional plan had an efficiency gap of -20% in 2002—all above my suggested 7% threshold for state legislative plans (paragraphs 115-16, 118-19, 121-22). But when converted to seats, *all* of these efficiency gaps become quite small, lower in all cases than the two-seat threshold proposed in the literature for congressional plans (Stephanopoulos & McGhee, 887-88). Specifically, using Trende's own calculations—which, as I discuss below, are incorrect in any event—Alabama had an efficiency gap of -0.9 seats in 2002, Arizona had an efficiency gap of 1.4 seats in 2012, Colorado had an efficiency gap of -0.6 seats in 2002 and -0.7 seats in 2012, Illinois had an efficiency gap of -1.7 seats in 2002, and Iowa had an efficiency gap of -1.0 seats in 2002. *None* of these scores are high enough to rise to presumptive unlawfulness under the literature's suggested two-seat threshold, meaning that we come to exactly the *opposite* conclusion as Trende after making the necessary adjustment.

Next take Trende's consideration of Alabama's congressional plan in 2002 (which had seven districts), Iowa's congressional plan in 2002 (five districts), and Colorado's congressional plans in 2002 and 2012 (seven districts each) (paragraphs 115-16, 119, 122). All four of these plans have fewer than eight districts, and so, based on the literature, should not be included in any efficiency gap analysis because of the measure's lumpiness when applied to so few seats. Trende nowhere acknowledges this limitation, and indeed appears unaware of its existence.

Moreover, Trende's study of congressional plans is marred by two further flaws, one conceptual and the other methodological. The conceptual defect is that, as in his earlier discussion of state legislative plans, he assumes that a large efficiency gap is all that is necessary to render a plan unconstitutional. He writes that efficiency gaps of -12.5%, -9%, -9%, -20%, and 16% "would invite court scrutiny as a Republican gerrymander" or "would invite court scrutiny as a Democratic gerrymander" (paragraphs 115, 116, 118, 119, 121, 122). But again, this is not plaintiffs' proposed test. A large efficiency gap is only a single prong of the test, and does not result in a verdict of unconstitutionality unless it is paired with a finding of partisan intent *and* a finding that it could have been avoided. Trende entirely overlooks these other elements.

The methodological defect is that whenever there were uncontested congressional races, Trende simply *substituted* presidential election results for the missing congressional results. As he put it in his deposition, he "used presidential results" and "imputed those results to the congressional races" whenever the races were uncontested (Trende deposition, p. 83). This is an exceptionally crude method that is guaranteed to produce errors, both because there is voter roll-off from the presidential to the congressional level and because voters may have different presidential and congressional preferences. Of course, presidential results can be used as the *inputs* to a regression model that *predicts* the outcomes of uncontested congressional races. Indeed, this is the preferred approach in the literature, and the approach I employed in my initial report. But presidential results cannot simply be plugged in without any adjustment, and no competent social scientist would have done so.

Accordingly, in my judgment, Trende's examination of particular state legislative and congressional plans is unreliable and entitled to no weight by the court. The state legislative analysis ignores the actual elements of plaintiffs' proposed test, and would have led to the opposite conclusion if these elements had been taken into account. Likewise, the congressional analysis ignores the test's prongs, fails to convert the efficiency gap from percentage points to seats, improperly considers states with small House delegations, improperly substitutes presidential election results whenever congressional results are missing—and deals with federal elections that simply are not part of this case.

Dated December 21, 2015

/s/ Simon Jackman
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Department of Political Science
Stanford University

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Case

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Rebuttal Report: Response to Expert Reports of Sean Trende and Nicholas Goedert

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December 21, 2015, Revised March 31, 2016

This report presents my responses to the criticisms that Sean Trende and Professor Nicholas Goedert make of my report.[1]

I. Summary

A. Both Trende and Goedert erroneously argue that Democrats are more geographically concentrated than Republicans in Wisconsin, which creates a natural pro-Republican bias even under a neutrally-drawn district plan. Both arguments are based on unreliable methodologies, flawed measures, and lead to inaccurate conclusions. Trende's methodology for measuring partisan concentration relies on an unorthodox method (the PVI) far more common among political commentators than academics who study spatial patterns of concentration and isolation. Moreover, as he applies it here, Trende relies on fundamentally inaccurate measures of geography that are guaranteed to demonstrate that Democratic wards are closer to one another than are Republican wards.

Goedert's arguments about geographic concentration are analogous to Trende's, and suffer from the same flaws in that they are based on superficial claims that do not rely on actual measures of spatial concentration or isolation. Moreover, Goedert's claims here contradict his own research, in which he finds that even after controlling for urbanization (a proxy for concentration), Republican control of the redistricting process has a large and statistically significant impact on a plan's bias. A model in one of his papers (Goedert 2015) also shows that a court-drawn or bipartisan map in Wisconsin would be expected to produce a *pro-Democratic bias*. The model generates the same expectation for a court-drawn or bipartisan map in a state that resembles the country as a whole. Accordingly, based on Goedert's own analysis, there is no natural pro-Republican tilt in either Wisconsin or the typical U.S. state.

In contrast to Trende's and Goedert's unorthodox techniques, widely (even universally) accepted measures of spatial distributions, such as Global Moran's I (Cho 2003) and the Isolation Index (Reardon 2004), show that Wisconsin's Republicans and Democrats are equally spatially concentrated and equally spatially isolated from each other, and that in some election years *Republicans are more concentrated* than Democrats.

B. Trende criticizes my method of estimating the partisanship of uncontested Assembly districts as biased. But his criticism stems from a superficial and erroneous discussion of a single figure in my report (Figure 2), and he erroneously believes that I set the Assembly votes in uncontested districts to the presidential vote in those districts. He does not take notice of the fact that my analysis was based on a comprehensive multiple regression model that controlled for the very factors that he claims create bias, nor that my model produces extraordinarily accurate forecasts of the actual data, using multiple methods.

[1] "Analysis of the Efficiency Gaps of Wisconsin's Current Legislative District Plan and Plaintiff's Demonstration Plan," July 3, 2015.

C. Trende criticizes my baseline measure of partisanship for not taking into account factors such as incumbency, candidate quality, and spending. This is an inaccurate criticism, because estimating baseline partisanship is *designed* to control for incumbency, campaign spending, and candidate quality. This is the method preferred in the academic literature on redistricting, which seeks to understand the consequences of hypothetical plans (in which candidate quality, spending, and incumbency are unknown). My approach is *identical* to the method used by Professor Gaddie, who produced the baseline partisan estimates used by Wisconsin's map drawers in 2011.

D. Goedert challenges my model for estimating baseline partisanship in 2012, contending that I took into account information that the authors of Act 43 did not have (the 2012 election results). However, my baseline estimates of partisanship are nearly identical to those generated by Gaddie in 2011, indicating the same conclusions follow whether 2012 or pre-2012 data are used in the analysis. In addition, pre-2012 election results are highly correlated with 2012 election results, indicating that it would make no difference if I had used earlier election results. Goedert dismisses the convergence between my estimates and Gaddie's estimates as "mostly coincidental," but offers no evidence or data to support his assertion.

E. Geodert also challenges my efficiency gap calculations for ignoring the effects of incumbency, which he asserts that any author of a redistricting plan would incorporate. His criticism fails to acknowledge that controlling for incumbency is the standard methodology for estimating the partisan consequences of a hypothetical district plan. Nevertheless, I recalculated efficiency gap estimates for both Act 43 and my Demonstration Plan, taking incumbency into account. The substantive conclusions are identical: the efficiency gap for my plan increases slightly (but is still well within acceptable limits), as does the efficiency gap for Act 43. The *difference* between the two plans' efficiency gaps remains enormous.

F. Goedert criticizes my efficiency gap calculations for not including any sensitivity testing to determine whether my results are robust to changes in the statewide electoral environment. I conducted a uniform swing analysis over the range of plausible election results, based on the maximum and minimum statewide Democratic Assembly vote since 1992. This analysis shows that the efficiency gaps of both Act 43 and the Demonstration Plan are robust: Act 43's efficiency gap remains very high across this range, significantly above the plaintiffs' suggested 7% threshold even in the face of an historic Democratic wave, and the Demonstration Plan's efficiency gap remains very low, and is always well below the threshold. Goedert is simply incorrect in asserting that the plans' respective efficiency gaps are not robust, and, again, offers no data or evidence to support his claim.

G. Throughout their reports, neither Trende nor Goedert has actually done any analysis that identifies problems with my analysis, or that specifically shows where my analysis is incorrect. Trende and Goedert merely offer speculative and unsubstantiated criticism, but never offer any substantive data or evidence that supports their arguments. And, as I will show, when they attempt to analyze Wisconsin's political geography, their conclusions are utterly wrong.

II. The Claim that Wisconsin's Political Geography Has a Pro Republican Bias

While I will go into more detail on the specific points each report makes, I focus first on a central argument both Trende and Goedert make: that Wisconsin has a natural distribution of Republicans and Democrats that produces an intrinsic pro-Republican bias in a neutrally-drawn redistricting plan. They claim that because Democrats in Wisconsin happen to be (allegedly) naturally concentrated in small pockets of overwhelming Democratic strength, even a neutrally-drawn map would produce a large pro-Republican efficiency gap. As a result, they conclude, it is not possible to consider a large pro-Republican efficiency gap as evidence of gerrymandering.

I begin by noting that both Trende and Goedert ignore the role that political geography already plays in plaintiffs' proposed test. Under the test's first prong, if the state's motive in enacting its plan was simply to follow the contours of the state's geography, then partisan intent would not be present and plaintiffs would proceed no further in their claim. Similarly, under the test's third prong, if the state can show that its plan's large efficiency gap was necessitated by the geographic distribution of the state's voters, then the plan would be upheld. These points mean that geography is already properly incorporated into plaintiffs' proposal.

There are, additionally, two points that fundamentally negate the utility of this line of attack. First, the geographic concentration argument is predicated on the foundational assumption that a *neutrally-drawn map* would have produced a pro-Republican bias. Even if Trende and Goedert are correct in this assumption (which they are not), they take no position on whether the process in Wisconsin was, in fact, neutral. The record of the federal redistricting trial clearly shows that Act 43 was designed with the predominant purpose of benefiting Republicans and disadvantaging Democrats, and neither Trende nor Goedert contradicts the findings in my report of examples of blatant packing and cracking that are the very DNA of a partisan gerrymander.

And second, even if the state's experts are correct that political geography has produced the pro-Republican bias in Wisconsin's state legislative district plan (which they are not), it is impossible for them to quantify *how much* of an effect geography has had: is it 5%? 10%? 90%? 100%? Neither Trende nor Goedert have actually done any analysis that *demonstrates* that the alleged concentration of Democrats *in Wisconsin* will produce a pro-Republican efficiency gap, or any work that quantifies how concentration is related to efficiency gap calculations. They simply assert (incorrectly) that Democrats are more concentrated than Republicans, and therefore that even a neutral map will produce a pro-Republican bias.

But they are also wrong on the facts. Their argument about geographic concentration is based on flawed data and measures, and has no basis in accepted methods of measuring geographic concentration and isolation. Trende, in particular, uses an unorthodox method with no support in the peer-reviewed literature, and one that is guaranteed to produce a biased result that shows Democrats far more concentrated than they actually are. Goedert's argument contradicts his own published work, which shows that partisan control of redistricting generates a substantial bias even after partisan concentration is taken into account. His argument, further, falls victim to the Modified Areal Unit Problem, in that it is based entirely on the analysis of wards, ignoring the fact that wards are aggregated into districts. As I demonstrate, this aggregation process completely changes the applicability of Goedert's conclusions.

When I analyze the geographic distribution of Wisconsin's Democrats and Republicans using widely accepted measures of spatial concentration and isolation (Global Moran's I and the Isolation Index), I find that there is very little evidence of significant disparities in how the parties' voters have been distributed in recent election cycles. Republicans are in fact *more concentrated* than Democrats when measured by the 2012 Assembly vote.

A. Trende

Trende spends nearly half of his report (paragraphs 62-105) arguing that Democrats are naturally more concentrated ("clustered") than Republicans in Wisconsin, which creates a natural packing effect. Much of this discussion is entirely irrelevant to Wisconsin (Trende's discussion of patterns in the southern United States, Virginia, and differences between the 1996 and 2008 Democratic coalitions; see paragraphs 62-77). Trende also simply asserts that "there is little doubt that the Democratic vote in Wisconsin is also increasingly concentrated in fewer counties" (paragraph 71). He neither explains the relevance of the *county* vote to the issue of geographic distribution and legislative redistricting, nor why the county vote pattern in 1988 or 1996 is germane to the environment in 2012.

1. The PVI (partisan vote index) is the wrong quantity of interest

As applied to Wisconsin, Trende attempts to demonstrate that over the last 20 years Democrats have become more concentrated. His method relies on a quantity he calls the Partisan Lean Index, which is the party's county or ward vote share minus the party's statewide vote share, and appears to be analogous to the Cook PVI, which is the same quantity calculated using the congressional district vote and the national presidential vote. Trende argues that Democratic wards are closer together than Republican wards, which to him is evidence of geographic clustering that produces a natural pro-Republican redistricting bias.

The PVI (which is how Trende abbreviates the measure) is a quantity that is not commonly used in the academic literature, and when it is, it is used largely as a simple descriptive statistic. What this index does is simply redistribute the ward vote around the statewide average, and thus tells us which areas are more Democratic (or Republican) than the state as a whole, and which areas are less so.[2] It tells us little about overall partisan strength, and is useful only in comparing elections at one level (here, counties or wards) to elections at another (the state).

The PVI is used almost exclusively by political commentators to describe congressional districts (the most widely known is the Cook PVI, which compares the average congressional district vote split over two consecutive elections to the average national presidential vote over those same elections). It is used less frequently in academic research, and then largely as a basic descriptive statistic used to classify districts as competitive or not. It is not used in the context of state legislative redistricting (Trende did not cite any studies that support the use of his measure, and could not identify any in his deposition).

Moreover, Trende appears to have made two errors in his calculation of the PVI.[3] First, while he states that his PVI is based on the top-of-the-ticket race in each year, he uses the gubernatorial elections as his top-of-the-ticket race in 2002, 2010, and 2014, but the U.S. Senate race in 2006, even though there was a gubernatorial race that year. While scholars may differ on whether a gubernatorial or U.S. Senate election is the correct top-ticket race, there is no justification whatsoever for being inconsistent.[4]

Second, in calculating his 2014 PVI, Trende mistakenly subtracted the *2014* statewide percentages from the *2012* ward totals (this is the code he used to generate the PVI for 2014; the error is highlighted, and "map_2012$r_share" is the ward vote for 2012):

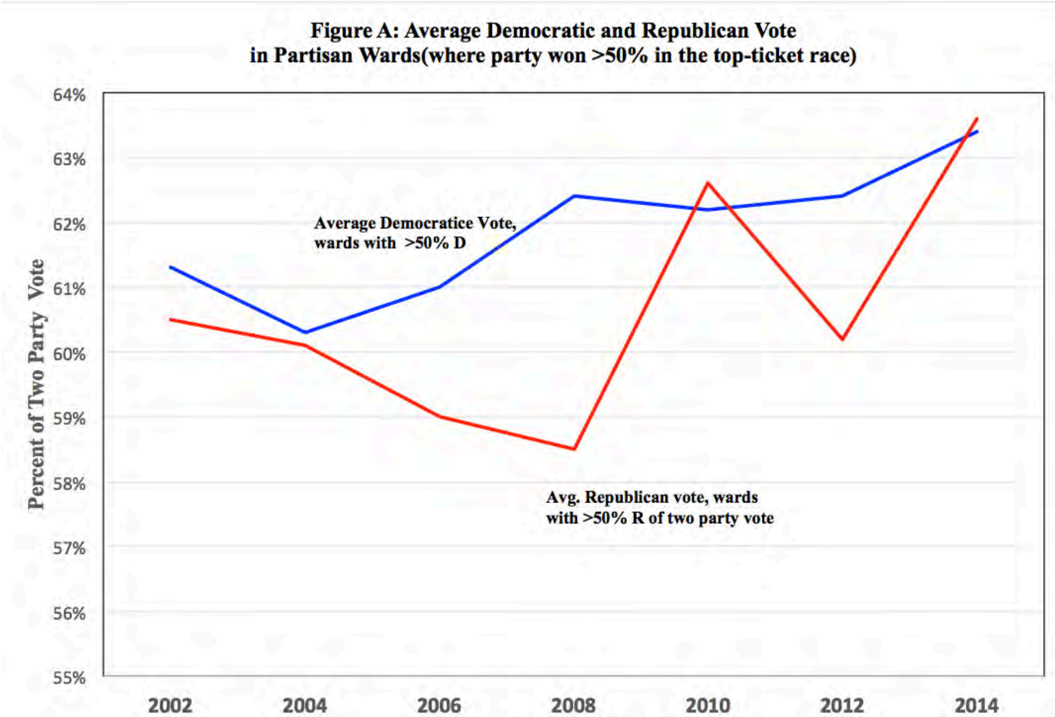
```
map_2014=readOGR("Wards_Final_Geo_111312_2014_ED.shp",
"Wards_Final_Geo_111312_2014_ED")
map_2014=spTransform(map_2014, CRS("+proj=longlat +datum=WGS84"))
map_2014$r_share=map_2014$GOVREP14/(map_2014$GOVREP14 + map_2014$GOVDEM14)
map_2014$pvi=map_2012$r_share - sum(map_2014$GOVREP14)/(sum(map_2014$GOVREP14) +
sum(map_2014$GOVDEM14))
map_2014$pvi[which(is.nan(map_2014$pvi))]=0
```

Instead of the PVI, the actual ward level vote (or party vote share) is a much more direct measure of ward partisanship. I used LTSB ward level data from 2002 to 2014 to calculate the average Democratic percentage of the vote in a Democratic ward (all wards that were more than 50% Democratic in the top-ticket race), and the average Republican vote in wards where Republicans won more than 50% of the top-ticket vote. A graph of this data shows a very different pattern from what Trende claims (Republicans are in red; Democrats in blue):

[2] The Cook Political Report notes that it "introduced the Partisan Vote Index (PVI) as a means of providing a more accurate picture of the competitiveness of each of the 435 congressional districts." http://cookpolitical.com/story/5604

[3] These occurred in the R file "Wisconsin_clustering_computation.R" that Trende disclosed.

[4] This inconsistency could well affect Trende's results, as the vote percentages were vastly different in the two races in Wisconsin. Democrats garnered 53.8% of the two-party vote in the gubernatorial election, but 60.5% in the Senate race (GAB data).



Here, we see that Democrats and Republicans have moved in almost identical fashion between 2002 and 2014. In 2002, Democrat wards were about 60.8% Democratic, and Republican wards were about 60.5% Republican in the top-ticket races. In 2014, similarly, both Democratic and Republican wards became more partisan: Democratic wards were 63.3% Democratic, and Republican wards 63.6% Republican.

Trende's claim that Democratic wards have become more Democratic, while Republican wards have not become more Republican (paragraphs 91-95), is simply false.

Trende offers no justification or support for why he is relying on the PVI measure rather than more direct indicators of ward partisanship; he merely asserts that it is a relevant quantity. Given that there are far more widely used and relevant measures of district level partisanship, his reliance on it in this context is unsupportable.

2. Trende's "Nearest Neighbor" Method is Inappropriate and Inaccurate

After introducing the PVI, Trende attempts to use it to demonstrate that Democrats have become more closely packed than Republicans (which, he asserts, produces a natural pro-Republican gerrymander). Apart from the irrelevance of the PVI, Trende's analysis uses a fundamentally flawed measure that is guaranteed to exaggerate the extent of Democratic concentrations. Instead of his measure, widely used and academically accepted metrics of concentration and isolation show that Democrats and Republicans are *both* highly segregated, and to about the same extent. Just as there are core areas of high Democratic strength in Milwaukee and Madison, there are similar Republican core areas in the "collar counties" of Waukesha, Ozaukee, and Washington.

The premise of Trende's argument is that pro-Democratic wards are closer to other pro-Democratic wards than are pro-Republican wards to other pro-Republican wards. His method, which I infer from his description, is to identify a pro-Democratic or pro-Republican ward of a certain percentage lean, and then to find the distance to the nearest ward with the *same* partisan lean. He determines the *median* distance between similar wards, and presents two graphs (about paragraph 98 in his report) showing that the median distance between similar Democratic wards is smaller than for Republican wards, and that as Democratic wards become more Democratic, they become closer to one another.

This is reminiscent of the nearest neighbor method used in the study of populations, but it bears little resemblance to how the concept is actually used in the literature, even in its earliest form (Clark and Evans (1954) used it to study the distribution of plant and animal populations).[5] His application of this method is highly unorthodox, unsuited to the study of redistricting, and not based on any accepted peer-reviewed academic work (he does not cite a single study in support of his method).

Trende's method is to start with a ward (call it *i*), calculate its PVI and assign it to a quantile, and then locate the closest ward that shares this PVI quantile (call it *j*). The geographic distance between wards *i and j* (presumably calculated using the ward centroids, although Trende fails to specify this key detail) is then recorded (paragraph 97). The process is repeated for every ward over every election from 2002 to 2014, producing for each election a matrix consisting of every ward and the distance to the nearest ward with the same PVI quantile. He then calculates median distances between wards of the same PVI quantiles, which he claims shows that Democratic wards are, and have been continuing to move, closer together than Republican wards.

There are several problems with this approach. First, and most fundamentally, the proximity of similar wards is simply not a measure of geographic concentration or clustering. Trende's method tells us nothing about which wards are actually *adjacent* to wards of a certain PVI. It only tells us how far these wards tend to be from other wards of the same partisan lean. It is entirely possible for wards of the same partisan makeup to be far apart but still easy to join in the same district (think of a sparsely populated but uniformly partisan area). Likewise, it is entirely possible that wards of the same partisan makeup are close together but quite difficult to combine in the same district (think of a densely populated but politically heterogeneous area). Trende's method cannot distinguish between these scenarios, and as a result it cannot tell us anything about the geographic patterns that actually matter for redistricting.

Second, Trende does not explicitly define in his report what a "similar partisan index" (paragraph 97) means. Clearly, Trende is classifying them in some way, defining "similar" as within some range, as his vague discussion of quantiles indicates (paragraph 98). But without specifying the range, it is impossible to know whether his measure has any meaning. Different

[5] Byers and Raferty (1998) use a near neighbor method to estimate the statistical relationship between points in space and how they differ from random distributions, or "clutter," in the context of distinguishing landmines from other objects during aerial reconnaissance. Neither their work nor Clark and Evans (1954) supports Trende's use of the method.

classification methods -- requiring a match of, say, within 0.1 percentage points, or classifying according to deciles or some other method -- are likely to yield very different results than requiring a match of within 0.5 or 1.0 percentage points or using a larger number of categories. His graphs suggest he is using some type of percentile distribution (the x axis label refers to "(.05% is the most Democratic [or Republican] Ward)," but he does not explicitly define why he chose this particular scheme or how he calculated the quantiles. On this point alone, his method lacks validity or replicability.

But there are two additional serious – fatal, in fact – flaws in this method. First, in treating the geographic distances between wards as his quantity of interest, Trende does not take into account the fact that wards in Wisconsin are not uniform in area. Ward areas actually vary widely: some are very small, others are moderate in size, and still others are very large (wards are drawn within specified population limits, but their geographic areas are not similarly constrained).

Table A shows the mean and median areas (in square miles) of Wisconsin wards. The average is 8.41 mi^2, but the range is huge: the smallest ward with a nontrivial population is in the City of Middleton: ward 19, with 690 people in an area of 0.0071 mi^2. The largest ward in the state is in the Town of Winter: ward 2 (in Sawyer County), with 565 people in an area of 227.7 $mi^{2.}$

Geographic distances between ward centroids will, obviously, depend on how large the wards are. Although centroid-to-centroid distances will not map perfectly onto area differences (because the distances will vary with the shape and orientation of wards), two large wards – even if they are adjacent – will show up as much farther apart than two smaller wards that might be separated by numerous other wards and municipal boundaries.

The problem is magnified when we observe that ward sizes are correlated with other relevant variables, particularly whether a ward is in a city, and most crucially, whether it is a Democratic or Republican ward:

Table A 2012 Ward Sizes (square miles)[6]	Mean	Median
Statewide Average	8.41	1.12
City of Milwaukee	0.29	0.20
Rest of State	8.83	1.27
Democratic Wards	5.91	0.56
Republican Wards	10.96	3.45

Wards in the city of Milwaukee have a mean area of only 0.29 mi^2, which is 3% of the size of the mean area statewide. Democratic wards (measured by whether the 2012 Democratic presidential vote was above 50%) are, on average, only about half the size of Republican wards (5.91 mi^2 vs. 10.96 mi^2).

In relying on the distance between wards, Trende is thus putting his thumb on the scale; all other things equal, this method will *always* show Democratic wards to be much closer than Republican wards, irrespective of whether this concentration is real or merely an artifact of ward area. To put it most simply, smaller Democratic wards will *always* appear closer than larger Republican wards.

But a second and equally serious problem lurks. Trende does not use the *mean* distance between wards as his quantity of interest, but rather the *median*. He justifies this choice "because outlying wards, such as Menominee County, exert an undue amount of leverage on averages" (paragraph 97).

This is the wrong measure, because the "nearest neighbor" approach is unlikely to pair, say, a ward in Milwaukee with a ward in northwest Wisconsin. Menominee County will not exercise "an undue amount of leverage" because it is an outlying ward. It will exercise an undue amount of leverage because it *has a very large area* (222.8 mi^2), which is something Trende should, but does not, correct for.

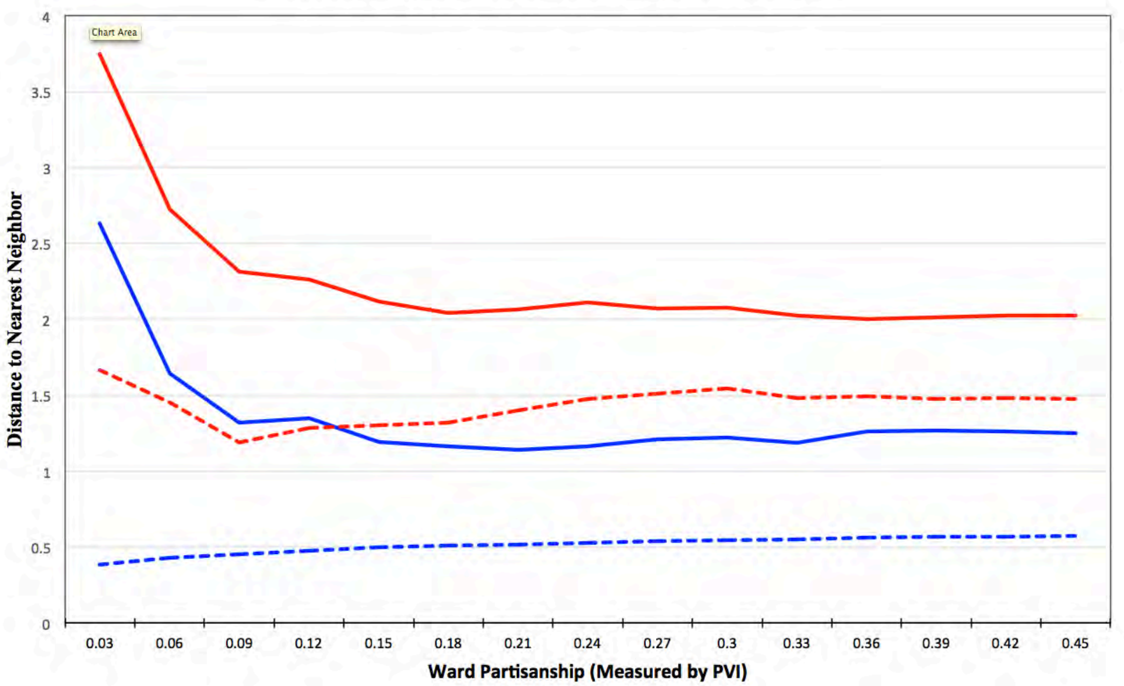
His use of the median rather than the mean further exaggerates the difference between Republican ward distances and Democratic ward distances. The average Republican ward area is 1.9 times larger than the average Democratic ward area (10.96 vs. 5.91 mi^2). But the *median* Republican ward is *6.2* times larger than the median Democratic ward (3.45 mi^2 vs. 0.56 mi^2).

[6] Calculated directly from the LTSB shape files of 2012 wards, obtained from http://legis.wisconsin.gov/gis/data.

Because the disparity is three times larger for the median versus the mean area, Trende is further stacking the deck in favor of his preferred hypothesis.

I was able to replicate Trende's analysis, using LTSB data and the R code he disclosed. When the mean distances between similar wards are included, Figure B is the result for the 2012 Election:[7]

Figure B
Nearest Neighbor Analysis: Mean vs. Median Distance



In this graph, the dotted lines are the median nearest neighbor distances for Democratic (blue) and Republican (red) wards, replicating what Trende did in his median distance graphs around paragraph 98 in his report. Wards become more partisan as we move from right to left.

The *mean* distances are shown with solid lines. While Republican wards remain farther apart than Democratic wards, the mean distances for both parties are much larger than the median distances. Proportionally, Republican and Democratic wards are much closer together in mean than in median distances (which is what one would expect, given the exaggerated difference between median Democratic and Republican ward sizes). Specifically, the mean distance between Republican wards is only about 70% larger than the mean distance between Democratic wards, compared to a 180% difference between the median Republican and Democratic distance.

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[7] The pattern Trende identifies is largely constant across all elections; adding the additional cycles will not change the results.

More relevant is the shape of the mean distance lines. They show that Republican and Democratic distances move precisely in parallel, and that strongly Democratic wards are significantly *farther apart* than weaker Democratic wards (as are strongly Republican wards). This is the complete opposite of Trende's claim that stronger Democratic wards are closer together than weaker Democratic wards, and it obliterates the core of Trende's report: the assertion that the pro-Republican bias evident in Act 43 is the natural result of Democrats being more geographically concentrated.

To conclude, Trende's argument about Democratic concentration is based on an irrelevant measure of partisanship (PVI) that is incorrectly calculated, applies a methodology that bears no relationship to any scholarship or actual research on spatial distribution, ignores a key feature of Wisconsin's actual political geography (ward area), relies on an improper distance measure that is enormously biased in favor of his hypothesis, and produces a result that fundamentally misrepresents what the data actually shows. Because of his use of a questionable method and fundamentally flawed measures, Trende's opinions should be regarded as uninformative.

B. Goedert

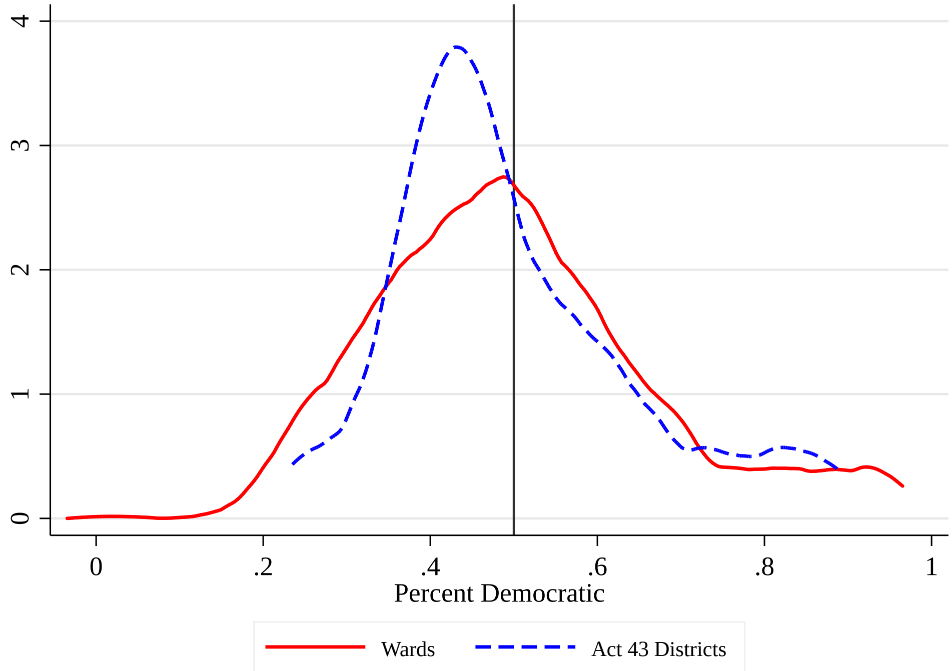
Goedert, like Trende, asserts that Wisconsin's natural geography creates an intrinsic pro-Republican bias in redistricting (p. 17). He cites his own research that geography produced a pro-Republican bias in the 2012 congressional election (p. 19).

The only analysis Goedert conducts as to Wisconsin is an examination of wards, which he claims shows "the bias inherent in Wisconsin's geography" (p. 21). His analysis is a simple "uniform swing" study of wards in 2012, adjusting the Democratic presidential vote in each ward downward by 3.5% to determine the overall ward distribution in the event of a tied election (Figure 1, p. 22). He asserts that based on this analysis, "Republicans would win 60.2% of wards, comprising 54.4% of the voting population" in a tied election (p. 22). This is the extent of his analysis.

This analysis, however, is a non sequitur, because it fails to aggregate wards to the relevant geographic level, which is *districts*. Goedert's failure to take this into account is an example of the Modified Areal Unit Problem, in which inferences at one level of geography frequently do not hold at other levels of aggregation; see King (1996). In this example, the ward level vote is far less relevant than the district level vote, because it is entirely possible that wards will be aggregated in such a way that the pattern he observes either disappears (or even reverses).

When we examine the distribution of *districts*, which have a population deviation small enough that we can consider them equal (the deviation under Act 43 is 0.76%), we in fact see almost the reverse pattern. The following graph (Figure C) displays Goedert's adjusted ward level presidential vote in a simulated 50-50 election, along with an adjusted baseline forecast for Act 43 districts, using my baseline open seat model, in a simulated tied election. Both wards and districts are weighted based on the number of votes cast in each unit. This allows me to directly compare ward level results to district level results:

Figure C: Distribution of Wards vs. Districts



What this figure demonstrates is that as wards are aggregated into districts, the distribution substantially changes. The red line is a kernel density plot of the ward Democratic vote percentage in a simulated tied election; it is a continuous version of the histogram Goedert presents in his Figure 1. The dotted blue line shows the predicted Democratic vote in Act 43 districts in a simulated tied election – or, what occurs after the wards are aggregated into Assembly districts. The overall shape of the curves, the mode of each distribution, and even the mean vote percentage vary as we aggregate from wards up to districts. Knowing the ward distribution ultimately does not tell us much about what the distribution of districts will look like; the process of aggregation is crucial.

More significantly, the district distribution is much more tilted in a Republican direction than is the ward distribution. The ward distribution is nearly normal in shape, and has a peak very close to 50% Democratic. In contrast, the *district* distribution is skewed to the right, and has a much higher peak around 42% Democratic, meaning that there are many more districts that Republicans win by relatively small margins (indicating that Democrats are cracked), and many more districts where Democrats win by much larger margins (indicating packing). Accordingly, the district distribution does *not* mirror the underlying distribution of wards. Rather, it reveals that Act 43's designers were able to distort a fairly neutral ward distribution into a far more advantageous district distribution, through gerrymandering.

1. Goedert's Published Work Contradicts His Report

Goedert's own prior work indicates that unified party control of state government has an independent and significant effect on the bias of redistricting plans, even after controlling for population concentration. This work also indicates that if Wisconsin, or a state resembling the country as a whole, had a court-drawn or bipartisan map in 2012, this map would have had a slight *pro-Democratic* bias. These findings further obliterate the claim that Act 43's extreme partisan tilt resulted from Wisconsin's natural political geography.

In a 2014 article, Goedert analyzes the consequences of different redistricting processes, looking for evidence that partisanship and geography each have an independent effect on the partisan bias of redistricting plans.[8] Using an unorthodox definition of gerrymandering – Goedert defines *any* redistricting plan created in a state with unified party control of state government as a partisan gerrymander – he finds that in states with more than six congressional districts, both urbanization (a proxy for Democratic concentration) and unified party control have a strong and statistically significant effect on the bias of a district plan (2014, 6). Goedert interprets his results as indicating that geography matters, and that higher urban concentration leads to more bias against Democrats (2014, 6). But what his results also show is that *even after taking urbanization into account*, the partisanship of the map drawers introduces a separate and significant bias: Republican-drawn maps are associated with an additional *13.6%* pro-Republican bias.

Geodert updated his 2014 article in a more recent manuscript, which incorporated the results of the 2014 midterm elections. Here, he finds that urbanization *no longer has a statistically significant effect* on the bias of district plans (2015, 6). Yet he stills finds evidence that the partisanship of map-drawers has a significant effect on district plans' bias (in 2014, a Republican-drawn plan adds 12.4% bias, or roughly the same as the 13.6% estimate for 2012).

So, on the one hand, Goedert's own work comes to different conclusions about the impact of urbanization (or Democratic concentration): sometimes it matters, other times it does not. But his work is consistent about the effect of partisan control: when partisans draw maps, they *always* do so in ways that dramatically bias plans in their favor. The clear inference is that geography matters much *less* than partisan control in explaining plans' electoral consequences.

Furthermore, we can use Goedert's regression model to generate a forecast of what would have occurred in 2012 in Wisconsin – as well as in a state resembling the country as a whole – under a neutral process (i.e., a court-drawn or bipartisan plan). His regression model includes the following variables (2015, 11):

1. Whether a district plan was drawn by Democrats or Republicans (court-drawn and bipartisan plans are the excluded category)
2. A state's African American population percentage
3. A state's Hispanic population percentage

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[8] Goedert's definition of bias is essentially identical to the efficiency gap. He "compare[s] the mean vote share with the expected seat share under a 'fair' map with zero bias and a historically average seats-votes curve" (2014, 3). In the "historically average seats-votes curve," "a 1% increase in vote share will produce about a 2% increase in seat share," which is the same seat-vote relationship implied by a zero efficiency gap (2014, 3). Goedert's bias estimates are thus largely indistinguishable from the efficiency gap calculations of Stephanopoulos and McGhee (2015).

4. The percentage of a state that is urbanized (according to the Census)
5. The statewide Democratic vote
6. The number of congressional seats.

With the coefficients of this model, and the appropriate data for Wisconsin (or any other state), we can calculate what the expected bias would be for a plan in 2012.[9] The dependent variable here is a measure of bias almost identical to the efficiency gap, with positive values indicating a pro-Democratic bias, and negative values a pro-Republican bias. Because this is a linear regression, we can multiply each coefficient by the value of the independent variable, and then sum the results to generate a forecast from any set of data values. In Table B, I set both Democratic and Republic Gerrymanders to 0, simulating a neutrally-drawn plan:

[9] Goedert generated two models, one for states with fewer than 6 congressional districts, and another for states with more than six. As Wisconsin has 8 districts, I use the latter.

Table B Goedert's Regression Model for 2012 Dependent Variable: Pro-Democratic Bias in a District Plan			
Variable Name	**(a) Coefficient Value**	**(b) Variable value for Wisconsin**	**Value (a) x (b)**
Democratic Gerrymander	16.6	0	0
Republican Gerrymander	-13.6	0	0
% Black	-0..29	6.6	-1.914
% Hispanic	0.77	6.5	5.005
% Urbanized	-0.72	70.2	-50.544
Statewide Democratic Congressional Vote	0.11	50.8 (2012)	5.588
Number of Seats	-0.16	8	-1.28
Constant	45.0	1	45
Total	**(sum of all values)**		**1.855**

Goedert's regression model thus predicts that if Wisconsin had a neutrally drawn plan in 2012, the resulting map would have had a *pro-Democratic* bias of 1.855%. In other words, in the absence of unified Republican control over the redistricting process, Wisconsin's demographic, geographic, and political characteristics would have resulted in a small natural *Democratic* advantage. And this is no fluke of the state or the election year. We can also use Goedert's model to predict what would happen in a state resembling the United States as a whole (i.e., a state that is 13.2% black, 17.4% Hispanic, 80.7% urbanized, 51% Democratic, and with

8.7 congressional seats[10]). Substituting these values into the regression model shows that in an "average" state, a neutrally-drawn map would have had a *pro-Democratic bias* of 0.684% in 2012.

Goedert's 2014 variant of the model (2015, 13) further predicts that Wisconsin would have had a *pro-Democratic bias* of 4.392% in 2014, and that the average state would have had a *pro-Democratic bias* of 1.589%. At this point, it is hard to see what is left of the thesis that political geography inherently favors Republicans. If anything, Goedert's own published analysis shows that Wisconsin's political geography slightly favors *Democrats*.

C. Accepted Measures of Geographic Concentration and Isolation Show that Democrats and Republicans are Equally Dispersed

In arguing that Republicans in Wisconsin enjoy a natural geographic advantage, both Trende and Geodert use ad hoc, unorthodox measures of concentration that are neither relevant nor accepted by the academic literature. In fact, there exist widely accepted metrics of geographic concentration and dispersion, used by geographers and demographers to study spatial patterns. Two of the most common are Global Moran's I (Anseln 1995; Cho 2003), and the Isolation Index (Glaeser and Vigdor 2012; Reardon 2004). I use these metrics to determine how Democrats and Republicans in Wisconsin are actually distributed.

