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Cutting Through the Thicket: Redistricting Simulations and the Detection of Partisan Gerrymanders

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ABSTRACT

Social scientists have made progress in providing the courts with useful measures of partisan asymmetry in the transformation of votes to seats, but have thus far left a larger question unanswered: how can partisan gerrymandering be distinguished from a state legislature's acceptable efforts to apply traditional districting criteria, keep communities of interest together, and facilitate the representation of minorities? This article demonstrates how a straightforward redistricting algorithm can be used to generate a benchmark against which to contrast a plan that has been called into constitutional question, thus laying bare any partisan advantage that cannot be attributed to legitimate legislative objectives. We use the controversial 2012 Florida Congressional map to show how our approach can be used to demonstrate an unconstitutional gerrymander.

INTRODUCTION

Most of the justices of the United States Supreme Court have joined in opinions expressing some level of discomfort with the practice of partisan gerrymandering, and several have been very clear about their willingness to strike down partisan gerrymanders in Pennsylvania, Texas, and Georgia.[1] However, constitutional challenges to partisan gerrymandering have failed repeatedly in recent years because pivotal justices have been unsatisfied with the standards for the identification of unconstitutional partisan gerrymanders laid out in *Davis v. Bandemer*,[2] as well as the alternatives laid out by the plaintiffs in *Vieth et al. v. Jubelirer*,[3] and more recently in *LULAC et al. v. Perry*.[4]

For Justice Kennedy in his *Vieth* concurrence, there are two problems. First is the lack of a "substantive definition of fairness in districting … Second is the absence of rules to limit and confine judicial intervention" (306–307). Writing for the *Vieth* plurality, Justice Scalia argues that these problems are fatal, and no workable definition or standard for fairness can be achieved. The "thicket" described by Justice Frankfurter[5] is simply too thick for the courts (Schuck 1987). With the *LULAC* decision, however, a majority of justices including Stevens, Breyer, Kennedy, Souter, and Ginsburg have expressed far greater optimism that progress can still be made, and they have invited further efforts.

In order to cut through the thicket, judges and lawyers must use the tools that have been sharpened in recent years by social scientists. First of all, Gary King and collaborators (King and Browning 1987; Gelman and King 1994; King et al. 2006; Grofman

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[1] *Vieth et al. v. Jubelirer*, 541 U.S. 267 (2004); *LULAC et al. v. Perry*, 548 U.S. 399 (2006); *Cox v. Larios et al.* 542 U.S. 947 (2004).
[2] 478 U.S. 109 (1986).
[3] 541 U.S. 267 (2004).
[4] 548 U.S. 399 (2006).
[5] *Colgrove v. Green*, 328 U.S. 549, 556 (1946).

and King 2007) have developed an approach to the measurement of partisan bias in the American two-party system, and a majority of justices has expressed some level of optimism about the potential of this or some related analysis to quantify harm to the representational rights associated with a redistricting plan (Grofman and King 2007; Stephanopoulos and McGhee 2015).

However, as Justice Kennedy and several of his colleagues have pointed out, "asymmetry alone is not a reliable measure of unconstitutional partisanship."[6] When attempting to assess whether a redistricting plan burdens the constitutional rights of a political party or its voters via either the First or Fourteenth Amendment, it is important to know whether the plan would produce substantially different seat shares for the two parties with an identical vote share. Yet such partisan asymmetry in the transformation of votes to seats could happen for several reasons that cannot be traced to partisan manipulation, including the application of traditional redistricting criteria, the protection of communities of interest through preservation of county and municipal boundaries, or the protections of minority voting rights associated with the Voting Rights Act (VRA).[7]

Perhaps the most basic problem with exclusive reliance on the symmetry standard was raised by Justice Scalia in the plurality opinion of *Vieth*, and has also been noted in classic studies of the United States and other former British colonies using single-member districts: Quite substantial asymmetries in the transformation of votes to seats can emerge even in the presence of non-partisan commissions purely because of the geography of the parties' supporters. Moreover, asymmetries in the transformation of votes to seats will often emerge as by-products of attempts to carve out districts in which minority groups can elect candidates of choice, and from efforts to avoid breaking up politically homogeneous neighborhoods.

These are perhaps the thorniest remaining sections of the thicket that must be cleared in order to challenge a partisan gerrymander in federal courts. This article develops a technique for cutting through them. We respond to Justice Kennedy's concerns, and most of those expressed by the *Vieth* plurality, by implementing a technique called for by Judge Easterbrook of the Seventh Circuit Court of Appeals in *Gonzalez et al. v. City of Aurora, IL.*[8] We use a transparent, straightforward, and replicable computer algorithm to simulate a large number of valid districting plans without regard for partisanship, applying only the traditional redistricting criteria that have been emphasized in virtually all recent court decisions including *LULAC*: compactness, contiguity, and population equality. The goal of this exercise is to have an objective baseline against which to contrast a redistricting plan that has been called into constitutional question.

We present simple procedures that enable us to make sure that this baseline is identical or superior to the plan in question on all relevant parameters such as population equality, contiguity, compactness, respect for county and municipal boundaries, and respect for the requirements of the Voting Rights Act.

We contrast the anticipated seat shares for the major parties in each of the simulated plans and in the plan promulgated by a state. If the partisanship of a proposed plan lies in the extreme tail of the distribution of simulated plans or outside the distribution altogether, courts can make relatively strong inferences about the plan's partisan effect and intent. That is, they can heavily discount the possibility that an asymmetry in the transformation of votes to seats can be explained away by natural geography, or by the state's "compelling interest" in protecting minorities or keeping cohesive political jurisdictions together.

Our approach makes the crucial distinction between intentional and unintentional asymmetries in the transformation of votes to seats, and lays bare any unconstitutional efforts of partisan mapmakers to undermine the fair representation of their adversary. Thus it circumvents thorny questions about "sole" or "predominant" intent that have stood in the way of recent constitutional challenges including *LULAC*.

For those who believe fairness requires symmetry or even proportionality, our proposed standard will seem to give state legislatures too much deference. Indeed, we take an avowedly realistic approach that responds not to notions of fairness that are uncontroversial in the classroom, but to the constitutional arguments that have prevented past standards from achieving success in the courtroom.

[6] *LULAC*, 548 U.S. at 420 (opinion of Kennedy J.).
[7] See *Vieth*, 541 U.S. at 281 (opinion of Scalia, J.).
[8] 535 F.3d 594 (7th Cir. 2008).

Indeed, our approach could potentially allow a relatively unfair plan to pass constitutional muster if one party had an especially inefficient geographic support distribution.

