# REDISTRICTING WITHOUT TRADEOFFS

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*The law of redistricting is built on the assumption that tradeoffs among line-drawing criteria are pervasive. This view helps explain crucial elements of partisan gerrymandering, racial vote dilution, and racial gerrymandering doctrine. This Article is the first to rigorously analyze the existence and extent of redistricting tradeoffs. The Article relies on ensembles of billions of district maps generated randomly by cutting-edge computer algorithms. These ensembles cover all electoral levels for seven priority states as well as congressional maps for all states with two or more U.S. House districts.*

*The Article finds that, contrary to the conventional wisdom of courts and scholars, redistricting tradeoffs are generally weak to nonexistent. In most cases, progress along one dimension (like compactness, partisan fairness, or minority representation) requires no regression along another axis. This conclusion has sweeping implications for redistricting law and policy. Legally, it bolsters plaintiffs alleging partisan gerrymandering or racial vote dilution, because their objectives can typically be achieved without sacrificing other goals. In policy terms, the usual absence of tradeoffs means that line-drawers can often have it all—maps that simultaneously comply with traditional criteria, treat the major parties fairly, lead to competitive elections, and properly represent minority voters.*



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## INTRODUCTION

The law of redistricting is based on the potential for tradeoffs among line-drawing criteria. Better performance along one dimension—compactness, partisan fairness, minority representation, and so on—is often thought to compel worse performance across one or more other parameters. Consider partisan gerrymandering, which the Supreme Court deemed nonjusticiable (under the federal Constitution) in the 2019 case of *Rucho v. Common Cause*.[1] One of the Court's rationales was that, according to some litigants, disregard for traditional (or form-related) criteria should be the standard for unlawful gerrymandering.[2] "If compliance with traditional districting criteria is the fairness touchstone," however, "how should mapdrawers prioritize competing criteria?"[3] Conflicts among traditional criteria supposedly make it impossible for courts to determine whether district plans adequately satisfy these requirements.

Analogously, courts that *are* open to partisan gerrymandering claims (like federal courts before *Rucho* and many state courts to this day) frequently ask "whether a plan's partisan effect is justifiable"—that is, "whether it can be explained by the legitimate state prerogatives and neutral factors that are implicated in the districting process."[4] This justification stage is, at its core, an evaluation of tradeoffs. The issue is whether a challenged map's partisan bias results from efforts to achieve permissible nonpartisan objectives. If so, a tradeoff exists between partisan fairness and valid nonpartisan goals, and the map is lawful. If not, partisan balance is possible without compromising other aims, and the map is unconstitutional.

The prospect of tradeoffs is also central to racial vote dilution doctrine under the Voting Rights Act (VRA). To succeed in this sort of suit, a plaintiff must show not only that an additional majority-minority district could be drawn, but that this hypothetical district could be "reasonably configured" in that "it comports with traditional districting criteria."[5] This requirement presumes that, in at least some cases, greater minority representation is attainable only through the creation of *unreasonably* configured districts that *violate* traditional criteria. When noncompliance with traditional criteria is the price of more minority representation, this element can't be established and the plaintiff loses.

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1. 139 S. Ct. 2484 (2019).

2. See id. at 2500 ("Or perhaps fairness should be measured by adherence to 'traditional' districting criteria, such as maintaining political subdivisions [and] keeping communities of interest together . . . .").

3. Id. at 2501.

4. Whitford v. Gill, 218 F. Supp. 3d 837, 911 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018).

5. Allen v. Milligan, 143 S. Ct. 1487, 1489 (2023).

A similar potential tradeoff is the crux of the constitutional claim of racial gerrymandering. To demonstrate that a district is a racial gerrymander—one unjustifiably crafted for a racially predominant purpose—"a plaintiff must prove that the State 'subordinated' race-neutral districting criteria . . . to 'racial considerations.'"[6] Such subordination occurs when race-neutral criteria are sacrificed on race-conscious grounds like targeting a particular demographic composition for a district. When race-neutral and race-conscious ends are both realized, racial predominance is absent and no liability ensues.