Moran's I is a measure of spatial autocorrelation, or how values of a variable in space correlate with values in nearby space. It can be calculated for an entire geographic system (Global Moran's I), or for any specific point in space (Local Moran's I). The Isolation Index indicates, for the average member of a group residing in a certain geographic unit (such as a ward), what share of the member's neighbors in the unit belong to the same group (Iceland and Weinberg 2002, 120). It measures how geographically isolated a group is (Reardon 2004, 153), and it can easily be adjusted, by deducting a group's share of the statewide population, to show how much *more* isolated a group is than we would expect given its statewide size (Glaeser and Vigdor 2012, 2). Both Moran's I and the Isolation Index are widely used in studies of residential segregation and sorting (Chung and Brown 2007; Massey and Denton 1989; Glaeser and Vigdor 2012; Dawkins 2007; Reardon 2004; Iceland and Weinberg 2002), epidemiology (Moore and Carpenter 1999), network effects (Cho 2003), and political geography (Glaeser and Ward 2005). The measures are also used by the U.S. Census Bureau itself (Iceland and Weinberg 2002).

Both Moran's I and the Isolation Index are directly applicable to the issue of measuring the geographic distribution of Democrats and Republicans in Wisconsin. In this context, Global Moran's I tells us how likely Democrats are to live clustered next to other Democrats (and Republicans to Republicans), and the Isolation Index, adjusted as noted above, tells us to what extent the average Democrat (or Republican) lives in a ward that is more heavily Democratic (or Republican) than the state as a whole. I use these indices to directly assess the geographic distribution of Democrats, and, more importantly, to compare it to the geographic distribution of Republicans.

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[10] Calculated as 435/50.

Global Moran's I is analogous to a correlation coefficient, and ranges from -1 to 1; scores close to 1 indicate a very high spatial correlation (i.e., clustering) of Democrats (or Republicans). The Isolation Index ranges from 0 to 1, and, adjusted as noted above, indicates to what extent the average Democrat or Republican lives in a ward that is more heavily Democratic or Republican than Wisconsin as a whole. In calculating both measures, I use the ward as the basic unit of geography and actual Assembly votes.[11] Because I only have geodata for the current wards, I only estimate Global Moran's I for 2012 and 2014. For the Isolation Index, I compute scores dating back to 2004. Both Global Moran's I and the Isolation Index are asymmetrical, and so must be calculated separately for Democrats and Republicans.

Table C shows the values of the Isolation Index, adjusted as noted above, for Democrats and Republicans in Wisconsin from 2004 to 2014:

	Table C Isolation Index	
	Dem-Rep	**Rep-Dem**
2014	0.23	0.20
2012	0.14	0.12
2010	0.15	0.17
2008	0.15	0.14
2006	0.16	0.17
2004	0.20	0.21

As is evident from Table C, Democrats were slightly less isolated than Republicans in 2004, 2006, and 2010, and slightly more so in 2008, 2012, and 2014. In all cases, the differences in isolation were very small, amounting to only one to three percentage points (out of a scale extending from 0% to 100%). In the 2012 election, for instance, the average Democrat lived in a ward whose Democratic vote share was 14% more Democratic than the state as a whole; analogously, the average Republican lived in a ward whose Republican vote share was 12% more Republican than the entire state. In the previous election, it was Republican voters who were more isolated than Democratic voters (17% versus 15%). This analysis in no way supports the claim that Republicans are more advantageously distributed than Democrats; on the contrary, both parties' supporters are almost identical in their geographic isolation over the last decade, and there is no clear temporal pattern. In some years, Democrats are marginally more isolated than Republicans, and in other years Republicans are marginally more isolated than Democrats.

[11] I calculated Global Moran's I using the method in Bivand and Piras (2015) and the R module spdep available at https://cran.r-project.org/web/packages/spdep/index.html. I calculated the isolation index using a Stata module (seg), available at http://econpapers.repec.org/software/bocbocode/s375001.htm.

The results are very similar with the Global Moran's I, again calculated for Democrats and Republicans in Wisconsin, although only for the two elections (2012 and 2014) for which the geodata is readily available:

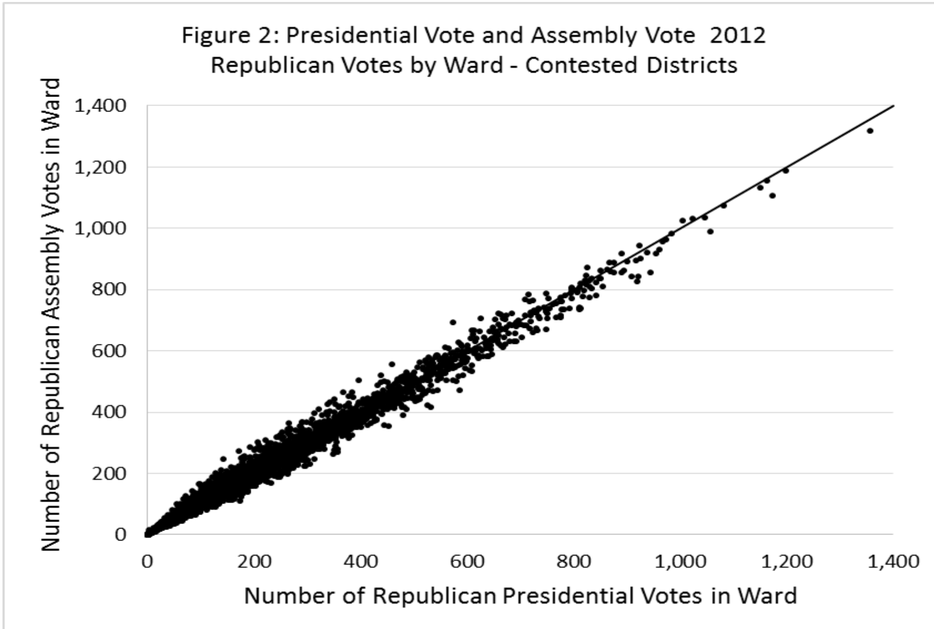
	Table D Global Moran's I	
	Democrats	**Republicans**
2014	0.75	0.68
2012	0.68	0.69

Here, we see that Democrats were slightly less spatially concentrated than Republicans in 2012, but slightly more spatially concentrated in 2014. The differences in both cases are tiny: 0.01 in 2012 and 0.07 in 2014, on a scale that stretches from -1 to 1. The message is quite clear: *both* Democrats and Republicans in Wisconsin tend to live near one another in distinct clusters, but there is no evidence that Democrats are *more* geographically clustered than Republicans.

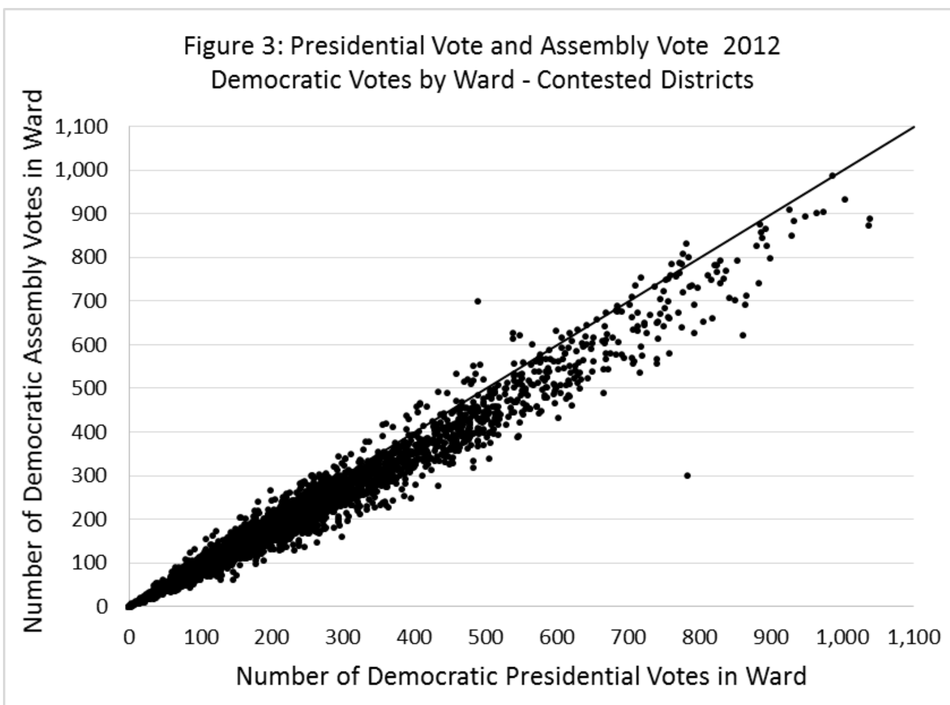
Accordingly, two widely used and accepted measures of geographic distribution show no consistent pattern, and no material difference in how Wisconsin's Democrats and Republicans are dispersed spatially. In no sense, therefore, is it an accurate statement that Democrats are much more concentrated than Republicans – the unsubstantiated claim that comprised the core of both Trende's and Geodert's arguments about natural gerrymanders.

III. Trende's Claim That My Vote Model Is Biased Is Incorrect

Trende claims that there may be "a systematic bias involved in imputing presidential results to state House results" (paragraph 135). As evidence he points to Figures 2 and 3 in my original report, which display the relationship between the ward level presidential vote and the ward level Assembly vote. Trende notes that Figure 2 shows that there is close to a 1:1 relationship between Republican presidential and Assembly votes, as the dots on the graph are distributed around the 45-degree line:



However, Trende claims that the relationship is different for Democratic votes (Figure 3 in my original report):



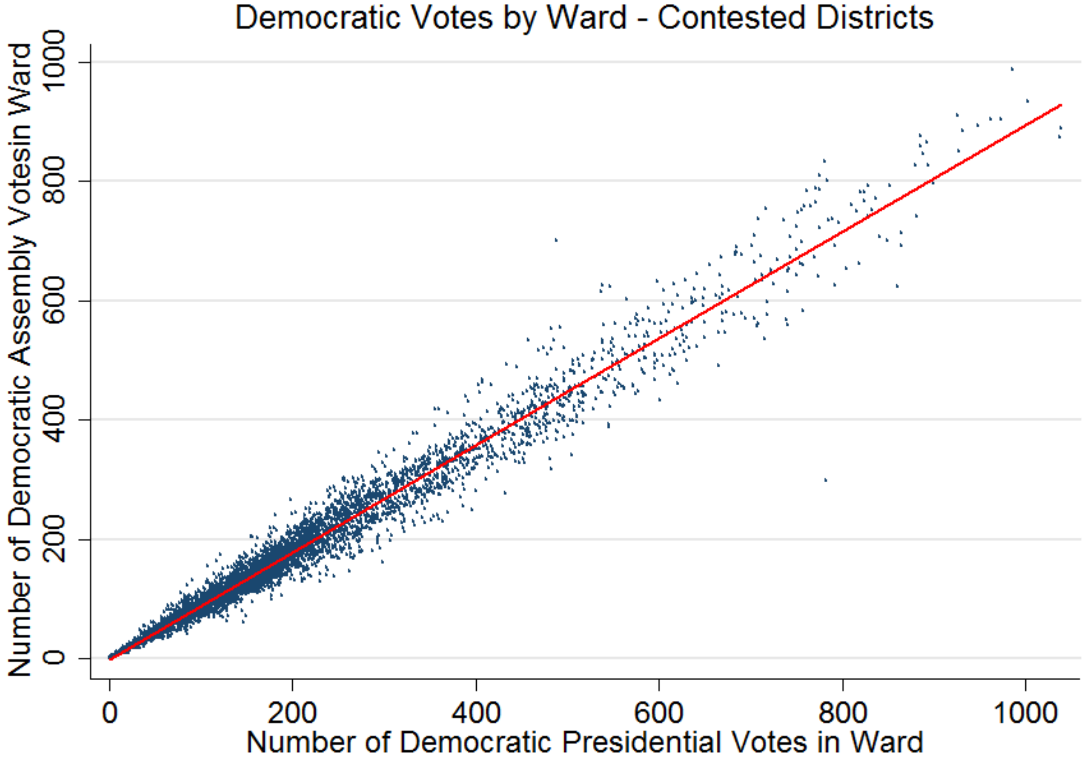
Here, Trende argues, the "dots systematically fall below the line, often creating differences on the order of 10 percent" (paragraph 138). This pattern, he asserts, will "skew the imputation" of votes, resulting in "too many votes [being] imputed in wards reporting a high number of Democratic votes" (paragraph 139).

Trende is completely and unambiguously wrong in this claim, which belies a fundamental lack of understanding of multiple regression and the causes of bias in statistical models. Trende appears to believe that I simply assumed that ward level Democratic Assembly votes are actually *equal* to ward level Democratic presidential votes, or that in estimating the Assembly vote in uncontested wards I merely used the value of the presidential vote (presumably because that is how he imputes the vote in uncontested districts in his own analysis; deposition page 83).

That is wrong. I displayed this graph merely to show that there is in fact a strong relationship between the two variables. The fact that the Democratic Assembly vote tends to fall below the presidential vote is completely irrelevant to any possible bias. In fact, regression analysis estimates the relationship between the two quantities by identifying the *slope* of the line that relates them, not how the relationship varies across a 45-degree line.

Below (Figure D) is a graph that plots the data in Figure 3 of my original report along with a fitted line of predicted values from a bivariate regression of the Democratic Assembly vote on the Democratic presidential vote. The red line consists of the predicted values of the Democratic Assembly vote in each ward:

Figure D: Presidential Vote and Assembly Vote 2012
Democratic Votes by Ward - Contested Districts



Here, we see that the fitted line runs *exactly* down the middle of the plotted points. My regression analysis of the Democratic Assembly vote (Table 1 in my original report) shows that the coefficient for the Democratic presidential vote is 0.931 ($p<0.0001$), which is precisely the pattern than we see in the bivariate relationship above. In a linear model, this coefficient is the

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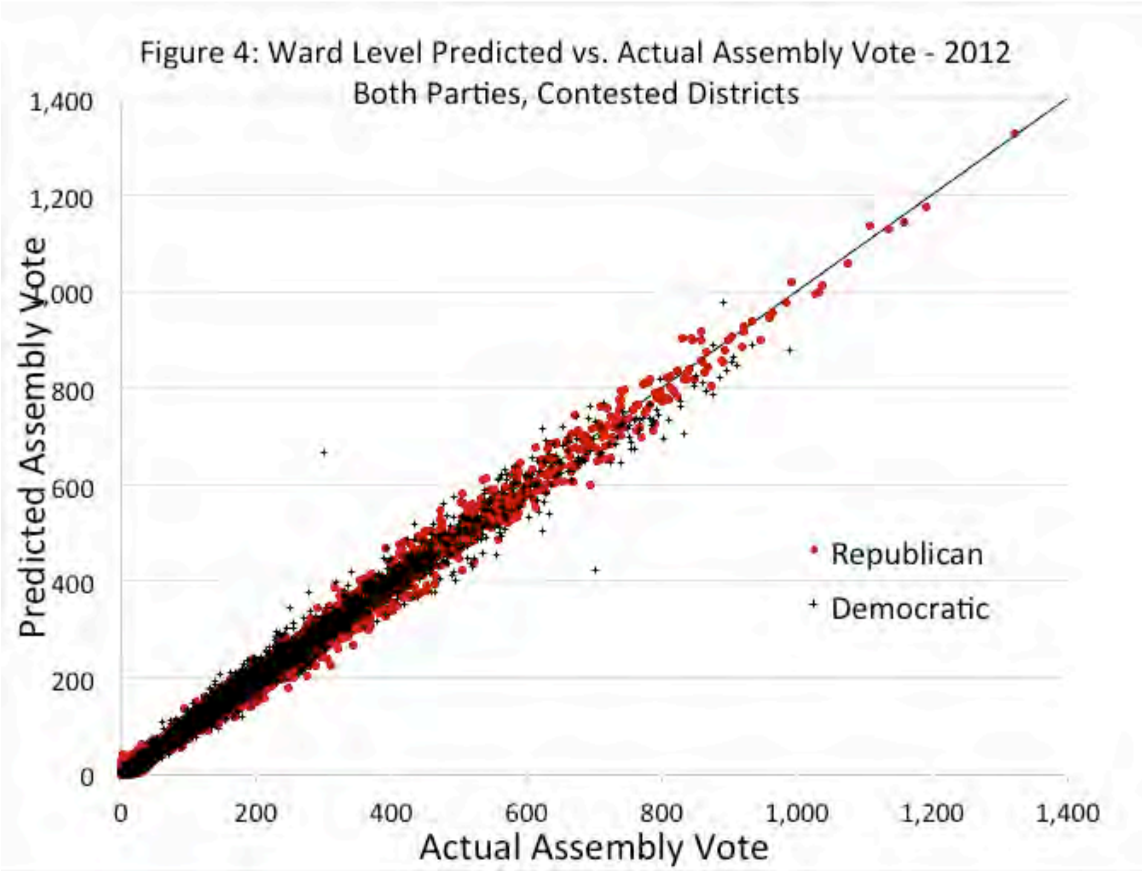
slope of the line that relates the presidential vote to the assembly vote. It is less than 1 (a 45-degree line), indicating that the Assembly vote rises more slowly than the presidential vote; i.e., the predicted Assembly vote will lie below the 45-degree line in Figure 2.

And, as is immediately apparent from the actual results of my regression (Figure 4 in my original report, which plots the actual vs. predicted ward level votes), there is no bias in the results. In this graph, the 45-degree line is where the *predicted* Assembly vote would fall if it were exactly equal to the actual Assembly vote:



Trende's criticism on this point is utterly misinformed. No one with a solid understanding of quantitative methods or regression analysis would have made it.

IV. Trende's Claim That My Efficiency Gap Calculations Ignore Incumbency, Candidate Quality, and Campaign Spending

In paragraphs 140-143, Trende criticizes my efficiency gap calculations for failing to take into account factors that can affect election results, such as get-out-the vote drives, candidate quality, recruitment, and campaign spending.

Trende offers no evidence that these factors would actually have a material effect on my estimates if I had more directly taken them into account. And he ignores the fact that any estimation of the results of a hypothetical district plan utilizes baseline estimates that, in effect, average out the effects of these factors (Gelman and King 1990; 1994). That is to say, my regression model *does* implicitly incorporate these factors, in its analysis of the relationship between the presidential vote (where none of these variables will affect the vote) and the Assembly vote (where they are all incorporated into the estimates).

Moreover, Trende's criticism overlooks the point that my model is based on precisely the same information that the authors of Act 43 considered in estimating the likely partisan effects of the new districts. In particular, Gaddie's analysis of the partisan effects in the new Act 43 districts was functionally equivalent to mine and based on exactly the same considerations.

Like his complaints about alleged bias in the regression analysis that I discuss above, Trende's criticism is uninformed and betrays a lack of knowledge of how hypothetical district plans are evaluated.

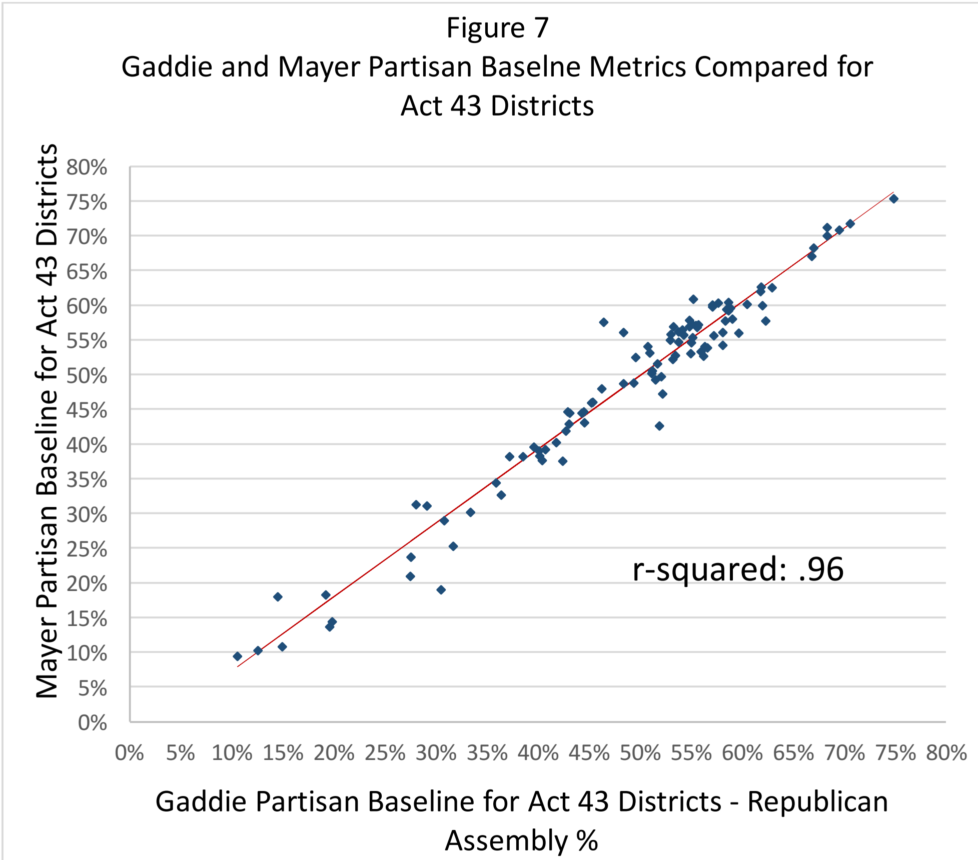
V. Goedert's Claim That My Efficiency Gap Calculations Incorporate Information Not Available to Act 43's Designers, and Ignore the Effects of Incumbency

Goedert criticizes my analysis for incorporating information that map drawers did not have (2012 election results), and for ignoring information that map drawers would have taken into account (incumbency in particular).

The first criticism is incorrect, as Act 43's designers in fact had information functionally equivalent to the 2012 election results in their possession, in the form of Gaddie's Act 43 district level estimates. These estimates, like my own, are baseline measures of partisanship, and they correlate almost perfectly with my results (r^2=0.96). In his deposition, Gaddie described in detail his method, which like mine assumed that all seats would be contested and that no incumbents would run (Gaddie Deposition, pp. 197, 198, 201, 202, 204):

> Let's suppose we have a seat with an incumbent and a seat without an incumbent and
> each one has an Assembly election. The party of the incumbent is presumably going to do a little stronger in the district where they have an incumbent than in an open seat. So I can't really take -- Let's suppose I move precincts from the open seat into that incumbent seat. I can't really take those open seat Assembly votes, add them, compare them to the percentage for the incumbent running for the same party, get an accurate estimation of the partisanship and the competitiveness of the district. So we attempt to create a substitute measure. Statewide elections are held in all precincts, they're held in all constituencies, so one thing that we often do is we do what we call reconstituted elections, or proxy elections, where we'll take one election or a composite of elections, like I described previously, and attempt to create some measure of partisan competitiveness, an expected vote or what we call a normal vote, what the vote would usually do without an incumbent in the district." (Gaddie Deposition, pp. 204-5)

To highlight the similarity between Gaddie's pre-2012 estimates and my own estimates using 2012 election results, below is a graph plotting the two sets of data (Figure 7 in my original report, p. 30):



This graph shows that the information the Act 43 authors relied on when drawing their map (the Gaddie estimates) and my estimates, are nearly identical. This is largely because they are both estimates of the same underlying quantity – the baseline partisanship of a hypothetical Assembly district. Goedert dismisses the nearly perfect correlation as "mostly coincidental" (p. 17), but offers no analysis or data to support this conclusion. It is simply an assertion offered without evidence.

And it is an entirely unpersuasive assertion for the additional reason that election results in Wisconsin (and in most states) are extremely highly correlated from one election to the next. For example, Wisconsin's counties remained geographically constant between 2008 and 2012, and Trende supplied information about the presidential vote in each county in each of these years. The 2008 county level presidential vote and the 2012 county level presidential vote are almost perfectly correlated (r^2=0.96), indicating that it would make no difference whether Act 43 was assessed using the former or the latter.[12] Either way, the same conclusion would follow: that

[12] Ward level 2008 and 2012 results cannot easily be compared because ward boundaries were redrawn after the 2010 Census.

the map is an extreme Republican gerrymander, and that the authors of Act 43 had information in their possession that predicted it.

Second, Goedert claims that map drawers do not ignore incumbency when drawing maps. That will generally be true when map drawers are trying to figure out which incumbent should be included in which district. But when it comes to estimating the likely partisanship of the new districts, ignoring incumbency (that is, controlling for it) is precisely what the drawers of Act 43 did, as Gaddie noted in his description of his methods. This approach is sensible since incumbents can be defeated, retire, run for higher office, or switch parties over a plan's decade-long lifespan. A map's authors will typically want to ensure that their projections do not depend on particular incumbents continuing to run in particular districts.

In any event, *including* incumbency in no way changes my substantive conclusions about Act 43 or the Demonstration Plan. I recalculated the efficiency gap for both maps, using my baseline partisan estimate and then incorporating incumbency into the model. For Act 43, I used the actual incumbents who ran in the plan's districts, with the adjustments noted in my report to account for paired incumbents and those who lost in primaries (p. 18, footnote 14).[13] For my plan, I geocoded incumbents' home addresses[14] and then identified which districts had incumbents residing in them using Maptitude for Redistricting. Table E shows the resulting efficiency gap calculations, and compares them to the open seat baseline I generated in my report:

Table E Efficiency Gap Calculations with Incumbents		
	Demonstration Plan	**Act 43**
Baseline Efficiency Gap	2.20%	11.69%
Efficiency Gap with Incumbency	3.89%	14.15%

The efficiency gap increases marginally for both plans (by 1.69% for the Demonstration Plan and 2.46% for Act 43), in large part because there were more Republican (50) than

[13] I recalculated vote estimates using predicted values of Democratic and Republican Assembly votes when one of the parties had an incumbent running.
[14] This information was provided to me by counsel.

Democratic (24) incumbents running in 2012. With twice as many incumbents, Republicans will win more seats than in the open seat baseline even though the Republican vote percentage remains below 50% in both cases. It is thus apparent that taking incumbency into account has no effect on my conclusion that Act 43 was an egregious partisan gerrymander; the substantive inferences are identical, with or without incumbency.[15]

VI. Goedert's Claim That I Did Not Perform Sensitivity Testing for Act 43's or the Demonstration Plan's Efficiency Gaps

Goedert criticizes the efficiency gap calculations for both Act 43 and the Demonstration Plan, arguing that I "provide no estimates for the efficiency gap of the demonstration plan under the range of plausible election outcomes facing legislators at the time they were drawing the map" (p. 16), and that I conduct no "sensitivity testing" of my calculations of Act 43's efficiency gap.

I note that Goedert has not provided any actual analysis showing that this sensitivity testing would have materially altered my conclusions, or even any citations showing that such testing is necessary to evaluate the adequacy of my calculations.

Still, it is possible to show that my calculations are robust to significant changes in the electoral environment. Using Jackman's historical estimates of the statewide Assembly vote in Wisconsin, I can determine the plausible variation of the overall vote over the course of a decade. Since 1992, the statewide Democratic percentage of the Assembly vote has ranged from a high of 54.6% (in 2006) to a low of 46.4% (in 2010). The Democratic share of the statewide vote in 2012 was 51.2% in my baseline calculations, which suggests a plausible range of -5% to +3% in conducting a sensitivity analysis. In effect, this approach asks whether Act 43's and the Demonstration Plan's efficiency gaps would be durable in the face of massive Democratic *or* Republican waves – an extremely rigorous test that exceeds what is normally found in the literature.

Following Goedert's method of applying a uniform swing (p.21), I can estimate the effects that these swings will have on the efficiency gap, both for Act 43 and for the Demonstration Plan. To maintain consistency and to address his concern that I did not

[15] We can use these calculations to determine how many more Democratic legislators would have been elected in 2012 if either the Demonstration Plan, or a plan with an efficiency gap of exactly zero, had been in place. Under the open-seat baseline, 9.49% more Democrats would have been elected under the Demonstration Plan (11.69% - 2.20%), and 11.69% more under a plan with an efficiency gap of exactly zero. Similarly, under the incumbent baseline, 10.26% more Democrats would have been elected under the Demonstration Plan (14.15% - 3.89%), and 14.15% more under a plan with an efficiency gap of exactly zero. In all cases, these are very large differences, amounting to anywhere from nine to thirteen Assembly seats.

incorporate incumbency in my baseline, I estimate the effects while treating as incumbents all of the prevailing candidates in the incumbent baseline (see Efficiency Gap With Incumbency in Table E above). Functionally, this simulates what would happen over the remainder of the decade (2014-2020) if after the 2012 elections Wisconsin experienced a Democratic or Republican wave.

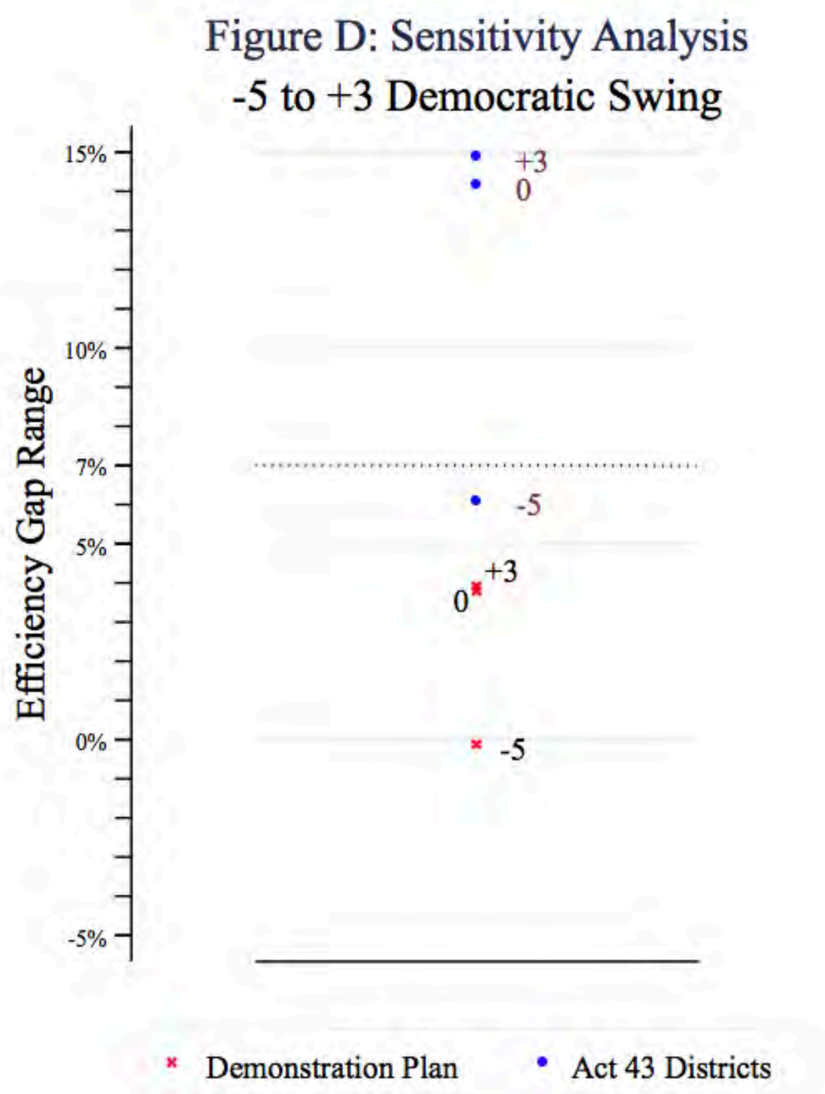
The results are shown in the following two tables, the first for the Demonstration Plan (Table F), and the second for Act 43 (Table G).[16] For the Demonstration Plan, the efficiency gap remains well below the plaintiffs' suggested 7% threshold, even when the statewide vote reaches the most extreme values either party has seen over the last three decades. Specifically, the efficiency gap goes to 3.75% in the event of a Democratic wave akin to that of 2006, and to –0.14% if a Republican wave like that of 2010 occurs. For Act 43, however, the efficiency gap remains extremely large and above the threshold absent a Republican wave, ranging from 14.88% in a Democratic wave to 6.09% in a Republican wave. Moreover, the sensitivity testing shows that even if the Democrats obtained over *54%* of the statewide Assembly vote – equal to their best performance in a generation – they *still* would not capture a majority of the Assembly, gaining only 45 seats. Act 43's gerrymandering thus effectively insulates the Republican Assembly majority from all plausible shifts in voter sentiment.

[16] There were some minor discrepancies in the underlying data used in my earlier report. The updates are reflected in the March 31, 2016 revision. The discrepancies caused no material difference in the results.

	Table F Efficiency Gap Estimates, Uniform Swing Demonstration Plan		
	D Minus 5 (all incumbents)	**My Plan Incumbent Baseline**	**D Plus 3 (all incumbents)**
party split (R-D)	51-48	50-49	43-56
Rep share of Seats	52%	49%	43%
Wasted Republican Votes	711,621	655,733	660,706
Wasted Democratic Votes	707,789	766,234	767,927
Gap	(3,833)	110,501	107,221
Total Democratic Votes	1,334,535	1,455,846	1,571,786
Total Republican Votes	1,504,285	1,388,087	1,285,480
Total Votes	2,838,820	2,843,933	2,857,266
Efficiency Gap (gap/total votes)	**-0.14%**	**3.89%**	**3.75%**

	Table G Efficiency Gap Estimates, Uniform Swing Act 43 Districts		
	D Minus 5 (all incumbents)	**Act 43 Actual**	**D Plus 3 (all incumbents)**
Party Split (R-D)	60-39	60-39	54-45
Rep share of Seats	61%	61%	55%
Wasted Republican Votes	622,966	509,747	500,607
Wasted Democratic Votes	795,844	911,954	924,690
Gap	172,878	402,207	424,083
Total Democratic Votes	1,317,061	1,452,132	1,551,205
Total Republican Votes	1,520,560	1,391,269	1,299,388
Total Votes	2,837,621	2,843,401	2,850,593
Efficiency Gap (gap/total votes)	**6.09%**	**14.15%**	**14.88%**

Figure E below shows these results graphically: the red x's are the efficiency gap estimates for the Demonstration Plan, and the blue diamonds the estimates for Act 43. The dotted line is at plaintiffs' suggested threshold of 7%. The figure clearly demonstrates that even across huge partisan swings, the efficiency gap under Act 43 remains very large, and the efficiency gap for the Demonstration Plan remains very small. In fact, Table G demonstrates the remarkable efficiency of Act 43's gerrymander, in that an additional 5% of the Republican statewide vote does not add a single seat to the Republican Assembly majority. The important feature here is how well Act 43 protects against a Democratic wave. This is further powerful confirmation of the durability of Act 43's bias – and the durable *lack* of bias of the Demonstration Plan.



VII. **Conclusion**

In their criticism of my report, both Trende and Goedert offer nothing but supposition, speculation, irrelevant discourse about Wisconsin political history, extraneous discussion of congressional redistricting in other parts of the United States, wildly inapposite and inaccurate conjecture about the geographic concentration of Democrats as a possible source of the pro-Republican bias of Act 43, unreliable methodologies, and minor quibbles that have no consequences for my conclusions. Neither Trende nor Goedert has conducted any valid analysis of either Act 43 or the Demonstration Plan – in fact, they make no mention at all of the specifics of the Demonstration plan.

Most significantly, nothing in their reports undercuts my fundamental conclusion that Act 43 constituted an egregious and durable gerrymander, and that it was entirely possible to draw a neutral map that met or exceeded Act 43 on all legal dimensions. If anything, the sensitivity testing substantially bolsters this conclusion, since it shows that Act 43's large efficiency gap and the Demonstration Plan's small one are durable in the face of enormous changes in Wisconsin's electoral environment.

Dated: December 21, 2015
Revised: March 31, 2016

/s/ Kenneth R. Mayer

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Department of Political Science

University of Wisconsin-Madison

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Sensitivity of the Efficiency Gap to Uniform Swing

How sensitive is the efficiency gap to reasonable swings in vote shares? In his report, Goedert asserts that it is extremely sensitive (pp. 11-15), but his claim is based on a small number of examples (pp. 12-13) as well as his own work at the congressional level involving only two elections (Goedert 2015). Sections 1-4 of my rebuttal report show that the first efficiency gap observed under a plan is a reliable indicator of the efficiency gap's magnitude and direction over the remainder of the plan's lifespan. These sections, however, are based on historical efficiency gap data rather than the "sensitivity testing for future results" deemed "crucial" by Goedert (p. 13). Accordingly, we conduct sensitivity testing here of exactly the kind earlier carried out by Stephanopoulos & McGhee (pp. 889-90, 898-99) and recommended by Goedert. This testing confirms the findings in Sections 1-4 of my rebuttal report, and further corroborates my conclusions therein about the efficiency gap's durability and reliability.

Methodologically, we investigate the behavior of the efficiency gap when we perturb it by mimicking "uniform swing" across a jurisdiction. That is, a given election produces a set of vote shares across districts. A new hypothetical election is considered in which all vote shares move up or down by a predetermined quantity (i.e., the "swing"); since all districts move by the same amount, this technique is known as uniform swing. In real-world elections swings are never precisely uniform, and so this method is widely considered to be a simplification; on the other hand, modeling or predicting swing district by district is quite difficult, especially for state legislative elections where we often lack useful district-level predictors of swing (or, more tellingly, predictors of the way the swing in a given state legislative district might depart from the statewide swing).

We restrict the following exercise to elections since the 2010 round of redistricting. For each election we simulate a series of uniform swings, evenly spaced between -5% to +5%, a quite large set of swings by the standards of state legislative elections. For instance, swings in Wisconsin state legislative elections from 1972 to 2014 are estimated to range between -7.6 percentage points from 2008 to 2010 (Democratic share of two-party vote, averaged by district) and +5.0 percentage points from 2004 to 2006. Similarly, Stephanopoulos & McGhee found that a swing of +/- 5.5 percentage points covered the vast majority of state legislative elections from 1972 to 2012 (p. 874).

At each level of uniform swing, we record the new vote shares and seat shares (some seats change hands if the swing pushes Democratic two-party vote share to the other side of 50%) and recompute the efficiency gap. We then examine how much the simulated efficiency gaps—generated under different levels of uniform swing—depart from the efficiency gap observed under the actual election. In particular, if relatively small swings produce large changes in *EG*, we might rightly be concerned about the stability and reliability of the efficiency gap as a characterization of a district plan. Keep in mind that this exercise keeps the district plan as it is and simply shifts vote shares up and down over a range of hypothetical levels of statewide swing, held constant over districts.

Figure 1 shows the relationships between efficiency gaps estimated using actual election results in state legislative elections held since the 2010 round of redistricting, and efficiency gaps estimated using a range of uniform swings. When uniform swing is zero, the simulation exercise leaves the actual election results unperturbed, and we simply recover the original efficiency gap estimates; all the data in the panel labelled "Swing +0.0" lies on the 45-degree line. As we increase the magnitude of hypothetical levels of uniform swing, the relationship between the observed efficiency gaps and the simulated efficiency gaps weakens, but only by a moderate amount. Even at high levels of uniform swing (approaching +/- five percentage points), the relationship between observed efficiency gaps and simulated efficiency gaps remains of significant strength; the blue line in each panel of Figure 1 is a regression line and in every case has a large and unambiguously positive slope, indicating a positive correlation between actual and simulated efficiency gaps.

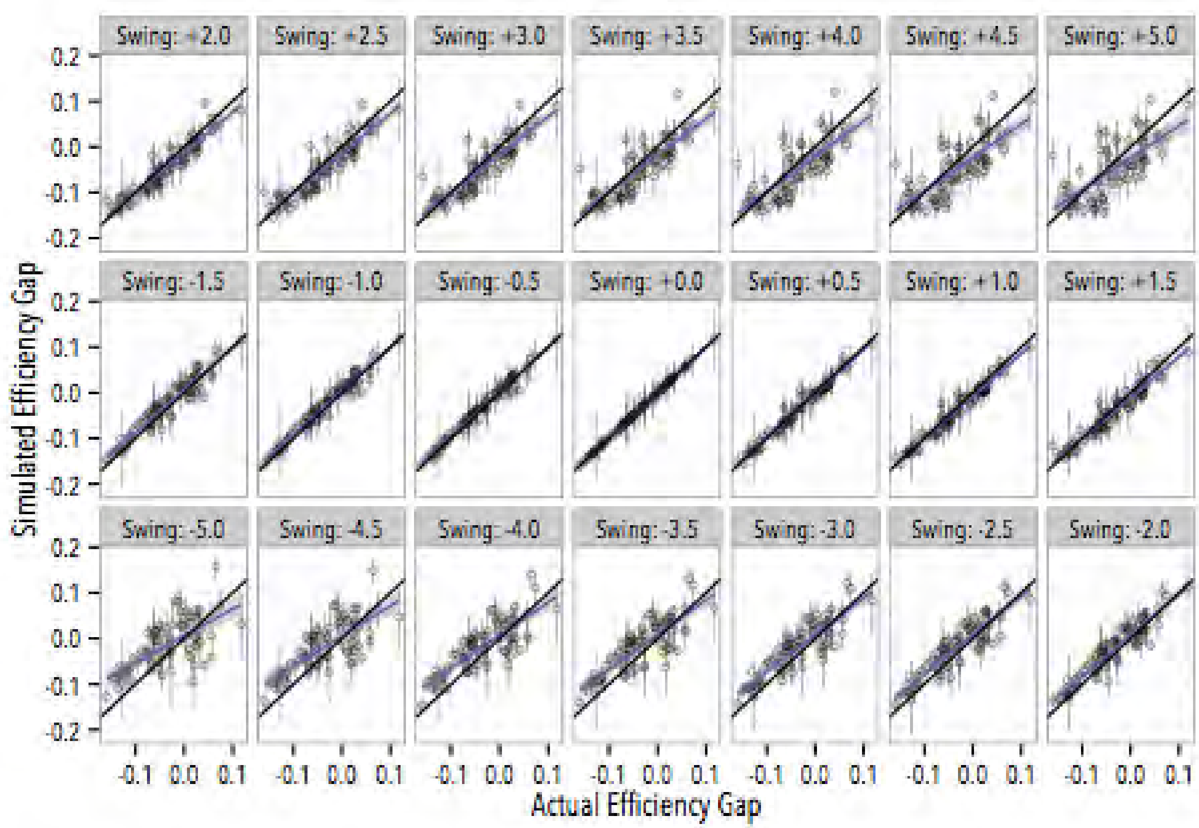

Figure 1: Actual efficiency gaps from state legislative elections 2012 to 2014 (horizontal axis), and corresponding simulated efficiency gaps generated by varying levels of uniform swing. Vertical lines indicate 95% confidence intervals. Dark diagonal lines are at forty-five degrees, the fit to the data that would result if actual and simulated efficiency gaps were equal (as is the case when the simulated level of uniform swing is set to zero, as in the middle panel of the second row). The blue line indicates a regression fit. For small to even moderately large values of uniform swing, there is a high degree of correspondence between the actual and simulated efficiency gaps.