However, we demonstrate that our standard has teeth. We work through a detailed analysis of the notorious congressional districting plan in Florida that was recently found to be in violation of the state's constitution on grounds of partisan gerrymandering after it was revealed that partisan operatives influenced the plan in violation of Florida's "fair districts" amendments.[9] In this article, we show that the enacted plan produced more Republican seats than could have been anticipated if the Florida Legislature was attempting to govern impartially. The outcome cannot be explained by the residential geography of voters, the requirements of the Voting Rights Act, or by the legislature's desire to draw compact districts or respect county or municipal boundaries.

WHY SIMULATE DISTRICTS?

The most common paths of attack in gerrymandering cases are the First Amendment and the Equal Protection Clause of the Fourteenth Amendment. According to Justice Stephens, "the concept of equal justice under law requires the State to govern impartially."[10] The challenge is to demonstrate that a legislature has abrogated this responsibility to such an extent that they have had a "discriminatory impact on the opportunities for voters and candidates of a particular party to influence the political process,"[11] or have burdened or penalized citizens because of "their association with a political party, or their expression of political views."[12]

For many social scientists with expertise in the study of plurality electoral systems, this notion of equal protection before the law invites analysis of partisan symmetry in the transformation of votes to seats. Social scientists are largely in agreement that it is possible to characterize the extent to which a redistricting plan treats both parties in a two-party system in a symmetric fashion. That is, we can assess whether a districting plan is "fair" in the sense that the parties would receive similar seat shares with similar vote shares.

Grofman and King (2007) summarize the evolution of this approach. Their quantitative approach to equal protection was raised during *LULAC* in the form of an amicus brief by written by Gary King and several co-authors (2006), and it received a surprisingly warm reception: it was discussed in three of the opinions, including that of the plurality, and a majority of justices have signed opinions indicating that a measure of partisan symmetry may be useful in examining future gerrymandering claims (Grofman and King 2007; Stephanopoulos and McGhee 2015).[13]

While it is encouraging to gerrymandering foes that justices are willing to use the tools of social science to help evaluate whether redistricting plans comport with the First and Fourteenth Amendments, it is quite clear that they view partisan asymmetry as a necessary but insufficient condition for constitutional challenge. While providing a useful red flag indicating that a redistricting plan can be expected to produce a discriminatory effect, partisan asymmetry is clearly not enough, even if combined with a good deal of circumstantial evidence about the intentions of the map-drawers. While recognizing that the mid-decade redistricting in Texas was a raw power play by the legislature, Kennedy, when writing for the *LULAC* plurality, is sympathetic to the possibility that "partisan aims did not guide every line it drew."[14] He chides the appellants for relying solely on the mid-decade nature of the redistricting to establish intent: "we are skeptical of a claim that seeks to invalidate a statute based on a legislature's unlawful motive but does so without reference to the content of the legislation enacted."[15]

The *LULAC* plurality is thus implying that a successful challenge requires a more difficult type of analysis than has yet been presented in a redistricting case. It requires a technique to sort out the difference

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[9] *Romo v. Detzner and Bondi*, Case No. 2012-CA-490 (Fla. Cir. Ct. 2014).
[10] See *Vieth*, 541 U.S. at 321 (opinion of Stevens, J.).
[11] *LULAC*, 548 U.S. at 466 (opinion of Stevens, J.).
[12] *Vieth*, 541 U.S. at 9 (opinion of Kennedy, J.).
[13] While he clearly views symmetry as an important matter in assessing the "fairness" of a plan, Justice Kennedy indicates skepticism about the use of the uniform swing or related methods for generating hypothetical elections in which the parties receive different vote shares. Throughout his *LULAC* opinion, he expresses greater comfort with the use of observed votes and seats to assess partisan symmetry, indicating that he would be more easily satisfied with some version of the simpler analysis conducted by Best et al. (2015) or Stephanopoulos and McGhee (2015).
[14] *LULAC*, 548 U.S. at 418 (opinion of Kennedy, J.).
[15] *Id.*

between partisan asymmetries that emerge from some "compelling"[16] or "legitimate"[17] interest from those that emerge from an invidious effort to discriminate against a political group.

The justices largely agree upon the "legitimate" interests: the application of traditional redistricting criteria including compactness, contiguity, and population equality, the preservation of political communities, and the protection of voting rights of racial and ethnic minorities. In fact, in all of the cases since *Bandemer*, most of the ink spilled by the liberal justices goes to point out gross deviations from traditional redistricting principles or unnecessary splits of municipalities. For instance, Stevens argues that "when any pretense of neutrality is forsaken unabashedly and all traditional districting criteria are subverted for partisan advantage—the governing body cannot be said to have acted impartially."[18] Likewise, Justice Souter proposes a test in his *Vieth* dissent that focuses on deviations from traditional redistricting principles that he takes as indicators of naked partisan intent.

While the liberal justices have been swayed by evidence of a "totality-of-the-circumstances" variety, Kennedy is not satisfied. Neither, of course, is Justice Scalia, who expresses confidence that there is no way to distinguish between acceptable and unacceptable partisan asymmetries.

The problem that troubles both Kennedy and Scalia is not trivial. As with Labour voters in the UK, Australia, and New Zealand throughout most of the twentieth century (Gudgin and Taylor 1979; Rydon 1957; Johnston 1992), the Democrats are highly clustered in dense city centers and along waterways, coastlines, and nineteenth century railroad corridors (Rodden 2010, 2015a). Moreover, unlike many other countries, the correlation between population density and voting behavior has been growing with each election in the United States (Rodden 2015b). As a result, the application of neutral redistricting principles focusing on compactness and contiguity in recent elections can produce relatively large bias in some states without any partisan manipulation (Chen and Rodden 2013). This problem has long been understood in other former British colonies, where significant electoral bias has been commonplace in spite of highly respected, neutral boundary commissions (Johnston, Rossiter, and Pattie 1999).

Citing Dixon (1968) and Schuck (1987), Justice Scalia describes this problem in some detail in writing for the *Vieth* plurality.[19] If expert witnesses are able to convince the justices that the partisan asymmetry associated with a redistricting plan surpasses some agreed threshold, e.g., one of those described by Grofman and King (2007) or Stephanopoulos and McGhee (2015), the courts have no way of knowing whether the explanation lies with partisan gerrymandering or geographic advantage.