Given the importance of tradeoffs in redistricting law, one might expect the academic literature to focus intently on them. One might think there would be studies galore on the existence and extent of tradeoffs among traditional criteria, among partisan fairness and nonpartisan goals, and among minority representation and nonracial aims. But that hunch would be wrong.[7] In fact, no legal scholarship has previously identified redistricting tradeoffs as a discrete topic of interest. A handful of political science articles have done so, but these pieces, while helpful, have been quite limited in their scope. They have mostly addressed just one state (not many of them)[8] and just one pair of criteria (not a wider array of partisan, racial, and other factors).[9] These few existing works have also analyzed small or unrepresentative sets of maps—not ones generated at scale to reflect accurately the relevant map universe.[10]

This Article is therefore the first to assess redistricting tradeoffs systematically. I cover congressional and state legislative maps for seven priority states, as well as congressional maps alone for all forty-four states

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6. Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1234 (2024) (quoting Miller v. Johnson, 515 U.S. 900, 916 (1995)).

7. See, e.g., Micah Altman & Michael McDonald, Redistricting by Formula: An Ohio Reform Experiment, 46 Am. Pol. Rsch. 103, 107 (2018) [hereinafter Altman & McDonald, Redistricting by Formula] ("There is little scholarly research on the inability of one criterion to constrain another . . . ."); James G. Gimpel & Laurel Harbridge-Yong, Conflicting Goals of Redistricting: Do Districts That Maximize Competition Reckon With Communities of Interest?, 19 Election L.J. 451, 453 (2020) ("[L]ittle scholarship . . . empirically assesses how the application of one criterion affects another not just in theory but in real-world map drafting.").

8. See, e.g., Micah Altman & Michael P. McDonald, Paradoxes of Political Reform: Congressional Redistricting in Florida, *in* Jigsaw Puzzle Politics in the Sunshine State 163, 163–64 (Seth C. McKee ed., 2015) [hereinafter Altman & McDonald, Paradoxes of Political Reform] (considering only Florida congressional maps).

9. See, e.g., Rahul Swamy, Douglas M. King, Ian G. Ludden, Kiera W. Dobbs & Sheldon H. Jacobson, A Practical Optimization Framework for Political Redistricting: A Case Study in Arizona, Socio-Econ. Planning Scis., Apr. 2024, at 13 [hereinafter Swamy et al., A Practical Optimization Framework] (considering only competitiveness and compactness (and only Arizona congressional maps)).

10. See, e.g., Bruce E. Cain, Karin Mac Donald & Iris Hui, Competition and Redistricting in California: Lessons for Reform 3 (2006) (considering only a few dozen human-drawn California congressional and state legislative maps).

with two or more congressional districts. This is a much larger swath of American redistricting than any prior study in this genre has surveyed. I examine most measurable line-drawing criteria: traditional requirements like compactness and adherence to county boundaries (each calculated in multiple ways), electoral variables like partisan fairness and competitiveness (also quantified through multiple metrics), and minority representation (estimated by ecological inference on a national scale, not crude demographic shortcuts). And to conduct this investigation, I use a total of more than fourteen billion district maps generated at random by cutting-edge computer algorithms.

The new map ensembles on which this project relies are themselves noteworthy. To my knowledge, they're the largest and highest-quality sets of maps yet created through the emerging method of computational redistricting. Unlike most other map ensembles, each one is demonstrably representative of the applicable map universe for the state and electoral level. And all these new sets of maps are publicly available—in numerous versions, to boot, corresponding to different degrees of population equality, compactness, and county-splitting—so other researchers may study and learn from them.[11]

The Article's principal finding is that tradeoffs among redistricting criteria are generally weak to nonexistent. More specifically, within the vast majority of randomly generated maps that are in the heartland of each bivariate distribution, substantial improvement along one dimension can almost always be achieved without any decline in terms of the other parameter. Typically, the correlation between each pair of criteria is also close to zero, and no meaningful link appears when alternative ensembles or measures are used or other variables are included as regression controls. These patterns hold among traditional criteria like compactness and adherence to county boundaries, which can be simultaneously increased in most cases. Likewise, partisan fairness is usually unrelated to traditional criteria and to minority representation—and it's often *positively* associated with competitiveness, meaning that these goods tend to be complements, not substitutes. Minority representation, too, mostly has little to no connection to the compliance of minority-opportunity districts with traditional criteria.