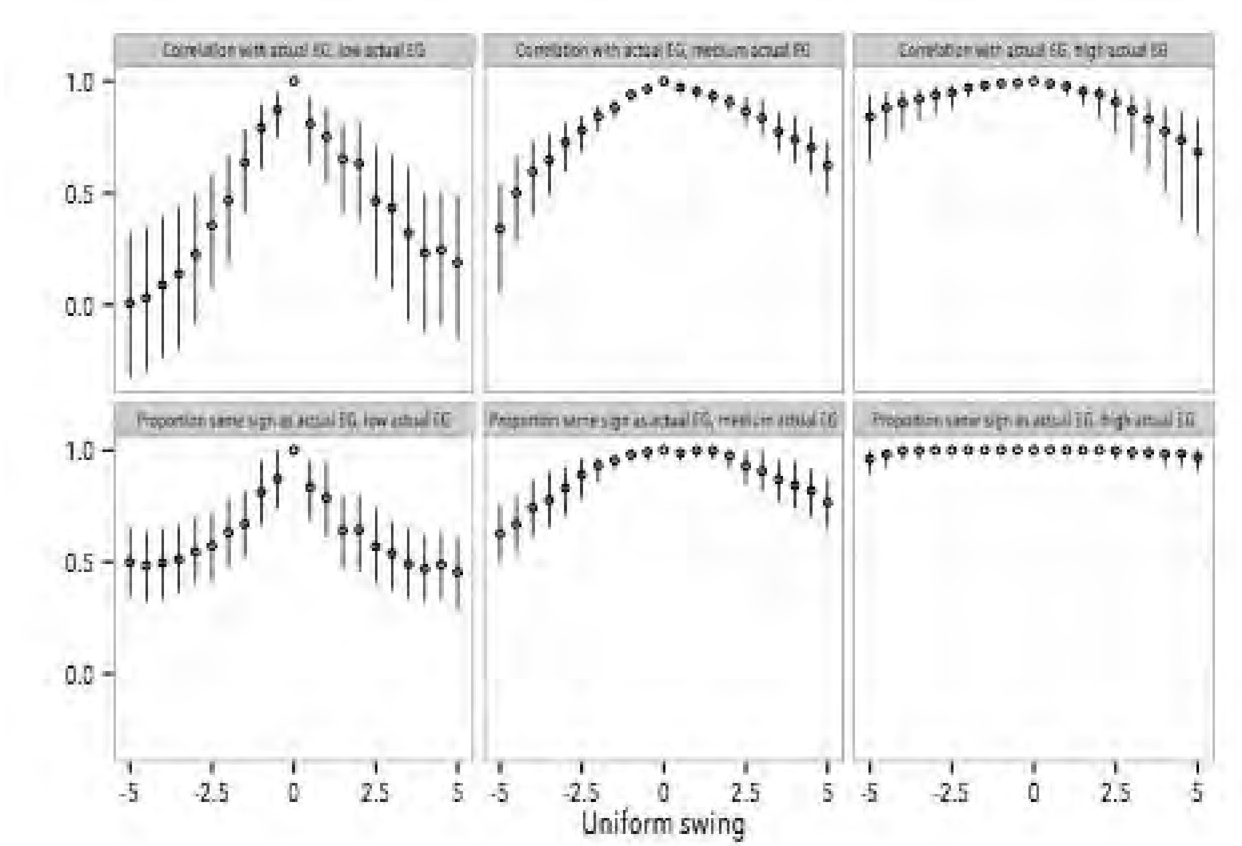

Figure 2: Correlation between actual efficiency gaps and simulated efficiency gaps (top row) and proportion of simulated efficiency gaps with same sign as actual efficiency gaps (bottom row), by hypothetical levels of uniform swing (horizontal axis). Vertical lines are 95% confidence intervals. The three columns correspond to actual efficiency gaps that are low in magnitude (less than .03 in absolute value; left column), medium (.03 to .07 in absolute value, middle column) and high (above .07 in absolute value, right column). When uniform swing is zero, the simulated efficiency gaps correspond to the actual efficiency gaps, and so the correlation between the two sets of efficiency gaps is exactly 1.0 and 100% of the simulated efficiency gaps have the same sign as the actual efficiency gaps.

The top row of Figure 2 displays correlations between actual efficiency gaps and simulated efficiency gaps, under different hypothetical levels of uniform swing (horizontal axis), with separate panels for low, medium, and high values of actual efficiency gaps. Note that when uniform swing is zero, the simulated efficiency gaps correspond to the actual efficiency gaps, and so the correlation between the two sets of efficiency gaps is exactly 1.0. As levels of uniform swing increase, the correlation between actual and simulated efficiency gaps diminishes. Small efficiency gaps (less than .03 in absolute value) are less resistant to perturbations from uniform swing; at high levels of uniform swing for small actual efficiency gaps, the correlation between actual efficiency gaps and simulated efficiency gaps approaches zero. However, larger values of the efficiency gap are much more robust to perturbations from uniform swing. In fact, for large actual efficiency gaps (greater than .07 in magnitude), the correlation between actual and simulated efficiency gaps stays impressively large over the entire range of uniform swing levels considered here (top right panel of Figure 2).

The bottom row of Figure 2 displays the proportion of simulated efficiency gaps that have the same sign as actual efficiency gaps, under a range of hypothetical levels of uniform swing (horizontal axis), again with separate panels for low, medium, and high values of actual efficiency gaps. Again we see that small efficiency gaps—less than .03 in magnitude and hence relatively close to zero—are reasonably likely to flip signs under moderate to large values of hypothetical uniform swing: about half of these small efficiency gap estimates flip signs when subjected to reasonably large statewide swings one way or the other. But large efficiency gaps—those greater than .07 in magnitude—show great resistance to flipping signs even in the face of moder- ate or even large hypothetical statewide swings (lower right panel of Figure 2). None of the large efficiency gaps flip signs when swings are below 2.5 percentage points and *barely any* flip signs even we consider larger statewide swings. Just 11% of actual efficiency gaps greater than .07 in magnitude flip signs when exposed to a very large, hypothetical statewide swing of minus five percentage points and only 9% flip signs when we consider a statewide swing of positive five percentage points.

In short, efficiency gap estimates display a high level of resistance to perturbations from even large levels of uniform swing. This further bolsters our confidence that the efficiency gap is measuring a durable property of a district plan. Moreover, the analysis reported here demonstrates that efficiency gaps are especially reliable when they are large, as is the case for the efficiency gaps generated under the Wisconsin plan. The efficiency gap changes if vote totals change, even if the district plan remains constant; this is "hardwired" into the definition and accompanying arithmetic of the efficiency gap. But to reiterate a conclusion from my original report: the amount of election-to-election variation in the efficiency gap is small relative to the var-iation in the efficiency gap across plans.

Exhibit 122 – Average Efficiency Gaps for Wisconsin Plans (1970s-2010s)

Cycle	Designer	Average Efficiency Gap
1970s	Divided government	-0.3%
1980s	Court	-1.9%
1990s	Court	-2.4%
2000s	Court	-7.6%
2010s	Professor Mayer	-1.9%

The measure of partisanship should exist to establish the change in the partisan balance of the district. We are not in court this time; we do not need to show that we have created a fair, balanced, or even a reactive map. But, we do need to show to lawmakers the political potential of the district.

I have gone through the electoral data for state office and built a partisan score for the assembly districts. It is based on a regression analysis of the Assembly vote from 2006, 2008, and 2010, and it is based on prior election indicators of future election performance.

I am also building a series of visual aides to demonstrate the partisan structure of Wisconsin politics. The graphs will communicate the top-to-bottom party basis of the state politics. It is evident, from the recent Supreme Court race and also the Milwaukee County executive contest, that the partisanship of Wisconsin is invading the ostensibly non-partisan races on the ballot this year.

EXHIBIT 25
WIT: Goepert
DATE: 12-15-15
Halma-Jilek Reporting, Inc.

"Plan Comparisons.xlsm"
Created 5/4/11 5:39 pm
accessed 4/27/12 4:50 pm
modified 4/27/12 4:50 pm
File path: /users/afoltz/Desktop/projects/Plan Comparisons.xlsm

Milwaukee_Gaddie_4_16_11_V1_B

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	51.22%	0.07%	1	54.04%	53.48%	-0.56%
2	54.93%	53.82%	-1.11%				
3	56.10%	55.81%	-0.29%				
4	53.31%	53.76%	0.45%	2	55.44%	54.14%	-1.30%
5	53.74%	55.30%	1.56%				
6	59.77%	59.49%	-0.28%				
7	48.20%	44.42%	-3.78%	3	40.52%	37.54%	-2.98%
8	22.39%	21.22%	-1.17%				
9	36.73%	35.67%	-1.06%				
10	10.27%	16.52%	6.25%	4	17.58%	19.41%	1.83%
11	11.91%	17.63%	5.72%				
12	29.23%	24.92%	-4.31%				
13	43.67%	55.57%	11.90%	5	50.62%	54.90%	4.28%
14	59.06%	54.40%	-4.66%				
15	48.21%	54.61%	6.40%				
16	14.21%	13.02%	-1.19%	6	14.12%	17.86%	3.74%
17	13.21%	22.95%	9.74%				
18	15.28%	15.86%	0.58%				
19	29.15%	26.71%	-2.44%	7	41.13%	39.65%	-1.48%
20	43.71%	41.73%	-1.98%				
21	51.92%	52.85%	0.93%				
22	39.05%	56.14%	17.09%	8	52.82%	62.31%	9.49%
23	51.70%	61.82%	10.12%				
24	67.29%	55.27%	-12.02%				
25	52.79%	53.33%	0.54%	9	52.96%	57.67%	4.71%
26	45.42%	54.99%	9.57%				
27	59.20%	64.23%	5.03%				
28	54.85%	54.94%	0.09%	10	53.14%	53.30%	0.16%
29	51.32%	50.92%	-0.40%				
30	53.29%	53.81%	0.52%				
31	67.57%	59.08%	-8.49%	11	67.64%	58.42%	-9.22%
32	61.06%	62.14%	1.08%				
33	72.24%	72.63%	0.39%				
34	54.51%	53.00%	-1.51%	12	53.37%	53.91%	0.54%
35	52.30%	52.43%	0.13%				
36	53.06%	56.44%	3.38%				
37	51.33%	55.61%	4.28%	13	59.22%	59.19%	-0.03%
38	65.80%	59.84%	-5.96%				
39	60.35%	62.24%	1.89%				
40	58.50%	55.95%	-2.55%	14	55.86%	56.06%	0.20%
41	60.60%	56.99%	-3.61%				
42	48.54%	42.99%	-5.55%				
43	44.14%	44.59%	0.45%	15	41.20%	40.45%	-0.75%
44	36.74%	37.27%	0.53%				
45	42.39%	53.84%	11.45%				
46	42.07%	44.57%	2.50%	16	39.06%	36.54%	-2.52%
47	48.69%	39.36%	-9.33%				
48	28.03%	27.24%	-0.79%				
49	49.68%	49.93%	0.25%	17	48.46%	49.58%	1.12%
50	52.08%	51.77%	-0.31%				
51	44.01%	47.13%	3.12%				
52	57.39%	57.88%	0.49%	18	54.96%	55.18%	0.22%
53	62.74%	63.58%	0.84%				
54	45.08%	45.28%	0.20%				
55	49.34%	57.19%	7.85%	19	53.32%	52.56%	-0.76%
56	61.05%	54.12%	-6.93%				
57	47.26%	46.45%	-0.81%				
58	70.90%	70.79%	-0.11%	20	70.55%	68.06%	-2.49%
59	72.74%	61.52%	-11.22%				
60	68.12%	71.32%	3.20%				
61	35.98%	33.44%	-2.54%	21	49.86%	58.82%	8.96%
62	44.35%	62.45%	18.10%				
63	63.09%	56.78%	-6.31%				
64	35.66%	42.16%	6.50%	22	47.56%	37.34%	-10.22%
65	45.44%	36.00%	-9.44%				
66	59.12%	57.24%	-1.88%				
67	51.72%	51.63%	-0.09%	23	49.98%	51.78%	1.80%
68	45.01%	51.15%	6.14%				
69	54.06%	53.57%	-0.49%				
70	49.74%	50.00%	0.26%	24	46.72%	46.21%	-0.51%
71	41.68%	40.95%	-0.73%				
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
72	49.03%	50.38%	1.35%				
73	39.55%	40.05%	0.50%	25	44.88%	45.67%	0.79%
74	43.78%	45.03%	1.25%				
75	51.71%	52.31%	0.60%				
76	24.29%	20.80%	-3.49%	26	20.85%	20.85%	0.00%
77	23.88%	24.52%	0.64%				
78	14.09%	17.18%	3.09%				
79	37.49%	36.70%	-0.79%	27	38.38%	39.67%	1.29%
80	42.15%	39.44%	-2.71%				
81	36.16%	39.11%	2.95%				
82	58.59%	55.72%	-2.87%	28	64.48%	62.55%	-1.93%
83	69.70%	70.25%	0.55%				
84	64.99%	61.26%	-3.73%				
85	48.91%	47.54%	-1.37%	29	52.00%	54.17%	2.17%
86	54.56%	55.31%	0.75%				
87	52.16%	53.42%	1.26%				
88	44.85%	53.47%	8.62%	30	50.38%	52.62%	2.24%
89	55.76%	55.58%	-0.18%				
90	49.59%	40.13%	-9.46%				
91	45.87%	44.45%	-1.42%	31	46.89%	44.98%	-1.91%
92	50.79%	53.85%	3.06%				
93	44.73%	39.55%	-5.18%				
94	51.57%	51.93%	0.36%	32	44.43%	44.60%	0.17%
95	36.02%	36.26%	0.24%				
96	45.32%	46.24%	0.92%				
97	59.96%	62.39%	2.43%	33	68.84%	67.97%	-0.87%
98	70.96%	67.99%	-2.97%				
99	73.35%	69.84%	-3.51%				

Current Map	Assembly	Senate
Safe GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Safe GOP (55%+)	34	10
New Lean GOP (52.1-54.9%):	18	8
Total GOP Seats (safe + lean):	52	18
New Swing (48-52%)	9	2
New Lean DEM (45.1-47.9%):	6	2
Safe DEM (-45%):	32	11
Total DEM Seats (safe + lean):	38	13

EXHIBIT
PENGAD 800-631-6989
39
Gaddie

Statewide2_Milwaukee_Gaddie_4_16_11_V1_B

Assembly				Senate			
DISTRICT	[illegible]	New	[illegible]	DISTRICT	[illegible]	[illegible]	[illegible]
1	51.15%	51.22%	0.07%	1	54.04%	53.48%	-0.56%
2	54.93%	53.82%	-1.11%				
3	56.10%	55.81%	-0.29%				
4	53.31%	53.76%	0.45%	2	55.44%	54.15%	-1.29%
5	53.74%	55.31%	1.57%				
6	59.77%	53.47%	-6.30%				
7	48.20%	44.42%	-3.78%	3	40.52%	37.54%	-2.98%
8	22.39%	21.22%	-1.17%				
9	36.73%	35.67%	-1.06%				
10	10.27%	16.52%	6.25%	4	17.58%	19.41%	1.83%
11	11.91%	17.63%	5.72%				
12	29.23%	24.92%	-4.31%				
13	43.67%	55.57%	11.90%	5	50.62%	54.90%	4.28%
14	59.06%	54.40%	-4.66%				
15	48.21%	54.61%	6.40%				
16	14.21%	13.02%	-1.19%	6	14.12%	17.86%	3.74%
17	13.21%	22.95%	9.74%				
18	15.28%	15.86%	0.58%				
19	29.15%	26.71%	-2.44%	7	41.13%	39.65%	-1.48%
20	43.71%	41.73%	-1.98%				
21	51.92%	52.85%	0.93%				
22	39.05%	56.14%	17.09%	8	52.82%	62.31%	9.49%
23	51.70%	61.82%	10.12%				
24	67.29%	69.84%	2.55%				
25	52.79%	53.33%	0.54%	9	52.96%	57.67%	4.71%
26	45.42%	54.99%	9.57%				
27	59.20%	64.23%	5.03%				
28	54.85%	54.94%	0.09%	10	53.14%	53.30%	0.16%
29	51.32%	50.92%	-0.40%				
30	53.29%	53.81%	0.52%				
31	67.57%	56.05%	-11.52%	11	67.64%	58.19%	-9.45%
32	61.06%	62.73%	1.67%				
33	72.24%	56.31%	-15.93%				
34	54.51%	53.44%	-1.07%	12	53.37%	53.89%	0.52%
35	52.30%	53.29%	0.99%				
36	53.06%	55.07%	2.01%				
37	51.33%	60.43%	9.10%	13	59.22%	61.69%	2.47%
38	65.80%	62.52%	-3.28%				
39	60.35%	62.04%	1.69%				
40	58.50%	55.67%	-2.83%	14	55.86%	55.64%	-0.22%
41	60.60%	55.29%	-5.31%				
42	48.54%	55.97%	7.43%				
43	44.14%	38.55%	-5.59%	15	41.20%	38.75%	-2.45%
44	36.74%	37.27%	0.53%				
45	42.39%	40.82%	-1.57%				
46	42.07%	44.57%	2.50%	16	39.06%	36.54%	-2.52%
47	48.69%	39.36%	-9.33%				
48	28.03%	27.24%	-0.79%				
49	49.68%	49.74%	0.06%	17	48.46%	49.23%	0.77%
50	52.08%	51.90%	-0.18%				
51	44.01%	46.20%	2.19%				
52	57.39%	57.88%	0.49%	18	54.96%	55.05%	0.09%
53	62.74%	62.78%	0.04%				
54	45.08%	45.19%	0.11%				
55	49.34%	57.94%	8.60%	19	53.32%	52.56%	-0.76%
56	61.05%	53.44%	-7.61%				
57	47.26%	46.45%	-0.81%				
58	70.90%	70.79%	-0.11%	20	70.55%	68.06%	-2.49%
59	72.74%	61.52%	-11.22%				
60	68.12%	71.32%	3.20%				
61	35.98%	57.24%	21.26%	21	49.86%	57.79%	7.93%
62	44.35%	59.48%	15.13%				
63	63.09%	56.78%	-6.31%				
64	35.66%	42.16%	6.50%	22	47.56%	37.34%	-10.22%
65	45.44%	36.00%	-9.44%				
66	59.12%	33.44%	-25.68%				
67	51.72%	51.63%	-0.09%	23	49.98%	51.75%	1.77%
68	45.01%	50.00%	4.99%				
69	54.06%	53.67%	-0.39%				
70	49.74%	47.54%	-2.20%	24	46.72%	46.64%	-0.08%
71	41.68%	41.01%	-0.67%				
DISTRICT	[illegible]	[illegible]	[illegible]	DISTRICT	[illegible]	[illegible]	[illegible]
72	49.03%	51.69%	2.66%				
73	39.55%	40.05%	0.50%	25	44.88%	45.67%	0.79%
74	43.78%	45.03%	1.25%				
75	51.71%	52.31%	0.60%				
76	24.29%	20.80%	-3.49%	26	20.85%	20.85%	0.00%
77	23.88%	24.52%	0.64%				
78	14.09%	17.18%	3.09%				
79	37.49%	36.70%	-0.79%	27	38.38%	40.45%	2.07%
80	42.15%	40.32%	-1.83%				
81	36.16%	44.54%	8.38%				
82	58.59%	55.72%	-2.87%	28	64.48%	62.49%	-1.99%
83	69.70%	70.15%	0.45%				
84	64.99%	61.26%	-3.73%				
85	48.91%	53.65%	4.74%	29	52.00%	54.23%	2.23%
86	54.56%	55.47%	0.91%				
87	52.16%	53.42%	1.26%				
88	44.85%	58.65%	13.80%	30	50.38%	52.29%	1.91%
89	55.76%	55.58%	-0.18%				
90	49.59%	40.13%	-9.46%				
91	45.87%	44.31%	-1.56%	31	46.89%	44.94%	-1.95%
92	50.79%	39.55%	-11.24%				
93	44.73%	51.15%	6.42%				
94	51.57%	51.93%	0.36%	32	44.43%	44.63%	0.20%
95	36.02%	36.26%	0.24%				
96	45.32%	46.40%	1.08%				
97	59.96%	62.39%	2.43%	33	68.84%	67.98%	-0.86%
98	70.96%	67.99%	-2.97%				
99	73.35%	72.66%	-0.69%				

Current Map	Assembly	Senate
Safe GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Safe GOP (55%+)	35	10
New Lean GOP (52.1-54.9%):	17	8
Total GOP Seats (safe + lean):	52	18
New Swing (48-52%)	9	2
New Lean DEM (45.1-47.9%):	6	2
Safe DEM (-45%):	32	11
Total DEM Seats (safe + lean):	38	13

Final Map

Assembly				Senate			
DISTRICT	Current	New		DISTRICT	Current	New	
1	51.15%	51.22%	0.07%	1	54.04%	53.73%	-0.31%
2	54.93%	54.84%	-0.09%				
3	56.10%	55.58%	-0.52%				
4	53.31%	53.47%	0.16%	2	55.44%	55.23%	-0.21%
5	53.74%	54.28%	0.54%				
6	59.77%	58.33%	-1.44%				
7	48.20%	45.38%	-2.82%	3	40.52%	38.12%	-2.40%
8	22.39%	30.48%	8.09%				
9	36.73%	29.14%	-7.59%				
10	10.27%	12.59%	2.32%	4	17.58%	19.63%	2.05%
11	11.91%	19.58%	7.67%				
12	29.23%	27.51%	-1.72%				
13	43.67%	58.67%	15.00%	5	50.62%	57.72%	7.10%
14	59.06%	58.64%	-0.42%				
15	48.21%	55.48%	7.27%				
16	14.21%	10.54%	-3.67%	6	14.12%	15.55%	1.43%
17	13.21%	19.84%	6.63%				
18	15.28%	14.94%	-0.34%				
19	29.15%	28.03%	-1.12%	7	41.13%	40.53%	-0.60%
20	43.71%	43.12%	-0.59%				
21	51.92%	52.94%	1.02%				
22	39.05%	66.82%	27.77%	8	52.82%	60.88%	8.06%
23	51.70%	57.64%	5.94%				
24	67.29%	58.49%	-8.80%				
25	52.79%	53.26%	0.47%	9	52.96%	55.19%	2.23%
26	45.42%	55.97%	10.55%				
27	59.20%	56.19%	-3.01%				
28	54.85%	55.00%	0.15%	10	53.14%	53.32%	0.18%
29	51.32%	50.97%	-0.35%				
30	53.29%	53.78%	0.49%				
31	67.57%	56.33%	-11.24%	11	67.64%	60.13%	-7.51%
32	61.06%	62.27%	1.21%				
33	72.24%	61.81%	-10.43%				
34	54.51%	55.22%	0.71%	12	53.37%	54.39%	1.02%
35	52.30%	52.99%	0.69%				
36	53.06%	54.84%	1.78%				
37	51.33%	58.11%	6.78%	13	59.22%	60.17%	0.95%
38	65.80%	60.45%	-5.35%				
39	60.35%	62.00%	1.65%				
40	58.50%	58.07%	-0.43%	14	55.86%	56.02%	0.16%
41	60.60%	55.16%	-5.44%				
42	48.54%	54.94%	6.40%				
43	44.14%	43.06%	-1.08%	15	41.20%	40.17%	-1.03%
44	36.74%	37.22%	0.48%				
45	42.39%	40.08%	-2.31%				
46	42.07%	42.39%	0.32%	16	39.06%	34.13%	-4.93%
47	48.69%	33.35%	-15.34%				
48	28.03%	27.56%	-0.47%				
49	49.68%	49.59%	-0.09%	17	48.46%	49.23%	0.77%
50	52.08%	52.06%	-0.02%				
51	44.01%	46.23%	2.22%				
52	57.39%	59.06%	1.67%	18	54.96%	55.01%	0.05%
53	62.74%	61.85%	-0.89%				
54	45.08%	45.22%	0.14%				
55	49.34%	55.06%	5.72%	19	53.32%	53.02%	-0.30%
56	61.05%	58.86%	-2.19%				
57	47.26%	44.50%	-2.76%				
58	70.90%	70.54%	-0.36%	20	70.55%	69.46%	-1.09%
59	72.74%	68.31%	-4.43%				
60	68.12%	69.52%	1.40%				
61	35.98%	57.22%	21.24%	21	49.86%	57.77%	7.91%
62	44.35%	56.56%	12.21%				
63	63.09%	59.64%	-3.45%				
64	35.66%	42.72%	7.06%	22	47.56%	36.97%	-10.59%
65	45.44%	35.92%	-9.52%				
66	59.12%	31.71%	-27.41%				
67	51.72%	51.67%	-0.05%	23	49.98%	51.75%	1.77%
68	45.01%	49.38%	4.37%				
69	54.06%	54.16%	0.10%				
70	49.74%	50.73%	0.99%	24	46.72%	47.51%	0.79%
71	41.68%	40.72%	-0.96%				
DISTRICT				DISTRICT			
72	49.03%	51.49%	2.46%				
73	39.55%	40.16%	0.61%	25	44.88%	44.88%	0.00%
74	43.78%	42.89%	-0.89%				
75	51.71%	52.18%	0.47%				
76	24.29%	14.49%	-9.80%	26	20.85%	20.98%	0.13%
77	23.88%	19.23%	-4.65%				
78	14.09%	30.84%	16.75%				
79	37.49%	41.80%	4.31%	27	38.38%	41.49%	3.11%
80	42.15%	38.55%	-3.60%				
81	36.16%	44.56%	8.40%				
82	58.59%	57.08%	-1.51%	28	64.48%	60.93%	-3.55%
83	69.70%	68.31%	-1.39%				
84	64.99%	57.10%	-7.89%				
85	48.91%	48.38%	-0.53%	29	52.00%	52.47%	0.47%
86	54.56%	55.08%	0.52%				
87	52.16%	53.74%	1.58%				
88	44.85%	53.19%	8.34%	30	50.38%	50.55%	0.17%
89	55.76%	55.73%	-0.03%				
90	49.59%	40.40%	-9.19%				
91	45.87%	39.57%	-6.30%	31	46.89%	44.94%	-1.95%
92	50.79%	44.30%	-6.49%				
93	44.73%	51.10%	6.37%				
94	51.57%	51.91%	0.34%	32	44.43%	44.63%	0.20%
95	36.02%	36.36%	0.34%				
96	45.32%	46.40%	1.08%				
97	59.96%	62.91%	2.95%	33	68.84%	68.60%	-0.24%
98	70.96%	67.02%	-3.94%				
99	73.35%	74.85%	1.50%				

Current Map	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (strong + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Strong DEM (-45%):	33	10
Total DEM Seats (strong + lean):	40	13

New Map	Assembly	Senate
Strong GOP (55%+)	38	12
New Lean GOP (52.1-54.9%):	14	5
Total GOP Seats (strong + lean):	52	17
New Swing (48-52%)	10	3
New Lean DEM (45.1-47.9%):	4	1
Strong DEM (-45%):	33	12
Total DEM Seats (strong + lean):	37	13

Final Map

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
99	73.35%	74.85%	1.50%	1	54.04%	53.73%	-0.31%
58	70.90%	70.54%	-0.36%				
60	68.12%	69.52%	1.40%				
59	72.74%	68.31%	-4.43%	2	55.44%	55.23%	-0.21%
83	69.70%	68.31%	-1.39%				
98	70.96%	67.02%	-3.94%				
22	39.05%	66.82%	27.77%	3	40.52%	38.12%	-2.40%
97	59.96%	62.91%	2.95%				
32	61.06%	62.27%	1.21%				
39	60.35%	62.00%	1.65%	4	17.58%	19.63%	2.05%
53	62.74%	61.85%	-0.89%				
33	72.24%	61.81%	-10.43%				
38	65.80%	60.45%	-5.35%	5	50.62%	57.72%	7.10%
63	63.09%	59.64%	-3.45%				
52	57.39%	59.06%	1.67%				
56	61.05%	58.86%	-2.19%	6	14.12%	15.55%	1.43%
13	43.67%	58.67%	15.00%				
14	59.06%	58.64%	-0.42%				
24	67.29%	58.49%	-8.80%	7	41.13%	40.53%	-0.60%
6	59.77%	58.33%	-1.44%				
37	51.33%	58.11%	6.78%				
40	58.50%	58.07%	-0.43%	8	52.82%	60.88%	8.06%
23	51.70%	57.64%	5.94%				
61	35.98%	57.22%	21.24%				
84	64.99%	57.10%	-7.89%	9	52.96%	55.19%	2.23%
82	58.59%	57.08%	-1.51%				
62	44.35%	56.56%	12.21%				
31	67.57%	56.33%	-11.24%	10	53.14%	53.32%	0.18%
27	59.20%	56.19%	-3.01%				
26	45.42%	55.97%	10.55%				
89	55.76%	55.73%	-0.03%	11	67.64%	60.13%	-7.51%
3	56.10%	55.58%	-0.52%				
15	48.21%	55.48%	7.27%				
34	54.51%	55.22%	0.71%	12	53.37%	54.39%	1.02%
41	60.60%	55.16%	-5.44%				
86	54.56%	55.08%	0.52%				
55	49.34%	55.06%	5.72%	13	59.22%	60.17%	0.95%
28	54.85%	55.00%	0.15%				
42	48.54%	54.94%	6.40%				
2	54.93%	54.84%	-0.09%	14	55.86%	56.02%	0.16%
36	53.06%	54.84%	1.78%				
5	53.74%	54.28%	0.54%				
69	54.06%	54.16%	0.10%	15	41.20%	40.17%	-1.03%
30	53.29%	53.78%	0.49%				
87	52.16%	53.74%	1.58%				
4	53.31%	53.47%	0.16%	16	39.06%	34.13%	-4.93%
25	52.79%	53.26%	0.47%				
88	44.85%	53.19%	8.34%				
35	52.30%	52.99%	0.69%	17	48.46%	49.23%	0.77%
21	51.92%	52.94%	1.02%				
75	51.71%	52.18%	0.47%				
50	52.08%	52.06%	-0.02%	18	54.96%	55.01%	0.05%
94	51.57%	51.91%	0.34%				
67	51.72%	51.67%	-0.05%				
72	49.03%	51.49%	2.46%	19	53.32%	53.02%	-0.30%
1	51.15%	51.22%	0.07%				
93	44.73%	51.10%	6.37%				
29	51.32%	50.97%	-0.35%	20	70.55%	69.46%	-1.09%
70	49.74%	50.73%	0.99%				
49	49.68%	49.59%	-0.09%				
68	45.01%	49.38%	4.37%	21	49.86%	57.77%	7.91%
85	48.91%	48.38%	-0.53%				
96	45.32%	46.40%	1.08%				
51	44.01%	46.23%	2.22%	22	47.56%	36.97%	-10.59%
7	48.20%	45.38%	-2.82%				
54	45.08%	45.22%	0.14%				
81	36.16%	44.56%	8.40%	23	49.98%	51.75%	1.77%
57	47.26%	44.50%	-2.76%				
92	50.79%	44.30%	-6.49%				
20	43.71%	43.12%	-0.59%	24	46.72%	47.51%	0.79%
43	44.14%	43.06%	-1.08%				

DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
74	43.78%	42.89%	-0.89%				
64	35.66%	42.72%	7.06%	25	44.88%	44.88%	0.00%
46	42.07%	42.39%	0.32%				
79	37.49%	41.80%	4.31%				
71	41.68%	40.72%	-0.96%	26	20.85%	20.98%	0.13%
90	49.59%	40.40%	-9.19%				
73	39.55%	40.16%	0.61%				
45	42.39%	40.08%	-2.31%	27	38.38%	41.49%	3.11%
91	45.87%	39.57%	-6.30%				
80	42.15%	38.55%	-3.60%				
44	36.74%	37.22%	0.48%	28	64.48%	60.93%	-3.55%
95	36.02%	36.36%	0.34%				
65	45.44%	35.92%	-9.52%				
47	48.69%	33.35%	-15.34%	29	52.00%	52.47%	0.47%
66	59.12%	31.71%	-27.41%				
78	14.09%	30.84%	16.75%				
8	22.39%	30.48%	8.09%	30	50.38%	50.55%	0.17%
9	36.73%	29.14%	-7.59%				
19	29.15%	28.03%	-1.12%				
48	28.03%	27.56%	-0.47%	31	46.89%	44.94%	-1.95%
12	29.23%	27.51%	-1.72%				
17	13.21%	19.84%	6.63%				
11	11.91%	19.58%	7.67%	32	44.43%	44.63%	0.20%
77	23.88%	19.23%	-4.65%				
18	15.28%	14.94%	-0.34%				
76	24.29%	14.49%	-9.80%	33	68.84%	68.60%	-0.24%
10	10.27%	12.59%	2.32%				
16	14.21%	10.54%	-3.67%				

Current Map		
	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (strong + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Strong DEM (-45%):	33	10
Total DEM Seats (strong + lean):	40	13

New Map		
	Assembly	Senate
Strong GOP (55%+)	38	12
New Lean GOP (52.1-54.9%):	14	5
Total GOP Seats (strong + lean):	52	17
New Swing (48-52%)	10	3
New Lean DEM (45.1-47.9%):	4	1
Strong DEM (-45%):	33	12
Total DEM Seats (strong + lean):	37	13

Kessler Map

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	58.28%	7.13%	1	54.04%	55.88%	1.84%
2	54.93%	48.90%	-6.03%				
3	56.10%	59.95%	3.85%				
4	53.31%	54.91%	1.60%	2	55.44%	57.84%	2.40%
5	53.74%	58.65%	4.91%				
6	59.77%	60.17%	0.40%				
7	48.20%	48.01%	-0.19%	3	40.52%	40.00%	-0.52%
8	22.39%	22.82%	0.43%				
9	36.73%	34.52%	-2.21%				
10	10.27%	33.07%	22.80%	4	17.58%	31.02%	13.44%
11	11.91%	30.48%	18.57%				
12	29.23%	29.01%	-0.22%				
13	43.67%	45.28%	1.61%	5	50.62%	49.98%	-0.64%
14	59.06%	57.34%	-1.72%				
15	48.21%	47.62%	-0.59%				
16	14.21%	14.26%	0.05%	6	14.12%	21.34%	7.22%
17	13.21%	24.94%	11.73%				
18	15.28%	23.19%	7.91%				
19	29.15%	31.45%	2.30%	7	41.13%	41.45%	0.32%
20	43.71%	45.14%	1.43%				
21	51.92%	49.51%	-2.41%				
22	39.05%	25.68%	-13.37%	8	52.82%	48.86%	-3.96%
23	51.70%	46.50%	-5.20%				
24	67.29%	71.71%	4.42%				
25	52.79%	49.48%	-3.31%	9	52.96%	49.17%	-3.79%
26	45.42%	46.38%	0.96%				
27	59.20%	51.22%	-7.98%				
28	54.85%	55.60%	0.75%	10	53.14%	53.19%	0.05%
29	51.32%	46.68%	-4.64%				
30	53.29%	57.21%	3.92%				
31	67.57%	69.18%	1.61%	11	67.64%	68.08%	0.44%
32	61.06%	61.62%	0.56%				
33	72.24%	71.77%	-0.47%				
34	54.51%	48.62%	-5.89%	12	53.37%	51.36%	-2.01%
35	52.30%	50.09%	-2.21%				
36	53.06%	54.77%	1.71%				
37	51.33%	49.82%	-1.51%	13	59.22%	60.12%	0.90%
38	65.80%	67.73%	1.93%				
39	60.35%	62.35%	2.00%				
40	58.50%	57.79%	-0.71%	14	55.86%	49.86%	-6.00%
41	60.60%	44.17%	-16.43%				
42	48.54%	48.23%	-0.31%				
43	44.14%	42.34%	-1.80%	15	41.20%	41.30%	0.10%
44	36.74%	38.88%	2.14%				
45	42.39%	43.02%	0.63%				
46	42.07%	42.59%	0.52%	16	39.06%	38.13%	-0.93%
47	48.69%	47.09%	-1.60%				
48	28.03%	27.47%	-0.56%				
49	49.68%	49.84%	0.16%	17	48.46%	48.46%	0.00%
50	52.08%	51.88%	-0.20%				
51	44.01%	44.09%	0.08%				
52	57.39%	57.29%	-0.10%	18	54.96%	54.84%	-0.12%
53	62.74%	62.70%	-0.04%				
54	45.08%	44.00%	-1.08%				
55	49.34%	49.95%	0.61%	19	53.32%	52.88%	-0.44%
56	61.05%	60.64%	-0.41%				
57	47.26%	48.31%	1.05%				
58	70.90%	70.35%	-0.55%	20	70.55%	69.15%	-1.40%
59	72.74%	69.94%	-2.80%				
60	68.12%	67.37%	-0.75%				
61	35.98%	42.56%	6.58%	21	49.86%	49.36%	-0.50%
62	44.35%	41.72%	-2.63%				
63	63.09%	61.66%	-1.43%				
64	35.66%	36.48%	0.82%	22	47.56%	46.30%	-1.26%
65	45.44%	44.02%	-1.42%				
66	59.12%	58.37%	-0.75%				
67	51.72%	51.10%	-0.62%	23	49.98%	49.21%	-0.77%
68	45.01%	44.54%	-0.47%				
69	54.06%	51.90%	-2.16%				
70	49.74%	49.42%	-0.32%	24	46.72%	46.56%	-0.16%
71	41.68%	41.48%	-0.20%				
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
72	49.03%	48.87%	-0.16%				
73	39.55%	40.78%	1.23%	25	44.88%	45.31%	0.43%
74	43.78%	44.86%	1.08%				
75	51.71%	50.50%	-1.21%				
76	24.29%	24.20%	-0.09%	26	20.85%	21.36%	0.51%
77	23.88%	26.21%	2.33%				
78	14.09%	13.34%	-0.75%				
79	37.49%	38.52%	1.03%	27	38.38%	38.25%	-0.13%
80	42.15%	41.95%	-0.20%				
81	36.16%	34.87%	-1.29%				
82	58.59%	59.64%	1.05%	28	64.48%	65.01%	0.53%
83	69.70%	67.79%	-1.91%				
84	64.99%	66.69%	1.70%				
85	48.91%	56.47%	7.56%	29	52.00%	56.13%	4.13%
86	54.56%	56.80%	2.24%				
87	52.16%	54.92%	2.76%				
88	44.85%	45.13%	0.28%	30	50.38%	49.62%	-0.76%
89	55.76%	55.33%	-0.43%				
90	49.59%	47.70%	-1.89%				
91	45.87%	45.82%	-0.05%	31	46.89%	46.82%	-0.07%
92	50.79%	49.85%	-0.94%				
93	44.73%	45.40%	0.67%				
94	51.57%	47.65%	-3.92%	32	44.43%	44.43%	0.00%
95	36.02%	40.44%	4.42%				
96	45.32%	45.76%	0.44%				
97	59.96%	69.88%	9.92%	33	68.84%	71.46%	2.62%
98	70.96%	72.93%	1.97%				
99	73.35%	71.84%	-1.51%				

Current Map	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (strong + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Strong DEM (-45%):	33	10
Total DEM Seats (strong + lean):	40	13

New Map	Assembly	Senate
Strong GOP (55%+)	31	8
New Lean GOP (52.1-54.9%):	3	3
Total GOP Seats (strong + lean):	34	11
New Swing (48-52%)	19	9
New Lean DEM (45.1-47.9%):	13	4
Strong DEM (-45%):	33	9
Total DEM Seats (strong + lean):	46	13

Questions and Responses:

Every question can be traced back to the principles that guide redistricting:

1. Equal Population
2. Sensitivity to Minority Concerns
3. Compact and Contiguous districts.

Different choices can be made along the way, but those criteria must be followed. SB 148 meets these criteria.