From Justice Powell's suggested approach in *Bandemer*[20] to Justice Souter's in his *Vieth* dissent,[21] the most common approach is to search for telltale signs of partisan manipulation such as highly non-compact districts or noteworthy violations of municipal boundaries. But as Scalia points out, substantial bias can emerge even with compact, visually appealing districts.[22] Moreover, in the states with the most extremely concentrated urban Democrats, the only hope for partisan symmetry might lie in breaking up overwhelmingly Democratic cities and drawing non-compact radial districts that cross municipal lines and extend into the suburbs, and the only way to overcome the inefficient Democratic support distribution outside of cities is to draw districts that meander along nineteenth century canals and rail corridors.

Moreover, a state legislature might cite several legitimate objectives when defending highly non-compact districts. First, legislators might claim to be interested in keeping various county and city boundaries together. Second, in its efforts to comply with Section 2 of the Voting Rights Act or otherwise advance the ability of minority groups to elect candidates of choice, a legislature may attempt to defend districts that are non-compact or that cross jurisdictional boundaries.

Justice Scalia is convinced that courts are not in a position to cut through this thicket. However, in

[16] In *Vieth*, Justice Kennedy cites *Elrod v. Burns*, 427 U.S. 347 (1976), arguing that the First Amendment protects voters from being burdened or penalized because of their vote history or partisan affiliation "absent a compelling government interest." *Vieth*, 541 U.S. at 317 (opinion of Kennedy, J.).

[17] Justice Stevens cites *Cleburne v. Cleburne Living Center, Inc.*, 473 U.S. 432, 447 (1985), arguing that "The equal protection component of the Fourteenth Amendment requires actions taken by the sovereign to be supported by some legitimate interest, and further establishes that a bare desire to harm a politically disfavored group is not a legitimate interest." *LULAC*, 548 U.S. at 466 (opinion of Stevens, J.).

[18] *Vieth*, 541 U.S. at 322 (opinion of Stevens, J.).

[19] *Vieth*, 541 U.S. at 291 (opinion of Scalia, J.).

[20] *Bandemer*, 478 U.S. at 161, 164–165 (opinion of Powell, L.).

[21] *Vieth*, 541 U.S. (opinion of Souter, J.).

[22] *Vieth*, 541 U.S. at 291 (opinion of Scalia, J.).

writing for the *LULAC* plurality, Kennedy merely points out that appellants have not yet made efforts to do so, and he maintains his position that future appellants might achieve success. It is also clear that he is looking for something beyond circumstantial evidence of intent or the presence of suspicious-looking districts. He is calling for analysis that facilitates the application of a uniform standard that can be applied in a variety of settings.

The rest of this article provides such a standard by building on the premise that in order to measure partisan asymmetries caused by deviations from acceptable districting principles, we must first observe what would happen in a plan drawn according to those principles. Better yet, we might like to look at hundreds or even thousands of such plans. As Judge Easterbrook has written in *Gonzalez et al. v. City of Aurora, IL*,[23] computer simulations provide an attractive way to establish such a baseline. "… computers can use census data to generate many variations on compact districts with equal population. One could do this exercise a hundred or a thousand times, each time placing the center of the first (or 'seed') district in a different location. That would generate a hundred or a thousand different maps … " (599).

Judge Easterbrook was referring to a Voting Rights Act case in which it was necessary to examine whether a given map was drawn "in order to advantage one ethnic group over another" (599), but the same logic applies to partisanship. By producing a large number of compact districting plans within acceptable equal-population parameters, we have a robust baseline against which to contrast the partisanship of a plan that has been called into question. Any natural geographic advantage for one party or another will be expressed in the partisanship of the simulated plans. Furthermore, we can make sure that the simulated plans protect the same communities of interest and the voting rights of the same minorities in exactly the same way as the legislature's plan. The difference between the partisanship of the simulated plans and that of the legislature's plan quantifies the partisan advantage that cannot be explained away as stemming from some "legitimate interest" of the legislature.

THE BASIC DISTRICTING ALGORITHM

Judge Easterbrook was certainly not the first to suggest the use of redistricting simulations to produce a set of baseline redistricting plans that are blind as to partisanship and race. For earlier efforts, see Vickrey (1961), Weaver and Hess (1963), Nagel (1965), Engstrom and Wildgen (1977), Altman (1998), Cirincione et al. (2003), Altman and McDonald (2004), and Johnston and Hughes (2008).

We improve upon these previous efforts at redistricting simulations in several ways. First, our approach is quite responsive to the federal courts' concern with the geographic compactness of individual districts. More importantly, our approach allows courts to account for all legal criteria and requirements in redistricting, such as the Voting Rights Act and the preservation of geographic communities of interest.

We demonstrate our approach by drawing a large number of simulated congressional districting plans for Florida's 27 districts. We must recognize that first, the legislature was required to comply with the Voting Rights Act, and second, the legislature may have had a compelling interest in keeping certain communities together by placing entire political jurisdictions in the same district.

When challenging the constitutionality of a districting plan using redistricting simulations, a plaintiff has two broad options for addressing such claims. The first strategy is to simulate a large number of plans, and simply discard those that fall short of some criteria that capture the crux of the state's legitimate objective. For instance, if a state claims that it interprets Section 2 of the Voting Rights Act as requiring two majority-African American districts, one might discard all simulated plans that fail to create two such districts, and use the remaining plans as the benchmark. Likewise, one can develop summary statistics capturing the extent to which each plan splits counties and municipalities, discarding the plans that produce more splits than the legislature's plan.

However, this approach will often not be practical. The state will often be defending a plan on the logic that it desired or was compelled to hold together a group, e.g., Cuban Americans or African Americans, in a very specific way that would not emerge from simulations based on traditional districting criteria. A classic example is Florida's

[23] 535 F.3d 594 (7th Cir. 2008).

FIG. 1. Florida Legislature's plan with 46 counties held intact (shaded in *gray* in panel 1), 384 cities held intact (shaded in *black* in panel 2), and protected Voting Rights Act (VRA) districts (shaded in *gray* in panel 3).

serpentine District 5, which the Florida Legislature explicitly deems to have been required by the Voting Rights Act. A majority-African American district in Northern Florida would not emerge from even a very large number of simulations, even using alternative simulation procedures that do not require compact districts.

Beyond interpretations of VRA requirements, there are a variety of additional instances in which a state might claim that beyond an overall goal of minimizing jurisdictional splits, they responded to requests or otherwise saw compelling reasons to keep *specific* counties or municipalities whole in order to protect communities of interest.