One might worry that these results are idiosyncratic to the new map ensembles on which they're based. To allay this concern, I rerun the analyses using the sets of congressional maps published in 2022 by the

11. These new map ensembles were generated by computer scientists Todd Proebsting and Alec Ramsay, with whom I extensively collaborated. For a more technical discussion of this project, see Kristopher Tapp, Todd Proebsting & Alec Ramsay, Parameter Effects in ReCom Ensembles 3–16 (May 28, 2025) (unpublished manuscript), https://arxiv.org/pdf/2505.21326v1 [https://perma.cc/XDQ5-US7F].

Algorithm-Assisted Redistricting Methodology (ALARM) Project.[12] The ALARM map ensembles are produced by a completely different computer algorithm. Yet they give rise to identical substantive conclusions. Again, within the heartland of maps in each bivariate distribution, concurrent progress along both dimensions is generally possible. And again, the correlation between each pair of criteria is, in the main, statistically and practically insignificant.

Why do courts—and many scholars[13]—wrongly suppose that redistricting tradeoffs are pervasive? A likely answer is that their mental models of mapmaking are too limited. They may fixate on a particular plan, which could be subject to material tradeoffs if it's amended, and overlook the near-infinite number of other district configurations, some of which almost certainly dominate the benchmark plan. To make this point empirically, I start with a recent court-drawn plan that epitomizes how humans balance redistricting criteria. When a computer algorithm initially adjusts this plan, tradeoffs among criteria indeed appear. Crucially, however, these tradeoffs lessen as the algorithm continues to run, moving further away from the original plan. When the algorithm runs for long enough, the tradeoffs disappear entirely as many maps are churned out that are superior to the judicial handiwork.

Courts and scholars may also intuit that, at some point, parallel improvement along two (or more) parameters becomes impossible. Eventually, a Pareto frontier must be reached where progress on one axis requires regression on another.[14] In the Article's last empirical contribution, I identify this frontier for each pair of redistricting criteria for each state and electoral level. Two facts about these frontiers are most striking. First, their slopes tend to be gentle, not steep. In other words, only a minor setback toward one objective is typically necessary for a major gain toward another goal. Second, enacted plans—plans crafted and ratified by humans—are rarely at these frontiers. In most cases, enacted plans are actually quite distant from the areas where compromises among criteria

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12. See Cory McCartan, Christopher Kenny, Tyler Simko, Shiro Kuriwaki, George Garcia III, Kevin Wang, Melissa Wu & Kosuke Imai, 50-State Redistricting Simulations, ALARM Project (Feb. 8, 2022), https://alarm-redist.org/fifty-states/ [https://perma.cc/5WGU-8PP2].

13. See, e.g., David Butler & Bruce Cain, Congressional Redistricting: Comparative and Theoretical Perspectives 1 (1992) ("There are both necessary and fortuitous conflicts between the various goals that most people think should be paramount in redistricting."); Sam D. Hayes, Competing Criteria: Rethinking Congressional Redistricting and Representation, 77 Pol. Rsch. Q. 1431, 1433 (2024) ("Criteria necessarily conflict with other potential criteria, and therefore choosing certain criteria precludes the option of using other criteria.").

14. More technically, a Pareto frontier consists of points along two or more dimensions that are not dominated (beat on every axis) by any other points. See, e.g., Chao Yang, Wei Ye & Qinchuan Li, Review of the Performance Optimization of Parallel Manipulators, Mechanism & Mach. Theory, Apr. 2022, at 15.

are unavoidable. These zones' existence, then, doesn't vindicate claims of ubiquitous tradeoffs because, as far as most mapmaking is concerned, the frontiers might as well be absent.