Why so many pairings?

Pairings are usually an inevitable consequence of reapportionment and the result of compliance with the principles of equal population, compact and contiguous districts and sensitivity to minority concerns. Legislative districts are reapportioned to be in place for 10 years. Out of 132 legislators, only 35 remain today in the seats they held in 2000. That is about 75 percent turnover for the 10 years that the districts put in place after the last reapportionment were in effect.

Why did you (split, draw, pair) X?

There are a number of ways to reapportion. The reapportionment involves competing principles and choices that have to be made. This legislation represents the choices that have been made that are consistent with the legal standards required.

Who made the decisions on how these districts were drawn?

We are making that decision right now. Today. The Legislature. Staff developed this bill in consultation with attorneys retained by the Senate and the Assembly to make sure that it conformed with all legal principles. The duty to pass it falls on the Legislature.

What is the partisan makeup of these districts?

The election data for the last 10 years was made available by the Government Accountability Board to the Legislature. All four caucuses were provided this information along with the hardware and software to use it. Everyone has the ability to draw their own conclusions and interpret how past elections may play out in the new districts. But no one has a crystal ball that will tell you how elections may play out in these districts next year, or 10 years from now when these districts will still be in effect. 10 years ago different experts offered wildly different opinions on how the proposed maps would perform politically.

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2-2-12 RPTR BB
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Who did you talk with about these maps?

Staff consulted with attorneys to make sure that all legal principles were followed in reapportioning the state.

Why are you offering choices on the Hispanic districts, but not on the African American districts?

Given the rapid growth of the Hispanic population during the ten year cycle, which is very different than other minority growth patterns, we simply thought providing a number of alternatives would be appropriate. If there are other alternatives for other minority groups, then those can be proposed and acted on by the Committee and the legislature.

Why were Republican Attorneys hired to draw maps but Democrats were not allowed attorneys to draw maps?

Attorneys did not draw these maps. Staff drew them. Attorneys merely advised on the legal principles that have to be followed. Your staff has had all the same hardware, software and data available to them for over a year. The census data has been available since the end of March. I don't know what your staff has been doing with all that equipment and data. Our staff has been working on this bill.

Why are you not drawing a 50 percent voting age Hispanic seat?

I haven't seen a map that has a Senate seat with a 50 percent voting age Hispanic population. No one has produced one that I'm aware of.

Why are you acting now? Why are you acting before the locals?

Former State Senate leader, Senator Robson, is suing the state in federal court for not acting quickly enough. This is a constitutional duty of the Legislature. There is no reason for us to delay action and let a court do our job for us.

Redistricting is not something that we have discretion on. The Constitution requires the legislature to do this every 10 years. Only when the legislature is unable to agree do the courts step in. When we pass these maps, it will be the first time in nearly 30 years that the Legislature has met its obligation.

Many of you weren't here 10 years ago and most of the Assembly was not here 10 years ago. But because the courts drew a fair map after the last census, we're here today in the majority in both houses. The maps we pass will determine who's here 10 years from now.

Today we're going to walk through the proposed maps and talk about how we got there. We have an opportunity and an obligation to draw these maps that Republicans haven't had in decades.

There are 3 primary principles that go into the drawing of every map.

- Equal population
- Compact and contiguous districts
- Sensitivity to minority concerns.

The process is never pain-free, no matter who draws the maps. There are always tradeoffs as you make decisions when drawing a map. The constitution and the statues lay out the principals we have to follow. What we've come up with is a fair map that meets all these criteria and which we are confident will stand up to any legal scrutiny.

- Three principles
- Disenfranchisement
- Over/Under population map
- Start in Milwaukee
- Hispanic districts

Notes

59 split municipalities

Overall deviation of 0.76 (0.37 to -0.39) in Asm. 0.62 (0.27 to -0.35) in Sen

1. Currently, the urban areas of Racine and Kenosha are paired in 2 senate districts with the more rural parts of each county. This maps pairs the two urban areas in one senate district, and the more rural parts of each county together in another senate district. This results in 2 districts which each share more in common throughout the senate seat.

PRIVILEGED ATTORNEY-CLEINT COMMUNCATION

Confidentiality and Nondisclosure Related to Reapportionment

Michael Best & Friedrich LLP ("MB&F") is currently engaged to represent the Wisconsin State Senate, by its Majority Leader Scott L. Fitzgerald ("Senate") in connection with matters relating to the reapportionment of the Wisconsin Senate, Assembly and Congressional Districts arising out of the 2010 census (the "Representation"). In connection with the Representation we have instructed certain individuals, working at our direction, to meet with certain members of the Senate for the purpose of discussing matters within the scope of the Representation. Such discussions shall be conducted for the sole purpose of assisting MB&F in rendering legal advice to the Senate and, therefore, are subject to the attorney-client and attorney work product privileges. Consistent with those privileges, such discussions are and shall remain confidential.

This letter will confirm our understanding that such discussions are and shall remain confidential and that you agree not to disclose the fact and/or contents of such discussions or any draft documents within your possession related to the subject of the Representation with persons outside of the privilege. If you have any questions regarding the foregoing, please feel free to raise those questions with me. Otherwise, in order to confirm the foregoing understanding, please sign on the line indicated below.

Sincerely,

MICHAEL BEST & FRIEDRICH LLP

Eric M. McLeod

APPROVED AND AGREED UPON:

Senator

Date: 4/12/11, 2011.

029472-0001\9030774.1

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EXHIBIT NO. 123
2-2-12 RPTR BB
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PRIVILEGED ATTORNEY-CLIENT COMMUNICATION

Confidentiality and Nondisclosure Related to Reapportionment

Michael Best & Friedrich LLP ("MB&F") is currently engaged to represent the Wisconsin State Assembly, by its Speaker Jeff Fitzgerald ("Assembly") in connection with matters relating to the reapportionment of the Wisconsin Senate, Assembly and Congressional Districts arising out of the 2010 census (the "Representation"). In connection with the Representation we have instructed certain individuals, working at our direction, to meet with certain members of the Assembly for the purpose of discussing matters within the scope of the Representation. Such discussions shall be conducted for the sole purpose of assisting MB&F in rendering legal advice to the Assembly and, therefore, are subject to the attorney-client and attorney work product privileges. Consistent with those privileges, such discussions are and shall remain confidential.

This letter will confirm our understanding that such discussions are and shall remain confidential and that you agree not to disclose the fact and/or contents of such discussions or any draft documents within your possession related to the subject of the Representation with persons outside of the privilege. If you have any questions regarding the foregoing, please feel free to raise those questions with me. Otherwise, in order to confirm the foregoing understanding, please sign on the line indicated below.

Sincerely,

MICHAEL BEST & FRIEDRICH LLP

[signature]

Eric M. McLeod

APPROVED AND AGREED UPON:

[signature] Date: 4/26, 2011.

Representative

029472-0001\9028399.1

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2-2-12 RPTR CB
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District/COMP	Observed	All_40	All_41	All_42	All_43	All_44	All_45	All_46	All_47	All_48	Composite	All_50	All_51	All_52	All_53	All_54	All_55	All_56	All_57	All_58	All_59	All_60
15	0.1786	0.0876	0.0976	0.1076	0.1176	0.1276	0.1376	0.1476	0.1576	0.1676	0.1786	0.1876	0.1976	0.2076	0.2176	0.2276	0.2376	0.2476	0.2576	0.2676	0.2776	0.2876
9	0.1941	0.1031	0.1131	0.1231	0.1331	0.1431	0.1531	0.1631	0.1731	0.1831	0.1941	0.2031	0.2131	0.2231	0.2331	0.2431	0.2531	0.2631	0.2731	0.2831	0.2931	0.3031
75	0.2085	0.1175	0.1275	0.1375	0.1475	0.1575	0.1675	0.1775	0.1875	0.1975	0.2085	0.2175	0.2275	0.2375	0.2475	0.2575	0.2675	0.2775	0.2875	0.2975	0.3075	0.3175
8	0.2125	0.1215	0.1315	0.1415	0.1515	0.1615	0.1715	0.1815	0.1915	0.2015	0.2125	0.2215	0.2315	0.2415	0.2515	0.2615	0.2715	0.2815	0.2915	0.3015	0.3115	0.3215
16	0.2245	0.1335	0.1435	0.1535	0.1635	0.1735	0.1835	0.1935	0.2035	0.2135	0.2245	0.2335	0.2435	0.2535	0.2635	0.2735	0.2835	0.2935	0.3035	0.3135	0.3235	0.3335
7	0.2293	0.1383	0.1483	0.1583	0.1683	0.1783	0.1883	0.1983	0.2083	0.2183	0.2293	0.2383	0.2483	0.2583	0.2683	0.2783	0.2883	0.2983	0.3083	0.3183	0.3283	0.3383
76	0.2522	0.1612	0.1712	0.1812	0.1912	0.2012	0.2112	0.2212	0.2312	0.2412	0.2522	0.2612	0.2712	0.2812	0.2912	0.3012	0.3112	0.3212	0.3312	0.3412	0.3512	0.3612
17	0.2911	0.2001	0.2101	0.2201	0.2301	0.2401	0.2501	0.2601	0.2701	0.2801	0.2911	0.3001	0.3101	0.3201	0.3301	0.3401	0.3501	0.3601	0.3701	0.3801	0.3901	0.4001
77	0.304	0.213	0.223	0.233	0.243	0.253	0.263	0.273	0.283	0.293	0.304	0.313	0.323	0.333	0.343	0.353	0.363	0.373	0.383	0.393	0.403	0.413
74	0.3078	0.2168	0.2268	0.2368	0.2468	0.2568	0.2668	0.2768	0.2868	0.2968	0.3078	0.3168	0.3268	0.3368	0.3468	0.3568	0.3668	0.3768	0.3868	0.3968	0.4068	0.4168
14	0.33	0.239	0.249	0.259	0.269	0.279	0.289	0.299	0.309	0.319	0.33	0.339	0.349	0.359	0.369	0.379	0.389	0.399	0.409	0.419	0.429	0.439
45	0.3654	0.2744	0.2844	0.2944	0.3044	0.3144	0.3244	0.3344	0.3444	0.3544	0.3654	0.3744	0.3844	0.3944	0.4044	0.4144	0.4244	0.4344	0.4444	0.4544	0.4644	0.4744
10	0.368	0.277	0.287	0.297	0.307	0.317	0.327	0.337	0.347	0.357	0.368	0.377	0.387	0.397	0.407	0.417	0.427	0.437	0.447	0.457	0.467	0.477
73	0.3727	0.2817	0.2917	0.3017	0.3117	0.3217	0.3317	0.3417	0.3517	0.3617	0.3727	0.3817	0.3917	0.4017	0.4117	0.4217	0.4317	0.4417	0.4517	0.4617	0.4717	0.4817
63	0.3734	0.2824	0.2924	0.3024	0.3124	0.3224	0.3324	0.3424	0.3524	0.3624	0.3734	0.3824	0.3924	0.4024	0.4124	0.4224	0.4324	0.4424	0.4524	0.4624	0.4724	0.4824
6	0.3754	0.2844	0.2944	0.3044	0.3144	0.3244	0.3344	0.3444	0.3544	0.3644	0.3754	0.3844	0.3944	0.4044	0.4144	0.4244	0.4344	0.4444	0.4544	0.4644	0.4744	0.4844
46	0.3756	0.2846	0.2946	0.3046	0.3146	0.3246	0.3346	0.3446	0.3546	0.3646	0.3756	0.3846	0.3946	0.4046	0.4146	0.4246	0.4346	0.4446	0.4546	0.4646	0.4746	0.4846
42	0.3876	0.2966	0.3066	0.3166	0.3266	0.3366	0.3466	0.3566	0.3666	0.3766	0.3876	0.3966	0.4066	0.4166	0.4266	0.4366	0.4466	0.4566	0.4666	0.4766	0.4866	0.4966
18	0.3965	0.3055	0.3155	0.3255	0.3355	0.3455	0.3555	0.3655	0.3755	0.3855	0.3965	0.4055	0.4155	0.4255	0.4355	0.4455	0.4555	0.4655	0.4755	0.4855	0.4955	0.5055
78	0.4045	0.3135	0.3235	0.3335	0.3435	0.3535	0.3635	0.3735	0.3835	0.3935	0.4045	0.4135	0.4235	0.4335	0.4435	0.4535	0.4635	0.4735	0.4835	0.4935	0.5035	0.5135
43	0.4096	0.3186	0.3286	0.3386	0.3486	0.3586	0.3686	0.3786	0.3886	0.3986	0.4096	0.4186	0.4286	0.4386	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5186
64	0.41	0.319	0.329	0.339	0.349	0.359	0.369	0.379	0.389	0.399	0.41	0.419	0.429	0.439	0.449	0.459	0.469	0.479	0.489	0.499	0.509	0.519
47	0.4109	0.3199	0.3299	0.3399	0.3499	0.3599	0.3699	0.3799	0.3899	0.3999	0.4109	0.4199	0.4299	0.4399	0.4499	0.4599	0.4699	0.4799	0.4899	0.4999	0.5099	0.5199
89	0.413	0.322	0.332	0.342	0.352	0.362	0.372	0.382	0.392	0.402	0.413	0.422	0.432	0.442	0.452	0.462	0.472	0.482	0.492	0.502	0.512	0.522
44	0.4155	0.3245	0.3345	0.3445	0.3545	0.3645	0.3745	0.3845	0.3945	0.4045	0.4155	0.4245	0.4345	0.4445	0.4545	0.4645	0.4745	0.4845	0.4945	0.5045	0.5145	0.5245
41	0.4373	0.3463	0.3563	0.3663	0.3763	0.3863	0.3963	0.4063	0.4163	0.4263	0.4373	0.4463	0.4563	0.4663	0.4763	0.4863	0.4963	0.5063	0.5163	0.5263	0.5363	0.5463
70	0.4423	0.3513	0.3613	0.3713	0.3813	0.3913	0.4013	0.4113	0.4213	0.4313	0.4423	0.4513	0.4613	0.4713	0.4813	0.4913	0.5013	0.5113	0.5213	0.5313	0.5413	0.5513
93	0.4463	0.3553	0.3653	0.3753	0.3853	0.3953	0.4053	0.4153	0.4253	0.4353	0.4463	0.4553	0.4653	0.4753	0.4853	0.4953	0.5053	0.5153	0.5253	0.5353	0.5453	0.5553
13	0.4482	0.3572	0.3672	0.3772	0.3872	0.3972	0.4072	0.4172	0.4272	0.4372	0.4482	0.4572	0.4672	0.4772	0.4872	0.4972	0.5072	0.5172	0.5272	0.5372	0.5472	0.5572
71	0.4488	0.3578	0.3678	0.3778	0.3878	0.3978	0.4078	0.4178	0.4278	0.4378	0.4488	0.4578	0.4678	0.4778	0.4878	0.4978	0.5078	0.5178	0.5278	0.5378	0.5478	0.5578
72	0.4494	0.3584	0.3684	0.3784	0.3884	0.3984	0.4084	0.4184	0.4284	0.4384	0.4494	0.4584	0.4684	0.4784	0.4884	0.4984	0.5084	0.5184	0.5284	0.5384	0.5484	0.5584
90	0.4494	0.3584	0.3684	0.3784	0.3884	0.3984	0.4084	0.4184	0.4284	0.4384	0.4494	0.4584	0.4684	0.4784	0.4884	0.4984	0.5084	0.5184	0.5284	0.5384	0.5484	0.5584
5	0.4515	0.3605	0.3705	0.3805	0.3905	0.4005	0.4105	0.4205	0.4305	0.4405	0.4515	0.4605	0.4705	0.4805	0.4905	0.5005	0.5105	0.5205	0.5305	0.5405	0.5505	0.5605
65	0.4564	0.3654	0.3754	0.3854	0.3954	0.4054	0.4154	0.4254	0.4354	0.4454	0.4564	0.4654	0.4754	0.4854	0.4954	0.5054	0.5154	0.5254	0.5354	0.5454	0.5554	0.5654
92	0.4625	0.3715	0.3815	0.3915	0.4015	0.4115	0.4215	0.4315	0.4415	0.4515	0.4625	0.4715	0.4815	0.4915	0.5015	0.5115	0.5215	0.5315	0.5415	0.5515	0.5615	0.5715
62	0.4653	0.3743	0.3843	0.3943	0.4043	0.4143	0.4243	0.4343	0.4443	0.4543	0.4653	0.4743	0.4843	0.4943	0.5043	0.5143	0.5243	0.5343	0.5443	0.5543	0.5643	0.5743
69	0.4664	0.3754	0.3854	0.3954	0.4054	0.4154	0.4254	0.4354	0.4454	0.4554	0.4664	0.4754	0.4854	0.4954	0.5054	0.5154	0.5254	0.5354	0.5454	0.5554	0.5654	0.5754
79	0.47	0.379	0.389	0.399	0.409	0.419	0.429	0.439	0.449	0.459	0.47	0.479	0.489	0.499	0.509	0.519	0.529	0.539	0.549	0.559	0.569	0.579
68	0.4703	0.3793	0.3893	0.3993	0.4093	0.4193	0.4293	0.4393	0.4493	0.4593	0.4703	0.4793	0.4893	0.4993	0.5093	0.5193	0.5293	0.5393	0.5493	0.5593	0.5693	0.5793
88	0.473	0.382	0.392	0.402	0.412	0.422	0.432	0.442	0.452	0.462	0.473	0.482	0.492	0.502	0.512	0.522	0.532	0.542	0.552	0.562	0.572	0.582
91	0.4739	0.3829	0.3929	0.4029	0.4129	0.4229	0.4329	0.4429	0.4529	0.4629	0.4739	0.4829	0.4929	0.5029	0.5129	0.5229	0.5329	0.5429	0.5529	0.5629	0.5729	0.5829
11	0.4796	0.3886	0.3986	0.4086	0.4186	0.4286	0.4386	0.4486	0.4586	0.4686	0.4796	0.4886	0.4986	0.5086	0.5186	0.5286	0.5386	0.5486	0.5586	0.5686	0.5786	0.5886
94	0.4828	0.3918	0.4018	0.4118	0.4218	0.4318	0.4418	0.4518	0.4618	0.4718	0.4828	0.4918	0.5018	0.5118	0.5218	0.5318	0.5418	0.5518	0.5618	0.5718	0.5818	0.5918
48	0.4923	0.4013	0.4113	0.4213	0.4313	0.4413	0.4513	0.4613	0.4713	0.4813	0.4923	0.5013	0.5113	0.5213	0.5313	0.5413	0.5513	0.5613	0.5713	0.5813	0.5913	0.6013
40	0.4948	0.4038	0.4138	0.4238	0.4338	0.4438	0.4538	0.4638	0.4738	0.4838	0.4948	0.5038	0.5138	0.5238	0.5338	0.5438	0.5538	0.5638	0.5738	0.5838	0.5938	0.6038
67	0.5037	0.4127	0.4227	0.4327	0.4427	0.4527	0.4627	0.4727	0.4827	0.4927	0.5037	0.5127	0.5227	0.5327	0.5427	0.5527	0.5627	0.5727	0.5827	0.5927	0.6027	0.6127
19	0.5053	0.4143	0.4243	0.4343	0.4443	0.4543	0.4643	0.4743	0.4843	0.4943	0.5053	0.5143	0.5243	0.5343	0.5443	0.5543	0.5643	0.5743	0.5843	0.5943	0.6043	0.6143
4	0.5075	0.4165	0.4265	0.4365	0.4465	0.4565	0.4665	0.4765	0.4865	0.4965	0.5075	0.5165	0.5265	0.5365	0.5465	0.5565	0.5665	0.5765	0.5865	0.5965	0.6065	0.6165
66	0.5175	0.4265	0.4365	0.4465	0.4565	0.4665	0.4765	0.4865	0.4965	0.5065	0.5175	0.5265	0.5365	0.5465	0.5565	0.5665	0.5765	0.5865	0.5965	0.6065	0.6165	0.6265
87	0.518	0.427	0.437	0.447	0.457	0.467	0.477	0.487	0.497	0.507	0.518	0.527	0.537	0.547	0.557	0.567	0.577	0.587	0.597	0.607	0.617	0.627
49	0.5196	0.4286	0.4386	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5196	0.5286	0.5386	0.5486	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286
53	0.5268	0.4358	0.4458	0.4558	0.4658	0.4758	0.4858	0.4958	0.5058	0.5158	0.5268	0.5358	0.5458	0.5558	0.5658	0.5758	0.5858	0.5958	0.6058	0.6158	0.6258	0.6358
54	0.527	0.436	0.446	0.456	0.466	0.476	0.486	0.496	0.506	0.516	0.527	0.536	0.546	0.556	0.566	0.576	0.586	0.596	0.606	0.616	0.626	0.636
27	0.533	0.442	0.452	0.462	0.472	0.482	0.492	0.502	0.512	0.522	0.533	0.542	0.552	0.562	0.572	0.582	0.592	0.602	0.612	0.622	0.632	0.642
61	0.5354	0.4444	0.4544	0.4644	0.4744	0.4844	0.4944	0.5044	0.5144	0.5244	0.5354	0.5444	0.5544	0.5644	0.5744	0.5844	0.5944	0.6044	0.6144	0.6244	0.6344	0.6444
28	0.5372	0.4462	0.4562	0.4662	0.4762	0.4862	0.4962	0.5062	0.5162	0.5262	0.5372	0.5462	0.5562	0.5662	0.5762	0.5862	0.5962	0.6062	0.6162	0.6262	0.6362	0.6462
3	0.5374	0.4464	0.4564	0.4664	0.4764	0.4864	0.4964	0.5064	0.5164	0.5264	0.5374	0.5464	0.5564	0.5664	0.5764	0.5864	0.5964	0.6064	0.6164	0.6264	0.6364	0.6464
84	0.5401	0.4491	0.4591	0.4691	0.4791	0.4891	0.4991	0.5091	0.5191	0.5291	0.5401	0.5491	0.5591	0.5691	0.5791	0.5891	0.5991	0.6091	0.6191	0.6291	0.6391	0.6491
1	0.5442	0.4532	0.4632	0.4732	0.4832	0.4932	0.5032	0.5132	0.5232	0.5332	0.5442	0.5532	0.5632	0.5732	0.5832	0.5932	0.6032	0.6132	0.6232	0.6332	0.6432	0.6532
52	0.5443	0.4533	0.4633	0.4733	0.4833	0.4933	0.5033	0.5133	0.5233	0.5333	0.5443	0.5533	0.5633	0.5733	0.5833	0.5933	0.6033	0.6133	0.6233	0.6333	0.6433	0.6533
2	0.545	0.454	0.464	0.474	0.484	0.494	0.504	0.514	0.524	0.534	0.545	0.554	0.564	0.574	0.584	0.594	0.604	0.614	0.624	0.634	0.644	0.654
12	0.549	0.458	0.468	0.478	0.488	0.498	0.508	0.518	0.528	0.538	0.549	0.558	0.568	0.578	0.588	0.598	0.608	0.618	0.628	0.638	0.648	0.658
32	0.5501	0.4591	0.4691	0.4791	0.4891	0.4991	0.5091	0.5191	0.5291	0.5391	0.5501	0.5591	0.5691	0.5791	0.5891	0.5991	0.6091	0.6191	0.6291	0.6391	0.6491	0.6591
51	0.5505	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095	0.5195	0.5295	0.5395	0.5505	0.5595	0.5695	0.5795	0.5895	0.5995	0.6095	0.6195	0.6295	0.6395	0.6495	0.6595
86	0.5511	0.4601	0.4701	0.4801	0.4901	0.5001	0.5101	0.5201	0.5301	0.5401	0.5511	0.5601	0.5701	0.5801	0.5901	0.6001	0.6101	0.6201	0.6301	0.6401	0.6501	0.6601
85	0.5513	0.4603	0.4703	0.4803	0.4903	0.5003	0.5103	0.5203	0.5303	0.5403	0.5513	0.5603	0.5703	0.5803	0.5903	0.6003	0.6103	0.6203	0.6303	0.6403	0.6503	0.6603
33	0.5529	0.4619	0.4719	0.4819	0.4919	0.5019	0.5119	0.5219	0.5319	0.5419	0.5529	0.5619	0.5719	0.5819	0.5919	0.6019	0.6119	0.6219	0.6319	0.6419	0.6519	0.6619
39	0.5562	0.4652	0.4752	0.4852	0.4952	0.5052	0.5152	0.5252	0.5352	0.5452	0.5562	0.5652	0.5752	0.5852	0.5952	0.6052	0.6152	0.6252	0.6352	0.6452	0.6552	0.6652
50	0.5579	0.4669	0.4769	0.4869	0.4969	0.5069	0.5169	0.5269	0.5369	0.5469	0.5579	0.5669	0.5769	0.5869	0.5969	0.6069	0.6169	0.6269	0.6369	0.6469	0.6569	0.6669
20	0.5721	0.4811	0.4911	0.5011	0.5111	0.5211	0.5311	0.5411	0.5511	0.5611	0.5721	0.5811	0.5911	0.6011	0.6111	0.6211	0.6311	0.6411	0.6511	0.6611	0.6711	0.6811
83	0.5725	0.4815	0.4915	0.5015	0.5115	0.5215	0.5315	0.5415	0.5515	0.5615	0.5725	0.5815	0.5915	0.6015	0.6115	0.6215	0.6315	0.6415	0.6515	0.6615	0.6715	0.6815
34	0.5729	0.4819	0.4919	0.5019	0.5119	0.5219	0.5319	0.5419	0.5519	0.5619	0.5729	0.5819	0.5919	0.6019	0.6119	0.6219	0.6319	0.6419	0.6519	0.6619	0.6719	0.6819
26	0.5735	0.4825	0.4925	0.5025	0.5125	0.5225	0.5325	0.5425	0.5525	0.5625	0.5735	0.5825	0.5925	0.6025	0.6125	0.6225	0.6325	0.6425	0.6525	0.6625	0.6725	0.6825
29	0.5741	0.4831	0.4931	0.5031	0.5131	0.5231	0.5331	0.5431	0.5531	0.5631	0.5741	0.5831	0.5931	0.6031	0.6131	0.6231	0.6331	0.6431	0.6531	0.6631	0.6731	0.6831
31	0.5741	0.4831	0.4931	0.5031	0.5131	0.5231	0.5331	0.5431	0.5531	0.5631	0.5741	0.5831	0.5931	0.6031	0.6131	0.6231	0.6331	0.6431	0.6531	0.6631	0.6731	0.6831
38	0.5759	0.4849	0.4949	0.5049	0.5149	0.5249	0.5349	0.5449	0.5549	0.5649	0.5759	0.5849	0.5949	0.6049	0.6149	0.6249	0.6349	0.6449	0.6549	0.6649	0.6749	0.6849
24	0.5767	0.4857	0.4957	0.5057	0.5157	0.5257	0.5357	0.5457	0.5557	0.5657	0.5767	0.5857	0.5957	0.6057	0.6157	0.6257	0.6357	0.6457	0.6557	0.6657	0.6757	0.6857
80	0.5769	0.4859	0.4959	0.5059	0.5159	0.5259	0.5359	0.5459	0.5559	0.5659	0.5769	0.5859	0.5959	0.6059	0.6159	0.6259	0.6359	0.6459	0.6559	0.6659	0.6759	0.6859
60	0.5779	0.4869	0.4969	0.5069	0.5169	0.5269	0.5369	0.5469	0.5569	0.5669	0.5779	0.5869	0.5969	0.6069	0.6169	0.6269	0.6369	0.6469	0.6569	0.6669	0.6769	0.6869
55	0.5818	0.4908	0.5008	0.5108	0.5208	0.5308	0.5408	0.5508	0.5608	0.5708	0.5818	0.5908	0.6008	0.6108	0.6208	0.6308	0.6408	0.6508	0.6608	0.6708	0.6808	0.6908
30	0.5819	0.4909	0.5009	0.5109	0.5209	0.5309	0.5409	0.5509	0.5609	0.5709	0.5819	0.5909	0.6009	0.6109	0.6209	0.6309	0.6409	0.6509	0.6609	0.6709	0.6809	0.6909
25	0.5825	0.4915	0.5015	0.5115	0.5215	0.5315	0.5415	0.5515	0.5615	0.5715	0.5825	0.5915	0.6015	0.6115	0.6215	0.6315	0.6415	0.6515	0.6615	0.6715	0.6815	0.6915
56	0.5963	0.5053	0.5153	0.5253	0.5353	0.5453	0.5553	0.5653	0.5753	0.5853	0.5963	0.6053	0.6153	0.6253	0.6353	0.6453	0.6553	0.6653	0.6753	0.6853	0.6953	0.7053
95	0.598	0.507	0.517	0.527	0.537	0.547	0.557	0.567	0.577	0.587	0.598	0.607	0.617	0.627	0.637	0.647	0.657	0.667	0.677	0.687	0.697	0.707
23	0.5985	0.5075	0.5175	0.5275	0.5375	0.5475	0.5575	0.5675	0.5775	0.5875	0.5985	0.6075	0.6175	0.6275	0.6375	0.6475	0.6575	0.6675	0.6775	0.6875	0.6975	0.7075
35	0.601	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.601	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.7	0.71
37	0.601	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.601	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.7	0.71
36	0.6169	0.5259	0.5359	0.5459	0.5559	0.5659	0.5759	0.5859	0.5959	0.6059	0.6169	0.6259	0.6359	0.6459	0.6559	0.6659	0.6759	0.6859	0.6959	0.7059	0.7159	0.7259
22	0.621	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.6	0.61	0.621	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.7	0.71	0.72	0.73
21	0.6231	0.5321	0.5421	0.5521	0.5621	0.5721	0.5821	0.5921	0.6021	0.6121	0.6231	0.6321	0.6421	0.6521	0.6621	0.6721	0.6821	0.6921	0.7021	0.7121	0.7221	0.7321
82	0.6243	0.5333	0.5433	0.5533	0.5633	0.5733	0.5833	0.5933	0.6033	0.6133	0.6243	0.6333	0.6433	0.6533	0.6633	0.6733	0.6833	0.6933	0.7033	0.7133	0.7233	0.7333
81	0.6249	0.5339	0.5439	0.5539	0.5639	0.5739	0.5839	0.5939	0.6039	0.6139	0.6249	0.6339	0.6439	0.6539	0.6639	0.6739	0.6839	0.6939	0.7039	0.7139	0.7239	0.7339
59	0.6345	0.5435	0.5535	0.5635	0.5735	0.5835	0.5935	0.6035	0.6135	0.6235	0.6345	0.6435	0.6535	0.6635	0.6735	0.6835	0.6935	0.7035	0.7135	0.7235	0.7335	0.7435
58	0.6404	0.5494	0.5594	0.5694	0.5794	0.5894	0.5994	0.6094	0.6194	0.6294	0.6404	0.6494	0.6594	0.6694	0.6794	0.6894	0.6994	0.7094	0.7194	0.7294	0.7394	0.7494
96	0.6798	0.5888	0.5988	0.6088	0.6188	0.6288	0.6388	0.6488	0.6588	0.6688	0.6798	0.6888	0.6988	0.7088	0.7188	0.7288	0.7388	0.7488	0.7588	0.7688	0.7788	0.7888
57	0.6806	0.5896	0.5996	0.6096	0.6196	0.6296	0.6396	0.6496	0.6596	0.6696	0.6806	0.6896	0.6996	0.7096	0.7196	0.7296	0.7396	0.7496	0.7596	0.7696	0.7796	0.7896
97	0.7036	0.6126	0.6226	0.6326	0.6426	0.6526	0.6626	0.6726	0.6826	0.6926	0.7036	0.7126	0.7226	0.7326	0.7426	0.7526	0.7626	0.7726	0.7826	0.7926	0.8026	0.8126
98	0.7266	0.6356	0.6456	0.6556	0.6656	0.6756	0.6856	0.6956	0.7056	0.7156	0.7266	0.7356	0.7456	0.7556	0.7656	0.7756	0.7856	0.7956	0.8056	0.8156	0.8256	0.8356
99	0.7266	0.6356	0.6456	0.6556	0.6656	0.6756	0.6856	0.6956	0.7056	0.7156	0.7266	0.7356	0.7456	0.7556	0.7656	0.7756	0.7856	0.7956	0.8056	0.8156	0.8256	0.8356