In such instances, our analytical solution is to grant deference to the state government and simply hold clusters of precincts—or even entire districts—fixed in order to accommodate the state's claims. With respect to Florida and the Voting Rights Act, the most deferential approach is to simply hold Districts 5, 20, and 24 fixed and conduct simulations for the rest of the state. That is, we give the Florida Legislature the benefit of the doubt that all three of these extremely Democratic districts are in compliance with the Voting Rights Act and the Florida Constitution and could not have been drawn with smaller Democratic majorities.

We can also apply the same deference to the preservation of county and municipal boundaries. The legislature's plan kept 46 of Florida's counties intact and split the remaining 21 counties among multiple congressional districts. We have also analyzed Florida's city boundaries, as captured by the Census Bureau's 2010 boundary file of consolidated cities, and discovered that the legislature's plan preserved the boundaries of 384 cities, out of a total of 411 incorporated cities. Unincorporated Census-designated places are not included in these calculations. Figure 1 depicts these counties and cities in the first two panels, and the protected VRA districts in the third panel.

We simply modify our algorithm to require that every simulated districting plan must preserve these same 46 counties and 384 cities. We turn them into inviolable building blocks, such that each preserved county or city is forced to lie entirely within the same simulated district.[24] In this way, we give the benefit of doubt to the legislature and assume that there are compelling reasons to hold these specific municipalities and counties together.

Leaving aside the three African American Voting Rights Act districts depicted in Figure 1, let us then simulate the remaining 24 districts as follows. We begin with 7,349 building blocks (precincts and clusters of precincts) and wish to create 24 districts with equal population.

1) To begin the simulation procedure, each of the 7,349 building blocks represents a single district. Hence, there are 7,349 districts, each containing only one building block at the outset.
2) Randomly select one of these districts and denote it as district i.
3) Among the neighboring districts that border district i, select the one whose centroid is

[24]When a single city contains multiple disjoint fragments, we treat each fragment as a separate city, requiring that each contiguous polygon comprising the city be kept intact.

geographically closest to the centroid of i, and denote it as district j.

4) Merge district i together with district j in order to form a single new district. There are now 7,348 total districts remaining.

Steps 2 through 4 are repeated over and over again until there are 24 districts. At this point in the procedure, these districts are geographically contiguous and highly compact, due to the nearest distance criterion employed in step 3. However, the districts are not guaranteed to be equally populated. Hence, repeated iterations of steps 5 through 8 are designed to achieve an equitable distribution of population across the simulated districts. These steps iteratively reassign precincts to different districts until equally populated districts are achieved.

5) Among all pairs of districts that border one another, identify the pair with the greatest disparity in district population. Within this pair, let us denote the more populated district as m and the less populated district as l.
6) Identify the set of all precincts currently within district m that could be reassigned to district l without violating the geographic contiguity of either district.
7) For each precinct p satisfying the criterion in step 6, define D_p as precinct p's geographic distance to the centroid of district m minus its distance to the centroid of district l.
8) Among the set of precincts that satisfy the criteria in Step 6, select the precinct with the highest value of D_p and reassign it from district m to district l.

Steps 5 through 8 are repeated until each of the 24 districts has a population within 1% of the ideal district population. Florida's population according to the 2010 census was 18,802,690, so the ideal district population is 696,396.

In order to get a feel for the districting plans produced by this procedure, see the sample maps in Figure 2. We have repeated this procedure 1,000 times, and produced a sample of 1,000 complete, valid districting plans.

Next, we want to make sure that our simulations do at least as good a job of producing compact districts as the Florida Legislature. We measure the compactness of districts using the Convex Hull Reock measure, which has found favor in a number of court cases requiring a quantification of compactness. It is defined as the area of a district divided by the area of the convex hull of the district. Geometrically, the district's convex hull is defined as the smallest convex polygon that fully contains the district. Hence, larger values of the Convex Hull Reock measure indicate that a district is more compact.

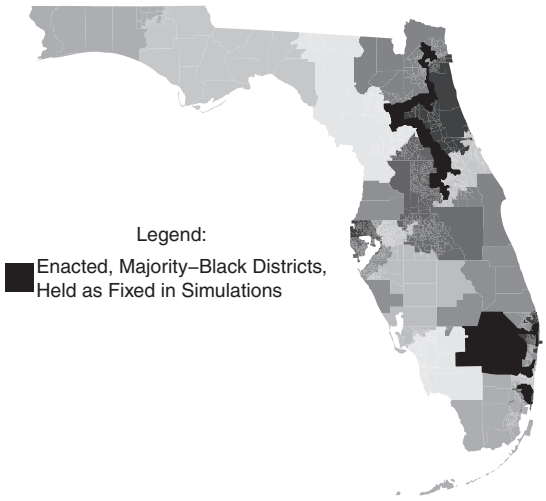

FIG. 2. Example of a simulated districting plan. Example of simulated congressional plan with three VRA-protected districts held fixed (FL-5, FL-20, and FL-24).

In Figure 3, the horizontal axis indicates the compactness of the Florida Legislature's enacted plan and our simulated districting plans. We first calculated the mean Convex Hull Reock scores across all 27 districts in the legislature's enacted plan. We found that the legislature's plan exhibits a mean Convex Hull Reock score of .6608, as denoted by the red star in Figure 3. The gray dots in this figure depict the mean compactness scores of the districts in the simulated plans, including the three majority-African American districts. Our districting algorithm produced a total of 1,000 different simulated congressional plans, with Convex Hull Reock scores ranging from .6682 to .6987. Hence, all 1,000 of our simulated plans produced districts that were, on average, substantially more compact than the legislature's plan.[25] Not every simulated district in our plans is more compact than every single district in the

[25]If our simulation procedure had produced a plan with a mean Convex Hull Reock score lower than that of the legislature's plan, we would have simply instructed the computer to drop it and start again.

