The Impact of Political Geography on Wisconsin Redistricting

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In this article, I apply a computer simulation methodology and perform statistical tests to analyze the legislative districting plan enacted by Wisconsin's Act 43.[1] I employ this computer simulation methodology to produce and analyze a large number of state assembly plans drawn using traditional districting principles. In conducting my analysis, I sought to answer the following three questions:

> 1) What level of electoral bias emerges from a non-partisan process that draws Wisconsin's assembly districts by following the traditional districting principles of equal apportionment, preserving communities of interest (county and municipal boundaries), respecting the Voting Rights Act, and maximizing compactness?
>
> 2) How likely is such a non-partisan process to produce a state assembly districting plan with minimal electoral bias, as measured by the plan's efficiency gap?
>
> 3) How likely is such a non-partisan process to produce a districting plan with an efficiency gap similar to that of the enacted Act 43?

Executive Summary

The results of my simulation analysis, as outlined below, demonstrate that a non-partisan districting process following traditional districting principles generally produces a state assembly plan with minimal bias. In fact, 144 of the 200 random districting plans produced by the non-gerrymandered computer simulation process exhibit an efficiency gap of within 3% of zero, indicating no substantial favoring of either Democrats or Republicans.

The remaining fifty-six simulated plans exhibit an efficiency gap between -5.8% and -3.0%. Because a negative efficiency gap indicates electoral bias in favor of Republicans, these

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[1] Those methodologies are described more fully in an earlier published article: Jowei Chen & Jonathan Rodden, *Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures,* Quarterly Journal of Political Science, Vol. 8, No. 3: 239-269 (2013).

results suggest that Wisconsin's natural political geography, combined with a non-partisan process following traditional districting principles, could plausibly produce a plan with a modest amount of Republican-favoring electoral bias.

These levels of natural electoral bias pale in comparison to the much more extreme electoral bias exhibited by the Act 43 plan. The Act 43 plan exhibits a Republican-favoring efficiency gap several times that of most simulated plans, and over twice as large as even the most biased of the 200 plans produced by the non-partisan computer simulation process. In sum, statistically speaking, it is extremely unlikely that a neutral districting process, using traditional factors, would have produced a plan exhibiting electoral bias as significant as that of Act 43.

Discussion

I begin with an explanation of the logic of the districting simulation approach, followed by an overview of the simulation technique. Then, I present the results of the simulations and illustrate how the Act 43 plan is a statistical outlier.

The Logic of Redistricting Simulations

When political representation is based on winner-take-all districts, asymmetries between votes and seats can emerge merely because one party's supporters are more clustered in space than those of the other party. When this happens, the party with a more concentrated support base achieves a smaller seat share because it racks up large numbers of "surplus" votes in the districts it wins, while falling just short of the winning threshold in many of the districts it loses. This can happen quite naturally in cities due to such factors as racial segregation, housing and labor markets, transportation infrastructure, and residential sorting by income and lifestyle.

By generating a large number of randomly drawn districting plans, optimizing traditional districting criteria, the computer simulation process demonstrates the range of districting plans that would likely emerge from a neutral process. Courts and litigants can then draw inferences by comparing the partisanship of enacted plans against this range of simulated plans.

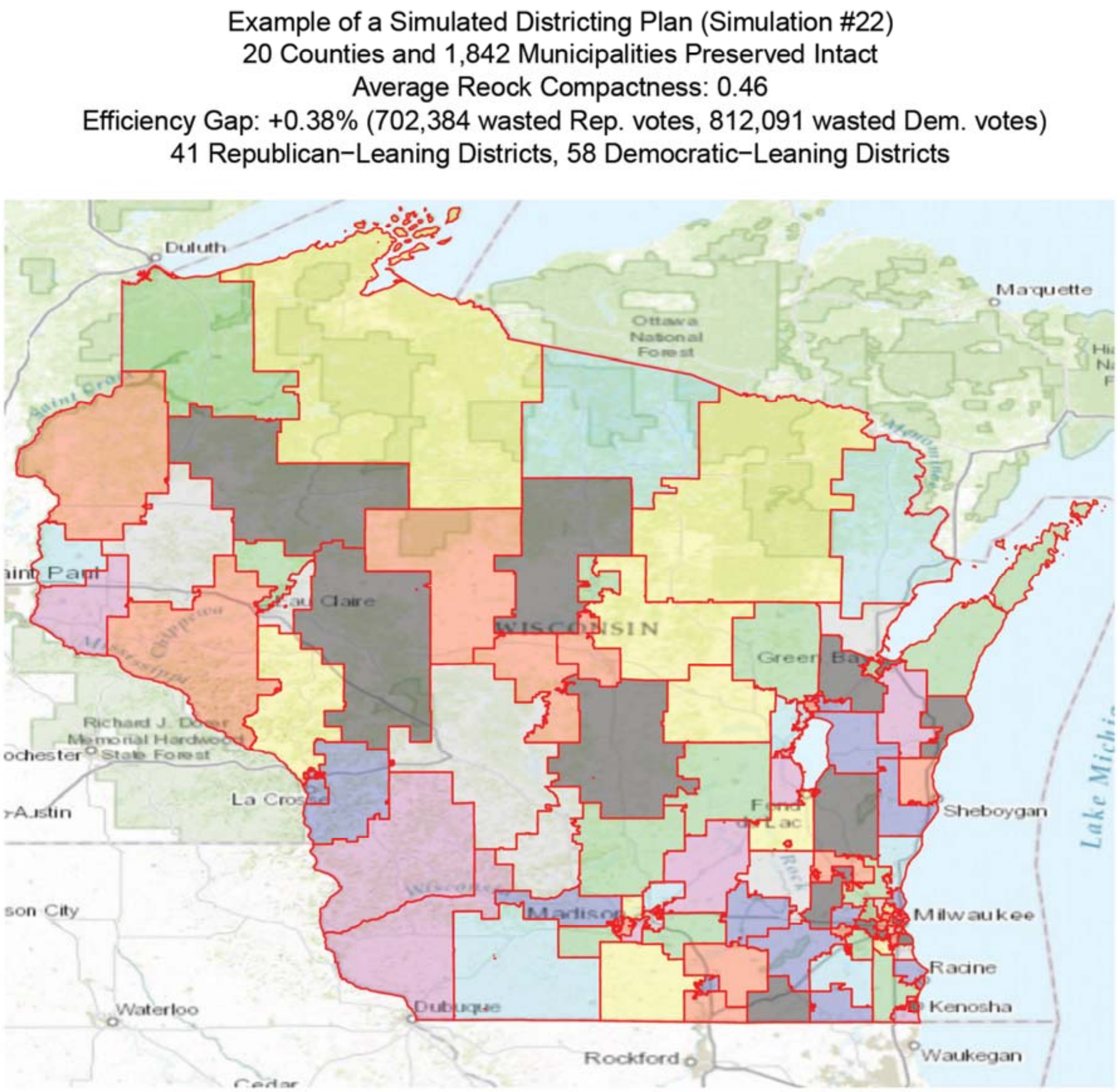
In my published academic research on legislative districting, partisan and racial gerrymandering, and electoral bias, I have developed computer simulation programming techniques that allow me to randomly produce a large number of alternative districting plans in any given state or county using precincts as building blocks. Most importantly, these computer simulations can be programmed to optimize districts with respect to any specified traditional districting goal while ignoring partisan considerations.