District / COMP	All_40	All_41	All_42	All_43	All_44	All_45	All_46	All_47	All_48	Composite	All_50	All_51	All_52	All_53	All_54	All_55	All_56	All_57	All_58	All_59	All_60
16	0.0502	0.0602	0.0702	0.0802	0.0902	0.1002	0.1102	0.1202	0.1302	0.1412	0.1502	0.1602	0.1702	0.1802	0.1902	0.2002	0.2102	0.2202	0.2302	0.2402	0.2502
10	0.0848	0.0948	0.1048	0.1148	0.1248	0.1348	0.1448	0.1548	0.1648	0.1758	0.1848	0.1948	0.2048	0.2148	0.2248	0.2348	0.2448	0.2548	0.2648	0.2748	0.2848
9	0.0926	0.1026	0.1126	0.1226	0.1326	0.1426	0.1526	0.1626	0.1726	0.1836	0.1926	0.2026	0.2126	0.2226	0.2326	0.2426	0.2526	0.2626	0.2726	0.2826	0.2926
17	0.115	0.125	0.135	0.145	0.155	0.165	0.175	0.185	0.195	0.206	0.215	0.225	0.235	0.245	0.255	0.265	0.275	0.285	0.295	0.305	0.315
76	0.1175	0.1275	0.1375	0.1475	0.1575	0.1675	0.1775	0.1875	0.1975	0.2085	0.2175	0.2275	0.2375	0.2475	0.2575	0.2675	0.2775	0.2875	0.2975	0.3075	0.3175
8	0.127	0.137	0.147	0.157	0.167	0.177	0.187	0.197	0.207	0.218	0.227	0.237	0.247	0.257	0.267	0.277	0.287	0.297	0.307	0.317	0.327
77	0.1685	0.1785	0.1885	0.1985	0.2085	0.2185	0.2285	0.2385	0.2485	0.2595	0.2685	0.2785	0.2885	0.2985	0.3085	0.3185	0.3285	0.3385	0.3485	0.3585	0.3685
15	0.1793	0.1893	0.1993	0.2093	0.2193	0.2293	0.2393	0.2493	0.2593	0.2703	0.2793	0.2893	0.2993	0.3093	0.3193	0.3293	0.3393	0.3493	0.3593	0.3693	0.3793
11	0.2154	0.2254	0.2354	0.2454	0.2554	0.2654	0.2754	0.2854	0.2954	0.3064	0.3154	0.3254	0.3354	0.3454	0.3554	0.3654	0.3754	0.3854	0.3954	0.4054	0.4154
18	0.2205	0.2305	0.2405	0.2505	0.2605	0.2705	0.2805	0.2905	0.3005	0.3115	0.3205	0.3305	0.3405	0.3505	0.3605	0.3705	0.3805	0.3905	0.4005	0.4105	0.4205
78	0.2211	0.2311	0.2411	0.2511	0.2611	0.2711	0.2811	0.2911	0.3011	0.3121	0.3211	0.3311	0.3411	0.3511	0.3611	0.3711	0.3811	0.3911	0.4011	0.4111	0.4211
75	0.2233	0.2333	0.2433	0.2533	0.2633	0.2733	0.2833	0.2933	0.3033	0.3143	0.3233	0.3333	0.3433	0.3533	0.3633	0.3733	0.3833	0.3933	0.4033	0.4133	0.4233
74	0.2898	0.2998	0.3098	0.3198	0.3298	0.3398	0.3498	0.3598	0.3698	0.3808	0.3898	0.3998	0.4098	0.4198	0.4298	0.4398	0.4498	0.4598	0.4698	0.4798	0.4898
79	0.2928	0.3028	0.3128	0.3228	0.3328	0.3428	0.3528	0.3628	0.3728	0.3838	0.3928	0.4028	0.4128	0.4228	0.4328	0.4428	0.4528	0.4628	0.4728	0.4828	0.4928
46	0.2996	0.3096	0.3196	0.3296	0.3396	0.3496	0.3596	0.3696	0.3796	0.3906	0.3996	0.4096	0.4196	0.4296	0.4396	0.4496	0.4596	0.4696	0.4796	0.4896	0.4996
7	0.3142	0.3242	0.3342	0.3442	0.3542	0.3642	0.3742	0.3842	0.3942	0.4052	0.4142	0.4242	0.4342	0.4442	0.4542	0.4642	0.4742	0.4842	0.4942	0.5042	0.5142
44	0.3148	0.3248	0.3348	0.3448	0.3548	0.3648	0.3748	0.3848	0.3948	0.4058	0.4148	0.4248	0.4348	0.4448	0.4548	0.4648	0.4748	0.4848	0.4948	0.5048	0.5148
47	0.3157	0.3257	0.3357	0.3457	0.3557	0.3657	0.3757	0.3857	0.3957	0.4067	0.4157	0.4257	0.4357	0.4457	0.4557	0.4657	0.4757	0.4857	0.4957	0.5057	0.5157
48	0.3197	0.3297	0.3397	0.3497	0.3597	0.3697	0.3797	0.3897	0.3997	0.4107	0.4197	0.4297	0.4397	0.4497	0.4597	0.4697	0.4797	0.4897	0.4997	0.5097	0.5197
19	0.3203	0.3303	0.3403	0.3503	0.3603	0.3703	0.3803	0.3903	0.4003	0.4113	0.4203	0.4303	0.4403	0.4503	0.4603	0.4703	0.4803	0.4903	0.5003	0.5103	0.5203
43	0.321	0.331	0.341	0.351	0.361	0.371	0.381	0.391	0.401	0.412	0.421	0.431	0.441	0.451	0.461	0.471	0.481	0.491	0.501	0.511	0.521
42	0.342	0.352	0.362	0.372	0.382	0.392	0.402	0.412	0.422	0.433	0.442	0.452	0.462	0.472	0.482	0.492	0.502	0.512	0.522	0.532	0.542
71	0.3428	0.3528	0.3628	0.3728	0.3828	0.3928	0.4028	0.4128	0.4228	0.4338	0.4428	0.4528	0.4628	0.4728	0.4828	0.4928	0.5028	0.5128	0.5228	0.5328	0.5428
72	0.3501	0.3601	0.3701	0.3801	0.3901	0.4001	0.4101	0.4201	0.4301	0.4411	0.4501	0.4601	0.4701	0.4801	0.4901	0.5001	0.5101	0.5201	0.5301	0.5401	0.5501
93	0.3519	0.3619	0.3719	0.3819	0.3919	0.4019	0.4119	0.4219	0.4319	0.4429	0.4519	0.4619	0.4719	0.4819	0.4919	0.5019	0.5119	0.5219	0.5319	0.5419	0.5519
94	0.3533	0.3633	0.3733	0.3833	0.3933	0.4033	0.4133	0.4233	0.4333	0.4443	0.4533	0.4633	0.4733	0.4833	0.4933	0.5033	0.5133	0.5233	0.5333	0.5433	0.5533
45	0.3541	0.3641	0.3741	0.3841	0.3941	0.4041	0.4141	0.4241	0.4341	0.4451	0.4541	0.4641	0.4741	0.4841	0.4941	0.5041	0.5141	0.5241	0.5341	0.5441	0.5541
20	0.3552	0.3652	0.3752	0.3852	0.3952	0.4052	0.4152	0.4252	0.4352	0.4462	0.4552	0.4652	0.4752	0.4852	0.4952	0.5052	0.5152	0.5252	0.5352	0.5452	0.5552
73	0.3578	0.3678	0.3778	0.3878	0.3978	0.4078	0.4178	0.4278	0.4378	0.4488	0.4578	0.4678	0.4778	0.4878	0.4978	0.5078	0.5178	0.5278	0.5378	0.5478	0.5578
14	0.3602	0.3702	0.3802	0.3902	0.4002	0.4102	0.4202	0.4302	0.4402	0.4512	0.4602	0.4702	0.4802	0.4902	0.5002	0.5102	0.5202	0.5302	0.5402	0.5502	0.5602
12	0.3649	0.3749	0.3849	0.3949	0.4049	0.4149	0.4249	0.4349	0.4449	0.4559	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5249	0.5349	0.5449	0.5549	0.5649
80	0.367	0.377	0.387	0.397	0.407	0.417	0.427	0.437	0.447	0.458	0.467	0.477	0.487	0.497	0.507	0.517	0.527	0.537	0.547	0.557	0.567
70	0.3762	0.3862	0.3962	0.4062	0.4162	0.4262	0.4362	0.4462	0.4562	0.4672	0.4762	0.4862	0.4962	0.5062	0.5162	0.5262	0.5362	0.5462	0.5562	0.5662	0.5762
91	0.3779	0.3879	0.3979	0.4079	0.4179	0.4279	0.4379	0.4479	0.4579	0.4689	0.4779	0.4879	0.4979	0.5079	0.5179	0.5279	0.5379	0.5479	0.5579	0.5679	0.5779
95	0.3787	0.3887	0.3987	0.4087	0.4187	0.4287	0.4387	0.4487	0.4587	0.4697	0.4787	0.4887	0.4987	0.5087	0.5187	0.5287	0.5387	0.5487	0.5587	0.5687	0.5787
21	0.3816	0.3916	0.4016	0.4116	0.4216	0.4316	0.4416	0.4516	0.4616	0.4726	0.4816	0.4916	0.5016	0.5116	0.5216	0.5316	0.5416	0.5516	0.5616	0.5716	0.5816
64	0.3846	0.3946	0.4046	0.4146	0.4246	0.4346	0.4446	0.4546	0.4646	0.4756	0.4846	0.4946	0.5046	0.5146	0.5246	0.5346	0.5446	0.5546	0.5646	0.5746	0.5846
69	0.39	0.4	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.481	0.49	0.5	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59
49	0.3936	0.4036	0.4136	0.4236	0.4336	0.4436	0.4536	0.4636	0.4736	0.4846	0.4936	0.5036	0.5136	0.5236	0.5336	0.5436	0.5536	0.5636	0.5736	0.5836	0.5936
90	0.396	0.406	0.416	0.426	0.436	0.446	0.456	0.466	0.476	0.487	0.496	0.506	0.516	0.526	0.536	0.546	0.556	0.566	0.576	0.586	0.596
92	0.3976	0.4076	0.4176	0.4276	0.4376	0.4476	0.4576	0.4676	0.4776	0.4886	0.4976	0.5076	0.5176	0.5276	0.5376	0.5476	0.5576	0.5676	0.5776	0.5876	0.5976
68	0.4021	0.4121	0.4221	0.4321	0.4421	0.4521	0.4621	0.4721	0.4821	0.4931	0.5021	0.5121	0.5221	0.5321	0.5421	0.5521	0.5621	0.5721	0.5821	0.5921	0.6021
6	0.4036	0.4136	0.4236	0.4336	0.4436	0.4536	0.4636	0.4736	0.4836	0.4946	0.5036	0.5136	0.5236	0.5336	0.5436	0.5536	0.5636	0.5736	0.5836	0.5936	0.6036
62	0.4066	0.4166	0.4266	0.4366	0.4466	0.4566	0.4666	0.4766	0.4866	0.4976	0.5066	0.5166	0.5266	0.5366	0.5466	0.5566	0.5666	0.5766	0.5866	0.5966	0.6066
61	0.4076	0.4176	0.4276	0.4376	0.4476	0.4576	0.4676	0.4776	0.4876	0.4986	0.5076	0.5176	0.5276	0.5376	0.5476	0.5576	0.5676	0.5776	0.5876	0.5976	0.6076
67	0.4088	0.4188	0.4288	0.4388	0.4488	0.4588	0.4688	0.4788	0.4888	0.4998	0.5088	0.5188	0.5288	0.5388	0.5488	0.5588	0.5688	0.5788	0.5888	0.5988	0.6088
63	0.4101	0.4201	0.4301	0.4401	0.4501	0.4601	0.4701	0.4801	0.4901	0.5011	0.5101	0.5201	0.5301	0.5401	0.5501	0.5601	0.5701	0.5801	0.5901	0.6001	0.6101
88	0.4128	0.4228	0.4328	0.4428	0.4528	0.4628	0.4728	0.4828	0.4928	0.5038	0.5128	0.5228	0.5328	0.5428	0.5528	0.5628	0.5728	0.5828	0.5928	0.6028	0.6128
89	0.4141	0.4241	0.4341	0.4441	0.4541	0.4641	0.4741	0.4841	0.4941	0.5051	0.5141	0.5241	0.5341	0.5441	0.5541	0.5641	0.5741	0.5841	0.5941	0.6041	0.6141
13	0.4152	0.4252	0.4352	0.4452	0.4552	0.4652	0.4752	0.4852	0.4952	0.5062	0.5152	0.5252	0.5352	0.5452	0.5552	0.5652	0.5752	0.5852	0.5952	0.6052	0.6152
86	0.418	0.428	0.438	0.448	0.458	0.468	0.478	0.488	0.498	0.509	0.518	0.528	0.538	0.548	0.558	0.568	0.578	0.588	0.598	0.608	0.618
50	0.419	0.429	0.439	0.449	0.459	0.469	0.479	0.489	0.499	0.51	0.519	0.529	0.539	0.549	0.559	0.569	0.579	0.589	0.599	0.609	0.619
41	0.4196	0.4296	0.4396	0.4496	0.4596	0.4696	0.4796	0.4896	0.4996	0.5106	0.5196	0.5296	0.5396	0.5496	0.5596	0.5696	0.5796	0.5896	0.5996	0.6096	0.6196
87	0.4214	0.4314	0.4414	0.4514	0.4614	0.4714	0.4814	0.4914	0.5014	0.5124	0.5214	0.5314	0.5414	0.5514	0.5614	0.5714	0.5814	0.5914	0.6014	0.6114	0.6214
66	0.4263	0.4363	0.4463	0.4563	0.4663	0.4763	0.4863	0.4963	0.5063	0.5173	0.5263	0.5363	0.5463	0.5563	0.5663	0.5763	0.5863	0.5963	0.6063	0.6163	0.6263
85	0.429	0.439	0.449	0.459	0.469	0.479	0.489	0.499	0.509	0.52	0.529	0.539	0.549	0.559	0.569	0.579	0.589	0.599	0.609	0.619	0.629
65	0.4296	0.4396	0.4496	0.4596	0.4696	0.4796	0.4896	0.4996	0.5096	0.5206	0.5296	0.5396	0.5496	0.5596	0.5696	0.5796	0.5896	0.5996	0.6096	0.6196	0.6296
35	0.4309	0.4409	0.4509	0.4609	0.4709	0.4809	0.4909	0.5009	0.5109	0.5219	0.5309	0.5409	0.5509	0.5609	0.5709	0.5809	0.5909	0.6009	0.6109	0.6209	0.6309
60	0.431	0.441	0.451	0.461	0.471	0.481	0.491	0.501	0.511	0.522	0.531	0.541	0.551	0.561	0.571	0.581	0.591	0.601	0.611	0.621	0.631
53	0.4335	0.4435	0.4535	0.4635	0.4735	0.4835	0.4935	0.5035	0.5135	0.5245	0.5335	0.5435	0.5535	0.5635	0.5735	0.5835	0.5935	0.6035	0.6135	0.6235	0.6335
54	0.4349	0.4449	0.4549	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5259	0.5349	0.5449	0.5549	0.5649	0.5749	0.5849	0.5949	0.6049	0.6149	0.6249	0.6349
22	0.4372	0.4472	0.4572	0.4672	0.4772	0.4872	0.4972	0.5072	0.5172	0.5282	0.5372	0.5472	0.5572	0.5672	0.5772	0.5872	0.5972	0.6072	0.6172	0.6272	0.6372
25	0.4386	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5186	0.5296	0.5386	0.5486	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286	0.6386
28	0.4404	0.4504	0.4604	0.4704	0.4804	0.4904	0.5004	0.5104	0.5204	0.5314	0.5404	0.5504	0.5604	0.5704	0.5804	0.5904	0.6004	0.6104	0.6204	0.6304	0.6404
55	0.4422	0.4522	0.4622	0.4722	0.4822	0.4922	0.5022	0.5122	0.5222	0.5332	0.5422	0.5522	0.5622	0.5722	0.5822	0.5922	0.6022	0.6122	0.6222	0.6322	0.6422
34	0.4427	0.4527	0.4627	0.4727	0.4827	0.4927	0.5027	0.5127	0.5227	0.5337	0.5427	0.5527	0.5627	0.5727	0.5827	0.5927	0.6027	0.6127	0.6227	0.6327	0.6427
26	0.4452	0.4552	0.4652	0.4752	0.4852	0.4952	0.5052	0.5152	0.5252	0.5362	0.5452	0.5552	0.5652	0.5752	0.5852	0.5952	0.6052	0.6152	0.6252	0.6352	0.6452
5	0.446	0.456	0.466	0.476	0.486	0.496	0.506	0.516	0.526	0.537	0.546	0.556	0.566	0.576	0.586	0.596	0.606	0.616	0.626	0.636	0.646
1	0.4494	0.4594	0.4694	0.4794	0.4894	0.4994	0.5094	0.5194	0.5294	0.5404	0.5494	0.5594	0.5694	0.5794	0.5894	0.5994	0.6094	0.6194	0.6294	0.6394	0.6494
3	0.4532	0.4632	0.4732	0.4832	0.4932	0.5032	0.5132	0.5232	0.5332	0.5442	0.5532	0.5632	0.5732	0.5832	0.5932	0.6032	0.6132	0.6232	0.6332	0.6432	0.6532
51	0.4564	0.4664	0.4764	0.4864	0.4964	0.5064	0.5164	0.5264	0.5364	0.5474	0.5564	0.5664	0.5764	0.5864	0.5964	0.6064	0.6164	0.6264	0.6364	0.6464	0.6564
2	0.4571	0.4671	0.4771	0.4871	0.4971	0.5071	0.5171	0.5271	0.5371	0.5481	0.5571	0.5671	0.5771	0.5871	0.5971	0.6071	0.6171	0.6271	0.6371	0.6471	0.6571
52	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5186	0.5286	0.5386	0.5496	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286	0.6386	0.6486	0.6586
81	0.4589	0.4689	0.4789	0.4889	0.4989	0.5089	0.5189	0.5289	0.5389	0.5499	0.5589	0.5689	0.5789	0.5889	0.5989	0.6089	0.6189	0.6289	0.6389	0.6489	0.6589
27	0.4618	0.4718	0.4818	0.4918	0.5018	0.5118	0.5218	0.5318	0.5418	0.5528	0.5618	0.5718	0.5818	0.5918	0.6018	0.6118	0.6218	0.6318	0.6418	0.6518	0.6618
4	0.4634	0.4734	0.4834	0.4934	0.5034	0.5134	0.5234	0.5334	0.5434	0.5544	0.5634	0.5734	0.5834	0.5934	0.6034	0.6134	0.6234	0.6334	0.6434	0.6534	0.6634
40	0.4676	0.4776	0.4876	0.4976	0.5076	0.5176	0.5276	0.5376	0.5476	0.5586	0.5676	0.5776	0.5876	0.5976	0.6076	0.6176	0.6276	0.6376	0.6476	0.6576	0.6676
24	0.4744	0.4844	0.4944	0.5044	0.5144	0.5244	0.5344	0.5444	0.5544	0.5654	0.5744	0.5844	0.5944	0.6044	0.6144	0.6244	0.6344	0.6444	0.6544	0.6644	0.6744
84	0.4788	0.4888	0.4988	0.5088	0.5188	0.5288	0.5388	0.5488	0.5588	0.5698	0.5788	0.5888	0.5988	0.6088	0.6188	0.6288	0.6388	0.6488	0.6588	0.6688	0.6788
36	0.4797	0.4897	0.4997	0.5097	0.5197	0.5297	0.5397	0.5497	0.5597	0.5707	0.5797	0.5897	0.5997	0.6097	0.6197	0.6297	0.6397	0.6497	0.6597	0.6697	0.6797
29	0.4873	0.4973	0.5073	0.5173	0.5273	0.5373	0.5473	0.5573	0.5673	0.5783	0.5873	0.5973	0.6073	0.6173	0.6273	0.6373	0.6473	0.6573	0.6673	0.6773	0.6873
23	0.4876	0.4976	0.5076	0.5176	0.5276	0.5376	0.5476	0.5576	0.5676	0.5786	0.5876	0.5976	0.6076	0.6176	0.6276	0.6376	0.6476	0.6576	0.6676	0.6776	0.6876
37	0.5012	0.5112	0.5212	0.5312	0.5412	0.5512	0.5612	0.5712	0.5812	0.5922	0.6012	0.6112	0.6212	0.6312	0.6412	0.6512	0.6612	0.6712	0.6812	0.6912	0.7012
39	0.5074	0.5174	0.5274	0.5374	0.5474	0.5574	0.5674	0.5774	0.5874	0.5984	0.6074	0.6174	0.6274	0.6374	0.6474	0.6574	0.6674	0.6774	0.6874	0.6974	0.7074
56	0.5118	0.5218	0.5318	0.5418	0.5518	0.5618	0.5718	0.5818	0.5918	0.6028	0.6118	0.6218	0.6318	0.6418	0.6518	0.6618	0.6718	0.6818	0.6918	0.7018	0.7118
96	0.5131	0.5231	0.5331	0.5431	0.5531	0.5631	0.5731	0.5831	0.5931	0.6041	0.6131	0.6231	0.6331	0.6431	0.6531	0.6631	0.6731	0.6831	0.6931	0.7031	0.7131
33	0.5148	0.5248	0.5348	0.5448	0.5548	0.5648	0.5748	0.5848	0.5948	0.6058	0.6148	0.6248	0.6348	0.6448	0.6548	0.6648	0.6748	0.6848	0.6948	0.7048	0.7148
30	0.5167	0.5267	0.5367	0.5467	0.5567	0.5667	0.5767	0.5867	0.5967	0.6077	0.6167	0.6267	0.6367	0.6467	0.6567	0.6667	0.6767	0.6867	0.6967	0.7067	0.7167
38	0.5273	0.5373	0.5473	0.5573	0.5673	0.5773	0.5873	0.5973	0.6073	0.6183	0.6273	0.6373	0.6473	0.6573	0.6673	0.6773	0.6873	0.6973	0.7073	0.7173	0.7273
59	0.5317	0.5417	0.5517	0.5617	0.5717	0.5817	0.5917	0.6017	0.6117	0.6227	0.6317	0.6417	0.6517	0.6617	0.6717	0.6817	0.6917	0.7017	0.7117	0.7217	0.7317
83	0.5329	0.5429	0.5529	0.5629	0.5729	0.5829	0.5929	0.6029	0.6129	0.6239	0.6329	0.6429	0.6529	0.6629	0.6729	0.6829	0.6929	0.7029	0.7129	0.7229	0.7329
32	0.5401	0.5501	0.5601	0.5701	0.5801	0.5901	0.6001	0.6101	0.6201	0.6311	0.6401	0.6501	0.6601	0.6701	0.6801	0.6901	0.7001	0.7101	0.7201	0.7301	0.7401
57	0.5532	0.5632	0.5732	0.5832	0.5932	0.6032	0.6132	0.6232	0.6332	0.6442	0.6532	0.6632	0.6732	0.6832	0.6932	0.7032	0.7132	0.7232	0.7332	0.7432	0.7532
82	0.5538	0.5638	0.5738	0.5838	0.5938	0.6038	0.6138	0.6238	0.6338	0.6448	0.6538	0.6638	0.6738	0.6838	0.6938	0.7038	0.7138	0.7238	0.7338	0.7438	0.7538
31	0.5854	0.5954	0.6054	0.6154	0.6254	0.6354	0.6454	0.6554	0.6654	0.6764	0.6854	0.6954	0.7054	0.7154	0.7254	0.7354	0.7454	0.7554	0.7654	0.7754	0.7854
97	0.5974	0.6074	0.6174	0.6274	0.6374	0.6474	0.6574	0.6674	0.6774	0.6884	0.6974	0.7074	0.7174	0.7274	0.7374	0.7474	0.7574	0.7674	0.7774	0.7874	0.7974
58	0.6145	0.6245	0.6345	0.6445	0.6545	0.6645	0.6745	0.6845	0.6945	0.7055	0.7145	0.7245	0.7345	0.7445	0.7545	0.7645	0.7745	0.7845	0.7945	0.8045	0.8145
98	0.6304	0.6404	0.6504	0.6604	0.6704	0.6804	0.6904	0.7004	0.7104	0.7214	0.7304	0.7404	0.7504	0.7604	0.7704	0.7804	0.7904	0.8004	0.8104	0.8204	0.8304
99	0.6425	0.6525	0.6625	0.6725	0.6825	0.6925	0.7025	0.7125	0.7225	0.7335	0.7425	0.7525	0.7625	0.7725	0.7825	0.7925	0.8025	0.8125	0.8225	0.8325	0.8425

District/COMP	All_40	All_41	All_42	All_43	All_44	All_45	All_46	All_47	All_48	Composite	All_50	All_51	All_52	All_53	All_54	All_55	All_56	All_57	All_58	All_59	All_60
16	0.0257	0.0357	0.0457	0.0557	0.0657	0.0757	0.0857	0.0957	0.1057	0.1167	0.1257	0.1357	0.1457	0.1557	0.1657	0.1757	0.1857	0.1957	0.2057	0.2157	0.2257
10	0.0372	0.0472	0.0572	0.0672	0.0772	0.0872	0.0972	0.1072	0.1172	0.1282	0.1372	0.1472	0.1572	0.1672	0.1772	0.1872	0.1972	0.2072	0.2172	0.2272	0.2372
78	0.056	0.066	0.076	0.086	0.096	0.106	0.116	0.126	0.136	0.147	0.156	0.166	0.176	0.186	0.196	0.206	0.216	0.226	0.236	0.246	0.256
18	0.0625	0.0725	0.0825	0.0925	0.1025	0.1125	0.1225	0.1325	0.1425	0.1535	0.1625	0.1725	0.1825	0.1925	0.2025	0.2125	0.2225	0.2325	0.2425	0.2525	0.2625
11	0.1053	0.1153	0.1253	0.1353	0.1453	0.1553	0.1653	0.1753	0.1853	0.1963	0.2053	0.2153	0.2253	0.2353	0.2453	0.2553	0.2653	0.2753	0.2853	0.2953	0.3053
17	0.1077	0.1177	0.1277	0.1377	0.1477	0.1577	0.1677	0.1777	0.1877	0.1987	0.2077	0.2177	0.2277	0.2377	0.2477	0.2577	0.2677	0.2777	0.2877	0.2977	0.3077
8	0.132	0.142	0.152	0.162	0.172	0.182	0.192	0.202	0.212	0.223	0.232	0.242	0.252	0.262	0.272	0.282	0.292	0.302	0.312	0.322	0.332
76	0.1393	0.1493	0.1593	0.1693	0.1793	0.1893	0.1993	0.2093	0.2193	0.2303	0.2393	0.2493	0.2593	0.2693	0.2793	0.2893	0.2993	0.3093	0.3193	0.3293	0.3393
77	0.1727	0.1827	0.1927	0.2027	0.2127	0.2227	0.2327	0.2427	0.2527	0.2637	0.2727	0.2827	0.2927	0.3027	0.3127	0.3227	0.3327	0.3427	0.3527	0.3627	0.3727
12	0.1746	0.1846	0.1946	0.2046	0.2146	0.2246	0.2346	0.2446	0.2546	0.2656	0.2746	0.2846	0.2946	0.3046	0.3146	0.3246	0.3346	0.3446	0.3546	0.3646	0.3746
47	0.1836	0.1936	0.2036	0.2136	0.2236	0.2336	0.2436	0.2536	0.2636	0.2746	0.2836	0.2936	0.3036	0.3136	0.3236	0.3336	0.3436	0.3536	0.3636	0.3736	0.3836
19	0.1921	0.2021	0.2121	0.2221	0.2321	0.2421	0.2521	0.2621	0.2721	0.2831	0.2921	0.3021	0.3121	0.3221	0.3321	0.3421	0.3521	0.3621	0.3721	0.3821	0.3921
61	0.2407	0.2507	0.2607	0.2707	0.2807	0.2907	0.3007	0.3107	0.3207	0.3317	0.3407	0.3507	0.3607	0.3707	0.3807	0.3907	0.4007	0.4107	0.4207	0.4307	0.4407
48	0.2463	0.2563	0.2663	0.2763	0.2863	0.2963	0.3063	0.3163	0.3263	0.3373	0.3463	0.3563	0.3663	0.3763	0.3863	0.3963	0.4063	0.4163	0.4263	0.4363	0.4463
64	0.2572	0.2672	0.2772	0.2872	0.2972	0.3072	0.3172	0.3272	0.3372	0.3482	0.3572	0.3672	0.3772	0.3872	0.3972	0.4072	0.4172	0.4272	0.4372	0.4472	0.4572
9	0.2603	0.2703	0.2803	0.2903	0.3003	0.3103	0.3203	0.3303	0.3403	0.3513	0.3603	0.3703	0.3803	0.3903	0.4003	0.4103	0.4203	0.4303	0.4403	0.4503	0.4603
79	0.2653	0.2753	0.2853	0.2953	0.3053	0.3153	0.3253	0.3353	0.3453	0.3563	0.3653	0.3753	0.3853	0.3953	0.4053	0.4153	0.4253	0.4353	0.4453	0.4553	0.4653
95	0.2743	0.2843	0.2943	0.3043	0.3143	0.3243	0.3343	0.3443	0.3543	0.3653	0.3743	0.3843	0.3943	0.4043	0.4143	0.4243	0.4343	0.4443	0.4543	0.4643	0.4743
44	0.2819	0.2919	0.3019	0.3119	0.3219	0.3319	0.3419	0.3519	0.3619	0.3729	0.3819	0.3919	0.4019	0.4119	0.4219	0.4319	0.4419	0.4519	0.4619	0.4719	0.4819
93	0.306	0.316	0.326	0.336	0.346	0.356	0.366	0.376	0.386	0.397	0.406	0.416	0.426	0.436	0.446	0.456	0.466	0.476	0.486	0.496	0.506
71	0.3086	0.3186	0.3286	0.3386	0.3486	0.3586	0.3686	0.3786	0.3886	0.3996	0.4086	0.4186	0.4286	0.4386	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086
43	0.3095	0.3195	0.3295	0.3395	0.3495	0.3595	0.3695	0.3795	0.3895	0.4005	0.4095	0.4195	0.4295	0.4395	0.4495	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095
73	0.3107	0.3207	0.3307	0.3407	0.3507	0.3607	0.3707	0.3807	0.3907	0.4017	0.4107	0.4207	0.4307	0.4407	0.4507	0.4607	0.4707	0.4807	0.4907	0.5007	0.5107
80	0.3249	0.3349	0.3449	0.3549	0.3649	0.3749	0.3849	0.3949	0.4049	0.4159	0.4249	0.4349	0.4449	0.4549	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5249
74	0.3257	0.3357	0.3457	0.3557	0.3657	0.3757	0.3857	0.3957	0.4057	0.4167	0.4257	0.4357	0.4457	0.4557	0.4657	0.4757	0.4857	0.4957	0.5057	0.5157	0.5257
81	0.3347	0.3447	0.3547	0.3647	0.3747	0.3847	0.3947	0.4047	0.4147	0.4257	0.4347	0.4447	0.4547	0.4647	0.4747	0.4847	0.4947	0.5047	0.5147	0.5247	0.5347
90	0.3382	0.3482	0.3582	0.3682	0.3782	0.3882	0.3982	0.4082	0.4182	0.4292	0.4382	0.4482	0.4582	0.4682	0.4782	0.4882	0.4982	0.5082	0.5182	0.5282	0.5382
20	0.3459	0.3559	0.3659	0.3759	0.3859	0.3959	0.4059	0.4159	0.4259	0.4369	0.4459	0.4559	0.4659	0.4759	0.4859	0.4959	0.5059	0.5159	0.5259	0.5359	0.5459
46	0.3525	0.3625	0.3725	0.3825	0.3925	0.4025	0.4125	0.4225	0.4325	0.4435	0.4525	0.4625	0.4725	0.4825	0.4925	0.5025	0.5125	0.5225	0.5325	0.5425	0.5525
57	0.356	0.366	0.376	0.386	0.396	0.406	0.416	0.426	0.436	0.447	0.456	0.466	0.476	0.486	0.496	0.506	0.516	0.526	0.536	0.546	0.556
7	0.3631	0.3731	0.3831	0.3931	0.4031	0.4131	0.4231	0.4331	0.4431	0.4541	0.4631	0.4731	0.4831	0.4931	0.5031	0.5131	0.5231	0.5331	0.5431	0.5531	0.5631
54	0.3642	0.3742	0.3842	0.3942	0.4042	0.4142	0.4242	0.4342	0.4442	0.4552	0.4642	0.4742	0.4842	0.4942	0.5042	0.5142	0.5242	0.5342	0.5442	0.5542	0.5642
51	0.3649	0.3749	0.3849	0.3949	0.4049	0.4149	0.4249	0.4349	0.4449	0.4559	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5249	0.5349	0.5449	0.5549	0.5649
96	0.3719	0.3819	0.3919	0.4019	0.4119	0.4219	0.4319	0.4419	0.4519	0.4629	0.4719	0.4819	0.4919	0.5019	0.5119	0.5219	0.5319	0.5419	0.5519	0.5619	0.5719
65	0.3757	0.3857	0.3957	0.4057	0.4157	0.4257	0.4357	0.4457	0.4557	0.4667	0.4757	0.4857	0.4957	0.5057	0.5157	0.5257	0.5357	0.5457	0.5557	0.5657	0.5757
92	0.3775	0.3875	0.3975	0.4075	0.4175	0.4275	0.4375	0.4475	0.4575	0.4685	0.4775	0.4875	0.4975	0.5075	0.5175	0.5275	0.5375	0.5475	0.5575	0.5675	0.5775
42	0.3841	0.3941	0.4041	0.4141	0.4241	0.4341	0.4441	0.4541	0.4641	0.4751	0.4841	0.4941	0.5041	0.5141	0.5241	0.5341	0.5441	0.5541	0.5641	0.5741	0.5841
85	0.3951	0.4051	0.4151	0.4251	0.4351	0.4451	0.4551	0.4651	0.4751	0.4861	0.4951	0.5051	0.5151	0.5251	0.5351	0.5451	0.5551	0.5651	0.5751	0.5851	0.5951
91	0.3979	0.4079	0.4179	0.4279	0.4379	0.4479	0.4579	0.4679	0.4779	0.4889	0.4979	0.5079	0.5179	0.5279	0.5379	0.5479	0.5579	0.5679	0.5779	0.5879	0.5979
72	0.403	0.413	0.423	0.433	0.443	0.453	0.463	0.473	0.483	0.494	0.503	0.513	0.523	0.533	0.543	0.553	0.563	0.573	0.583	0.593	0.603
49	0.4081	0.4181	0.4281	0.4381	0.4481	0.4581	0.4681	0.4781	0.4881	0.4991	0.5081	0.5181	0.5281	0.5381	0.5481	0.5581	0.5681	0.5781	0.5881	0.5981	0.6081
68	0.4102	0.4202	0.4302	0.4402	0.4502	0.4602	0.4702	0.4802	0.4902	0.5012	0.5102	0.5202	0.5302	0.5402	0.5502	0.5602	0.5702	0.5802	0.5902	0.6002	0.6102
29	0.4154	0.4254	0.4354	0.4454	0.4554	0.4654	0.4754	0.4854	0.4954	0.5064	0.5154	0.5254	0.5354	0.5454	0.5554	0.5654	0.5754	0.5854	0.5954	0.6054	0.6154
70	0.4193	0.4293	0.4393	0.4493	0.4593	0.4693	0.4793	0.4893	0.4993	0.5103	0.5193	0.5293	0.5393	0.5493	0.5593	0.5693	0.5793	0.5893	0.5993	0.6093	0.6193
6	0.4225	0.4325	0.4425	0.4525	0.4625	0.4725	0.4825	0.4925	0.5025	0.5135	0.5225	0.5325	0.5425	0.5525	0.5625	0.5725	0.5825	0.5925	0.6025	0.6125	0.6225
1	0.4233	0.4333	0.4433	0.4533	0.4633	0.4733	0.4833	0.4933	0.5033	0.5143	0.5233	0.5333	0.5433	0.5533	0.5633	0.5733	0.5833	0.5933	0.6033	0.6133	0.6233
94	0.4249	0.4349	0.4449	0.4549	0.4649	0.4749	0.4849	0.4949	0.5049	0.5159	0.5249	0.5349	0.5449	0.5549	0.5649	0.5749	0.5849	0.5949	0.6049	0.6149	0.6249
75	0.4286	0.4386	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5196	0.5286	0.5386	0.5486	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286
67	0.4294	0.4394	0.4494	0.4594	0.4694	0.4794	0.4894	0.4994	0.5094	0.5204	0.5294	0.5394	0.5494	0.5594	0.5694	0.5794	0.5894	0.5994	0.6094	0.6194	0.6294
50	0.4301	0.4401	0.4501	0.4601	0.4701	0.4801	0.4901	0.5001	0.5101	0.5211	0.5301	0.5401	0.5501	0.5601	0.5701	0.5801	0.5901	0.6001	0.6101	0.6201	0.6301
21	0.4376	0.4476	0.4576	0.4676	0.4776	0.4876	0.4976	0.5076	0.5176	0.5286	0.5376	0.5476	0.5576	0.5676	0.5776	0.5876	0.5976	0.6076	0.6176	0.6276	0.6376
4	0.4388	0.4488	0.4588	0.4688	0.4788	0.4888	0.4988	0.5088	0.5188	0.5298	0.5388	0.5488	0.5588	0.5688	0.5788	0.5888	0.5988	0.6088	0.6188	0.6288	0.6388
25	0.4395	0.4495	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095	0.5195	0.5305	0.5395	0.5495	0.5595	0.5695	0.5795	0.5895	0.5995	0.6095	0.6195	0.6295	0.6395
35	0.4395	0.4495	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095	0.5195	0.5305	0.5395	0.5495	0.5595	0.5695	0.5795	0.5895	0.5995	0.6095	0.6195	0.6295	0.6395
5	0.4397	0.4497	0.4597	0.4697	0.4797	0.4897	0.4997	0.5097	0.5197	0.5307	0.5397	0.5497	0.5597	0.5697	0.5797	0.5897	0.5997	0.6097	0.6197	0.6297	0.6397
62	0.4405	0.4505	0.4605	0.4705	0.4805	0.4905	0.5005	0.5105	0.5205	0.5315	0.5405	0.5505	0.5605	0.5705	0.5805	0.5905	0.6005	0.6105	0.6205	0.6305	0.6405
30	0.4406	0.4506	0.4606	0.4706	0.4806	0.4906	0.5006	0.5106	0.5206	0.5316	0.5406	0.5506	0.5606	0.5706	0.5806	0.5906	0.6006	0.6106	0.6206	0.6306	0.6406
37	0.441	0.451	0.461	0.471	0.481	0.491	0.501	0.511	0.521	0.532	0.541	0.551	0.561	0.571	0.581	0.591	0.601	0.611	0.621	0.631	0.641
69	0.4434	0.4534	0.4634	0.4734	0.4834	0.4934	0.5034	0.5134	0.5234	0.5344	0.5434	0.5534	0.5634	0.5734	0.5834	0.5934	0.6034	0.6134	0.6234	0.6334	0.6434
87	0.4455	0.4555	0.4655	0.4755	0.4855	0.4955	0.5055	0.5155	0.5255	0.5365	0.5455	0.5555	0.5655	0.5755	0.5855	0.5955	0.6055	0.6155	0.6255	0.6355	0.6455
34	0.4549	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5249	0.5349	0.5459	0.5549	0.5649	0.5749	0.5849	0.5949	0.6049	0.6149	0.6249	0.6349	0.6449	0.6549
26	0.4557	0.4657	0.4757	0.4857	0.4957	0.5057	0.5157	0.5257	0.5357	0.5467	0.5557	0.5657	0.5757	0.5857	0.5957	0.6057	0.6157	0.6257	0.6357	0.6457	0.6557
2	0.4591	0.4691	0.4791	0.4891	0.4991	0.5091	0.5191	0.5291	0.5391	0.5501	0.5591	0.5691	0.5791	0.5891	0.5991	0.6091	0.6191	0.6291	0.6391	0.6491	0.6591
45	0.462	0.472	0.482	0.492	0.502	0.512	0.522	0.532	0.542	0.553	0.562	0.572	0.582	0.592	0.602	0.612	0.622	0.632	0.642	0.652	0.662
15	0.4624	0.4724	0.4824	0.4924	0.5024	0.5124	0.5224	0.5324	0.5424	0.5534	0.5624	0.5724	0.5824	0.5924	0.6024	0.6124	0.6224	0.6324	0.6424	0.6524	0.6624
86	0.4646	0.4746	0.4846	0.4946	0.5046	0.5146	0.5246	0.5346	0.5446	0.5556	0.5646	0.5746	0.5846	0.5946	0.6046	0.6146	0.6246	0.6346	0.6446	0.6546	0.6646
3	0.4672	0.4772	0.4872	0.4972	0.5072	0.5172	0.5272	0.5372	0.5472	0.5582	0.5672	0.5772	0.5872	0.5972	0.6072	0.6172	0.6272	0.6372	0.6472	0.6572	0.6672
22	0.4686	0.4786	0.4886	0.4986	0.5086	0.5186	0.5286	0.5386	0.5486	0.5596	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286	0.6386	0.6486	0.6586	0.6686
89	0.4696	0.4796	0.4896	0.4996	0.5096	0.5196	0.5296	0.5396	0.5496	0.5606	0.5696	0.5796	0.5896	0.5996	0.6096	0.6196	0.6296	0.6396	0.6496	0.6596	0.6696
27	0.4724	0.4824	0.4924	0.5024	0.5124	0.5224	0.5324	0.5424	0.5524	0.5634	0.5724	0.5824	0.5924	0.6024	0.6124	0.6224	0.6324	0.6424	0.6524	0.6624	0.6724
28	0.4733	0.4833	0.4933	0.5033	0.5133	0.5233	0.5333	0.5433	0.5533	0.5643	0.5733	0.5833	0.5933	0.6033	0.6133	0.6233	0.6333	0.6433	0.6533	0.6633	0.6733
55	0.4738	0.4838	0.4938	0.5038	0.5138	0.5238	0.5338	0.5438	0.5538	0.5648	0.5738	0.5838	0.5938	0.6038	0.6138	0.6238	0.6338	0.6438	0.6538	0.6638	0.6738
36	0.4747	0.4847	0.4947	0.5047	0.5147	0.5247	0.5347	0.5447	0.5547	0.5657	0.5747	0.5847	0.5947	0.6047	0.6147	0.6247	0.6347	0.6447	0.6547	0.6647	0.6747
56	0.4811	0.4911	0.5011	0.5111	0.5211	0.5311	0.5411	0.5511	0.5611	0.5721	0.5811	0.5911	0.6011	0.6111	0.6211	0.6311	0.6411	0.6511	0.6611	0.6711	0.6811
82	0.4812	0.4912	0.5012	0.5112	0.5212	0.5312	0.5412	0.5512	0.5612	0.5722	0.5812	0.5912	0.6012	0.6112	0.6212	0.6312	0.6412	0.6512	0.6612	0.6712	0.6812
84	0.4842	0.4942	0.5042	0.5142	0.5242	0.5342	0.5442	0.5542	0.5642	0.5752	0.5842	0.5942	0.6042	0.6142	0.6242	0.6342	0.6442	0.6542	0.6642	0.6742	0.6842
66	0.4851	0.4951	0.5051	0.5151	0.5251	0.5351	0.5451	0.5551	0.5651	0.5761	0.5851	0.5951	0.6051	0.6151	0.6251	0.6351	0.6451	0.6551	0.6651	0.6751	0.6851
32	0.4863	0.4963	0.5063	0.5163	0.5263	0.5363	0.5463	0.5563	0.5663	0.5773	0.5863	0.5963	0.6063	0.6163	0.6263	0.6363	0.6463	0.6563	0.6663	0.6763	0.6863
14	0.4864	0.4964	0.5064	0.5164	0.5264	0.5364	0.5464	0.5564	0.5664	0.5774	0.5864	0.5964	0.6064	0.6164	0.6264	0.6364	0.6464	0.6564	0.6664	0.6764	0.6864
88	0.4866	0.4966	0.5066	0.5166	0.5266	0.5366	0.5466	0.5566	0.5666	0.5776	0.5866	0.5966	0.6066	0.6166	0.6266	0.6366	0.6466	0.6566	0.6666	0.6766	0.6866
40	0.4916	0.5016	0.5116	0.5216	0.5316	0.5416	0.5516	0.5616	0.5716	0.5826	0.5916	0.6016	0.6116	0.6216	0.6316	0.6416	0.6516	0.6616	0.6716	0.6816	0.6916
52	0.4975	0.5075	0.5175	0.5275	0.5375	0.5475	0.5575	0.5675	0.5775	0.5885	0.5975	0.6075	0.6175	0.6275	0.6375	0.6475	0.6575	0.6675	0.6775	0.6875	0.6975
63	0.4995	0.5095	0.5195	0.5295	0.5395	0.5495	0.5595	0.5695	0.5795	0.5905	0.5995	0.6095	0.6195	0.6295	0.6395	0.6495	0.6595	0.6695	0.6795	0.6895	0.6995
39	0.5007	0.5107	0.5207	0.5307	0.5407	0.5507	0.5607	0.5707	0.5807	0.5917	0.6007	0.6107	0.6207	0.6307	0.6407	0.6507	0.6607	0.6707	0.6807	0.6907	0.7007
13	0.5012	0.5112	0.5212	0.5312	0.5412	0.5512	0.5612	0.5712	0.5812	0.5922	0.6012	0.6112	0.6212	0.6312	0.6412	0.6512	0.6612	0.6712	0.6812	0.6912	0.7012
23	0.502	0.512	0.522	0.532	0.542	0.552	0.562	0.572	0.582	0.593	0.602	0.612	0.622	0.632	0.642	0.652	0.662	0.672	0.682	0.692	0.702
33	0.508	0.518	0.528	0.538	0.548	0.558	0.568	0.578	0.588	0.599	0.608	0.618	0.628	0.638	0.648	0.658	0.668	0.678	0.688	0.698	0.708
41	0.5084	0.5184	0.5284	0.5384	0.5484	0.5584	0.5684	0.5784	0.5884	0.5994	0.6084	0.6184	0.6284	0.6384	0.6484	0.6584	0.6684	0.6784	0.6884	0.6984	0.7084
31	0.5228	0.5328	0.5428	0.5528	0.5628	0.5728	0.5828	0.5928	0.6028	0.6138	0.6228	0.6328	0.6428	0.6528	0.6628	0.6728	0.6828	0.6928	0.7028	0.7128	0.7228
53	0.524	0.534	0.544	0.554	0.564	0.574	0.584	0.594	0.604	0.615	0.624	0.634	0.644	0.654	0.664	0.674	0.684	0.694	0.704	0.714	0.724
97	0.5244	0.5344	0.5444	0.5544	0.5644	0.5744	0.5844	0.5944	0.6044	0.6154	0.6244	0.6344	0.6444	0.6544	0.6644	0.6744	0.6844	0.6944	0.7044	0.7144	0.7244
38	0.5451	0.5551	0.5651	0.5751	0.5851	0.5951	0.6051	0.6151	0.6251	0.6361	0.6451	0.6551	0.6651	0.6751	0.6851	0.6951	0.7051	0.7151	0.7251	0.7351	0.7451
24	0.5827	0.5927	0.6027	0.6127	0.6227	0.6327	0.6427	0.6527	0.6627	0.6737	0.6827	0.6927	0.7027	0.7127	0.7227	0.7327	0.7427	0.7527	0.7627	0.7727	0.7827
60	0.5867	0.5967	0.6067	0.6167	0.6267	0.6367	0.6467	0.6567	0.6667	0.6777	0.6867	0.6967	0.7067	0.7167	0.7267	0.7367	0.7467	0.7567	0.7667	0.7767	0.7867
83	0.5927	0.6027	0.6127	0.6227	0.6327	0.6427	0.6527	0.6627	0.6727	0.6837	0.6927	0.7027	0.7127	0.7227	0.7327	0.7427	0.7527	0.7627	0.7727	0.7827	0.7927
99	0.6058	0.6158	0.6258	0.6358	0.6458	0.6558	0.6658	0.6758	0.6858	0.6968	0.7058	0.7158	0.7258	0.7358	0.7458	0.7558	0.7658	0.7758	0.7858	0.7958	0.8058
59	0.6153	0.6253	0.6353	0.6453	0.6553	0.6653	0.6753	0.6853	0.6953	0.7063	0.7153	0.7253	0.7353	0.7453	0.7553	0.7653	0.7753	0.7853	0.7953	0.8053	0.8153
58	0.6182	0.6282	0.6382	0.6482	0.6582	0.6682	0.6782	0.6882	0.6982	0.7092	0.7182	0.7282	0.7382	0.7482	0.7582	0.7682	0.7782	0.7882	0.7982	0.8082	0.8182
98	0.6508	0.6608	0.6708	0.6808	0.6908	0.7008	0.7108	0.7208	0.7308	0.7418	0.7508	0.7608	0.7708	0.7808	0.7908	0.8008	0.8108	0.8208	0.8308	0.8408	0.8508