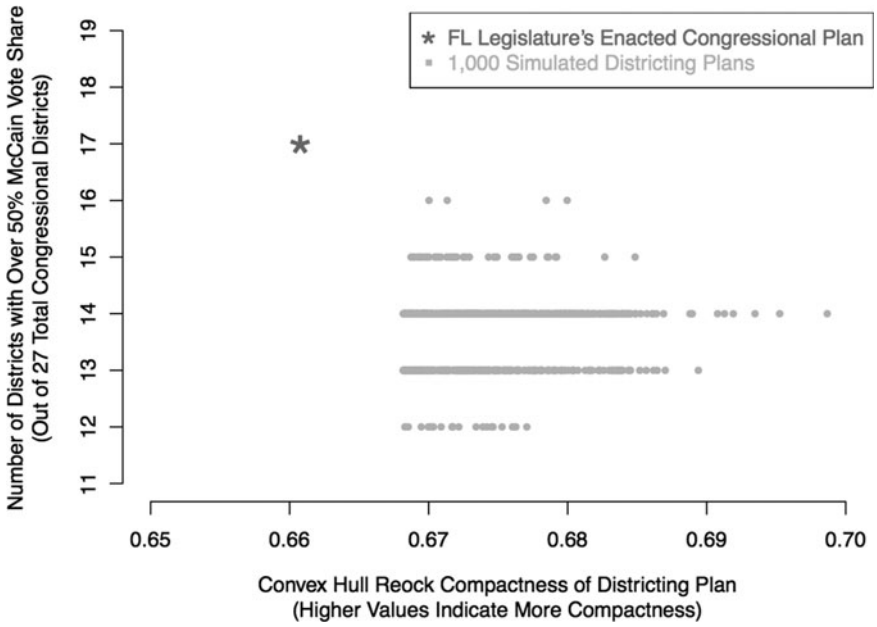

FIG. 3. Comparison of simulated districting plans to the Florida Legislature's enacted congressional plan.

legislature's enacted plan. However, the mean compactness across all 27 districts in each simulated plan is superior to the mean compactness of the legislature's enacted districts.

RESULTS

Using our districting simulation technique, expert witnesses for an appellant can draw hundreds or even thousands of simulated districting plans. The next step is to measure the partisanship of these plans and contrast them with that of the plan in question. The best approach to measuring partisanship depends upon the election results that are available at the level of geo-coded precincts. It is important to use recent data, especially in states like Florida or Arizona where rapid population change and changing political geography mean that election data can quickly become obsolete. In some states, precinct-level data are available for a wide variety of statewide offices. In other states, it may be that precinct-level data are only available for the presidential election.

It can be difficult for non-specialists to understand the lingo of social science research, and seemingly complex models might be viewed by judges with suspicion. Thus it may be advantageous for an appellant to pursue a relatively simple approach to partisanship. The simplest approach is to aggregate precinct-level presidential votes to the level of districts in each simulated plan, as well as in the plan in question. For each of our simulated plans, we analyze 2008 presidential vote totals at the precinct level, and we calculate the number of districts in which McCain voters outnumbered Obama voters.

Figure 4 presents the distribution of this quantity across all 1,000 plans in the form of a histogram. A sizable majority (approximately 64%) of the simulated plans would create 14 Republican seats. Only 4% of the simulated plans created 15 Republican seats, and 16 Republican seats emerged in less than one half of one percent of the simulations. The legislature's plan produced 17 such seats: a result that never occurred in the simulations.

Our approach is, if anything, overly deferential to the legislature in that it holds huge swaths of its districting plan intact in the simulated districts. Nevertheless, Figure 4 shows that the pro-Republican bias of the legislature's plan is still an extreme outlier relative to the simulated plans. Furthermore, Figure 3 depicts the relationship between the compactness of each districting plan on the horizontal axis and the plan's number of Republican seats along the vertical axis. As Figure 3 illustrates, the legislature's plan is significantly more pro-Republican than both the most compact and least compact of our simulated plans.

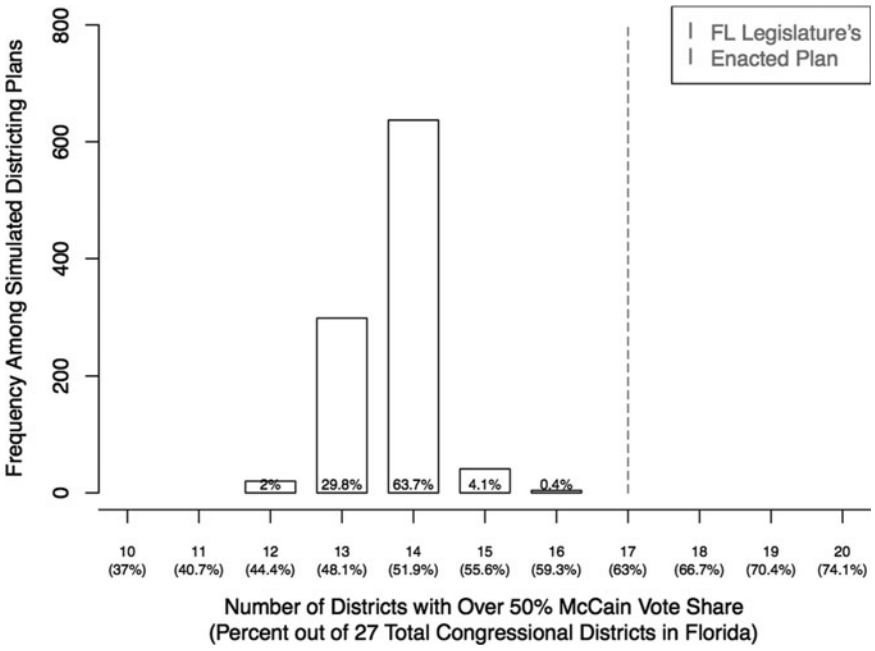

FIG. 4. Results of 1,000 simulated districting plans with 46 counties and 384 cities kept intact and Districts 5, 20, and 24 held fixed.

Our analysis also makes it possible to get a clearer sense of how this extreme partisan advantage was created. In general, partisan advantage is achieved by stuffing one's opponents into excessively homogeneous districts that they win with very large majorities, and spreading one's supporters as efficiently as possible over the remaining districts so as to win them with smaller but tolerably comfortable majorities. This is typically referred to as "packing" and "cracking." Florida's residential geography produces this effect to some extent even without intentional gerrymandering. Our simulations, however, allow us to examine whether the plan submitted by the legislature has gone further than what would be expected from a non-partisan plan.

To do so, we can take each simulated plan and arrange the districts from the most Democratic to the most Republican. We can then do the same for the legislature's plan, and ask whether it produces Democratic districts that are more "packed" with Democrats than the baseline obtained from the simulations. Moreover, we can ask whether Republican votes are more evenly distributed across the remaining districts so as to produce more victories in the pivotal districts than would be expected based on our sample of non-partisan plans.

Figure 5 presents this analysis. The districts are arrayed from left to right from the most Democratic district to the most Republican district. The red X markers indicate the McCain vote share of each district in the legislature's plan, and the corresponding district number is indicated on the horizontal axis below. We also rank each district within each of our 1,000 plans from the most Democratic to the most Republican, representing each district generated by each simulation with a small grey dot, ordering each district within each simulation from the most Democratic to the most Republican.