I use this simulation approach to analyze Wisconsin's Act 43 plan. First, I analyze the Legislature's districting plans and identify areas in which these enacted plans deviate significantly from equally populated districts. To analyze the Legislature's motivations for these population deviations, I use computer simulations to randomly generate two-hundred districting plans that optimize four criteria: equal apportionment within 1% of ideal district population, preservation of municipal boundaries, preservation of county boundaries, and maximization of geographic compactness. Additionally, to comply with the Voting Rights Act, I preserve the one majority-Hispanic and six majority-Black districts that were drawn in the Act 43 plan.

I then compare the computer-generated, non-partisan districting plans to the Act 43 plan using various measures of partisanship and electoral bias. The results show that computer-simulated districting plans produced by a non-partisan process preserve significantly more county and municipal boundaries than the Act 43 plan. More importantly, the simulated plans always produce significantly less electoral bias than Act 43, often resulting in a partisan efficiency gap of close to 0%. Thus, Wisconsin's Act 43 plan creates a level of electoral bias falling completely outside the range of likely outcomes under a non-partisan districting process that creates equally populated districts while maximizing compactness and preserving county and municipal boundaries.

Figure 1 illustrates an example of a computer simulated plan producing ninety-nine Assembly districts in Wisconsin. The plan displayed in Figure 1 is one of 200 complete districting plans produced by the simulation process and analyzed in this brief.

FIGURE 1



In simulating Assembly districting plans for Wisconsin, the computer algorithm follows the following traditional districting criteria:

1) ***Equal Apportionment:*** Wisconsin's 2010 Census population was 5,686,986, so each of the 99 Assembly districts has an ideal population of 57,444.3. The computer simulation algorithm is designed to draw ninety-nine districts so that every district is within 1% of the ideal district population. As a result of this criterion, every computer simulated district produced for this analysis contains a population ranging from 56,871 to 58,017.

2) ***County Boundaries***: Wisconsin contains seventy-two counties, and Act 43 preserves fourteen of these counties intact while splitting each of the remaining fifty-eight counties into two or more Assembly districts. The left column of Table 1 lists the fourteen counties that Act 43 preserves intact.

All of the computer simulated plans preserve intact a significantly higher number of county boundaries. As Figure 2 illustrates, each of the simulated plans preserves from 18 to 25 counties intact. Though the precise set of intact counties differs from one simulated plan to the next, there are eighteen counties that are always preserved intact in 100% of the simulated plans. These counties are the first eighteen counties listed in the right column of Table 1. An additional twenty counties are preserved intact in some, but not all, of the simulated plans. These twenty additional counties are also listed in the right column of Table 1, along with the frequency with which each county is preserved intact in the simulated plans.

TABLE 1: Counties Preserved Intact in Enacted and Simulated Districting Plans

Counties Preserved Intact in Act 43 Assembly Plan	Counties Preserved Intact in Computer-Simulated Ninety-Nine -District Plans
Ashland	Ashland (100% of Simulated Plans)
Bayfield	Bayfield (100% of Simulated Plans)
Crawford	Buffalo (100% of Simulated Plans)
Door	Burnett (100% of Simulated Plans)
Florence	Crawford (100% of Simulated Plans)
Grant	Door (100% of Simulated Plans)
Iron	Florence (100% of Simulated Plans)
Kewaunee	Forest (100% of Simulated Plans)
Lincoln	Grant (100% of Simulated Plans)
Menominee	Iron (100% of Simulated Plans)
Pepin	Kewaunee (100% of Simulated Plans)
Price	Lincoln (100% of Simulated Plans)
Rusk	Marquette (100% of Simulated Plans)
Taylor	Menominee (100% of Simulated Plans)
	Pepin (100% of Simulated Plans)
	Price (100% of Simulated Plans)
	Rusk (100% of Simulated Plans)
	Taylor (100% of Simulated Plans)
	Marinette (58% of Simulated Plans)
	Douglas (51% of Simulated Plans)
	Vilas (38% of Simulated Plans)
	Lafayette (21% of Simulated Plans)
	Oneida (16% of Simulated Plans)
	Green Lake (15% of Simulated Plans)
	Langlade (12% of Simulated Plans)
	Richland (10% of Simulated Plans)
	Trempealeau (5% of Simulated Plans)
	Polk (4% of Simulated Plans)
	Vernon (3% of Simulated Plans)
	Sawyer (3% of Simulated Plans)
	Dunn (3% of Simulated Plans)
	Waushara (2% of Simulated Plans)
	Pierce (2% of Simulated Plans)
	Barron (2% of Simulated Plans)
	Iowa (1% of Simulated Plans)
	Green (1% of Simulated Plans)
	Clark (1% of Simulated Plans)
	Adams (1% of Simulated Plans)