These findings have sweeping implications for redistricting law. Begin with the *Rucho* Court's argument that disregard for traditional criteria can't be the standard for unlawful partisan gerrymandering because these requirements usually conflict.[15] In fact, in most distributions of maps for most states and electoral levels, these requirements are rarely at odds. So, under this approach, courts wouldn't need to decide how to "prioritize competing criteria"[16] because these criteria are seldom in competition. Instead, courts could insist on strong performance with respect to all traditional requirements. Plans would then be invalid if they fell short along any of these dimensions, because this subpar score normally could not be explained by an aim to satisfy another criterion.

In states where partisan gerrymandering suits can still be brought, these results also augur poorly for defendants at the justification stage of the inquiry. At this stage, a defendant maintains that a plan's bias is attributable to the pursuit of some legitimate nonpartisan end.[17] In the map ensembles, however, partisan fairness is infrequently in tension with nonpartisan criteria like compactness, adherence to county boundaries, competitiveness, and minority representation. Most often, partisan fairness is uncorrelated with these criteria and can be improved without losing any ground in these respects. The upshot is that, in the mine run of litigation, a defendant should be hard-pressed to justify a biased plan. Data like that presented here should generally help to refute any attempted justification.

Turning from party to race, the Article bears good news for racial vote dilution plaintiffs. One of their obligations is to show that minority representation could be bolstered without unreasonably worsening the compliance of minority-opportunity districts with traditional criteria.[18] The map ensembles illustrate that this is possible in many circumstances. Furthermore, opportunity districts don't typically become less mindful of traditional criteria as their volume rises. Accordingly, the element that has been the stumbling block for many past VRA litigants[19] could now be

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15. See Rucho v. Common Cause, 139 S. Ct. 2484, 2500 (2019).

16. Id. at 2501.

17. See, e.g., Whitford v. Gill, 218 F. Supp. 3d 837, 911 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018) (explaining that the justification inquiry asks whether a plan's partisan effect "can be explained by the legitimate state prerogatives and neutral factors that are implicated in the districting process").

18. See, e.g., Allen v. Milligan, 143 S. Ct. 1487, 1503 (2023).

19. See, e.g., Brief of *Amici Curiae* Professors Jowei Chen, Christopher S. Elmendorf, Nicholas O. Stephanopoulos & Christopher S. Warshaw in Support of Appellees/Respondents at 14–18, *Allen*, 143 S. Ct. 1487 (Nos. 21-1086, 21-1087), 2022 WL 2873376 (noting that, in almost half of recent racial vote dilution cases, plaintiffs have been unable

easier to establish with modern redistricting technology. Indeed, these plaintiffs might consult maps produced for this project for ideas about how to prove this pillar of their cases.[20]

In the racial gerrymandering context, finally (and uniquely), the Article's findings benefit defendants. Here, a district is subject to strict scrutiny if it subordinates race-neutral criteria to racial considerations.[21] The map ensembles indicate that, as a rule, such subordination is unnecessary. By and large, racial considerations like reaching certain levels of minority representation can be achieved while satisfying race-neutral criteria to the same extent. Consequently, just as VRA plaintiffs may wish to peruse this project's maps for offensive purposes, potential racial gerrymandering defendants could filter the maps for ones that accomplish their race-conscious objectives without sacrificing other goals that are race-neutral. If a jurisdiction adopts this kind of map, a court is unlikely to find that any district was designed for a racially predominant reason.

The Article is organized as follows. Part I explains how redistricting law (and much redistricting scholarship) assumes the existence of widespread tradeoffs among line-drawing criteria. Part II summarizes the small extant literature on redistricting tradeoffs and describes the Article's empirical strategy. Part III presents the Article's results. These span: (1) a congressional map ensemble for an illustrative state; (2) congressional and state legislative map ensembles for seven priority states; (3) the ALARM congressional map ensembles for all states with two or more congressional districts; (4) local tradeoffs for a recent court-drawn plan; and (5) Pareto frontiers for all map ensembles. Part IV discusses the implications of these analyses. They unsettle several redistricting subfields and reveal an available future in which plans abide by traditional criteria while yielding fair representation for voters of all partisan and racial affiliations.