Recall that the three most Democratic districts on the far left are the heavily African American districts that we left untouched, so there are no simulation results corresponding to the first three red X markers. These are, of course, overwhelmingly Democratic districts. As we move to the right, the red X markers and the clusters of grey dots become separated, and we see striking evidence of an extremely effective effort to create Republican partisan advantage. In the next four districts, Democrats are far more packed in the legislature's plan than in the entire range of plans produced by the simulations (the red X markers are well below the clusters of gray dots).

The partisanship of the eighth most Democratic district (number 22) is roughly in line with the

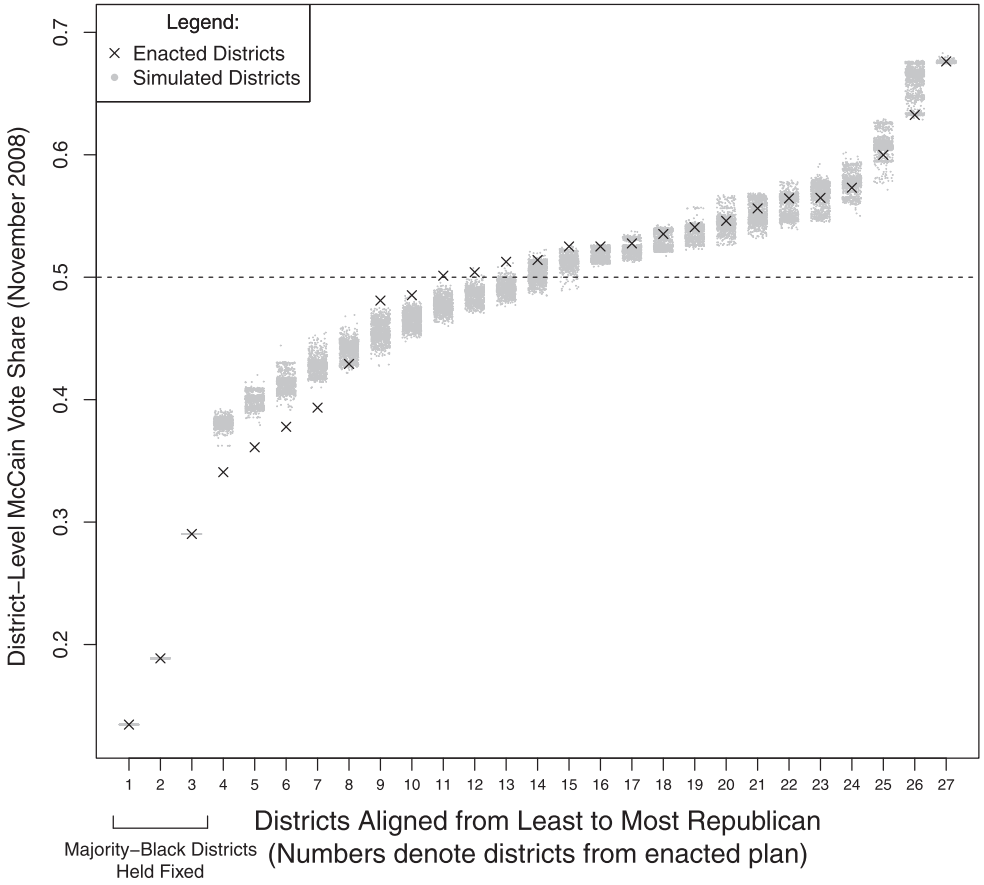

FIG. 5. Comparison of simulated vs. actual districts with three majority-black voting-age population districts (FL-5, FL-20, and FL-24) held fixed.

simulations, but after that, we see an abrupt switch. Once we get to the middle of the distribution, into the class of districts that are conceivably winnable by Republicans, the red X markers are either completely beyond or at the very high end of the range of the simulations, indicating that the legislature's plan produces a sizable advantage for Republicans in the pivotal districts. The ninth and tenth most Democratic districts would be comfortable Democratic victories in the simulations, but in the legislature's plan they are much closer to 50 percent.[26] In the next three districts, the legislature's plan produces narrow Republican majorities while the simulations, on average, produce narrow Democratic majorities. Overall, in the middle of the distribution—where districts are most evenly divided between Democrats and Republicans and partisan legislative majorities are won or lost—the red X markers are above the vast majority of the gray dots, indicating that the legislature's plan is clearly and consistently more favorable to the Republicans than the non-partisan baseline.

To summarize, our analysis reveals that relative to a non-partisan baseline, the districting plan submitted by the legislature effectively takes Republicans from solidly Democratic districts and places them in pivotal districts, transforming them from Democratic majorities or toss-ups into Republican majorities.

LESS DEFERENTIAL APPROACHES

Plaintiffs may not wish to be quite so deferential to a state legislature, especially regarding the Voting Rights Act. The claim of the Florida Legislature that

[26]In 2012, the Republicans in fact won District 13 and lost 18 by a razor-thin margin.

the Voting Rights Act required three overwhelmingly Democratic African American districts can certainly be disputed. While a majority-African American district never emerged from simulations in Northern Florida, we found that one majority African American district, and sometimes two, emerged naturally from the simulations in the Miami-Dade area.

It is plausible that the extremely large Democratic majorities in Districts 5 and 20 reflect efforts to achieve partisan advantage under the cloak of non-retrogression. Thus, it is useful to generate an alternative set of baseline plans that are less deferential to the legislature. We proceeded by progressively dropping our protections for the legislature's proposed VRA districts, thus throwing more of the precincts into our non-partisan simulation procedure. First, we conducted simulations that only preserved Districts 24 and 5. Second, we conduct simulations that only preserved Districts 24 and 20. Third, we conducted simulations that only preserved District 24. Not surprisingly, these less deferential simulations demonstrated slightly less pro-Republican bias than when we protected all three districts, thus making the legislature's plan appear to be even more anomalous.

A more rigorous analytical approach would be to take a deeper dive into the logic of Section 2 of the Voting Rights Act and to use computer simulations to develop a judgment about the number and regional placement of required VRA districts. In a separate paper, Chen (2015) uses computer simulations to determine the extent to which minority populations can be reasonably concentrated into legislative districts in various regions across various states. The results of these minority-focused simulations create a baseline indication of how VRA-protected minority districts might be drawn in the absence of partisan manipulation. The remaining non-minority districts are then simulated in both a race-blind and partisan-neutral manner, thus creating a baseline set of simulations in which both the VRA districts and non-minority districts are drawn without any partisan intent. These simulations thus serve as a more rigorous baseline, producing a set of maps that guarantee both compliance with the VRA as well as compliance with a partisan-neutral districting mandate.