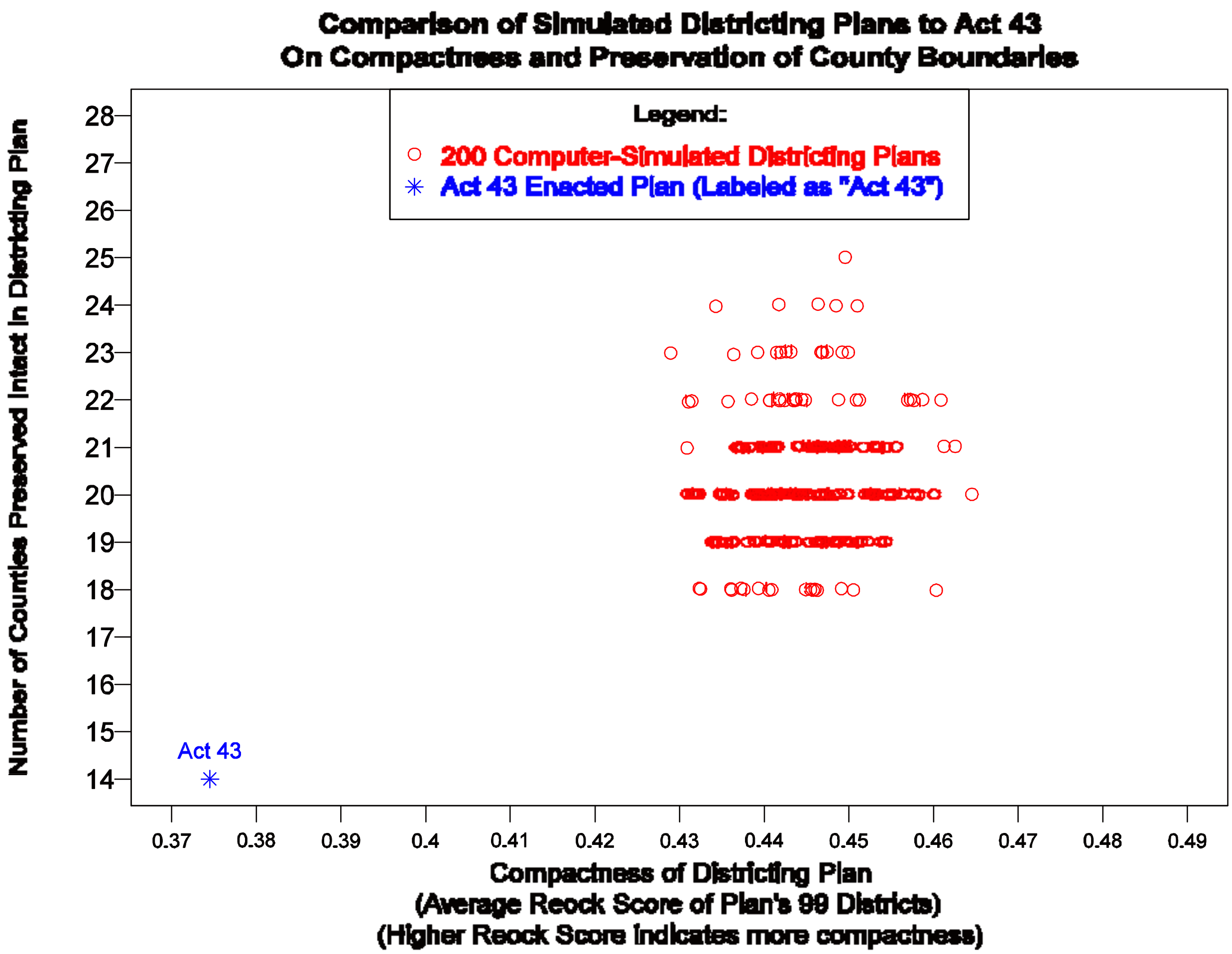
3) ***Municipalities Boundaries***: Wisconsin contains a total of 1,896 municipalities, which include cities, towns, and villages. For purposes of counting municipal splits, I treated each Census Minor Civil Division (MCD) as a separate municipality, even if two MCD's have the same name.

Act 43 preserves intact the boundaries of 1,825 municipalities. All of the computer simulated plans preserve intact a significantly higher number of municipalities. The number of municipalities preserved intact in the simulations ranges from 1,837 to 1,853.

4) ***Geographic Compactness***: Beyond preserving county and municipal boundaries, the simulation algorithm prioritizes the drawing of geographically compact districts. Compactness is quantifiably measured by a Reock score for each district in any given plan. The Reock score of a district is calculated by first drawing the smallest possible bounding circle that completely encloses the district's borders; hence, the bounding circle will always be at least as large as the district itself. The Reock score is then calculated as the ratio of the district's area to the area of the bounding circle. Therefore, the Reock score will always be a fraction less than or equal to one, with a higher Reock score indicating a more compact district. The Reock score for an entire plan is then calculated as the average score for the ninety-nine Assembly districts within the plan.