DISTRICT	All_40	All_41	All_42	All_43	All_44	All_45	All_46	All_47	All_48	ALL0410	All_50	All_51	All_52	All_53	All_54	All_55	All_56	All_57	All_58	All_59	All_60
99	0.6404	0.6504	0.6604	0.6704	0.6804	0.6904	0.7004	0.7104	0.7204	0.7314	0.7404	0.7504	0.7604	0.7704	0.7804	0.7904	0.8004	0.8104	0.8204	0.8304	0.8404
60	0.6189	0.6289	0.6389	0.6489	0.6589	0.6689	0.6789	0.6889	0.6989	0.7099	0.7189	0.7289	0.7389	0.7489	0.7589	0.7689	0.7789	0.7889	0.7989	0.8089	0.8189
59	0.6166	0.6266	0.6366	0.6466	0.6566	0.6666	0.6766	0.6866	0.6966	0.7076	0.7166	0.7266	0.7366	0.7466	0.7566	0.7666	0.7766	0.7866	0.7966	0.8066	0.8166
97	0.6075	0.6175	0.6275	0.6375	0.6475	0.6575	0.6675	0.6775	0.6875	0.6985	0.7075	0.7175	0.7275	0.7375	0.7475	0.7575	0.7675	0.7775	0.7875	0.7975	0.8075
32	0.5914	0.6014	0.6114	0.6214	0.6314	0.6414	0.6514	0.6614	0.6714	0.6824	0.6914	0.7014	0.7114	0.7214	0.7314	0.7414	0.7514	0.7614	0.7714	0.7814	0.7914
24	0.5883	0.5983	0.6083	0.6183	0.6283	0.6383	0.6483	0.6583	0.6683	0.6793	0.6883	0.6983	0.7083	0.7183	0.7283	0.7383	0.7483	0.7583	0.7683	0.7783	0.7883
58	0.5553	0.5653	0.5753	0.5853	0.5953	0.6053	0.6153	0.6253	0.6353	0.6463	0.6553	0.6653	0.6753	0.6853	0.6953	0.7053	0.7153	0.7253	0.7353	0.7453	0.7553
53	0.5424	0.5524	0.5624	0.5724	0.5824	0.5924	0.6024	0.6124	0.6224	0.6334	0.6424	0.6524	0.6624	0.6724	0.6824	0.6924	0.7024	0.7124	0.7224	0.7324	0.7424
98	0.5408	0.5508	0.5608	0.5708	0.5808	0.5908	0.6008	0.6108	0.6208	0.6318	0.6408	0.6508	0.6608	0.6708	0.6808	0.6908	0.7008	0.7108	0.7208	0.7308	0.7408
27	0.5377	0.5477	0.5577	0.5677	0.5777	0.5877	0.5977	0.6077	0.6177	0.6287	0.6377	0.6477	0.6577	0.6677	0.6777	0.6877	0.6977	0.7077	0.7177	0.7277	0.7377
83	0.5365	0.5465	0.5565	0.5665	0.5765	0.5865	0.5965	0.6065	0.6165	0.6275	0.6365	0.6465	0.6565	0.6665	0.6765	0.6865	0.6965	0.7065	0.7165	0.7265	0.7365
31	0.5208	0.5308	0.5408	0.5508	0.5608	0.5708	0.5808	0.5908	0.6008	0.6118	0.6208	0.6308	0.6408	0.6508	0.6608	0.6708	0.6808	0.6908	0.7008	0.7108	0.7208
63	0.5157	0.5257	0.5357	0.5457	0.5557	0.5657	0.5757	0.5857	0.5957	0.6067	0.6157	0.6257	0.6357	0.6457	0.6557	0.6657	0.6757	0.6857	0.6957	0.7057	0.7157
23	0.5132	0.5232	0.5332	0.5432	0.5532	0.5632	0.5732	0.5832	0.5932	0.6042	0.6132	0.6232	0.6332	0.6432	0.6532	0.6632	0.6732	0.6832	0.6932	0.7032	0.7132
13	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.601	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.7	0.71
33	0.5006	0.5106	0.5206	0.5306	0.5406	0.5506	0.5606	0.5706	0.5806	0.5916	0.6006	0.6106	0.6206	0.6306	0.6406	0.6506	0.6606	0.6706	0.6806	0.6906	0.7006
39	0.4982	0.5082	0.5182	0.5282	0.5382	0.5482	0.5582	0.5682	0.5782	0.5892	0.5982	0.6082	0.6182	0.6282	0.6382	0.6482	0.6582	0.6682	0.6782	0.6882	0.6982
84	0.496	0.506	0.516	0.526	0.536	0.546	0.556	0.566	0.576	0.587	0.596	0.606	0.616	0.626	0.636	0.646	0.656	0.666	0.676	0.686	0.696
55	0.4946	0.5046	0.5146	0.5246	0.5346	0.5446	0.5546	0.5646	0.5746	0.5856	0.5946	0.6046	0.6146	0.6246	0.6346	0.6446	0.6546	0.6646	0.6746	0.6846	0.6946
40	0.4932	0.5032	0.5132	0.5232	0.5332	0.5432	0.5532	0.5632	0.5732	0.5842	0.5932	0.6032	0.6132	0.6232	0.6332	0.6432	0.6532	0.6632	0.6732	0.6832	0.6932
15	0.4887	0.4987	0.5087	0.5187	0.5287	0.5387	0.5487	0.5587	0.5687	0.5797	0.5887	0.5987	0.6087	0.6187	0.6287	0.6387	0.6487	0.6587	0.6687	0.6787	0.6887
41	0.4855	0.4955	0.5055	0.5155	0.5255	0.5355	0.5455	0.5555	0.5655	0.5765	0.5855	0.5955	0.6055	0.6155	0.6255	0.6355	0.6455	0.6555	0.6655	0.6755	0.6855
61	0.4842	0.4942	0.5042	0.5142	0.5242	0.5342	0.55442	0.5542	0.5642	0.5752	0.5842	0.5942	0.6042	0.6142	0.6242	0.6342	0.6442	0.6542	0.6642	0.6742	0.6842
52	0.4831	0.4931	0.5031	0.5131	0.5231	0.5331	0.5431	0.5531	0.5631	0.5741	0.5831	0.5931	0.6031	0.6131	0.6231	0.6331	0.6431	0.6531	0.6631	0.6731	0.6831
22	0.4817	0.4917	0.5017	0.5117	0.5217	0.5317	0.5417	0.5517	0.5617	0.5727	0.5817	0.5917	0.6017	0.6117	0.6217	0.6317	0.6417	0.6517	0.6617	0.6717	0.6817
5	0.4807	0.4907	0.5007	0.5107	0.5207	0.5307	0.5407	0.5507	0.5607	0.5717	0.5807	0.5907	0.6007	0.6107	0.6207	0.6307	0.6407	0.6507	0.6607	0.6707	0.6807
88	0.4759	0.4859	0.4959	0.5059	0.5159	0.5259	0.5359	0.5459	0.5559	0.5669	0.5759	0.5859	0.5959	0.6059	0.6159	0.6259	0.6359	0.6459	0.6559	0.6659	0.6759
38	0.4732	0.4832	0.4932	0.5032	0.5132	0.5232	0.5332	0.5432	0.5532	0.5642	0.5732	0.5832	0.5932	0.6032	0.6132	0.6232	0.6332	0.6432	0.6532	0.6632	0.6732
37	0.4717	0.4817	0.4917	0.5017	0.5117	0.5217	0.5317	0.5417	0.5517	0.5627	0.5717	0.5817	0.5917	0.6017	0.6117	0.6217	0.6317	0.6417	0.6517	0.6617	0.6717
89	0.4684	0.4784	0.4884	0.4984	0.5084	0.5184	0.5284	0.5384	0.5484	0.5594	0.5684	0.5784	0.5884	0.5984	0.6084	0.6184	0.6284	0.6384	0.6484	0.6584	0.6684
14	0.4642	0.4742	0.4842	0.4942	0.5042	0.5142	0.5242	0.5342	0.5442	0.5552	0.5642	0.5742	0.5842	0.5942	0.6042	0.6142	0.6242	0.6342	0.6442	0.6542	0.6642
36	0.4639	0.4739	0.4839	0.4939	0.5039	0.5139	0.5239	0.5339	0.5439	0.5549	0.5639	0.5739	0.5839	0.5939	0.6039	0.6139	0.6239	0.6339	0.6439	0.6539	0.6639
3	0.4598	0.4698	0.4798	0.4898	0.4998	0.5098	0.5198	0.5298	0.5398	0.5508	0.5598	0.5698	0.5798	0.5898	0.5998	0.6098	0.6198	0.6298	0.6398	0.6498	0.6598
86	0.4585	0.4685	0.4785	0.4885	0.4985	0.5085	0.5185	0.5285	0.5385	0.5495	0.5585	0.5685	0.5785	0.5885	0.5985	0.6085	0.6185	0.6285	0.6385	0.6485	0.6585
28	0.4521	0.4621	0.4721	0.4821	0.4921	0.5021	0.5121	0.5221	0.5321	0.5431	0.5521	0.5621	0.5721	0.5821	0.5921	0.6021	0.6121	0.6221	0.6321	0.6421	0.6521
29	0.4509	0.4609	0.4709	0.4809	0.4909	0.5009	0.5109	0.5209	0.5309	0.5419	0.5509	0.5609	0.5709	0.5809	0.5909	0.6009	0.6109	0.6209	0.6309	0.6409	0.6509
82	0.4509	0.4609	0.4709	0.4809	0.4909	0.5009	0.5109	0.5209	0.5309	0.5419	0.5509	0.5609	0.5709	0.5809	0.5909	0.6009	0.6109	0.6209	0.6309	0.6409	0.6509
2	0.4504	0.4604	0.4704	0.4804	0.4904	0.5004	0.5104	0.5204	0.5304	0.5414	0.5504	0.5604	0.5704	0.5804	0.5904	0.6004	0.6104	0.6204	0.6304	0.6404	0.6504
62	0.4496	0.4596	0.4696	0.4796	0.4896	0.4996	0.5096	0.5196	0.5296	0.5406	0.5496	0.5596	0.5696	0.5796	0.5896	0.5996	0.6096	0.6196	0.6296	0.6396	0.6496
35	0.4486	0.4586	0.4686	0.4786	0.4886	0.4986	0.5086	0.5186	0.5286	0.5396	0.5486	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286	0.6386	0.6486
87	0.4474	0.4574	0.4674	0.4774	0.4874	0.4974	0.5074	0.5174	0.5274	0.5384	0.5474	0.5574	0.5674	0.5774	0.5874	0.5974	0.6074	0.6174	0.6274	0.6374	0.6474
69	0.4458	0.4558	0.4658	0.4758	0.4858	0.4958	0.5058	0.5158	0.5258	0.5368	0.5458	0.5558	0.5658	0.5758	0.5858	0.5958	0.6058	0.6158	0.6258	0.6358	0.6458
25	0.4425	0.4525	0.4625	0.4725	0.4825	0.4925	0.5025	0.5125	0.5225	0.5335	0.5425	0.5525	0.5625	0.5725	0.5825	0.5925	0.6025	0.6125	0.6225	0.6325	0.6425
4	0.4404	0.4504	0.4604	0.4704	0.4804	0.4904	0.5004	0.5104	0.5204	0.5314	0.5404	0.5504	0.5604	0.5704	0.5804	0.5904	0.6004	0.6104	0.6204	0.6304	0.6404
21	0.4375	0.4475	0.4575	0.4675	0.4775	0.4875	0.4975	0.5075	0.5175	0.5285	0.5375	0.5475	0.5575	0.5675	0.5775	0.5875	0.5975	0.6075	0.6175	0.6275	0.6375
56	0.4367	0.4467	0.4567	0.4667	0.4767	0.4867	0.4967	0.5067	0.5167	0.5277	0.5367	0.5467	0.5567	0.5667	0.5767	0.5867	0.5967	0.6067	0.6167	0.6267	0.6367
34	0.4363	0.4463	0.4563	0.4663	0.4763	0.4863	0.4963	0.5063	0.5163	0.5273	0.5363	0.5463	0.5563	0.5663	0.5763	0.5863	0.5963	0.6063	0.6163	0.6263	0.6363
30	0.4349	0.4449	0.4549	0.4649	0.4749	0.4849	0.4949	0.5049	0.5149	0.5259	0.5349	0.5449	0.5549	0.5649	0.5749	0.5849	0.5949	0.6049	0.6149	0.6249	0.6349
71	0.4348	0.4448	0.4548	0.4648	0.4748	0.4848	0.4948	0.5048	0.5148	0.5258	0.5348	0.5448	0.5548	0.5648	0.5748	0.5848	0.5948	0.6048	0.6148	0.6248	0.6348
75	0.4338	0.4438	0.4538	0.4638	0.4738	0.4838	0.4938	0.5038	0.5138	0.5248	0.5338	0.5438	0.5538	0.5638	0.5738	0.5838	0.5938	0.6038	0.6138	0.6238	0.6338
26	0.4314	0.4414	0.4514	0.4614	0.4714	0.4814	0.4914	0.5014	0.5114	0.5224	0.5314	0.5414	0.5514	0.5614	0.5714	0.5814	0.5914	0.6014	0.6114	0.6214	0.6314
42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.5	0.51	0.521	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.6	0.61	0.62	0.63
94	0.4296	0.4396	0.4496	0.4596	0.4696	0.4796	0.4896	0.4996	0.5096	0.5206	0.5296	0.5396	0.5496	0.5596	0.5696	0.5796	0.5896	0.5996	0.6096	0.6196	0.6296
50	0.4292	0.4392	0.4492	0.4592	0.4692	0.4792	0.4892	0.4992	0.5092	0.5202	0.5292	0.5392	0.5492	0.5592	0.5692	0.5792	0.5892	0.5992	0.6092	0.6192	0.6292
67	0.4225	0.4325	0.4425	0.4525	0.4625	0.4725	0.4825	0.4925	0.5025	0.5135	0.5225	0.5325	0.5425	0.5525	0.5625	0.5725	0.5825	0.5925	0.6025	0.6125	0.6225
6	0.4217	0.4317	0.4417	0.4517	0.4617	0.4717	0.4817	0.4917	0.5017	0.5127	0.5217	0.5317	0.5417	0.5517	0.5617	0.5717	0.5817	0.5917	0.6017	0.6117	0.6217
1	0.4212	0.4312	0.4412	0.4512	0.4612	0.4712	0.4812	0.4912	0.5012	0.5122	0.5212	0.5312	0.5412	0.5512	0.5612	0.5712	0.5812	0.5912	0.6012	0.6112	0.6212
85	0.405	0.415	0.425	0.435	0.445	0.455	0.465	0.475	0.485	0.496	0.505	0.515	0.525	0.535	0.545	0.555	0.565	0.575	0.585	0.595	0.605
93	0.4024	0.4124	0.4224	0.4324	0.4424	0.4524	0.4624	0.4724	0.4824	0.4934	0.5024	0.5124	0.5224	0.5324	0.5424	0.5524	0.5624	0.5724	0.5824	0.5924	0.6024
72	0.3996	0.4096	0.4196	0.4296	0.4396	0.4496	0.4596	0.4696	0.4796	0.4906	0.4996	0.5096	0.5196	0.5296	0.5396	0.5496	0.5596	0.5696	0.5796	0.5896	0.5996
68	0.3876	0.3976	0.4076	0.4176	0.4276	0.4376	0.4476	0.4576	0.4676	0.4786	0.4876	0.4976	0.5076	0.5176	0.5276	0.5376	0.5476	0.5576	0.5676	0.5776	0.5876
49	0.3871	0.3971	0.4071	0.4171	0.4271	0.4371	0.4471	0.4571	0.4671	0.4781	0.4871	0.4971	0.5071	0.5171	0.5271	0.5371	0.5471	0.5571	0.5671	0.5771	0.5871
51	0.3784	0.3884	0.3984	0.4084	0.4184	0.4284	0.4384	0.4484	0.4584	0.4694	0.4784	0.4884	0.4984	0.5084	0.5184	0.5284	0.5384	0.5484	0.5584	0.5684	0.5784
57	0.3782	0.3882	0.3982	0.4082	0.4182	0.4282	0.4382	0.4482	0.4582	0.4692	0.4782	0.4882	0.4982	0.5082	0.5182	0.5282	0.5382	0.5482	0.5582	0.5682	0.5782
7	0.3713	0.3813	0.3913	0.4013	0.4113	0.4213	0.4313	0.4413	0.4513	0.4623	0.4713	0.4813	0.4913	0.5013	0.5113	0.5213	0.5313	0.5413	0.5513	0.5613	0.5713
90	0.3658	0.3758	0.3858	0.3958	0.4058	0.4158	0.4258	0.4358	0.4458	0.4568	0.4658	0.4758	0.4858	0.4958	0.5058	0.5158	0.5258	0.5358	0.5458	0.5558	0.5658
96	0.3643	0.3743	0.3843	0.3943	0.4043	0.4143	0.4243	0.4343	0.4443	0.4553	0.4643	0.4743	0.4843	0.4943	0.5043	0.5143	0.5243	0.5343	0.5443	0.5543	0.5643
92	0.3634	0.3734	0.3834	0.3934	0.4034	0.4134	0.4234	0.4334	0.4434	0.4544	0.4634	0.4734	0.4834	0.4934	0.5034	0.5134	0.5234	0.5334	0.5434	0.5534	0.5634
46	0.3622	0.3722	0.3822	0.3922	0.4022	0.4122	0.4222	0.4322	0.4422	0.4532	0.4622	0.4722	0.4822	0.4922	0.5022	0.5122	0.5222	0.5322	0.5422	0.5522	0.5622
54	0.3579	0.3679	0.3779	0.3879	0.3979	0.4079	0.4179	0.4279	0.4379	0.4489	0.4579	0.4679	0.4779	0.4879	0.4979	0.5079	0.5179	0.5279	0.5379	0.5479	0.5579
65	0.3536	0.3636	0.3736	0.3836	0.3936	0.4036	0.4136	0.4236	0.4336	0.4446	0.4536	0.4636	0.4736	0.4836	0.4936	0.5036	0.5136	0.5236	0.5336	0.5436	0.5536
45	0.3495	0.3595	0.3695	0.3795	0.3895	0.3995	0.4095	0.4195	0.4295	0.4405	0.4495	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095	0.5195	0.5295	0.5395	0.5495
81	0.3495	0.3595	0.3695	0.3795	0.3895	0.3995	0.4095	0.4195	0.4295	0.4405	0.4495	0.4595	0.4695	0.4795	0.4895	0.4995	0.5095	0.5195	0.5295	0.5395	0.5495
43	0.3361	0.3461	0.3561	0.3661	0.3761	0.3861	0.3961	0.4061	0.4161	0.4271	0.4361	0.4461	0.4561	0.4661	0.4761	0.4861	0.4961	0.5061	0.5161	0.5261	0.5361
74	0.335	0.345	0.355	0.365	0.375	0.385	0.395	0.405	0.415	0.426	0.435	0.445	0.455	0.465	0.475	0.485	0.495	0.505	0.515	0.525	0.535
73	0.3151	0.3251	0.3351	0.3451	0.3551	0.3651	0.3751	0.3851	0.3951	0.4061	0.4151	0.4251	0.4351	0.4451	0.4551	0.4651	0.4751	0.4851	0.4951	0.5051	0.5151
20	0.3138	0.3238	0.3338	0.3438	0.3538	0.3638	0.3738	0.3838	0.3938	0.4048	0.4138	0.4238	0.4338	0.4438	0.4538	0.4638	0.4738	0.4838	0.4938	0.5038	0.5138
70	0.3114	0.3214	0.3314	0.3414	0.3514	0.3614	0.3714	0.3814	0.3914	0.4024	0.4114	0.4214	0.4314	0.4414	0.4514	0.4614	0.4714	0.4814	0.4914	0.5014	0.5114
91	0.3043	0.3143	0.3243	0.3343	0.3443	0.3543	0.3643	0.3743	0.3843	0.3953	0.4043	0.4143	0.4243	0.4343	0.4443	0.4543	0.4643	0.4743	0.4843	0.4943	0.5043
44	0.2947	0.3047	0.3147	0.3247	0.3347	0.3447	0.3547	0.3647	0.3747	0.3857	0.3947	0.4047	0.4147	0.4247	0.4347	0.4447	0.4547	0.4647	0.4747	0.4847	0.4947
79	0.2915	0.3015	0.3115	0.3215	0.3315	0.3415	0.3515	0.3615	0.3715	0.3825	0.3915	0.4015	0.4115	0.4215	0.4315	0.4415	0.4515	0.4615	0.4715	0.4815	0.4915
47	0.2828	0.2928	0.3028	0.3128	0.3228	0.3328	0.3428	0.3528	0.3628	0.3738	0.3828	0.3928	0.4028	0.4128	0.4228	0.4328	0.4428	0.4528	0.4628	0.4728	0.4828
95	0.2723	0.2823	0.2923	0.3023	0.3123	0.3223	0.3323	0.3423	0.3523	0.3633	0.3723	0.3823	0.3923	0.4023	0.4123	0.4223	0.4323	0.4423	0.4523	0.4623	0.4723
64	0.2676	0.2776	0.2876	0.2976	0.3076	0.3176	0.3276	0.3376	0.3476	0.3586	0.3676	0.3776	0.3876	0.3976	0.4076	0.4176	0.4276	0.4376	0.4476	0.4576	0.4676
9	0.26	0.27	0.28	0.29	0.3	0.31	0.32	0.33	0.34	0.351	0.36	0.37	0.38	0.39	0.4	0.41	0.42	0.43	0.44	0.45	0.46
80	0.2576	0.2676	0.2776	0.2876	0.2976	0.3076	0.3176	0.3276	0.3376	0.3486	0.3576	0.3676	0.3776	0.3876	0.3976	0.4076	0.4176	0.4276	0.4376	0.4476	0.4576
66	0.2237	0.2337	0.2437	0.2537	0.2637	0.2737	0.2837	0.2937	0.3037	0.3147	0.3237	0.3337	0.3437	0.3537	0.3637	0.3737	0.3837	0.3937	0.4037	0.4137	0.4237
78	0.2176	0.2276	0.2376	0.2476	0.2576	0.2676	0.2776	0.2876	0.2976	0.3086	0.3176	0.3276	0.3376	0.3476	0.3576	0.3676	0.3776	0.3876	0.3976	0.4076	0.4176
48	0.1836	0.1936	0.2036	0.2136	0.2236	0.2336	0.2436	0.2536	0.2636	0.2746	0.2836	0.2936	0.3036	0.3136	0.3236	0.3336	0.3436	0.3536	0.3636	0.3736	0.3836
19	0.1727	0.1827	0.1927	0.2027	0.2127	0.2227	0.2327	0.2427	0.2527	0.2637	0.2727	0.2827	0.2927	0.3027	0.3127	0.3227	0.3327	0.3427	0.3527	0.3627	0.3727
12	0.164	0.174	0.184	0.194	0.204	0.214	0.224	0.234	0.244	0.255	0.264	0.274	0.284	0.294	0.304	0.314	0.324	0.334	0.344	0.354	0.364
8	0.1335	0.1435	0.1535	0.1635	0.1735	0.1835	0.1935	0.2035	0.2135	0.2245	0.2335	0.2435	0.2535	0.2635	0.2735	0.2835	0.2935	0.3035	0.3135	0.3235	0.3335
10	0.1204	0.1304	0.1404	0.1504	0.1604	0.1704	0.1804	0.1904	0.2004	0.2114	0.2204	0.2304	0.2404	0.2504	0.2604	0.2704	0.2804	0.2904	0.3004	0.3104	0.3204
11	0.1193	0.1293	0.1393	0.1493	0.1593	0.1693	0.1793	0.1893	0.1993	0.2103	0.2193	0.2293	0.2393	0.2493	0.2593	0.2693	0.2793	0.2893	0.2993	0.3093	0.3193
77	0.1013	0.1113	0.1213	0.1313	0.1413	0.1513	0.1613	0.1713	0.1813	0.1923	0.2013	0.2113	0.2213	0.2313	0.2413	0.2513	0.2613	0.2713	0.2813	0.2913	0.3013
18	0.0764	0.0864	0.0964	0.1064	0.1164	0.1264	0.1364	0.1464	0.1564	0.1674	0.1764	0.1864	0.1964	0.2064	0.2164	0.2264	0.2364	0.2464	0.2564	0.2664	0.2764
76	0.0536	0.0636	0.0736	0.0836	0.0936	0.1036	0.1136	0.1236	0.1336	0.1446	0.1536	0.1636	0.1736	0.1836	0.1936	0.2036	0.2136	0.2236	0.2336	0.2436	0.2536
17	0.0324	0.0424	0.0524	0.0624	0.0724	0.0824	0.0924	0.1024	0.1124	0.1234	0.1324	0.1424	0.1524	0.1624	0.1724	0.1824	0.1924	0.2024	0.2124	0.2224	0.2324
16	0.0311	0.0411	0.0511	0.0611	0.0711	0.0811	0.0911	0.1011	0.1111	0.1221	0.1311	0.1411	0.1511	0.1611	0.1711	0.1811	0.1911	0.2011	0.2111	0.2211	0.2311

District	Observed	Index_40	Index_41	Index_42	Index_43	Index_44	Index_45	Index_46	Index_47	Index_48	Index_49	Index_50	Index_51	Index_52	Index_53	Index_54	Index_55	Index_56	Index_57	Index_58	Index_59	Index_60
16	0.1555	0.0645	0.0745	0.0845	0.0945	0.1045	0.1145	0.1245	0.1345	0.1445	0.1545	0.1645	0.1745	0.1845	0.1945	0.2045	0.2145	0.2245	0.2345	0.2445	0.2545	0.2645
9	0.1844	0.0934	0.1034	0.1134	0.1234	0.1334	0.1434	0.1534	0.1634	0.1734	0.1834	0.1934	0.2034	0.2134	0.2234	0.2334	0.2434	0.2534	0.2634	0.2734	0.2834	0.2934
10	0.1963	0.1053	0.1153	0.1253	0.1353	0.1453	0.1553	0.1653	0.1753	0.1853	0.1953	0.2053	0.2153	0.2253	0.2353	0.2453	0.2553	0.2653	0.2753	0.2853	0.2953	0.3053
8	0.2068	0.1158	0.1258	0.1358	0.1458	0.1558	0.1658	0.1758	0.1858	0.1958	0.2058	0.2158	0.2258	0.2358	0.2458	0.2558	0.2658	0.2758	0.2858	0.2958	0.3058	0.3158
76	0.2098	0.1188	0.1288	0.1388	0.1488	0.1588	0.1688	0.1788	0.1888	0.1988	0.2088	0.2188	0.2288	0.2388	0.2488	0.2588	0.2688	0.2788	0.2888	0.2988	0.3088	0.3188
17	0.2183	0.1273	0.1373	0.1473	0.1573	0.1673	0.1773	0.1873	0.1973	0.2073	0.2173	0.2273	0.2373	0.2473	0.2573	0.2673	0.2773	0.2873	0.2973	0.3073	0.3173	0.3273
75	0.2572	0.1662	0.1762	0.1862	0.1962	0.2062	0.2162	0.2262	0.2362	0.2462	0.2562	0.2662	0.2762	0.2862	0.2962	0.3062	0.3162	0.3262	0.3362	0.3462	0.3562	0.3662
77	0.2984	0.2074	0.2174	0.2274	0.2374	0.2474	0.2574	0.2674	0.2774	0.2874	0.2974	0.3074	0.3174	0.3274	0.3374	0.3474	0.3574	0.3674	0.3774	0.3874	0.3974	0.4074
18	0.2995	0.2085	0.2185	0.2285	0.2385	0.2485	0.2585	0.2685	0.2785	0.2885	0.2985	0.3085	0.3185	0.3285	0.3385	0.3485	0.3585	0.3685	0.3785	0.3885	0.3985	0.4085
15	0.3141	0.2231	0.2331	0.2431	0.2531	0.2631	0.2731	0.2831	0.2931	0.3031	0.3131	0.3231	0.3331	0.3431	0.3531	0.3631	0.3731	0.3831	0.3931	0.4031	0.4131	0.4231
74	0.3368	0.2458	0.2558	0.2658	0.2758	0.2858	0.2958	0.3058	0.3158	0.3258	0.3358	0.3458	0.3558	0.3658	0.3758	0.3858	0.3958	0.4058	0.4158	0.4258	0.4358	0.4458
46	0.3474	0.2564	0.2664	0.2764	0.2864	0.2964	0.3064	0.3164	0.3264	0.3364	0.3464	0.3564	0.3664	0.3764	0.3864	0.3964	0.4064	0.4164	0.4264	0.4364	0.4464	0.4564
47	0.3562	0.2652	0.2752	0.2852	0.2952	0.3052	0.3152	0.3252	0.3352	0.3452	0.3552	0.3652	0.3752	0.3852	0.3952	0.4052	0.4152	0.4252	0.4352	0.4452	0.4552	0.4652
64	0.3697	0.2787	0.2887	0.2987	0.3087	0.3187	0.3287	0.3387	0.3487	0.3587	0.3687	0.3787	0.3887	0.3987	0.4087	0.4187	0.4287	0.4387	0.4487	0.4587	0.4687	0.4787
78	0.3725	0.2815	0.2915	0.3015	0.3115	0.3215	0.3315	0.3415	0.3515	0.3615	0.3715	0.3815	0.3915	0.4015	0.4115	0.4215	0.4315	0.4415	0.4515	0.4615	0.4715	0.4815
7	0.3812	0.2902	0.3002	0.3102	0.3202	0.3302	0.3402	0.3502	0.3602	0.3702	0.3802	0.3902	0.4002	0.4102	0.4202	0.4302	0.4402	0.4502	0.4602	0.4702	0.4802	0.4902
45	0.3852	0.2942	0.3042	0.3142	0.3242	0.3342	0.3442	0.3542	0.3642	0.3742	0.3842	0.3942	0.4042	0.4142	0.4242	0.4342	0.4442	0.4542	0.4642	0.4742	0.4842	0.4942
11	0.3895	0.2985	0.3085	0.3185	0.3285	0.3385	0.3485	0.3585	0.3685	0.3785	0.3885	0.3985	0.4085	0.4185	0.4285	0.4385	0.4485	0.4585	0.4685	0.4785	0.4885	0.4985
43	0.3937	0.3027	0.3127	0.3227	0.3327	0.3427	0.3527	0.3627	0.3727	0.3827	0.3927	0.4027	0.4127	0.4227	0.4327	0.4427	0.4527	0.4627	0.4727	0.4827	0.4927	0.5027
44	0.4047	0.3137	0.3237	0.3337	0.3437	0.3537	0.3637	0.3737	0.3837	0.3937	0.4037	0.4137	0.4237	0.4337	0.4437	0.4537	0.4637	0.4737	0.4837	0.4937	0.5037	0.5137
19	0.4053	0.3143	0.3243	0.3343	0.3443	0.3543	0.3643	0.3743	0.3843	0.3943	0.4043	0.4143	0.4243	0.4343	0.4443	0.4543	0.4643	0.4743	0.4843	0.4943	0.5043	0.5143
65	0.4063	0.3153	0.3253	0.3353	0.3453	0.3553	0.3653	0.3753	0.3853	0.3953	0.4053	0.4153	0.4253	0.4353	0.4453	0.4553	0.4653	0.4753	0.4853	0.4953	0.5053	0.5153
90	0.4138	0.3228	0.3328	0.3428	0.3528	0.3628	0.3728	0.3828	0.3928	0.4028	0.4128	0.4228	0.4328	0.4428	0.4528	0.4628	0.4728	0.4828	0.4928	0.5028	0.5128	0.5228
79	0.4156	0.3246	0.3346	0.3446	0.3546	0.3646	0.3746	0.3846	0.3946	0.4046	0.4146	0.4246	0.4346	0.4446	0.4546	0.4646	0.4746	0.4846	0.4946	0.5046	0.5146	0.5246
48	0.4158	0.3248	0.3348	0.3448	0.3548	0.3648	0.3748	0.3848	0.3948	0.4048	0.4148	0.4248	0.4348	0.4448	0.4548	0.4648	0.4748	0.4848	0.4948	0.5048	0.5148	0.5248
71	0.4412	0.3502	0.3602	0.3702	0.3802	0.3902	0.4002	0.4102	0.4202	0.4302	0.4402	0.4502	0.4602	0.4702	0.4802	0.4902	0.5002	0.5102	0.5202	0.5302	0.5402	0.5502
94	0.4463	0.3553	0.3653	0.3753	0.3853	0.3953	0.4053	0.4153	0.4253	0.4353	0.4453	0.4553	0.4653	0.4753	0.4853	0.4953	0.5053	0.5153	0.5253	0.5353	0.5453	0.5553
72	0.4483	0.3573	0.3673	0.3773	0.3873	0.3973	0.4073	0.4173	0.4273	0.4373	0.4473	0.4573	0.4673	0.4773	0.4873	0.4973	0.5073	0.5173	0.5273	0.5373	0.5473	0.5573
73	0.4488	0.3578	0.3678	0.3778	0.3878	0.3978	0.4078	0.4178	0.4278	0.4378	0.4478	0.4578	0.4678	0.4778	0.4878	0.4978	0.5078	0.5178	0.5278	0.5378	0.5478	0.5578
91	0.4494	0.3584	0.3684	0.3784	0.3884	0.3984	0.4084	0.4184	0.4284	0.4384	0.4484	0.4584	0.4684	0.4784	0.4884	0.4984	0.5084	0.5184	0.5284	0.5384	0.5484	0.5584
66	0.4503	0.3593	0.3693	0.3793	0.3893	0.3993	0.4093	0.4193	0.4293	0.4393	0.4493	0.4593	0.4693	0.4793	0.4893	0.4993	0.5093	0.5193	0.5293	0.5393	0.5493	0.5593
42	0.4504	0.3594	0.3694	0.3794	0.3894	0.3994	0.4094	0.4194	0.4294	0.4394	0.4494	0.4594	0.4694	0.4794	0.4894	0.4994	0.5094	0.5194	0.5294	0.5394	0.5494	0.5594
89	0.4543	0.3633	0.3733	0.3833	0.3933	0.4033	0.4133	0.4233	0.4333	0.4433	0.4533	0.4633	0.4733	0.4833	0.4933	0.5033	0.5133	0.5233	0.5333	0.5433	0.5533	0.5633
93	0.4624	0.3714	0.3814	0.3914	0.4014	0.4114	0.4214	0.4314	0.4414	0.4514	0.4614	0.4714	0.4814	0.4914	0.5014	0.5114	0.5214	0.5314	0.5414	0.5514	0.5614	0.5714
14	0.4649	0.3739	0.3839	0.3939	0.4039	0.4139	0.4239	0.4339	0.4439	0.4539	0.4639	0.4739	0.4839	0.4939	0.5039	0.5139	0.5239	0.5339	0.5439	0.5539	0.5639	0.5739
63	0.4721	0.3811	0.3911	0.4011	0.4111	0.4211	0.4311	0.4411	0.4511	0.4611	0.4711	0.4811	0.4911	0.5011	0.5111	0.5211	0.5311	0.5411	0.5511	0.5611	0.5711	0.5811
80	0.4737	0.3827	0.3927	0.4027	0.4127	0.4227	0.4327	0.4427	0.4527	0.4627	0.4727	0.4827	0.4927	0.5027	0.5127	0.5227	0.5327	0.5427	0.5527	0.5627	0.5727	0.5827
70	0.4751	0.3841	0.3941	0.4041	0.4141	0.4241	0.4341	0.4441	0.4541	0.4641	0.4741	0.4841	0.4941	0.5041	0.5141	0.5241	0.5341	0.5441	0.5541	0.5641	0.5741	0.5841
6	0.4788	0.3878	0.3978	0.4078	0.4178	0.4278	0.4378	0.4478	0.4578	0.4678	0.4778	0.4878	0.4978	0.5078	0.5178	0.5278	0.5378	0.5478	0.5578	0.5678	0.5778	0.5878
69	0.4819	0.3909	0.4009	0.4109	0.4209	0.4309	0.4409	0.4509	0.4609	0.4709	0.4809	0.4909	0.5009	0.5109	0.5209	0.5309	0.5409	0.5509	0.5609	0.5709	0.5809	0.5909
95	0.4854	0.3944	0.4044	0.4144	0.4244	0.4344	0.4444	0.4544	0.4644	0.4744	0.4844	0.4944	0.5044	0.5144	0.5244	0.5344	0.5444	0.5544	0.5644	0.5744	0.5844	0.5944
49	0.4923	0.4013	0.4113	0.4213	0.4313	0.4413	0.4513	0.4613	0.4713	0.4813	0.4913	0.5013	0.5113	0.5213	0.5313	0.5413	0.5513	0.5613	0.5713	0.5813	0.5913	0.6013
92	0.4926	0.4016	0.4116	0.4216	0.4316	0.4416	0.4516	0.4616	0.4716	0.4816	0.4916	0.5016	0.5116	0.5216	0.5316	0.5416	0.5516	0.5616	0.5716	0.5816	0.5916	0.6016
88	0.5055	0.4145	0.4245	0.4345	0.4445	0.4545	0.4645	0.4745	0.4845	0.4945	0.5045	0.5145	0.5245	0.5345	0.5445	0.5545	0.5645	0.5745	0.5845	0.5945	0.6045	0.6145
41	0.5056	0.4146	0.4246	0.4346	0.4446	0.4546	0.4646	0.4746	0.4846	0.4946	0.5046	0.5146	0.5246	0.5346	0.5446	0.5546	0.5646	0.5746	0.5846	0.5946	0.6046	0.6146
12	0.5122	0.4212	0.4312	0.4412	0.4512	0.4612	0.4712	0.4812	0.4912	0.5012	0.5112	0.5212	0.5312	0.5412	0.5512	0.5612	0.5712	0.5812	0.5912	0.6012	0.6112	0.6212
68	0.5143	0.4233	0.4333	0.4433	0.4533	0.4633	0.4733	0.4833	0.4933	0.5033	0.5133	0.5233	0.5333	0.5433	0.5533	0.5633	0.5733	0.5833	0.5933	0.6033	0.6133	0.6233
20	0.5162	0.4252	0.4352	0.4452	0.4552	0.4652	0.4752	0.4852	0.4952	0.5052	0.5152	0.5252	0.5352	0.5452	0.5552	0.5652	0.5752	0.5852	0.5952	0.6052	0.6152	0.6252
67	0.5175	0.4265	0.4365	0.4465	0.4565	0.4665	0.4765	0.4865	0.4965	0.5065	0.5165	0.5265	0.5365	0.5465	0.5565	0.5665	0.5765	0.5865	0.5965	0.6065	0.6165	0.6265
85	0.5247	0.4337	0.4437	0.4537	0.4637	0.4737	0.4837	0.4937	0.5037	0.5137	0.5237	0.5337	0.5437	0.5537	0.5637	0.5737	0.5837	0.5937	0.6037	0.6137	0.6237	0.6337
50	0.5253	0.4343	0.4443	0.4543	0.4643	0.4743	0.4843	0.4943	0.5043	0.5143	0.5243	0.5343	0.5443	0.5543	0.5643	0.5743	0.5843	0.5943	0.6043	0.6143	0.6243	0.6343
5	0.5256	0.4346	0.4446	0.4546	0.4646	0.4746	0.4846	0.4946	0.5046	0.5146	0.5246	0.5346	0.5446	0.5546	0.5646	0.5746	0.5846	0.5946	0.6046	0.6146	0.6246	0.6346
55	0.5302	0.4392	0.4492	0.4592	0.4692	0.4792	0.4892	0.4992	0.5092	0.5192	0.5292	0.5392	0.5492	0.5592	0.5692	0.5792	0.5892	0.5992	0.6092	0.6192	0.6292	0.6392
54	0.531	0.44	0.45	0.46	0.47	0.48	0.49	0.5	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.6	0.61	0.62	0.63	0.64
28	0.5332	0.4422	0.4522	0.4622	0.4722	0.4822	0.4922	0.5022	0.5122	0.5222	0.5322	0.5422	0.5522	0.5622	0.5722	0.5822	0.5922	0.6022	0.6122	0.6222	0.6322	0.6422
62	0.5372	0.4462	0.4562	0.4662	0.4762	0.4862	0.4962	0.5062	0.5162	0.5262	0.5362	0.5462	0.5562	0.5662	0.5762	0.5862	0.5962	0.6062	0.6162	0.6262	0.6362	0.6462
1	0.5373	0.4463	0.4563	0.4663	0.4763	0.4863	0.4963	0.5063	0.5163	0.5263	0.5363	0.5463	0.5563	0.5663	0.5763	0.5863	0.5963	0.6063	0.6163	0.6263	0.6363	0.6463
29	0.5382	0.4472	0.4572	0.4672	0.4772	0.4872	0.4972	0.5072	0.5172	0.5272	0.5372	0.5472	0.5572	0.5672	0.5772	0.5872	0.5972	0.6072	0.6172	0.6272	0.6372	0.6472
84	0.5384	0.4474	0.4574	0.4674	0.4774	0.4874	0.4974	0.5074	0.5174	0.5274	0.5374	0.5474	0.5574	0.5674	0.5774	0.5874	0.5974	0.6074	0.6174	0.6274	0.6374	0.6474
86	0.5402	0.4492	0.4592	0.4692	0.4792	0.4892	0.4992	0.5092	0.5192	0.5292	0.5392	0.5492	0.5592	0.5692	0.5792	0.5892	0.5992	0.6092	0.6192	0.6292	0.6392	0.6492
87	0.5422	0.4512	0.4612	0.4712	0.4812	0.4912	0.5012	0.5112	0.5212	0.5312	0.5412	0.5512	0.5612	0.5712	0.5812	0.5912	0.6012	0.6112	0.6212	0.6312	0.6412	0.6512
53	0.5424	0.4514	0.4614	0.4714	0.4814	0.4914	0.5014	0.5114	0.5214	0.5314	0.5414	0.5514	0.5614	0.5714	0.5814	0.5914	0.6014	0.6114	0.6214	0.6314	0.6414	0.6514
27	0.5426	0.4516	0.4616	0.4716	0.4816	0.4916	0.5016	0.5116	0.5216	0.5316	0.5416	0.5516	0.5616	0.5716	0.5816	0.5916	0.6016	0.6116	0.6216	0.6316	0.6416	0.6516
34	0.5439	0.4529	0.4629	0.4729	0.4829	0.4929	0.5029	0.5129	0.5229	0.5329	0.5429	0.5529	0.5629	0.5729	0.5829	0.5929	0.6029	0.6129	0.6229	0.6329	0.6429	0.6529
3	0.544	0.453	0.463	0.473	0.483	0.493	0.503	0.513	0.523	0.533	0.543	0.553	0.563	0.573	0.583	0.593	0.603	0.613	0.623	0.633	0.643	0.653
2	0.5458	0.4548	0.4648	0.4748	0.4848	0.4948	0.5048	0.5148	0.5248	0.5348	0.5448	0.5548	0.5648	0.5748	0.5848	0.5948	0.6048	0.6148	0.6248	0.6348	0.6448	0.6548
52	0.5501	0.4591	0.4691	0.4791	0.4891	0.4991	0.5091	0.5191	0.5291	0.5391	0.5491	0.5591	0.5691	0.5791	0.5891	0.5991	0.6091	0.6191	0.6291	0.6391	0.6491	0.6591
25	0.5519	0.4609	0.4709	0.4809	0.4909	0.5009	0.5109	0.5209	0.5309	0.5409	0.5509	0.5609	0.5709	0.5809	0.5909	0.6009	0.6109	0.6209	0.6309	0.6409	0.6509	0.6609
4	0.5523	0.4613	0.4713	0.4813	0.4913	0.5013	0.5113	0.5213	0.5313	0.5413	0.5513	0.5613	0.5713	0.5813	0.5913	0.6013	0.6113	0.6213	0.6313	0.6413	0.6513	0.6613
35	0.5528	0.4618	0.4718	0.4818	0.4918	0.5018	0.5118	0.5218	0.5318	0.5418	0.5518	0.5618	0.5718	0.5818	0.5918	0.6018	0.6118	0.6218	0.6318	0.6418	0.6518	0.6618
51	0.5572	0.4662	0.4762	0.4862	0.4962	0.5062	0.5162	0.5262	0.5362	0.5462	0.5562	0.5662	0.5762	0.5862	0.5962	0.6062	0.6162	0.6262	0.6362	0.6462	0.6562	0.6662
26	0.5576	0.4666	0.4766	0.4866	0.4966	0.5066	0.5166	0.5266	0.5366	0.5466	0.5566	0.5666	0.5766	0.5866	0.5966	0.6066	0.6166	0.6266	0.6366	0.6466	0.6566	0.6666
40	0.5602	0.4692	0.4792	0.4892	0.4992	0.5092	0.5192	0.5292	0.5392	0.5492	0.5592	0.5692	0.5792	0.5892	0.5992	0.6092	0.6192	0.6292	0.6392	0.6492	0.6592	0.6692
21	0.5663	0.4753	0.4853	0.4953	0.5053	0.5153	0.5253	0.5353	0.5453	0.5553	0.5653	0.5753	0.5853	0.5953	0.6053	0.6153	0.6253	0.6353	0.6453	0.6553	0.6653	0.6753
33	0.5664	0.4754	0.4854	0.4954	0.5054	0.5154	0.5254	0.5354	0.5454	0.5554	0.5654	0.5754	0.5854	0.5954	0.6054	0.6154	0.6254	0.6354	0.6454	0.6554	0.6654	0.6754
30	0.5731	0.4821	0.4921	0.5021	0.5121	0.5221	0.5321	0.5421	0.5521	0.5621	0.5721	0.5821	0.5921	0.6021	0.6121	0.6221	0.6321	0.6421	0.6521	0.6621	0.6721	0.6821
81	0.5752	0.4842	0.4942	0.5042	0.5142	0.5242	0.5342	0.5442	0.5542	0.5642	0.5742	0.5842	0.5942	0.6042	0.6142	0.6242	0.6342	0.6442	0.6542	0.6642	0.6742	0.6842
13	0.5772	0.4862	0.4962	0.5062	0.5162	0.5262	0.5362	0.5462	0.5562	0.5662	0.5762	0.5862	0.5962	0.6062	0.6162	0.6262	0.6362	0.6462	0.6562	0.6662	0.6762	0.6862
61	0.5777	0.4867	0.4967	0.5067	0.5167	0.5267	0.5367	0.5467	0.5567	0.5667	0.5767	0.5867	0.5967	0.6067	0.6167	0.6267	0.6367	0.6467	0.6567	0.6667	0.6767	0.6867
36	0.5791	0.4881	0.4981	0.5081	0.5181	0.5281	0.5381	0.5481	0.5581	0.5681	0.5781	0.5881	0.5981	0.6081	0.6181	0.6281	0.6381	0.6481	0.6581	0.6681	0.6781	0.6881
56	0.5797	0.4887	0.4987	0.5087	0.5187	0.5287	0.5387	0.5487	0.5587	0.5687	0.5787	0.5887	0.5987	0.6087	0.6187	0.6287	0.6387	0.6487	0.6587	0.6687	0.6787	0.6887
39	0.5839	0.4929	0.5029	0.5129	0.5229	0.5329	0.5429	0.5529	0.5629	0.5729	0.5829	0.5929	0.6029	0.6129	0.6229	0.6329	0.6429	0.6529	0.6629	0.6729	0.6829	0.6929
83	0.587	0.496	0.506	0.516	0.526	0.536	0.546	0.556	0.566	0.576	0.586	0.596	0.606	0.616	0.626	0.636	0.646	0.656	0.666	0.676	0.686	0.696
24	0.5924	0.5014	0.5114	0.5214	0.5314	0.5414	0.5514	0.5614	0.5714	0.5814	0.5914	0.6014	0.6114	0.6214	0.6314	0.6414	0.6514	0.6614	0.6714	0.6814	0.6914	0.7014
32	0.5934	0.5024	0.5124	0.5224	0.5324	0.5424	0.5524	0.5624	0.5724	0.5824	0.5924	0.6024	0.6124	0.6224	0.6324	0.6424	0.6524	0.6624	0.6724	0.6824	0.6924	0.7024
23	0.5996	0.5086	0.5186	0.5286	0.5386	0.5486	0.5586	0.5686	0.5786	0.5886	0.5986	0.6086	0.6186	0.6286	0.6386	0.6486	0.6586	0.6686	0.6786	0.6886	0.6986	0.7086
31	0.6014	0.5104	0.5204	0.5304	0.5404	0.5504	0.5604	0.5704	0.5804	0.5904	0.6004	0.6104	0.6204	0.6304	0.6404	0.6504	0.6604	0.6704	0.6804	0.6904	0.7004	0.7104
37	0.6017	0.5107	0.5207	0.5307	0.5407	0.5507	0.5607	0.5707	0.5807	0.5907	0.6007	0.6107	0.6207	0.6307	0.6407	0.6507	0.6607	0.6707	0.6807	0.6907	0.7007	0.7107
38	0.6018	0.5108	0.5208	0.5308	0.5408	0.5508	0.5608	0.5708	0.5808	0.5908	0.6008	0.6108	0.6208	0.6308	0.6408	0.6508	0.6608	0.6708	0.6808	0.6908	0.7008	0.7108
22	0.6088	0.5178	0.5278	0.5378	0.5478	0.5578	0.5678	0.5778	0.5878	0.5978	0.6078	0.6178	0.6278	0.6378	0.6478	0.6578	0.6678	0.6778	0.6878	0.6978	0.7078	0.7178
82	0.6095	0.5185	0.5285	0.5385	0.5485	0.5585	0.5685	0.5785	0.5885	0.5985	0.6085	0.6185	0.6285	0.6385	0.6485	0.6585	0.6685	0.6785	0.6885	0.6985	0.7085	0.7185
60	0.6148	0.5238	0.5338	0.5438	0.5538	0.5638	0.5738	0.5838	0.5938	0.6038	0.6138	0.6238	0.6338	0.6438	0.6538	0.6638	0.6738	0.6838	0.6938	0.7038	0.7138	0.7238
57	0.6163	0.5253	0.5353	0.5453	0.5553	0.5653	0.5753	0.5853	0.5953	0.6053	0.6153	0.6253	0.6353	0.6453	0.6553	0.6653	0.6753	0.6853	0.6953	0.7053	0.7153	0.7253
96	0.6275	0.5365	0.5465	0.5565	0.5665	0.5765	0.5865	0.5965	0.6065	0.6165	0.6265	0.6365	0.6465	0.6565	0.6665	0.6765	0.6865	0.6965	0.7065	0.7165	0.7265	0.7365
59	0.6561	0.5651	0.5751	0.5851	0.5951	0.6051	0.6151	0.6251	0.6351	0.6451	0.6551	0.6651	0.6751	0.6851	0.6951	0.7051	0.7151	0.7251	0.7351	0.7451	0.7551	0.7651
99	0.6702	0.5792	0.5892	0.5992	0.6092	0.6192	0.6292	0.6392	0.6492	0.6592	0.6692	0.6792	0.6892	0.6992	0.7092	0.7192	0.7292	0.7392	0.7492	0.7592	0.7692	0.7792
97	0.686	0.595	0.605	0.615	0.625	0.635	0.645	0.655	0.665	0.675	0.685	0.695	0.705	0.715	0.725	0.735	0.745	0.755	0.765	0.775	0.785	0.795
58	0.6946	0.6036	0.6136	0.6236	0.6336	0.6436	0.6536	0.6636	0.6736	0.6836	0.6936	0.7036	0.7136	0.7236	0.7336	0.7436	0.7536	0.7636	0.7736	0.7836	0.7936	0.8036
98	0.7109	0.6199	0.6299	0.6399	0.6499	0.6599	0.6699	0.6799	0.6899	0.6999	0.7099	0.7199	0.7299	0.7399	0.7499	0.7599	0.7699	0.7799	0.7899	0.7999	0.8099	0.8199