We have also found that a less deferential approach works well in addressing the Florida Legislature's claims about the Voting Rights Act and the creation of districts in which Hispanics can elect candidates of choice. Building up from block-level census data, we simply calculated the Hispanic share of voting-age population in each of the 27 districts in each of the simulated plans, as well as in the legislature's plan. Because of the geography of the Hispanic population in South Florida, we discovered that all of the simulated plans produced exactly three super-majority-Hispanic districts (over 60% Hispanic population), which is the same number created by the legislature's plan.

Hence, to address whether the ethnic composition of these districts could account for the partisan bias of the legislature's enacted plan, we identified the subset of simulations that create similarly Hispanic districts in the South Florida region of the state. In order to do this, Figure 6 examines the subset of our simulated plans that produce three districts with Hispanic majorities of 60 percent. We also examine in Figure 7 the smaller subset that creates three districts with 65 percent super-majorities. We find that the partisanship of these subsets is no different than that of the full sample of plans, thus laying to rest the notion that the partisan bias of the legislature's plan can be explained, for instance, by an effort to create to Hispanic super-majority districts.

Plaintiffs in industrialized Northern states with highly concentrated urban African American populations might find that all possible interpretations of the Voting Rights Act are easily satisfied by simulations that make no explicit efforts with regard to race. In such cases, as with our approach to Hispanics in Florida, plaintiffs might consider using the less deferential strategy of dropping any simulated plans that might be suspected of failing to conform to stipulations of the Voting Rights Act.

Once a plaintiff can show that the redistricting plan in question is an extreme outlier in its partisanship relative to a large number of simulated plans that are similar or more exacting in terms of compactness, contiguity, population equality, the preservation of boundaries, and the protection of minority voting rights, the burden of proof should shift to the state.

The state legislature might very well argue that its plan remains an outlier because of its responses to idiosyncratic requests that arose in public hearings, or because it felt compelled to protect communities of interest beyond those that were protected by the preservation of municipal and county boundaries. The burden should fall upon the state to be specific about these claims as part of the discovery process. This allows judges to evaluate whether these claims are even plausible, as public hearings

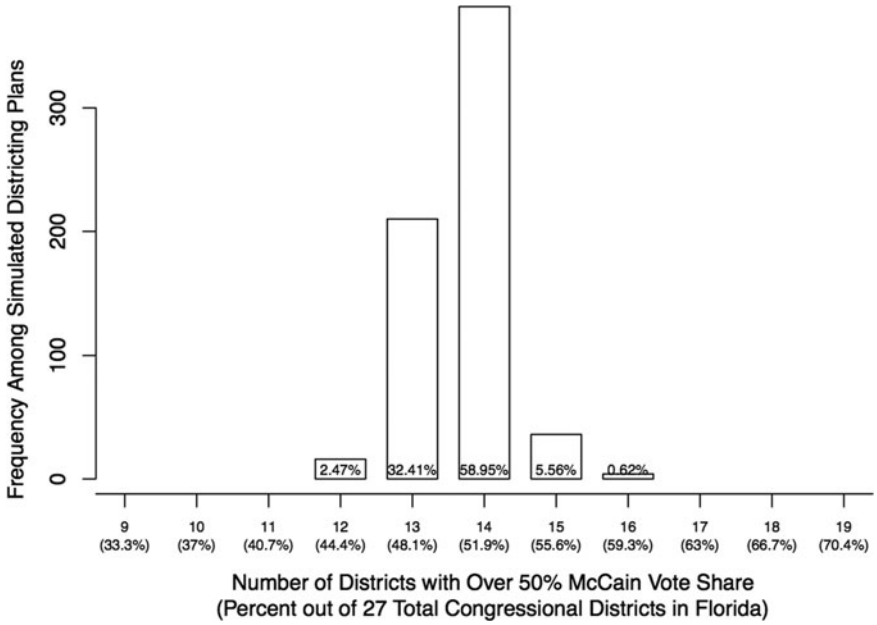

FIG. 6. Results of 648 (out of 1,000 total) simulated districting plans containing three districts with over 60% Hispanic voting-age population (all plans include 46 counties and 384 cities kept intact and Districts 5, 20, and 24 held fixed).

themselves may well be manipulated by political operatives from either party. More importantly, it allows the plaintiffs to take the state legislature at its word, holding the relevant clusters of census blocks fixed and rerunning the simulations using the deferential approach described above.

At this point, one of two things will happen. If a significant gap between the partisanship of the simulated maps and the challenged map remains, the presumption of inappropriate partisan manipulation remains. If the gap disappears, the burden is on the state to explain why its interest in protecting a specific combination of neighborhoods is more important than protecting the equal protection rights of the voters for one of the parties.

We presented our Florida congressional districting simulation findings in an expert report in *Romo v. Detzner and Bondi* (Case No. 2012-CA-412), a lawsuit in which Florida voters alleged the state's 2012 congressional plan had violated the Florida Constitution's prohibition on partisan gerrymandering. On July 9, 2015, the Florida Supreme Court struck down eight of the state's congressional districts as unconstitutional gerrymanders, requiring the state legislature to redraw Districts 5, 13, 14, 21, 22, 25, 26, and 27.

Notably, many of these eight invalidated districts are ones that, according to the simulation results, packed a statistically unusual number of Democratic voters. District 14, for example, was drawn to span the Tampa-St. Petersburg area in a non-compact fashion. The court rejected the legislature's enacted district configuration in this area, in which an already-safe Democratic District 14 based in Tampa awkwardly reaches across Tampa Bay and carves out Democratic voters in downtown St. Petersburg, ensuring that neighboring District 13 is more favorable to the Republican party. The Florida Supreme Court thus directed the legislature to avoid crossing Tampa Bay in a redrawn version of each of these districts. As originally drawn, District 14, in addition to being more non-compact than simulated districts in the same area, was significantly more Democratic-leaning than every single one of the corresponding simulated districts, as illustrated in Figure 5.

DISCUSSION AND CONCLUSIONS

Justice Scalia pointedly argued that if a workable standard for identifying unconstitutional partisan gerrymandering had not emerged in the two decades since *Bandemer*, it was unlikely to emerge in the future.[27] We do not share his lack of faith in scientific

[27] *Vieth*, 541 U.S. at 304 (opinion of Scalia, J.).