To compare the compactness of the computer simulated plans and the Act 43 Assembly plan, the horizontal axis of Figure 2 measures the Reock score for the Act 43 Assembly plan as well as the 200 computer simulated plans. Figure 2 illustrates that plans produced by the partisan-neutral computer simulation process are always significantly more compact than the Act 43 Assembly plan. While the Act 43 plan has a Reock score of 0.37, the 200 computer simulated plans exhibit Reock scores ranging from 0.43 to 0.46, indicating that 100% of the simulated plans are substantially more compact than the plan enacted by the Wisconsin Legislature.

FIGURE 2



5) ***The Voting Rights Act:*** Act 43 produces one majority-Hispanic district (Assembly District 8) and six majority-African-American districts (Assembly Districts 10, 11, 12, 16, 17, and 18). To comply with the Voting Rights Act, the computer simulated plans preserve each of these seven majority-minority districts exactly as they were drawn in the Act 43 plan. In other words, these seven districts from Act 43 appear in each of my computer-simulated plans exactly as they were drawn by the Wisconsin Legislature with no modifications.

Simulation Results

The following describes the simulation results and inferences about Act 43.

Efficiency Gap: To calculate the efficiency gap of Act 43 and of each simulated plan, I first calculate the partisanship of each simulated district and each Act 43 Assembly district by calculating Republican Mitt Romney's share of the two-party presidential vote in November 2012 within each district. Using Mitt Romney and Barack Obama votes as a simple measure of district partisanship, I then calculate the districting plan's efficiency gap using the method outlined in *Partisan Gerrymandering and the Efficiency Gap*.[2] Districts are classified as Republican victories if Romney votes exceeded Obama votes in November 2012 and as Democratic victories if Obama garnered more votes than Romney. For each party, I then calculate the total sum of surplus votes in districts the party won and lost votes in districts where the party lost. The efficiency gap is then calculated as total wasted Republican votes minus total wasted Democratic votes, divided by the total number of two-party votes cast statewide.

Figure 3 illustrates the efficiency gap of the two-hundred simulated Assembly districting plans produced using the traditional districting criteria described in the previous section, and of Act 43. Each red circle in Figure 3 represents a complete simulated districting plan, with its efficiency gap measured along the horizontal axis. The vertical axis measures the total number of counties preserved intact by the plan, a number that, as noted above, ranges from eighteen to twenty-five counties for each simulation.

[2] Nicholas O. Stephanopoulos & Eric M. McGhee, *Partisan Gerrymandering and the Efficiency Gap*, 82 University of Chicago Law Review 831 (2015).