Tale of the Tape

Assembly	Current Map	Team Map	Joe Assertive	Tad Aggressive
Strong GOP (55%+)	27	38	36	33
Lean GOP (52.1 - 54.9%)	13	14	15	21
TOTAL GOP (strong + lean)	40	52	51	54
Swing (48-52%)	19	10	11	6
Lean DEM (45.1-47.9%)	7	4	7	9
Strong DEM (45% and below)	33	33	30	30
TOTAL DEM (strong + lean)	40	37	37	39

Current map: 49 seats are 50% or better.

Team map: 59 Assembly seats are 50% or better

Senate	Current Map	Team Map	Joe Assertive	Tad Aggressive
Strong GOP (55%+)	7	12	9	11
Lean GOP (52.1 - 54.9%)	8	5	7	7
TOTAL GOP (strong + lean)	15	17	16	18
Swing (48-52%)	5	3	4	2
Lean DEM (45.1-47.9%)	3	1	2	2
Strong DEM (45% and below)	10	12	11	11
TOTAL DEM (strong + lean)	13	13	13	13

Current map: 17 seats are 50% or better.

Team map: 19 Senate seats are 50% or better

Criteria to Monitor…

Total deviation range:	Our goal for the total range is 1% (-.5 to +.5) For an Assembly district, that equates to about a range of -287 people to +287 people
Split Municipalities:	How many municipalities do we split? How many municipalities do we split over and above the minimum number necessary?
Split Counties:	Same questions asked of municipalities
Pairings:	Total number of pairings as well as R vs D, D vs D, R vs R, and 3-way
Senate Disenfranchisement:	How many people are moved from an even numbered senate seat to an odd one? How does that number compare to census-driven disenfranchisement and previous cycles?

<u>Municipal and County Splits</u>

Number of MCDs that must be split for Assembly:	11
Number of MCDs that must be split for Senate:	2
Number of counties that must be split for Assembly:	25
Number of counties that must be split for Senate:	6

<u>Disenfranchisement</u>

1992	257,000	5.25%	(percent of the total population at the time)
2002	171,613	3.14%	(percent of the total population at the time)

Good outcomes:

Adam Aggressive	Team Map	statistical pick up	GOP inc strengthened (55% and below)	DEM incumbent weakened (45% and over)	GOP donors
35	0				
17	0				
52	0				
9	0				
6	0				
32	0				
38	0				

statistical pickup = seat that is currently held by DEM that goes to 55% or more
(example: if #13 cullen goes from 44% to 58%)

Adam Aggressive	Team Map
10	0
8	0
18	0
2	0
2	0
11	0
13	0

GOP incumbent strengthened = positive movement on composite

DEM incumbent weakened = positive GOP movement on composite

GOP Donors = those who are helping the team

DEM incumbent strengthened = DEM over 45% who has negative movement on composite

GOP incumbent weakened = those 55% and below who have negative movement on composite

statistical loss = seat that is currently held by GOP that goes to 45% or below
(example: If #47 goes all Dane cty we lose the number, but not the incumbent)

GOP non-donors = those over 55% who do not donate points

Bad outcomes:

(45% and above)	(55% and below)		
DEM incumbent	GOP inc	statistical	GOP
strengthened	weakened	loss	non-donors

Statistical Pick Up
Currently held DEM seats that move to 55% or better

district	old	new	
13	43.7%	58.6%	(open seat)
15	48.2%	55.5%	(staskunas)
22	39.1%	57.6%	(ott/pasch)
37	51.3%	58.1%	(open)
62	44.4%	56.6%	(mason)

GOP seats strengthened a lot
Currently held GOP seats that start at 55% or below that improve by at least 1%

district	new incumbe	old	new	improvement
21	(honadel)	51.9%	52.9%	1.0%
23	(knodl)	51.7%	58.5%	6.8%
26	(endsley)	45.5%	56.0%	10.5%
36	(mursau)	53.1%	54.8%	1.7%
42	(ripp)	48.5%	54.9%	6.4%
44	(knilans)	36.7%	38.1%	1.4%
51	(marklein)	44.0%	46.2%	2.2%
55	(kaufert/litgen	49.3%	56.4%	7.1%
68	(bernier)	45.0%	49.4%	4.4%
72	(krug)	49.0%	51.5%	2.5%
87	(williams)	52.2%	53.7%	1.5%
88	(klenke/jacqu	44.9%	53.2%	8.3%
93	(petryk)	44.7%	51.1%	6.4%
96	(nerison)	45.3%	46.4%	1.1%

New 31st laudenbeck and augu Amy goes from 42.4% to 56.4% but ge

GOP seats strengthened a little
Currently held GOP seats that start at 55% or below that improve less than 1%

district	new incumbe	old	new	improvement
4	(weininger)	53.3%	53.5%	0.2%
5	(steineke)	53.7%	54.3%	0.6%
28	(severson)	54.9%	55.0%	0.1%
30	(knudson)	53.3%	53.8%	0.5%
34	(meyer)	54.5%	55.2%	0.7%
35	(tiffany)	52.3%	53.1%	0.8%
75	(rivard)	51.7%	52.1%	0.4%
86	(petrowski)	54.6%	55.1%	0.5%
49	(tranel)	49.7%	49.8%	0.1%
69	(suder)	54.1%	54.2%	0.1%
25	(ziegelbauer)	52.8%	53.3%	0.5%

(bies, nygren, brooks and larson remain v

GOP seats weakened a little
Currently held GOP seats that start at 55% or below that decline

district	new incumbe	old	new	improvement
2	(open)	54.9%	54.8%	-0.1%
29	(murtha)	51.3%	51.0%	-0.3%
43	(wynn)	44.1%	41.8%	-2.3%

GOP seats likely lost
Currently held GOP seats that drop below 45%

district	new incumbe	old	new	improvement

Pairings 11 dems 13 gop

7	45.4%	krusick/zepnick	dem	dem
92	44.3%	danau/radcliffe	dem	dem
77	18.9	hulsey/berceau	dem	dem
22	57.6%	ott/pasch	gop	dem
60	66.8%	pridemore/kessle	gop	dem
61	57.2%	kerkman/steinbri	gop	dem
14	58.8%	kooyenga/cullen	gop	dem
33	61.2%	nass/jorgenson	gop	dem
55	56.4%	kaufert/litgens	gop	gop
88	53.2%	klenke/jacque	gop	gop
89	55.7%	van roy/nygren	gop	gop
31	56.4%	august/loudenbe	gop	gop

Open Seats

2	54.8%	(jacque)
9	29.1%	(hispanic)
12	27.5%	(african-american)
13	58.7%	
38	58.5%	
56	57.6%	
65	35.9%	
32	62.1%	(august)
80	38.9%	
90	40.4%	
91	39.5%	
48	27.6%	
78	31.4%	

90	(open)	49.6%	40.4%	-9.2%
45	(ringhand)	42.4%	37.9%	-4.5%
47	(parisi seat)	48.7%	32.9%	-15.8%

GOP Donors to the Team
Incumbents with numbers above 55% that donate to the team

Tauchen	Spanbauer
Ott	Stroebel
Kooyenga	Strachota
Knodl	LaMaheau
Nass	Vos
Farrow	Kerkman
Kleefisch	Stone
Peterson	Kuglitsch
Ballweg	Craig
Kestell	Litgens

DEMS weakened
Currently held DEM seats (45% or better) that become more GOP

district	new incumbe	old	new	improvement
46	(hebl)	42.4%	45.0%	2.6%
54	(hinz)	45.1%	45.2%	0.1%
70	(vruwink)	49.7%	50.7%	1.0%
94	(doyle)	51.6%	51.9%	0.3%

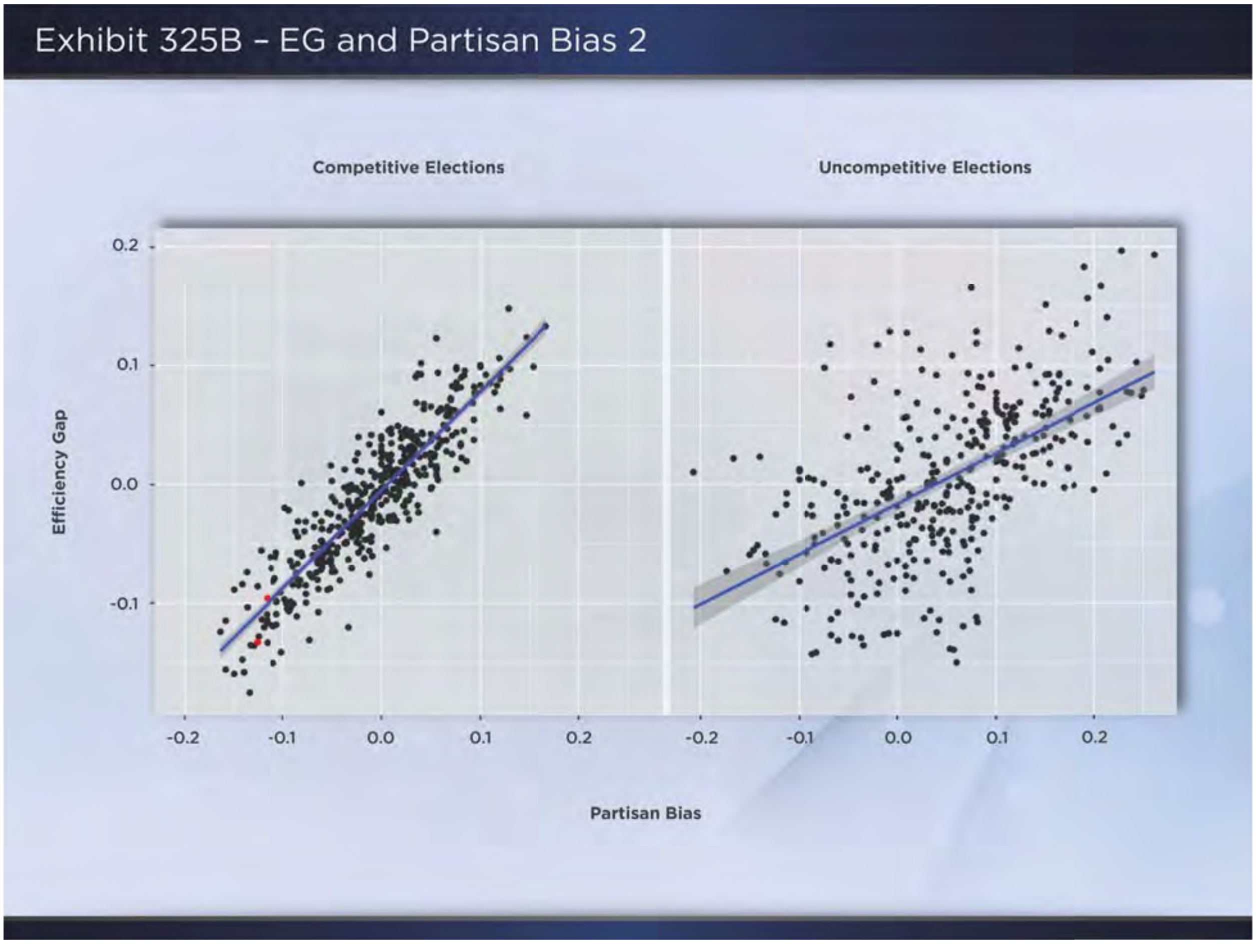
Exhibit 325B – EG and Partisan Bias 2
Competitive Elections
Uncompetitive Elections
Efficiency Gap
0.2
0.1
0.0
-0.1
-0.2
-0.1
0.0
0.1
0.2
-0.2
-0.1
0.0
0.1
0.2
Partisan Bias

Exhibit 329 – EG and PB on Same Chart

Memorandum

To: Representative Garey Bies

CC: Speaker Jeff Fitzgerald; Majority Leader Scott Suder; Rep. Robin Vos

From: Adam Foltz - Assembly Redistricting Coordinator

Date: 6/19/2011

Re: New Map for the 1st District

District Number & New District Population

As a result of the redistricting process, your district's number did not change and will remain the 1st Assembly District.

Census results showed your current district being under populated by -3,255. The new 1st District has a population of 57,220, making it is just -224 people, or -0.40%, off from the new ideal population of 57,444.

Comparison of Key Races in Current 1st Assembly District Versus New 1st Assembly District

Race	Old District %	New District %	Change in Percentage	Old District Votes	New District Votes	Change in Votes
Walker '10	53.12%	53.38%	0.25%	13079	13795	716
JB '10	60.58%	60.74%	0.15%	14659	15428	769
McCain '08	42.50%	42.59%	0.09%	13481	14240	759
JB '06	50.71%	50.70%	0.00%	12992	13661	669
Bush '04	52.28%	52.87%	0.59%	16756	17678	922

PRIVLEGED &
CONFIDENTIAL

Memorandum

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CC: Speaker Jeff Fitzgerald; Majority Leader Scott Suder; Rep. Robin Vos

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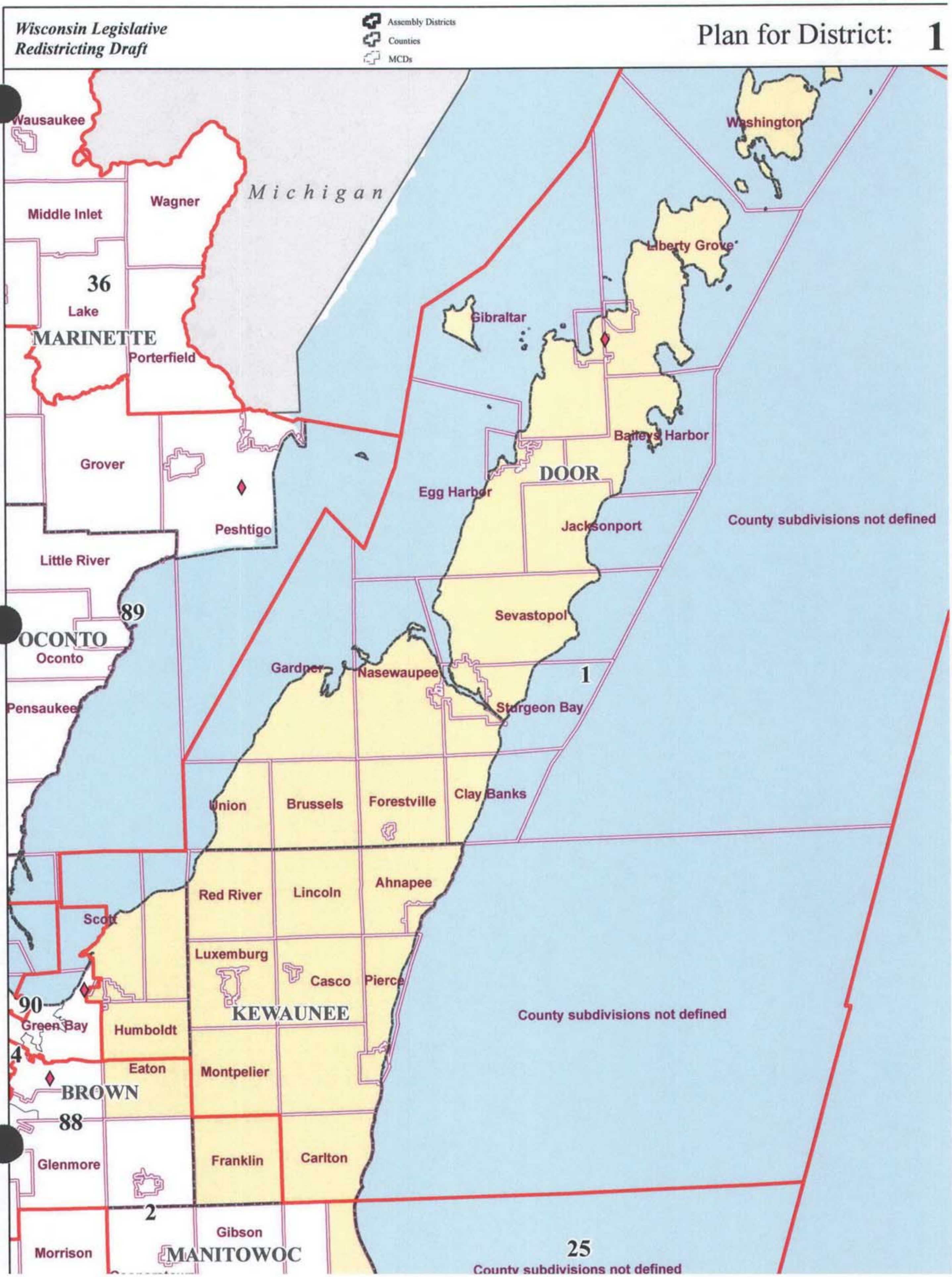
McCain '08	42.50%	42.59%	0.09%	13481	14240	759
JB '06	50.71%	50.70%	0.00%	12992	13661	669
Bush '04	52.28%	52.87%	0.59%	16756	17678	922

PRIVLEGED & CONFIDENTIAL

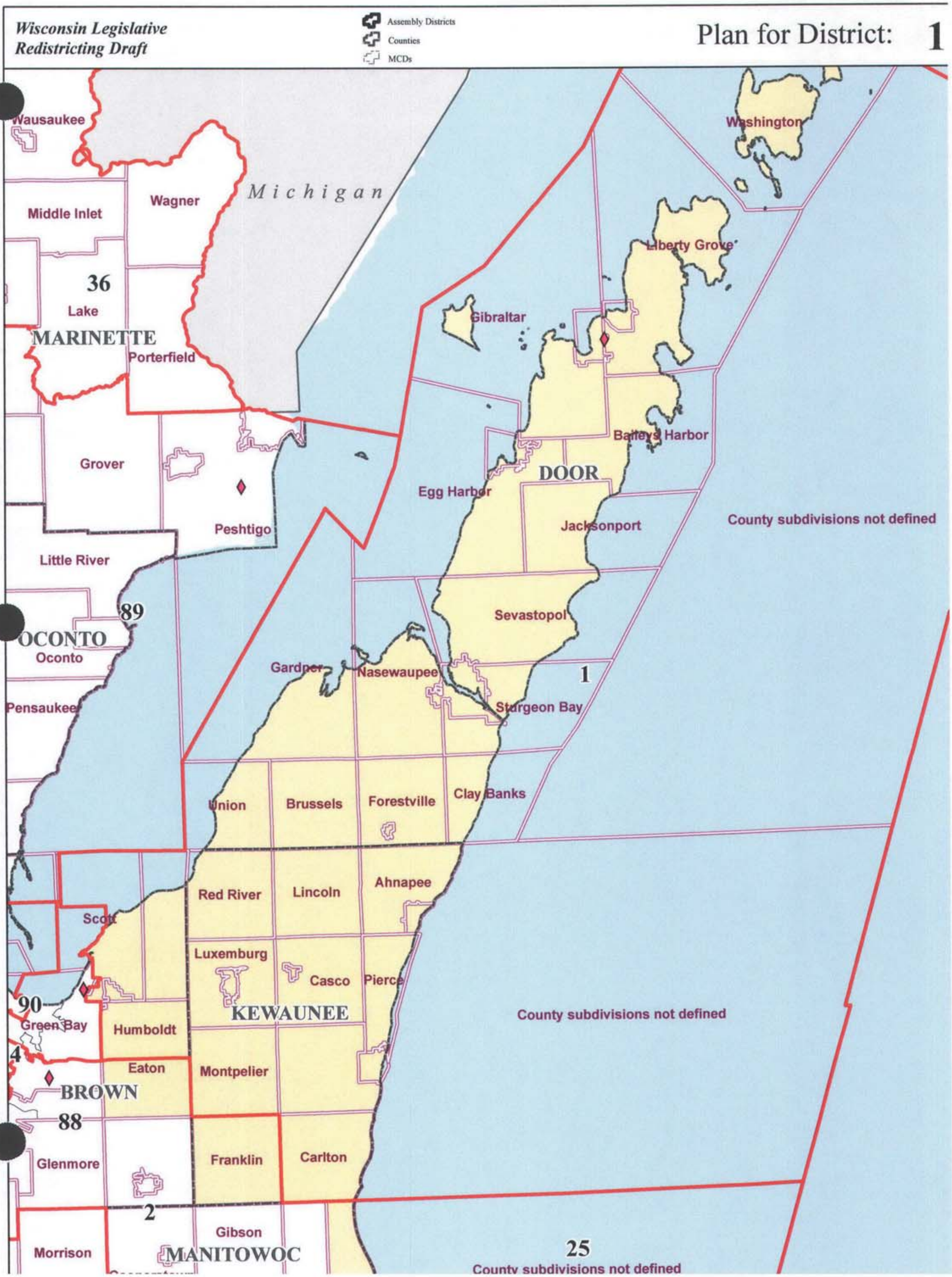
Wisconsin Legislative Redistricting Draft

Plan for District: 1



Wisconsin Legislative Redistricting Draft

Plan for District: **1**



SA351

McLeod, Eric M (22257)

From: Jim Troupis [jrtroupis@troupislawoffice.com]
Sent: Tuesday, June 21, 2011 6:29 PM
To: McLeod, Eric M (22257)
Cc: AdamFoltz@gmail.com; tottman@gmail.com; Sarah Troupis
Subject: Experts

Eric,
Ken Mayer returned from Ireland and is willing to come to work for us. I asked him to reach out to Cannon to also assist as they are co-authors on a number of papers. He is going to do that tonight. Professor Grofman has called back and would like to help, as well. I strongly believe Prof. Grofman is essential to our efforts as he brings to any three judge panel three decades of national and international redistricting work on both sides of the aisle. He has been recognized by courts as perhaps the single most respected political scientist addressing matters of redistricting. There is no doubt we will end up in Court of whatever is passed, and so having a stable of powerful experts is essential. Without Grofman in 2001 we would not have succeeded in getting the map we did get as Easterbrook followed his direction in drawing the map.
We will need to put everyone under confidentiality and retention agreements which will require retainers. Let's discuss this tomorrow and get folks under contract before the map becomes public. They will want to review it ASAP.
I hope things went well today at the caucus. I am sorry I was here in Washington. I did meet with the General Counsel at the RNC and reported on this and other issues. Unfortunately I missed Dr. Hofeller.
Jim

James R. Troupis
Troupis Law Office LLC
jrtroupis@troupislawoffice.com
ph. 608-807-4096

Tad MayQandD

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	51.22%	0.07%	1	54.04%	53.35%	-0.69%
2	54.93%	54.14%	-0.79%				
3	56.10%	55.08%	-1.02%				
4	53.31%	53.14%	-0.17%	2	55.44%	53.91%	-1.53%
5	53.74%	57.17%	3.43%				
6	59.77%	51.27%	-8.50%				
7	48.20%	46.23%	-1.97%	3	40.52%	38.89%	-1.63%
8	22.39%	22.45%	0.06%				
9	36.73%	35.10%	-1.63%				
10	10.27%	21.14%	10.87%	4	17.58%	22.39%	4.81%
11	11.91%	21.03%	9.12%				
12	29.23%	25.50%	-3.73%				
13	43.67%	60.10%	16.43%	5	50.62%	57.88%	7.26%
14	59.06%	55.52%	-3.54%				
15	48.21%	57.97%	9.76%				
16	14.21%	12.21%	-2.00%	6	14.12%	13.84%	-0.28%
17	13.21%	12.34%	-0.87%				
18	15.28%	16.74%	1.46%				
19	29.15%	26.37%	-2.78%	7	41.13%	39.25%	-1.88%
20	43.71%	40.48%	-3.23%				
21	51.92%	52.85%	0.93%				
22	39.05%	57.27%	18.22%	8	52.82%	61.73%	8.91%
23	51.70%	60.42%	8.72%				
24	67.29%	67.93%	0.64%				
25	52.79%	53.35%	0.56%	9	52.96%	56.39%	3.43%
26	45.42%	52.24%	6.82%				
27	59.20%	62.87%	3.67%				
28	54.85%	54.31%	-0.54%	10	53.14%	53.70%	0.56%
29	51.32%	54.19%	2.87%				
30	53.29%	52.59%	-0.70%				
31	67.57%	61.18%	-6.39%	11	67.64%	63.05%	-4.59%
32	61.06%	68.24%	7.18%				
33	72.24%	59.16%	-13.08%				
34	54.51%	52.73%	-1.78%	12	53.37%	54.01%	0.64%
35	52.30%	53.96%	1.66%				
36	53.06%	55.49%	2.43%				
37	51.33%	56.27%	4.94%	13	59.22%	57.17%	-2.05%
38	65.80%	56.42%	-9.38%				
39	60.35%	58.92%	-1.43%				
40	58.50%	58.42%	-0.08%	14	55.86%	56.03%	0.17%
41	60.60%	57.65%	-2.95%				
42	48.54%	52.10%	3.56%				
43	44.14%	42.71%	-1.43%	15	41.20%	41.60%	0.40%
44	36.74%	38.57%	1.83%				
45	42.39%	44.05%	1.66%				
46	42.07%	45.32%	3.25%	16	39.06%	36.39%	-2.67%
47	48.69%	37.38%	-11.31%				
48	28.03%	27.46%	-0.57%				
49	49.68%	47.81%	-1.87%	17	48.46%	48.93%	0.47%
50	52.08%	52.02%	-0.06%				
51	44.01%	46.94%	2.93%				
52	57.39%	57.41%	0.02%	18	54.96%	55.30%	0.34%
53	62.74%	63.34%	0.60%				
54	45.08%	44.89%	-0.19%				
55	49.34%	58.56%	9.22%	19	53.32%	52.76%	-0.56%
56	61.05%	52.77%	-8.28%				
57	47.26%	46.92%	-0.34%				
58	70.90%	64.63%	-6.27%	20	70.55%	68.81%	-1.74%
59	72.74%	70.76%	-1.98%				
60	68.12%	70.99%	2.87%				
61	35.98%	57.52%	21.54%	21	49.86%	57.45%	7.59%
62	44.35%	54.06%	9.71%				
63	63.09%	60.67%	-2.42%				
64	35.66%	35.86%	0.20%	22	47.56%	37.61%	-9.95%
65	45.44%	44.46%	-0.98%				
66	59.12%	31.47%	-27.65%				
67	51.72%	51.35%	-0.37%	23	49.98%	50.93%	0.95%
68	45.01%	47.86%	2.85%				
69	54.06%	53.68%	-0.38%				
70	49.74%	40.24%	-9.50%	24	46.72%	47.05%	0.33%
71	41.68%	52.58%	10.90%				
72	49.03%	49.06%	0.03%				
73	39.55%	40.61%	1.06%	25	44.88%	45.04%	0.16%
74	43.78%	42.60%	-1.18%				
75	51.71%	52.48%	0.77%				
76	24.29%	14.46%	-9.83%	26	20.85%	20.98%	0.13%
77	23.88%	19.23%	-4.65%				
78	14.09%	30.86%	16.77%				
79	37.49%	38.25%	0.76%	27	38.38%	39.01%	0.63%
80	42.15%	34.86%	-7.29%				
81	36.16%	44.05%	7.89%				
82	58.59%	54.19%	-4.40%	28	64.48%	58.50%	-5.98%
83	69.70%	62.75%	-6.95%				
84	64.99%	58.70%	-6.29%				
85	48.91%	49.60%	0.69%	29	52.00%	52.79%	0.79%
86	54.56%	54.95%	0.39%				
87	52.16%	53.84%	1.68%				
88	44.85%	56.69%	11.84%	30	50.38%	53.21%	2.83%
89	55.76%	55.94%	0.18%				
90	49.59%	45.68%	-3.91%				
91	45.87%	39.53%	-6.34%	31	46.89%	44.84%	-2.05%
92	50.79%	45.44%	-5.35%				
93	44.73%	49.34%	4.61%				
94	51.57%	52.06%	0.49%	32	44.43%	44.41%	-0.02%
95	36.02%	36.33%	0.31%				
96	45.32%	45.53%	0.21%				
97	59.96%	69.85%	9.89%	33	68.84%	68.87%	0.03%
98	70.96%	63.18%	-7.78%				
99	73.35%	73.14%	-0.21%				

Current Map	Assembly	Senate
Safe GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Safe GOP (55%+)	33	11
New Lean GOP (52.1-54.9%):	21	7
Total GOP Seats (safe + lean):	54	18
New Swing (48-52%)	6	2
New Lean DEM (45.1-47.9%):	9	2
Safe DEM (-45%):	30	11
Total DEM Seats (safe + lean):	39	13

Joe Assertive

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	51.43%	0.28%	1	54.04%	53.95%	-0.09%
2	54.93%	55.01%	0.08%				
3	56.10%	55.82%	-0.28%				
4	53.31%	52.98%	-0.33%	2	55.44%	54.51%	-0.93%
5	53.74%	53.07%	-0.67%				
6	59.77%	57.76%	-2.01%				
7	48.20%	45.41%	-2.79%	3	40.52%	38.26%	-2.26%
8	22.39%	22.30%	-0.09%				
9	36.73%	35.13%	-1.60%				
10	10.27%	12.82%	2.55%	4	17.58%	19.36%	1.78%
11	11.91%	19.63%	7.72%				
12	29.23%	26.56%	-2.67%				
13	43.67%	59.22%	15.55%	5	50.62%	57.58%	6.96%
14	59.06%	57.74%	-1.32%				
15	48.21%	55.34%	7.13%				
16	14.21%	11.67%	-2.54%	6	14.12%	16.03%	1.91%
17	13.21%	19.87%	6.66%				
18	15.28%	15.35%	0.07%				
19	29.15%	28.31%	-0.84%	7	41.13%	40.81%	-0.32%
20	43.71%	43.69%	-0.02%				
21	51.92%	52.86%	0.94%				
22	39.05%	55.96%	16.91%	8	52.82%	60.68%	7.86%
23	51.70%	59.30%	7.60%				
24	67.29%	67.37%	0.08%				
25	52.79%	53.05%	0.26%	9	52.96%	54.74%	1.78%
26	45.42%	54.67%	9.25%				
27	59.20%	56.34%	-2.86%				
28	54.85%	56.43%	1.58%	10	53.14%	53.46%	0.32%
29	51.32%	50.64%	-0.68%				
30	53.29%	53.16%	-0.13%				
31	67.57%	61.04%	-6.53%	11	67.64%	59.65%	-7.99%
32	61.06%	58.28%	-2.78%				
33	72.24%	59.90%	-12.34%				
34	54.51%	54.59%	0.08%	12	53.37%	54.76%	1.39%
35	52.30%	53.05%	0.75%				
36	53.06%	56.57%	3.51%				
37	51.33%	53.20%	1.87%	13	59.22%	58.90%	-0.32%
38	65.80%	63.61%	-2.19%				
39	60.35%	59.17%	-1.18%				
40	58.50%	58.26%	-0.24%	14	55.86%	55.30%	-0.56%
41	60.60%	59.94%	-0.66%				
42	48.54%	47.51%	-1.03%				
43	44.14%	38.57%	-5.57%	15	41.20%	44.25%	3.05%
44	36.74%	38.69%	1.95%				
45	42.39%	54.68%	12.29%				
46	42.07%	44.35%	2.28%	16	39.06%	34.65%	-4.41%
47	48.69%	27.46%	-21.23%				
48	28.03%	33.77%	5.74%				
49	49.68%	49.91%	0.23%	17	48.46%	49.07%	0.61%
50	52.08%	52.11%	0.03%				
51	44.01%	45.59%	1.58%				
52	57.39%	58.85%	1.46%	18	54.96%	55.51%	0.55%
53	62.74%	61.50%	-1.24%				
54	45.08%	45.52%	0.44%				
55	49.34%	56.48%	7.14%	19	53.32%	53.02%	-0.30%
56	61.05%	57.21%	-3.84%				
57	47.26%	44.70%	-2.56%				
58	70.90%	70.92%	0.02%	20	70.55%	69.70%	-0.85%
59	72.74%	70.63%	-2.11%				
60	68.12%	67.77%	-0.35%				
61	35.98%	33.17%	-2.81%	21	49.86%	50.10%	0.24%
62	44.35%	53.15%	8.80%				
63	63.09%	59.05%	-4.04%				
64	35.66%	34.82%	-0.84%	22	47.56%	46.77%	-0.79%
65	45.44%	46.67%	1.23%				
66	59.12%	57.61%	-1.51%				
67	51.72%	52.04%	0.32%	23	49.98%	51.78%	1.80%
68	45.01%	50.12%	5.11%				
69	54.06%	53.44%	-0.62%				
70	49.74%	51.03%	1.29%	24	46.72%	46.69%	-0.03%
71	41.68%	39.96%	-1.72%				
72	49.03%	49.40%	0.37%				
73	39.55%	40.17%	0.62%	25	44.88%	44.44%	-0.44%
74	43.78%	41.67%	-2.11%				
75	51.71%	51.96%	0.25%				
76	24.29%	23.03%	-1.26%	26	20.85%	20.98%	0.13%
77	23.88%	26.37%	2.49%				
78	14.09%	14.70%	0.61%				
79	37.49%	35.63%	-1.86%	27	38.38%	39.87%	1.49%
80	42.15%	41.59%	-0.56%				
81	36.16%	42.57%	6.41%				
82	58.59%	57.22%	-1.37%	28	64.48%	61.10%	-3.38%
83	69.70%	68.37%	-1.33%				
84	64.99%	57.52%	-7.47%				
85	48.91%	48.61%	-0.30%	29	52.00%	52.67%	0.67%
86	54.56%	55.56%	1.00%				
87	52.16%	53.65%	1.49%				
88	44.85%	51.35%	6.50%	30	50.38%	50.56%	0.18%
89	55.76%	56.06%	0.30%				
90	49.59%	42.92%	-6.67%				
91	45.87%	48.89%	3.02%	31	46.89%	44.89%	-2.00%
92	50.79%	46.85%	-3.94%				
93	44.73%	39.70%	-5.03%				
94	51.57%	51.59%	0.02%	32	44.43%	44.58%	0.15%
95	36.02%	36.53%	0.51%				
96	45.32%	46.29%	0.97%				
97	59.96%	61.54%	1.58%	33	68.84%	68.82%	-0.02%
98	70.96%	74.18%	3.22%				
99	73.35%	69.58%	-3.77%				

Current Map	Assembly	Senate
Safe GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Safe GOP (55%+)	36	9
New Lean GOP (52.1-54.9%):	15	7
Total GOP Seats (safe + lean):	51	16
New Swing (48-52%)	11	4
New Lean DEM (45.1-47.9%):	7	2
Safe DEM (-45%):	30	11
Total DEM Seats (safe + lean):	37	13

DRAFT

Proposed Map Room Access Policy

All access pass:

Adam Foltz, Tad Ottman, Speaker Fitzgerald, Majority Leader Fitzgerald, Eric McLeod, Jim Troupis, any legal staff determined by Eric or Jim.