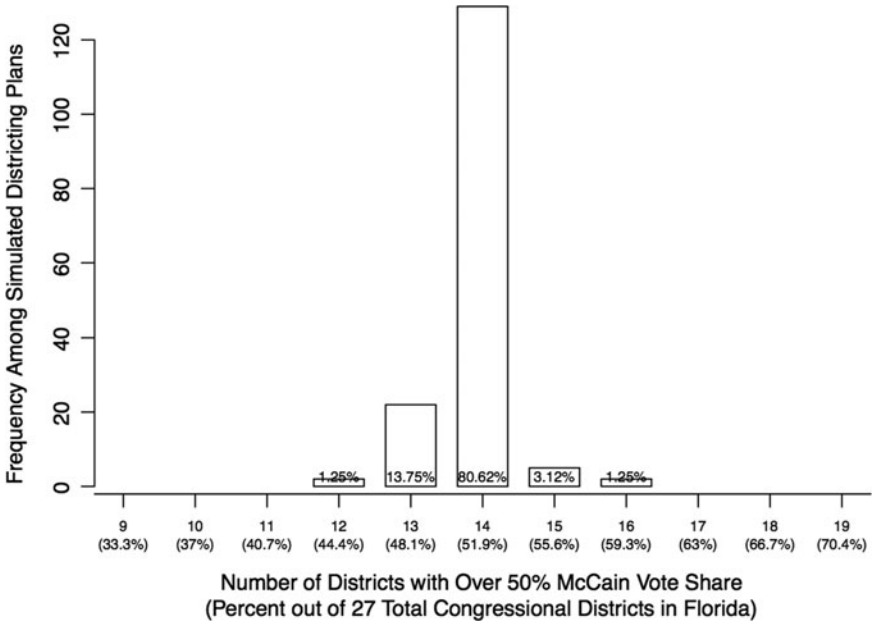

FIG. 7. Results of 160 (out of 1,000 total) simulated districting plans containing three districts with over 65% Hispanic voting-age population (all plans include 46 counties and 384 cities kept intact and Districts 5, 20, and 24 held fixed).

progress. Rapid innovations in data collection and computational social science allow us to know many things in 2015 that we did not know in the 1980s or even 2000. Digitized precinct boundaries for many states were not available until quite recently, and advances in computational power have dramatically increased our capacity to complete large numbers of simulations.

This article has demonstrated how computer simulations can be used to break down the remaining hurdle to justiciability. While social scientists have already developed solid techniques for measuring the partisan asymmetry that must be at the heart of a constitutional challenge based on the First or Fourteenth Amendments of the U.S. Constitution, potential plaintiffs have lacked a way to show that this asymmetry emerges from the use of political classifications "in a way unrelated to any legitimate legislative objective."[28] This article has provided a tool that enables plaintiffs to do so. We have defined those legislative objectives in a way that directly follows the redistricting principles that the courts have repeatedly embraced.

While Justice Scalia ridicules the goal of meaningful determinations about fairness in redistricting as "flabby,"[29] we have shown that it is possible to take a precise, slender approach to the question that should be more palatable to the pivotal justices than the totality-of-circumstances approaches of the past.

Perhaps the most obvious critique of our approach is that it is too slender: it asks too little of state legislatures and would allow some asymmetric plans to withstand scrutiny. Our approach is avowedly realistic rather than idealistic, but we have also demonstrated that it appears to have considerable potential for would-be plaintiffs in the states that have aroused the most suspicion as overt partisan gerrymanders in the most recent redistricting cycle.

We do not take a position as to the exact threshold that should be applied when determining how substantially the districting plan in question should be allowed to differ from the simulated plans. In Florida, the question was of little importance since the legislature's plan was outside the entire distribution of simulated plans. If a numerical threshold is necessary, we share Justice Stevens' assessment that it is the role of the courts rather than academics to establish one.[30] Courts might, for instance, adopt a standard whereby a contested plan does not withstand scrutiny if it is more favorable for a political party than 95 percent of the relevant simulated plans. One might also

[28] *Vieth*, 541 U.S. at 310 (opinion of Kennedy, J.).
[29] *Vieth*, 541 U.S. at 300 (opinion of Scalia, J.).
[30] *Vieth*, 541 U.S. at 344 (opinion of Stevens, J.).

relax the standard to 90 percent, or perhaps as low as 75 percent. We do not propose a magic number.

We do not envision that a plaintiff would use our approach in isolation. On the contrary, it would be most effective in combination with evidence of partisan asymmetry and perhaps more traditional evidence including direct testimony about intent and critiques of individual districts. As with Justice Stevens' description of partisan symmetry, we view it as a "helpful (though certainly not talismanic) tool."[31]

It is also a rather flexible tool. States may have different preferences regarding how to weight the various criteria of compactness, minimizing population deviations, respect for communities of interest, and protection of minority voters. The simulation algorithm is able to adopt to these differing priorities by requiring stricter benchmarks on some redistricting goals and more lenient benchmarks on other goals. Moreover, clusters of neighborhoods or entire districts can be preserved, and simulated plans can be discarded, in order to allow for the legitimate challenges faced by mapmakers in different states with different geographic constellations of minority groups and communities of interest.

An additional critique of our approach is philosophical. Altman and McDonald (2010) argue that automated redistricting is of limited value because of the computational intractability of optimizing over several criteria including compactness, population equality, jurisdictional integrity, partisan, minority representation, and partisan symmetry. Our goal, however, is not to develop "optimal" districts and propose that they replace human-drawn maps. Our more modest goal is to leave partisanship aside and develop a transparent benchmark that solves all of the other districting challenges at least as well as the humans drawing the plan under review, in many cases granting significant deference to the choices made by the state. To be of use to judges as a non-partisan benchmark, it is not necessary that the simulations optimize on several criteria. Given the emphasis placed by the courts on compactness and the preservation of municipal boundaries, it is also not necessary that the simulations represent a truly random sample of all feasible redistricting plans.

A final critique of our approach is that judges might not trust computer simulations. One might point out, for instance, Kennedy's skepticism about the hypothetical reversed election outcomes at the heart of the King et al. (2006) approach to partisan symmetry. However, the basic problem facing the courts cannot be solved without some benchmark notion of what a constitutionally acceptable plan would look like, and such a benchmark must be tailored to the state's unique circumstances. It is difficult to know how such a benchmark would be created in a more impartial and transparent way than with computer simulations. It is possible for plaintiffs to provide images of simulated maps along with simple statistics that would make them just as tangible as hand-drawn maps. The optimism of the 1960s that computers would someday replace humans in the redistricting process was misplaced. However, we have shown how simulated districting plans can be used as part of a larger strategy to hold humans accountable.

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[31] *Id.*

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