FIGURE 3

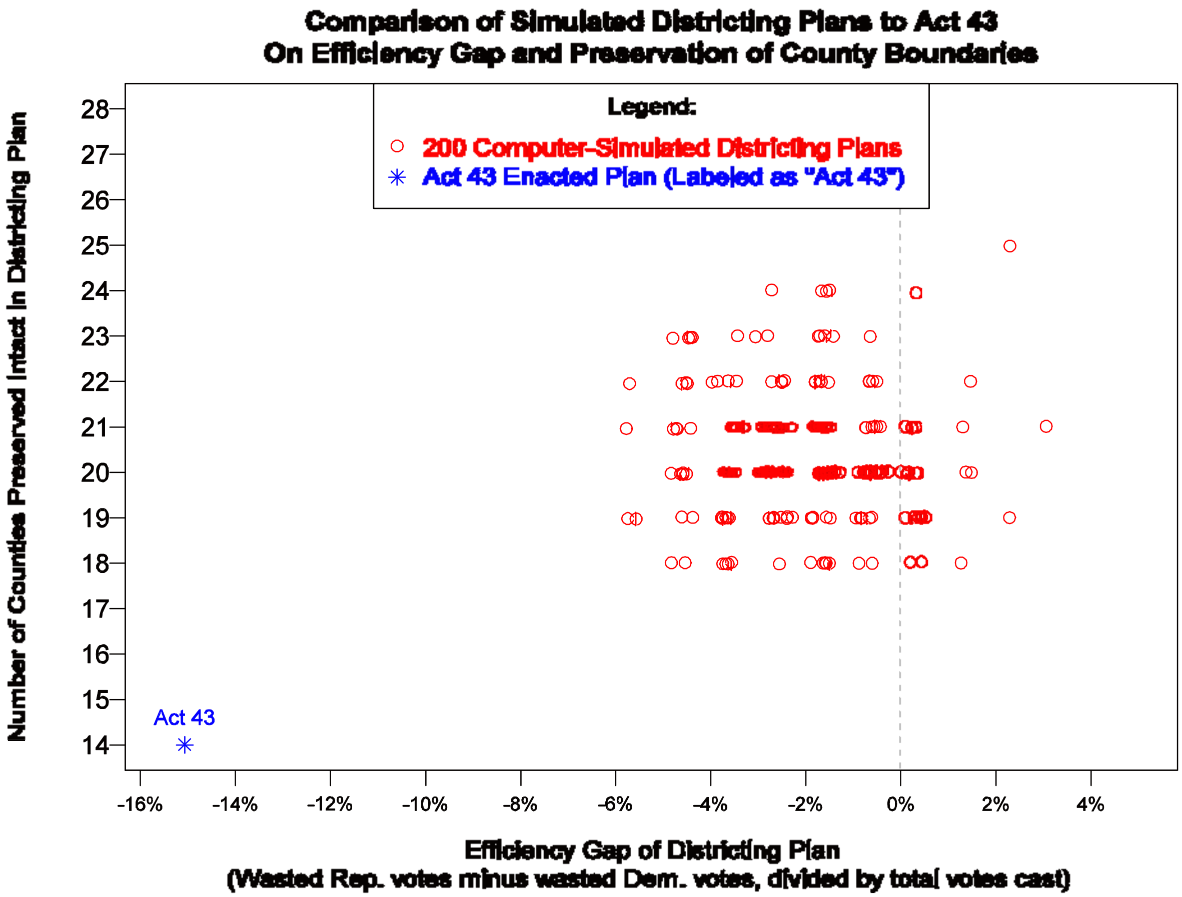


Figure 3 reveals that the simulated districting plans are reasonably neutral with respect to electoral bias. About 72% of the simulated plans exhibit an efficiency gap within 3% of zero, indicating de minimis electoral bias in favor of either party. In fact, 23% of the simulations produce an efficiency gap between -1.0% and +1.0%. These patterns illustrate that a non-partisan districting process following traditional criteria very commonly produces a neutral Assembly plan in Wisconsin with minimal electoral bias.

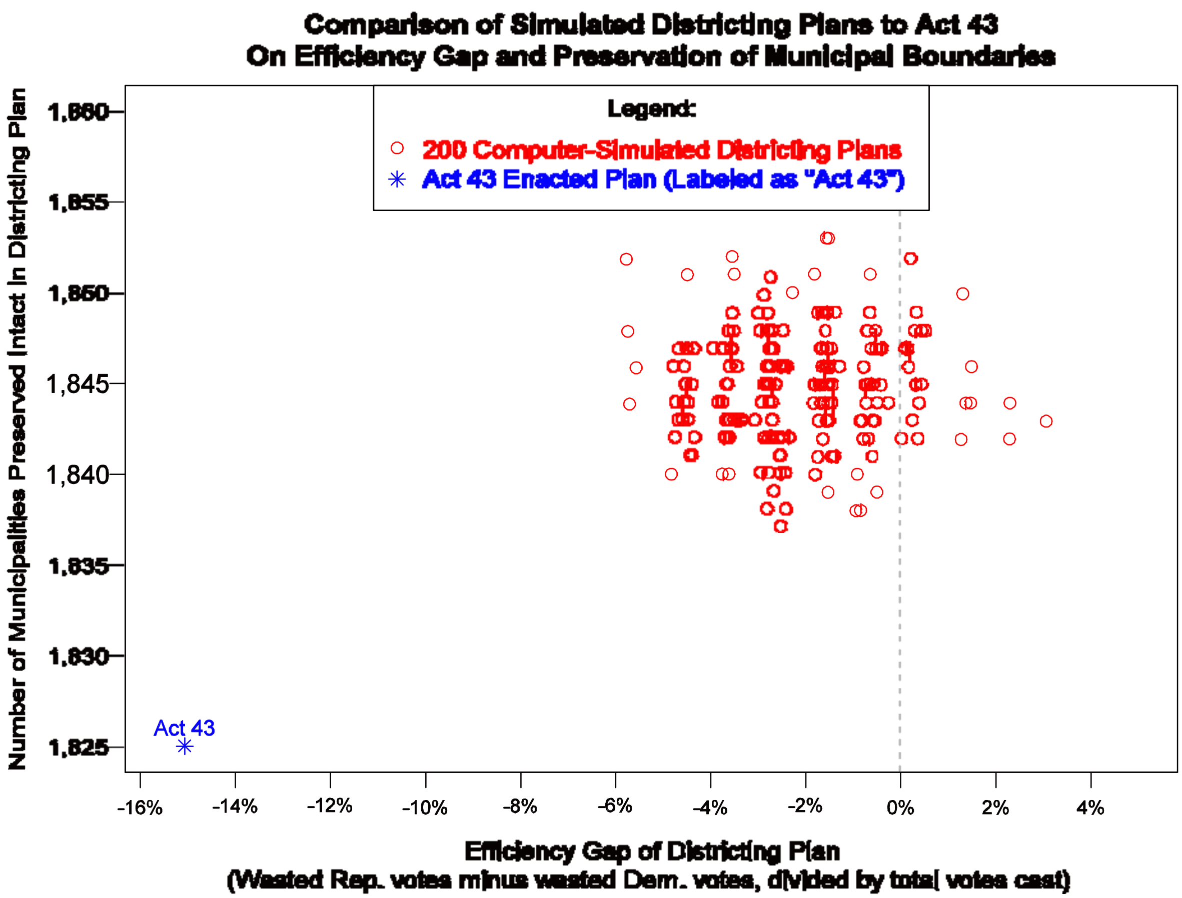
It is important to note that the simulations produce plans with both positive and negative efficiency gaps. Although the efficiency gap of every simulated plan is relatively small in magnitude, 90% of plans exhibit a negative efficiency gap, indicating slightly more wasted Democratic votes than wasted Republican votes. But 10% of the plans exhibit a positive efficiency gap, reflecting more wasted Republican votes. Hence, it is not extraordinary for Wisconsin's political geography, combined with traditional redistricting criteria, to naturally produce a districting plan that somewhat favors Republicans.

The blue star in the lower left corner of Figure 3 represents the Assembly plan enacted by Act 43. This blue star depicts the enacted plan's efficiency gap of -15.1%, reflecting significantly more wasted Democratic votes than wasted Republican votes. Thus, the level of electoral bias in the Act 43 Assembly plan is not only entirely outside of the range produced by the simulated plans, the enacted plan's efficiency gap is well over twice as biased as the most biased of the two-hundred simulated plans. The improbable nature of the Act 43 efficiency gap allows us to conclude with high statistical certainty that neutral, non-partisan districting criteria, combined with Wisconsin's natural political geography, would not have produced a districting plan as electorally skewed as the Act 43 Assembly plan.