Full map access (Ability to look at complete maps. Access to office when Tad, Adam, or a member of the legal team is present):

Senator Rich Zipperer, Representative?

John Hogan, Andrew Gustafson (once non-disclosure statements are signed)

A limited number of other staff (2 to 4) may be requested to assist in drawing at a later date. No staff allowed in the office without signing a non-disclosure statement.

Joe Handrick

Other consultants designated by the legal team.

Limited access

Legislators will be allowed into the office for the sole purpose of looking at and discussing their district. They are only to be present when an All Access member is present. No statewide or regional printouts will be on display while they are present (with the exception of existing districts). They will be asked at each visit to sign an agreement that the meeting they are attending is confidential and they are not to discuss it (not a formal non-disclosure statement).

Question: Should legislators who have access to the full map be asked to sign a non-disclosure statement? Is there any advantage or disadvantage in their doing so?

Joe Aggressive

Team Map

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	51.22%	0.07%	1	54.04%	53.73%	-0.31%
2	54.93%	54.84%	-0.09%				
3	56.10%	55.58%	-0.52%				
4	53.31%	53.47%	0.16%	2	55.44%	55.23%	-0.21%
5	53.74%	54.28%	0.54%				
6	59.77%	58.33%	-1.44%				
7	48.20%	45.38%	-2.82%	3	40.52%	38.12%	-2.40%
8	22.39%	30.48%	8.09%				
9	36.73%	29.14%	-7.59%				
10	10.27%	12.59%	2.32%	4	17.58%	19.63%	2.05%
11	11.91%	19.58%	7.67%				
12	29.23%	27.51%	-1.72%				
13	43.67%	58.67%	15.00%	5	50.62%	57.72%	7.10%
14	59.06%	58.64%	-0.42%				
15	48.21%	55.48%	7.27%				
16	14.21%	10.54%	-3.67%	6	14.12%	15.55%	1.43%
17	13.21%	19.84%	6.63%				
18	15.28%	14.94%	-0.34%				
19	29.15%	28.03%	-1.12%	7	41.13%	40.53%	-0.60%
20	43.71%	43.12%	-0.59%				
21	51.92%	52.94%	1.02%				
22	39.05%	57.64%	18.59%	8	52.82%	60.88%	8.06%
23	51.70%	58.49%	6.79%				
24	67.29%	66.82%	-0.47%				
25	52.79%	53.26%	0.47%	9	52.96%	55.19%	2.23%
26	45.42%	55.97%	10.55%				
27	59.20%	56.19%	-3.01%				
28	54.85%	55.00%	0.15%	10	53.14%	53.32%	0.18%
29	51.32%	50.97%	-0.35%				
30	53.29%	53.78%	0.49%				
31	67.57%	56.41%	-11.16%	11	67.64%	60.14%	-7.50%
32	61.06%	62.07%	1.01%				
33	72.24%	61.92%	-10.32%				
34	54.51%	55.22%	0.71%	12	53.37%	54.39%	1.02%
35	52.30%	52.99%	0.69%				
36	53.06%	54.84%	1.78%				
37	51.33%	58.11%	6.78%	13	59.22%	60.17%	0.95%
38	65.80%	60.45%	-5.35%				
39	60.35%	62.00%	1.65%				
40	58.50%	58.07%	-0.43%	14	55.86%	56.02%	0.16%
41	60.60%	55.16%	-5.44%				
42	48.54%	54.94%	6.40%				
43	44.14%	41.82%	-2.32%	15	41.20%	39.37%	-1.83%
44	36.74%	38.06%	1.32%				
45	42.39%	37.89%	-4.50%				
46	42.07%	44.95%	2.88%	16	39.06%	34.74%	-4.32%
47	48.69%	32.92%	-15.77%				
48	28.03%	27.56%	-0.47%				
49	49.68%	49.59%	-0.09%	17	48.46%	49.23%	0.77%
50	52.08%	52.06%	-0.02%				
51	44.01%	46.23%	2.22%				
52	57.39%	59.06%	1.67%	18	54.96%	55.01%	0.05%
53	62.74%	61.85%	-0.89%				
54	45.08%	45.22%	0.14%				
55	49.34%	56.43%	7.09%	19	53.32%	53.02%	-0.30%
56	61.05%	57.59%	-3.46%				
57	47.26%	44.50%	-2.76%				
58	70.90%	70.54%	-0.36%	20	70.55%	69.46%	-1.09%
59	72.74%	68.31%	-4.43%				
60	68.12%	69.52%	1.40%				
61	35.98%	57.22%	21.24%	21	49.86%	57.77%	7.91%
62	44.35%	56.56%	12.21%				
63	63.09%	59.64%	-3.45%				
64	35.66%	42.72%	7.06%	22	47.56%	36.97%	-10.59%
65	45.44%	35.92%	-9.52%				
66	59.12%	31.71%	-27.41%				
67	51.72%	51.67%	-0.05%	23	49.98%	51.75%	1.77%
68	45.01%	49.38%	4.37%				
69	54.06%	54.16%	0.10%				
70	49.74%	50.73%	0.99%	24	46.72%	47.51%	0.79%
71	41.68%	40.72%	-0.96%				
72	49.03%	51.49%	2.46%				
73	39.55%	40.16%	0.61%	25	44.88%	44.88%	0.00%
74	43.78%	42.89%	-0.89%				
75	51.71%	52.18%	0.47%				
76	24.29%	14.48%	-9.81%	26	20.85%	20.98%	0.13%
77	23.88%	18.90%	-4.98%				
78	14.09%	31.38%	17.29%				
79	37.49%	40.62%	3.13%	27	38.38%	41.56%	3.18%
80	42.15%	39.90%	-2.25%				
81	36.16%	44.56%	8.40%				
82	58.59%	57.08%	-1.51%	28	64.48%	60.95%	-3.53%
83	69.70%	68.32%	-1.38%				
84	64.99%	57.10%	-7.89%				
85	48.91%	48.38%	-0.53%	29	52.00%	52.47%	0.47%
86	54.56%	55.08%	0.52%				
87	52.16%	53.74%	1.58%				
88	44.85%	53.19%	8.34%	30	50.38%	50.55%	0.17%
89	55.76%	55.73%	-0.03%				
90	49.59%	40.40%	-9.19%				
91	45.87%	39.57%	-6.30%	31	46.89%	44.94%	-1.95%
92	50.79%	44.30%	-6.49%				
93	44.73%	51.10%	6.37%				
94	51.57%	51.91%	0.34%	32	44.43%	44.63%	0.20%
95	36.02%	36.36%	0.34%				
96	45.32%	46.40%	1.08%				
97	59.96%	62.92%	2.96%	33	68.84%	68.60%	-0.24%
98	70.96%	74.85%	3.89%				
99	73.35%	67.02%	-6.33%				

Current Map	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Strong GOP (55%+)	38	12
New Lean GOP (52-54.9%):	14	5
Total GOP Seats (safe + lean):	52	17
New Swing (48-52%)	10	3
New Lean DEM (45.1-47.9%):	4	1
Safe DEM (-45%):	33	12
Total DEM Seats (safe + lean):	37	13

Team Map - Ranking

Joe Aggressive (2)

	Assembly				Senate			
	DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	98	70.96%	74.83%	3.87%	33	68.84%	68.56%	-0.28%
2	58	70.90%	70.55%	-0.35%	20	70.55%	68.46%	-2.09%
3	24	67.29%	69.52%	2.23%	8	52.82%	61.64%	8.82%
4	83	69.70%	68.35%	-1.35%	28	64.48%	60.90%	-3.58%
5	59	72.74%	68.26%	-4.48%	13	59.22%	60.34%	1.12%
6	99	73.35%	66.88%	-6.47%	11	67.64%	60.14%	-7.50%
7	60	68.12%	66.82%	-1.30%	5	50.62%	57.79%	7.17%
8	97	59.96%	63.05%	3.09%	21	49.86%	57.77%	7.91%
9	32	61.06%	62.06%	1.00%	14	55.86%	55.96%	0.10%
10	39	60.35%	62.00%	1.65%	2	55.44%	55.23%	-0.21%
11	33	72.24%	61.92%	-10.32%	9	52.96%	55.19%	2.23%
12	53	62.74%	61.81%	-0.93%	18	54.96%	55.01%	0.05%
13	37	51.33%	60.58%	9.25%	12	53.37%	54.43%	1.06%
14	63	63.09%	59.64%	-3.45%	1	54.04%	53.73%	-0.31%
15	52	57.39%	59.06%	1.67%	10	53.14%	53.31%	0.17%
16	14	59.06%	58.76%	-0.30%	19	53.32%	53.02%	-0.30%
17	13	43.67%	58.68%	15.01%	29	52.00%	52.52%	0.52%
18	23	51.70%	58.51%	6.81%	23	49.98%	51.69%	1.71%
19	38	65.80%	58.46%	-7.34%	30	50.38%	50.55%	0.17%
20	6	59.77%	58.33%	-1.44%	17	48.46%	49.23%	0.77%
21	22	39.05%	57.63%	18.58%	24	46.72%	47.39%	0.67%
22	56	61.05%	57.55%	-3.50%	31	46.89%	44.93%	-1.96%
23	40	58.50%	57.51%	-0.99%	25	44.88%	44.84%	-0.04%
24	61	35.98%	57.23%	21.25%	32	44.43%	44.63%	0.20%
25	82	58.59%	57.13%	-1.46%	27	38.38%	40.98%	2.60%
26	84	64.99%	56.94%	-8.05%	7	41.13%	40.53%	-0.60%
27	62	44.35%	56.56%	12.21%	15	41.20%	39.51%	-1.69%
28	55	49.34%	56.43%	7.09%	3	40.52%	38.12%	-2.40%
29	31	67.57%	56.41%	-11.16%	22	47.56%	36.97%	-10.59%
30	27	59.20%	56.13%	-3.07%	16	39.06%	35.24%	-3.82%
31	26	45.42%	56.03%	10.61%	26	20.85%	20.98%	0.13%
32	41	60.60%	55.79%	-4.81%	4	17.58%	19.63%	2.05%
33	89	55.76%	55.73%	-0.03%	6	14.12%	15.57%	1.45%
34	3	56.10%	55.58%	-0.52%				
35	15	48.21%	55.52%	7.31%				
36	34	54.51%	55.22%	0.71%				
37	86	54.56%	55.11%	0.55%				
38	28	54.85%	54.99%	0.14%				
39	2	54.93%	54.84%	-0.09%				
40	36	53.06%	54.84%	1.78%				
41	42	48.54%	54.63%	6.09%				
42	5	53.74%	54.28%	0.54%				
43	87	52.16%	53.92%	1.76%				
44	69	54.06%	53.85%	-0.21%				
45	30	53.29%	53.80%	0.51%				
46	4	53.31%	53.47%	0.16%				
47	25	52.79%	53.27%	0.48%				
48	88	44.85%	53.19%	8.34%				
49	35	52.30%	53.08%	0.78%				
50	21	51.92%	52.94%	1.02%				
51	75	51.71%	52.14%	0.43%				
52	94	51.57%	51.91%	0.34%				
53	50	52.08%	51.87%	-0.21%				
54	67	51.72%	51.67%	-0.05%				
55	1	51.15%	51.22%	0.07%				
56	93	44.73%	51.15%	6.42%				
57	29	51.32%	50.94%	-0.38%				
58	72	49.03%	50.42%	1.39%				
59	70	49.74%	50.17%	0.43%				
60	49	49.68%	49.75%	0.07%				
61	68	45.01%	49.66%	4.65%				
62	85	48.91%	48.31%	-0.60%				
63	96	45.32%	46.40%	1.08%				
64	51	44.01%	46.28%	2.27%				
65	7	48.20%	45.35%	-2.85%				
66	54	45.08%	45.26%	0.18%				
67	46	42.07%	45.19%	3.12%				
68	81	36.16%	44.56%	8.40%				
69	57	47.26%	44.49%	-2.77%				
70	92	50.79%	44.30%	-6.49%				
71	20	43.71%	43.06%	-0.65%				
72	64	35.66%	42.72%	7.06%				
73	74	43.78%	42.43%	-1.35%				
74	43	44.14%	41.96%	-2.18%				
75	71	41.68%	41.92%	0.24%				
76	73	39.55%	40.52%	0.97%				
77	90	49.59%	40.40%	-9.19%				
78	79	37.49%	40.09%	2.60%				
79	91	45.87%	39.53%	-6.34%				
80	80	42.15%	38.65%	-3.50%				
81	45	42.39%	38.18%	-4.21%				
82	44	36.74%	38.07%	1.33%				
83	95	36.02%	36.36%	0.34%				
84	65	45.44%	35.92%	-9.52%				
85	47	48.69%	34.47%	-14.22%				
86	66	59.12%	31.71%	-27.41%				
87	78	14.09%	30.86%	16.77%				
88	8	22.39%	30.48%	8.09%				
89	9	36.73%	29.14%	-7.59%				
90	19	29.15%	28.03%	-1.12%				
91	12	29.23%	27.51%	-1.72%				
92	48	28.03%	27.45%	-0.58%				
93	17	13.21%	19.88%	6.67%				
94	11	11.91%	19.58%	7.67%				
95	77	23.88%	19.23%	-4.65%				
96	18	15.28%	14.94%	-0.34%				
97	76	24.29%	14.46%	-9.83%				
98	10	10.27%	12.59%	2.32%				
99	16	14.21%	10.54%	-3.67%				

Current Map	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52.1-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Strong GOP (55%+)	37	12
New Lean GOP (52.1-54.9%):	14	5
Total GOP Seats (safe + lean):	51	17
New Swing (48-52%)	11	3
New Lean DEM (45.1-47.9%):	5	1
Safe DEM (-45%):	32	12
Total DEM Seats (safe + lean):	37	13

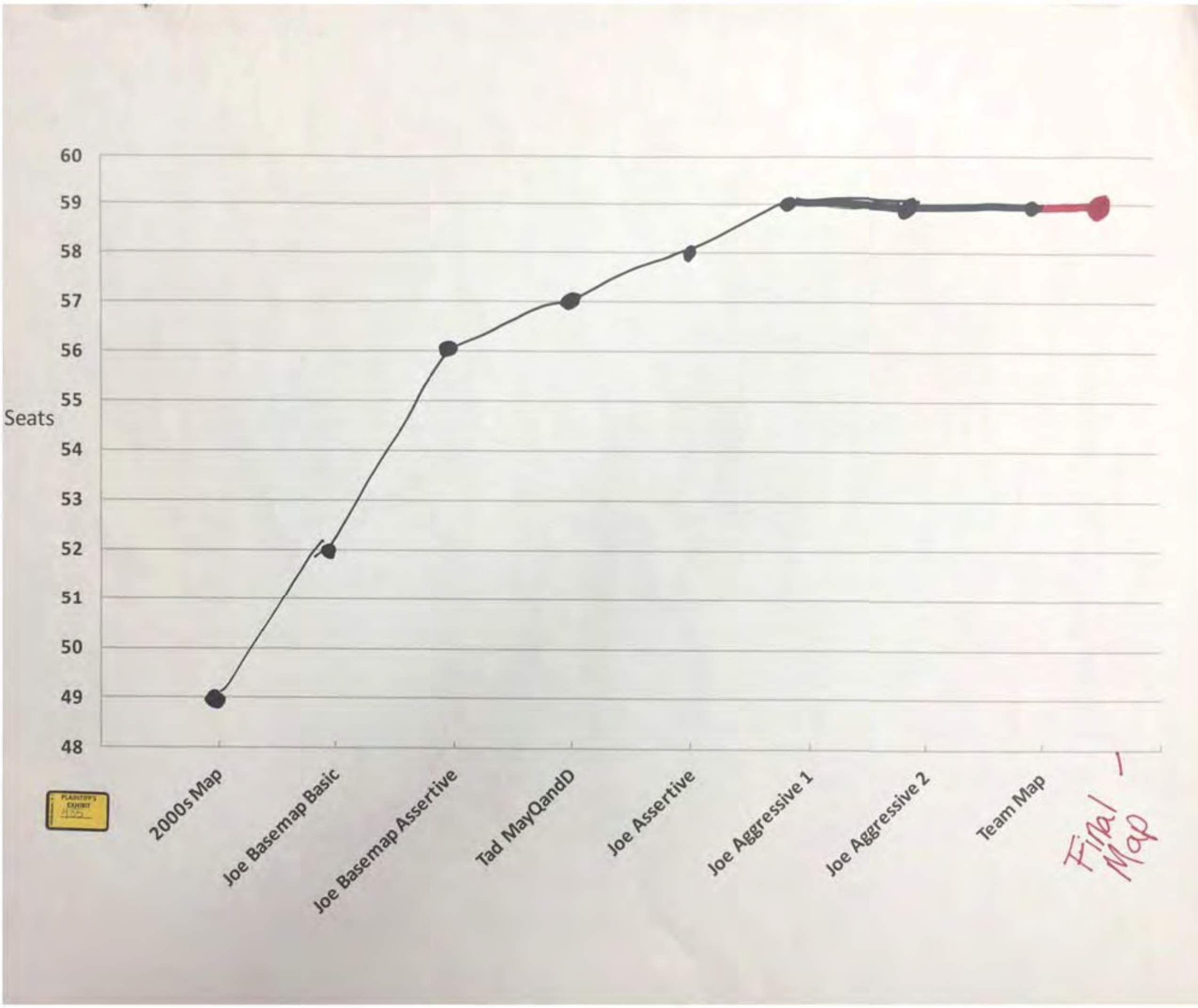
TeamMap 6-15-11

Team Map

Assembly				Senate			
DISTRICT	Current	New	Delta	DISTRICT	Current	New	Delta
1	51.15%	51.22%	0.07%	1	54.04%	53.73%	-0.31%
2	54.93%	54.84%	-0.09%				
3	56.10%	55.58%	-0.52%				
4	53.31%	53.47%	0.16%	2	55.44%	55.23%	-0.21%
5	53.74%	54.28%	0.54%				
6	59.77%	58.33%	-1.44%				
7	48.20%	45.38%	-2.82%	3	40.52%	38.12%	-2.40%
8	22.39%	30.48%	8.09%				
9	36.73%	29.14%	-7.59%				
10	10.27%	12.59%	2.32%	4	17.58%	19.63%	2.05%
11	11.91%	19.58%	7.67%				
12	29.23%	27.51%	-1.72%				
13	43.67%	58.67%	15.00%	5	50.62%	57.72%	7.10%
14	59.06%	58.64%	-0.42%				
15	48.21%	55.48%	7.27%				
16	14.21%	10.54%	-3.67%	6	14.12%	15.55%	1.43%
17	13.21%	19.84%	6.63%				
18	15.28%	14.94%	-0.34%				
19	29.15%	28.03%	-1.12%	7	41.13%	40.53%	-0.60%
20	43.71%	43.12%	-0.59%				
21	51.92%	52.94%	1.02%				
22	39.05%	66.82%	27.77%	8	52.82%	60.88%	8.06%
23	51.70%	57.64%	5.94%				
24	67.29%	58.49%	-8.80%				
25	52.79%	53.26%	0.47%	9	52.96%	55.19%	2.23%
26	45.42%	55.97%	10.55%				
27	59.20%	56.19%	-3.01%				
28	54.85%	55.00%	0.15%	10	53.14%	53.32%	0.18%
29	51.32%	50.97%	-0.35%				
30	53.29%	53.78%	0.49%				
31	67.57%	56.33%	-11.24%	11	67.64%	60.13%	-7.51%
32	61.06%	62.28%	1.22%				
33	72.24%	61.81%	-10.43%				
34	54.51%	55.22%	0.71%	12	53.37%	54.39%	1.02%
35	52.30%	52.99%	0.69%				
36	53.06%	54.84%	1.78%				
37	51.33%	58.11%	6.78%	13	59.22%	60.17%	0.95%
38	65.80%	60.45%	-5.35%				
39	60.35%	62.00%	1.65%				
40	58.50%	58.07%	-0.43%	14	55.86%	56.02%	0.16%
41	60.60%	55.16%	-5.44%				
42	48.54%	54.94%	6.40%				
43	44.14%	43.06%	-1.08%	15	41.20%	40.17%	-1.03%
44	36.74%	37.22%	0.48%				
45	42.39%	40.08%	-2.31%				
46	42.07%	42.39%	0.32%	16	39.06%	34.13%	-4.93%
47	48.69%	33.36%	-15.33%				
48	28.03%	27.56%	-0.47%				
49	49.68%	49.59%	-0.09%	17	48.46%	49.23%	0.77%
50	52.08%	52.06%	-0.02%				
51	44.01%	46.23%	2.22%				
52	57.39%	59.06%	1.67%	18	54.96%	55.01%	0.05%
53	62.74%	61.85%	-0.89%				
54	45.08%	45.22%	0.14%				
55	49.34%	56.43%	7.09%	19	53.32%	53.02%	-0.30%
56	61.05%	57.59%	-3.46%				
57	47.26%	44.50%	-2.76%				
58	70.90%	70.54%	-0.36%	20	70.55%	69.46%	-1.09%
59	72.74%	68.31%	-4.43%				
60	68.12%	69.52%	1.40%				
61	35.98%	57.22%	21.24%	21	49.86%	57.77%	7.91%
62	44.35%	56.56%	12.21%				
63	63.09%	59.64%	-3.45%				
64	35.66%	42.72%	7.06%	22	47.56%	36.97%	-10.59%
65	45.44%	35.92%	-9.52%				
66	59.12%	31.71%	-27.41%				
67	51.72%	51.67%	-0.05%	23	49.98%	51.75%	1.77%
68	45.01%	49.38%	4.37%				
69	54.06%	54.16%	0.10%				
70	49.74%	50.73%	0.99%	24	46.72%	47.51%	0.79%
71	41.68%	40.72%	-0.96%				
72	49.03%	51.49%	2.46%				
73	39.55%	40.16%	0.61%	25	44.88%	44.88%	0.00%
74	43.78%	42.89%	-0.89%				
75	51.71%	52.18%	0.47%				
76	24.29%	14.49%	-9.80%	26	20.85%	20.98%	0.13%
77	23.88%	18.90%	-4.98%				
78	14.09%	31.38%	17.29%				
79	37.49%	41.77%	4.28%	27	38.38%	41.48%	3.10%
80	42.15%	38.55%	-3.60%				
81	36.16%	44.56%	8.40%				
82	58.59%	57.08%	-1.51%	28	64.48%	60.93%	-3.55%
83	69.70%	68.31%	-1.39%				
84	64.99%	57.10%	-7.89%				
85	48.91%	48.38%	-0.53%	29	52.00%	52.47%	0.47%
86	54.56%	55.08%	0.52%				
87	52.16%	53.74%	1.58%				
88	44.85%	53.19%	8.34%	30	50.38%	50.55%	0.17%
89	55.76%	55.73%	-0.03%				
90	49.59%	40.40%	-9.19%				
91	45.87%	39.57%	-6.30%	31	46.89%	44.94%	-1.95%
92	50.79%	44.30%	-6.49%				
93	44.73%	51.10%	6.37%				
94	51.57%	51.91%	0.34%	32	44.43%	44.63%	0.20%
95	36.02%	36.36%	0.34%				
96	45.32%	46.40%	1.08%				
97	59.96%	62.91%	2.95%	33	68.84%	68.60%	-0.24%
98	70.96%	74.85%	3.89%				
99	73.35%	67.02%	-6.33%				

Current Map	Assembly	Senate
Strong GOP (55%+)	27	7
Lean GOP (52-54.9%):	13	8
Total GOP Seats (safe + lean):	40	15
Swing (48-52%):	19	5
Lean DEM (45.1-47.9%):	7	3
Safe DEM (-45%):	33	10
Total DEM Seats (safe + lean):	40	13

New Map	Assembly	Senate
Strong GOP (55%+)	38	12
New Lean GOP (52-54.9%):	14	5
Total GOP Seats (safe + lean):	52	17
New Swing (48-52%)	10	3
New Lean DEM (45.1-47.9%):	4	1
Safe DEM (-45%):	33	12
Total DEM Seats (safe + lean):	37	13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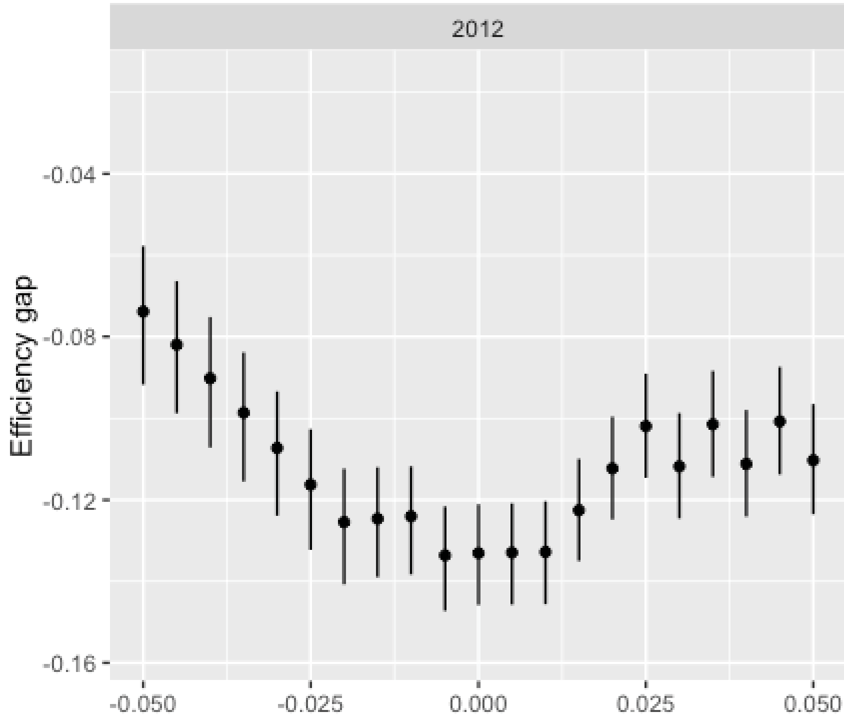
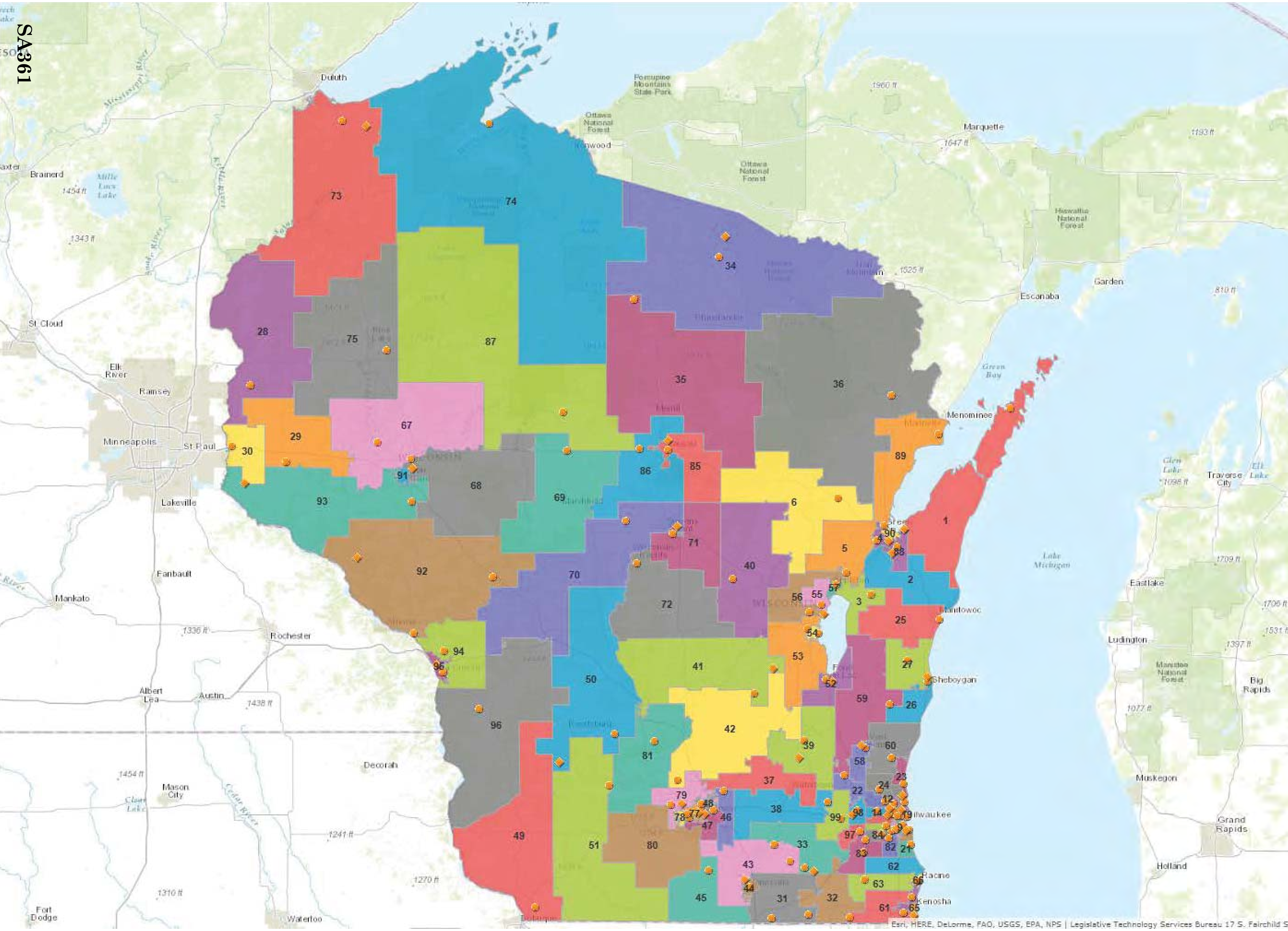
Seats
2000s Map
Joe Basemap Basic
Joe Basemap Assertive
Tad MayQandD
Joe Assertive
Joe Aggressive 1
Joe Aggressive 2
Team Map
Final Map

Wisconsin Sensitivity Testing



SA361



Duluth
Brainerd
St Cloud
Elk River
Ramsey
Minneapolis
St Paul
Lakeville
Faribault
Mankato
Rochester
Albert Lea
Austin
Decorah
Mason City
Fort Dodge
Waterloo
Dubuque
Porcupine Mountains State Park
Ottawa National Forest
Ironwood
Marquette
Hiawatha National Forest
Escanaba
Garden
Green Bay
Menominee
Lake Michigan
Traverse City
Eastlake
Ludington
Manistee National Forest
Big Rapids
Muskegon
Grand Rapids
Holland
Manitowoc
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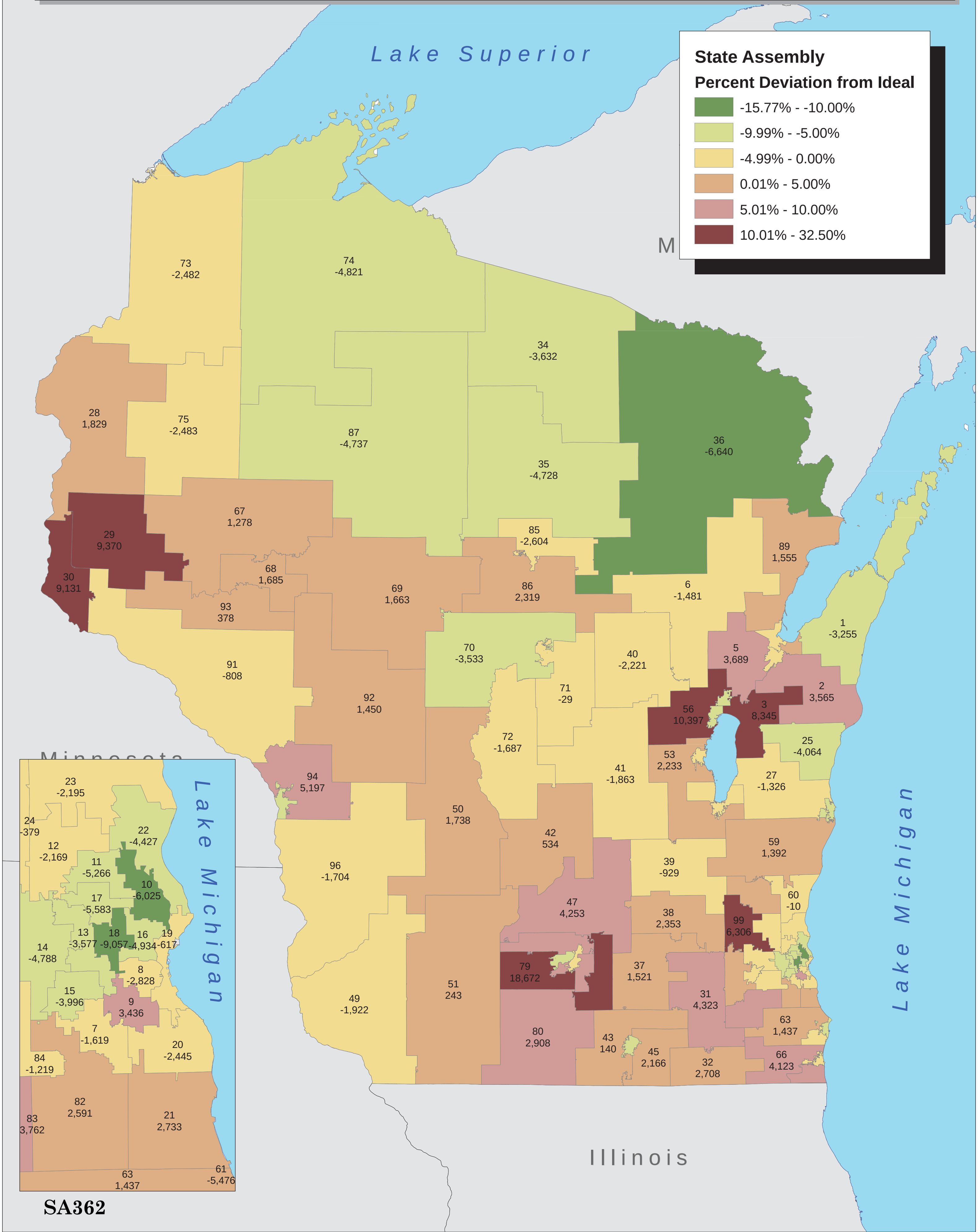
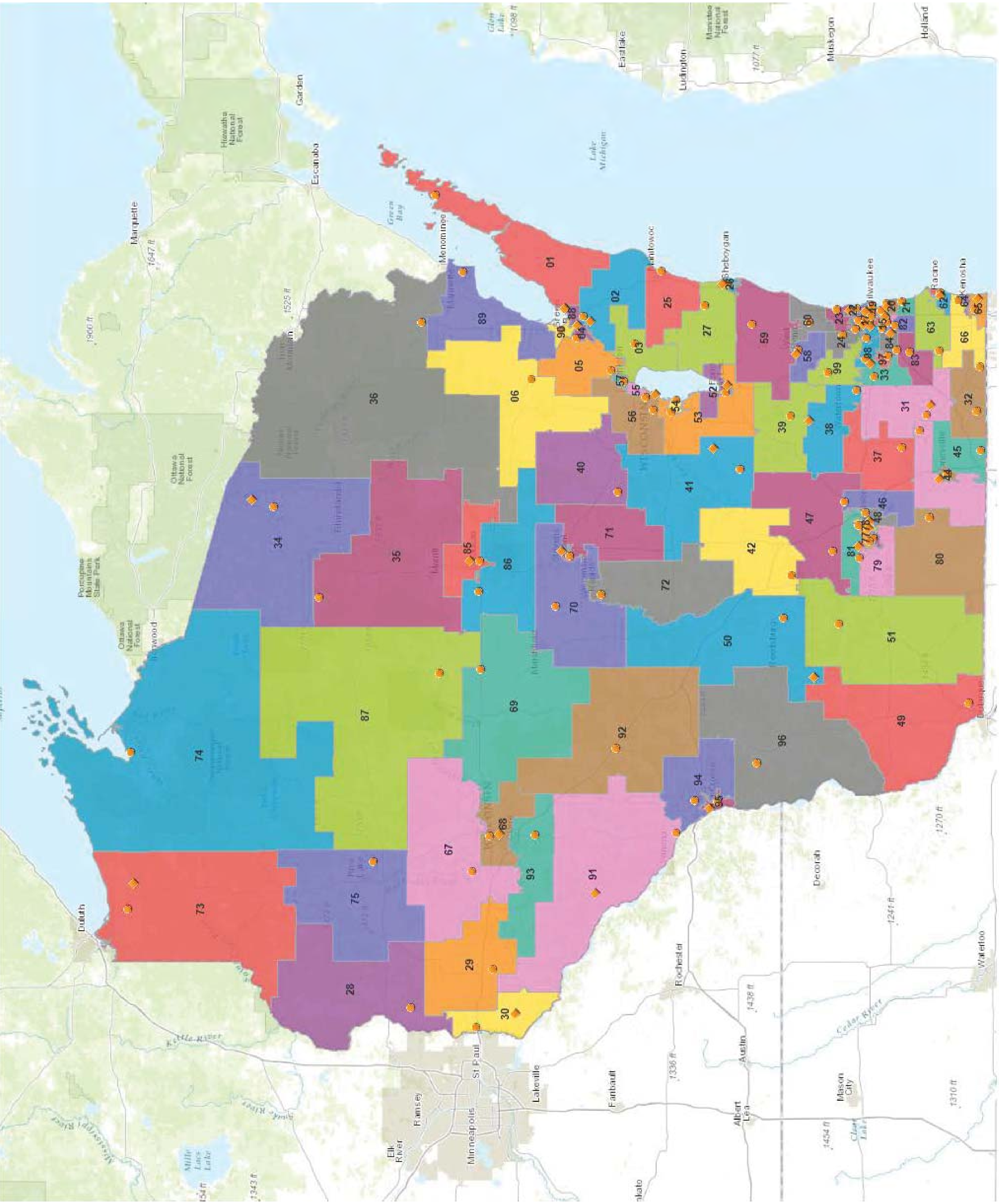
Esri, HERE, DeLorme, FAO, USGS, EPA, NPS | Legislative Technology Services Bureau 17 S. Fairchild St.,

2002 Assembly Districts - Over/Under Population



SA362


Duluth
Minneapolis
St Paul
Lakeville
Ramsey
Elk River
Faribault
Rochester
Austin
Albert Lea
Mason City
Decorah
Waterloo
Marquette
Escanaba
Garden
Menominee
Green Bay
Lake Michigan
Sheboygan
Racine
Kenosha
Ludington
Muskegon
Holland
Eastlake
Ottawa National Forest
Hiawatha National Forest
Porcupine Mountains State Park
Manistee National Forest
Kettle River
Cedar River

SA363