Figure 3 additionally illustrates that the Act 43 plan preserves intact far fewer counties than would have been reasonably possible under a neutral process prioritizing traditional districting criteria. The Act 43 plan keeps intact only fourteen of Wisconsin's seventy-two counties. Meanwhile, each of the simulated plans preserves eighteen to twenty-five counties fully intact. Figure 3 suggests a possible connection between Act 43 plan's creation of an extreme efficiency gap and the plan's splitting up of far more counties than what could have been reasonably expected under a partisan-neutral districting process.

Figure 4 illustrates the same patterns regarding the splitting of municipal boundaries. As before, the horizontal axis of Figure 4 measures the efficiency gap of the simulated plans and the Act 43 Assembly plan. The vertical axis in Figure 4 measures the number of municipalities kept intact within each plan. Figure 4 illustrates that Act 43 is a statistical outlier not only in terms of its large, Republican-favoring efficiency gap, but also in its splitting of far more municipalities than any of the simulated plans.

FIGURE 4



As an additional measure of the partisanship of each plan, Figure 5 reports the number of Republican-leaning districts—defined as districts in which Romney voters outnumbered Obama voters in November 2012—in each plan. The horizontal axis in Figure 5 measures the number of

Republican districts (out of the ninety-nine Assembly districts) created by each simulated plan and by the Act 43 Assembly plan. The vertical axis measures the number of counties preserved intact by each plan. As before, red circles denote the two-hundred computer simulated plans, while the blue star represents the Act 43 plan.

FIGURE 5

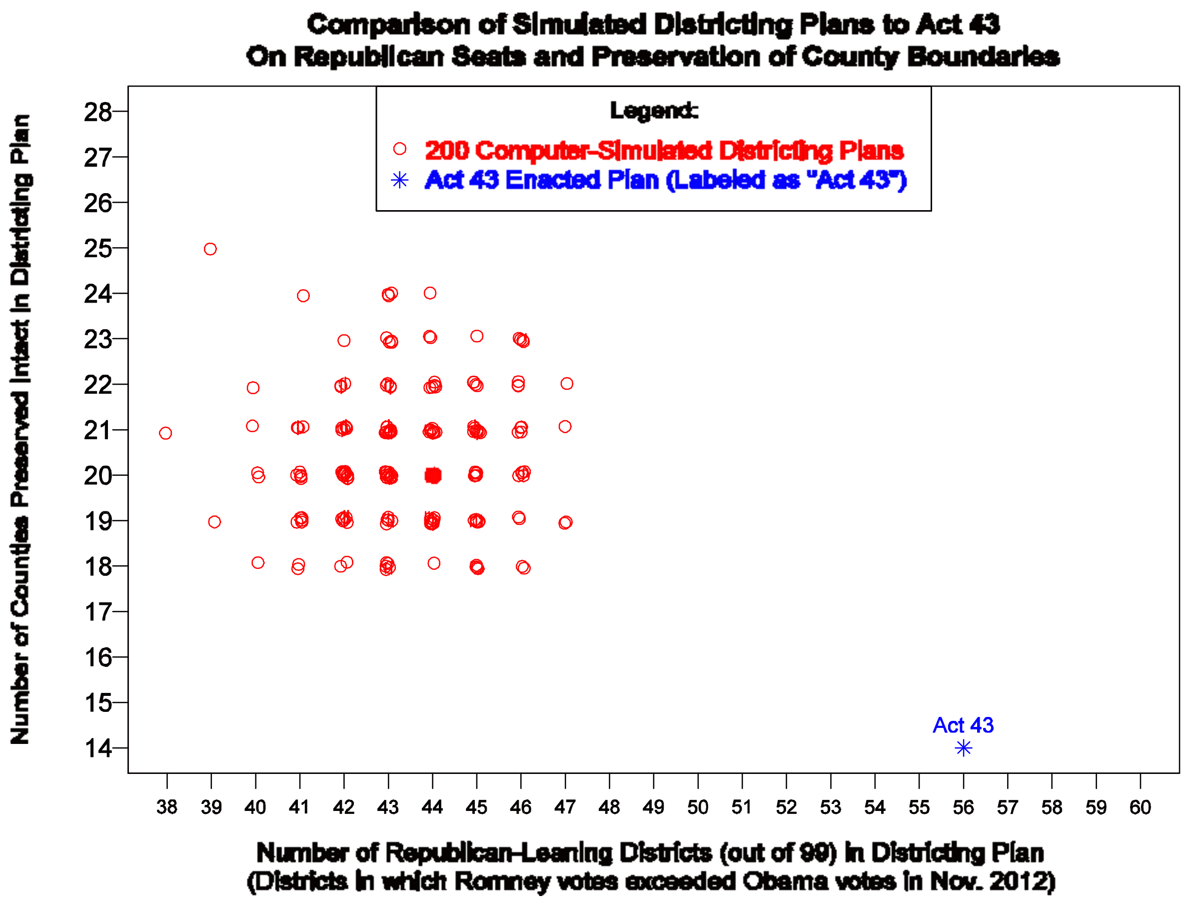


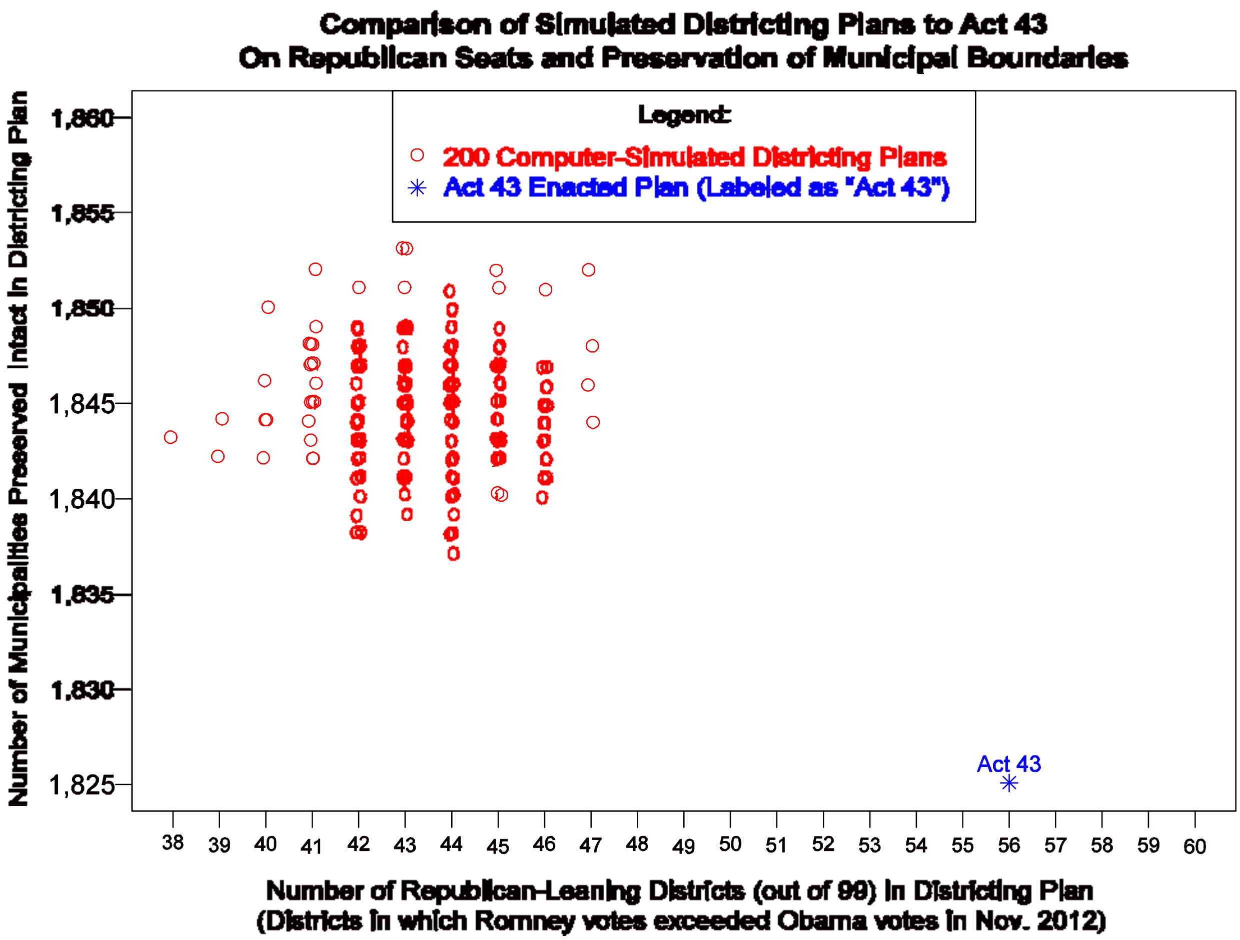
Figure 5 illustrates the contrast between the simulated plans and the Act 43 plan in terms of their partisan division of Assembly seats. In the simulated plans (drawn in a non-partisan manner respecting traditional districting criteria), between thirty-eight and forty-seven districts contain more Republican than Democratic voters. This range translates to a 38.4% to 47.4%

Republican share of the ninety-nine total Assembly districts, a range consistent with and reflective of the Republicans' statewide 46.5% share of the November 2012 presidential vote.

Yet the Act 43 plan creates a total of fifty-six Republican-leaning Assembly districts, as measured by 2012 presidential vote share. This total is far outside of the range of partisan outcomes observed in the simulations, indicating that the Act 43 plan was the product of an intentional effort to craft more Republican-leaning districts than was possible under a partisan-neutral map-drawing process following traditional districting criteria. As before, the fact that Act 43 preserved intact far fewer counties than any of the simulated plans suggests that the Act 43 Assembly plan had to violate the traditional districting principle of respecting county boundaries in order to achieve fifty-six Republican-leaning districts, an extremely improbable outcome.

Figure 6 illustrates the same pattern regarding the splitting of municipal boundaries. As in Figure 5, the horizontal axis of Figure 6 measures the number of Republican districts (out of ninety-nine) created by each simulated plan and by the Act 43 Assembly plan. But the vertical axis in Figure 6 measures the number of municipalities kept intact within each plan. This Figure illustrates that the Act 43 plan's statistically extreme creation of fifty-six Republican districts came at the expense of preserving far fewer municipalities intact than were reasonably possible under the partisan-neutral process followed by the computer simulations.

FIGURE 6

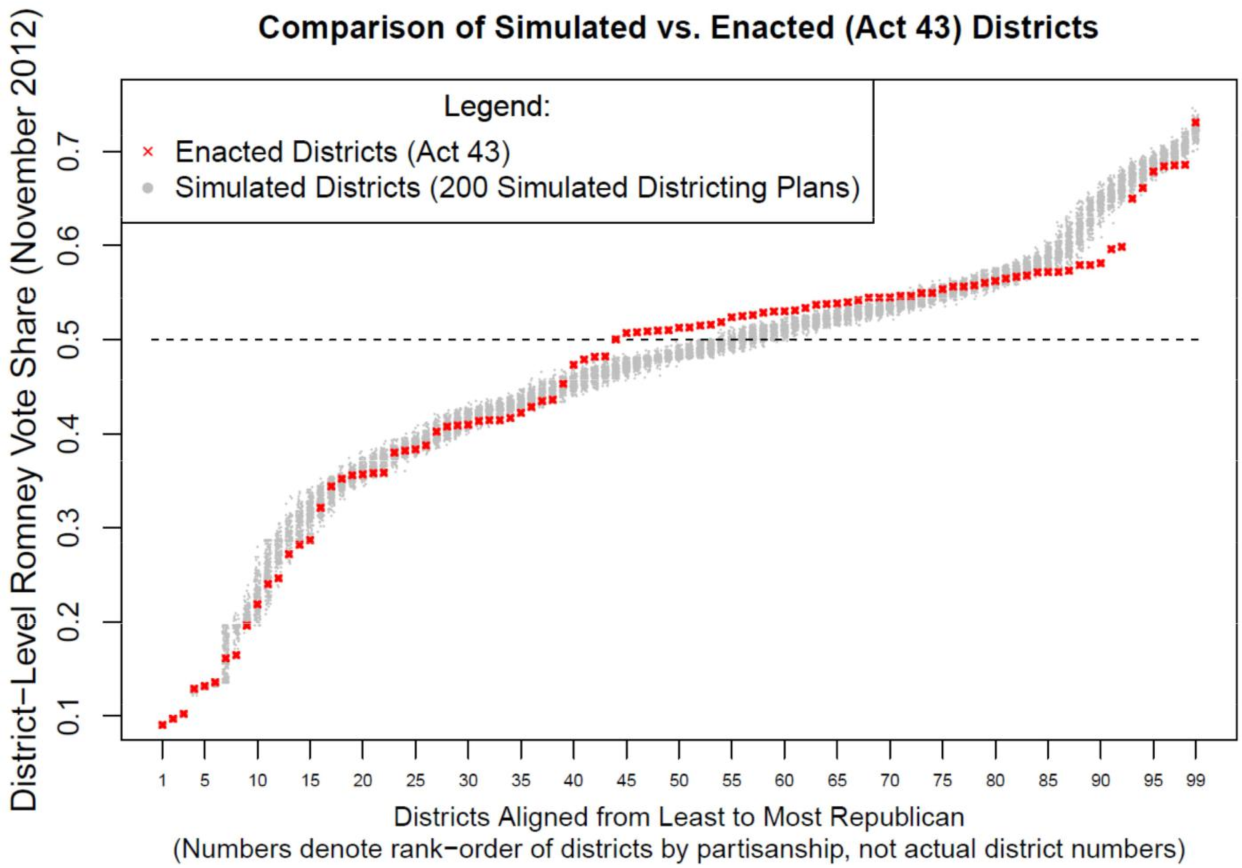


How did Act 43 create such a statistically improbable Assembly plan in terms of its partisan division of seats? Figure 7 provides suggestive evidence. Figure 7 displays the partisanship, measured by the Romney share of the November 2012 vote, of every single district in all simulated districting plans and the enacted Act 43 plan. The vertical axis measures each district's partisanship, with gray dots representing simulated districts and red stars representing the ninety-nine Assembly districts created under Act 43.

Figure 7 contains a total of ninety-nine columns. For each simulated plan and for the Act 43 plan, the ninety-nine districts are aligned from left to right by partisanship. In other words, the left-most red star represents the most Democratic-leaning Act 43 district (Assembly District 16, in which Romney won 9.0% of the presidential vote), while the right-most red star represents the most Republican-leaning Act 43 district (Assembly District 99, in which Romney won 73.1% of the presidential vote). The gray dots representing districts for each simulated plan are similarly aligned by partisanship across the ninety-nine columns in Figure 7.

Overall, Figure 7 allows comparison of the enacted and the simulated districting plans with respect to their distribution of partisanship across districts. Most strikingly, Figure 7 illustrates how Act 43 created its unusually large sum of fifty-six Republican-leaning districts. As illustrated in the middle portion of Figure 7, Act 43 created eleven Republican-leaning districts that would instead have been Democratic-leaning districts when drawn by the partisan-neutral simulation process. This creation is evidenced by the noticeable divergence of the red stars away from the entire range of gray circles in the middle portion of Figure 7. In order to convert these Democratic-leaning districts into Republican-leaning districts, the Act 43 plan appears to have pulled Republican voters away from what would otherwise have been more heavily Republican districts, as illustrated in the far right portion of Figure 7. In the right-most fifteen columns in Figure 7, the red stars often fall under the entire range of gray circles, showing that Act 43 unpacked some Republican voters from these safe Republican districts and placed more Republican votes into what would otherwise have been slightly Democratic districts, tipping them into Republican-leaning districts.

FIGURE 7



Conclusion

Using computer simulations to generate a large baseline sample of legally valid districting plans under a partisan-neutral map-drawing process following traditional districting criteria, we find that drawing a minimally biased Assembly map is reasonably possible. The results show that the non-partisan simulation process successfully produces valid districting plans with a neutral efficiency gap with striking frequency.

Furthermore, we are able to discover not merely the ways in which the enacted Act 43 plan deviates from traditional districting criteria, but also the partisan consequences of such deviations. Act 43 not only created an extremely biased Assembly plan with an efficiency gap far outside of any gap observed in 200 simulations, the enacted plan achieved this partisan outcome at the expense of traditional districting principles, splitting apart far more counties and municipalities than were necessary.