## I. CLAIMS OF TRADEOFFS

Many courts and scholars assert that tradeoffs among redistricting criteria are common. In this Part, I review these voluminous claims and the logic that seems to underpin them. These claims are made with

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to prove that an additional, reasonably configured, majority-minority district could be drawn).

20. After the Supreme Court's recent decision in Louisiana v. Callais, Nos. 24-109, 24-110, 2026 WL 1153054 (U.S. Apr. 29, 2026), however, plaintiffs' illustrative maps must also achieve jurisdictions' *political* goals (which may include partisan advantage). See id. at *13, *15. This Article doesn't focus on this additional constraint, which is likely to prove insuperable in many cases.

21. See, e.g., Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1233 (2024).

respect to elements of the doctrines of partisan gerrymandering, racial vote dilution, and racial gerrymandering. These claims apply to tradeoffs among traditional criteria, among partisan fairness and nonpartisan goals, and among minority representation and nonracial aims. These claims' origin is likely how easy it is to imagine scenarios—both hypothetical and grounded in real political geography—in which redistricting objectives indeed conflict. And, especially in their stronger forms, these claims aren't very convincing. The initial doubts raised about them here blossom into full empirical refutations later in the Article.

### A. *Partisan Gerrymandering Justiciability*

As noted at the outset, *Rucho* was the landmark 2019 case in which the Supreme Court held that partisan gerrymandering is nonjusticiable—incapable of being adjudicated—under the federal Constitution.[22] There are several reasons why a legal theory might be nonjusticiable.[23] In *Rucho*, the Court relied solely on one of these bases: unworkability. In the Court's view, none of the proposals advocated by the parties before it, by dissenting Justices, or by amici was "judicially manageable"[24] in that it could "reliably differentiate unconstitutional from '[permissible] gerrymandering.'"[25]

One of the standards recommended to the Court was "adherence to 'traditional' districting criteria."[26] These are principles that have long been used by jurisdictions across the country to craft districts.[27] Traditional criteria are often prescribed by state constitutions or statutes, and even when they lack the force of law, they tend to carry considerable normative weight.[28] While consensus on the full list of traditional principles is elusive, they include, at least, contiguity, compactness, respect for political subdivisions (like towns and counties), and respect for communities of interest.[29] The hallmark of these criteria is that they relate solely

22. *Rucho*, 139 S. Ct. at 2507.

23. See Baker v. Carr, 369 U.S. 186, 211–26 (1962) (discussing these rationales at length).

24. *Rucho*, 139 S. Ct. at 2491.

25. Id. at 2499 (quoting Hunt v. Cromartie, 526 U.S. 541, 551 (1999)).

26. Id. at 2500; see also Yunsieg P. Kim & Jowei Chen, Gerrymandered by Definition: The Distortion of "Traditional" Districting Criteria and a Proposal for Their Empirical Redefinition, 2021 Wis. L. Rev. 101, 144 (elaborating on this proposal).

27. See, e.g., Redistricting Criteria, Nat'l Conf. St. Legislatures, https://www.ncsl.org/elections-and-campaigns/2020-redistricting-criteria [https://perma.cc/FXX3-GYKM] (last updated Sep. 3, 2025) (noting that these "principles have been adopted and used for decades by many states").

28. See, e.g., id. (listing the criteria used by each state in the 2020 redistricting cycle).

29. See, e.g., *Rucho*, 139 S. Ct. at 2500 (identifying some traditional criteria); Bethune-Hill v. Va. State Bd. of Elections, 580 U.S. 178, 183 (2017) (same); Redistricting Criteria, supra note 27 (same).

to the *forms* of districts: their shapes and their intersections with other geographic units. Traditional principles *don't* take into account districts' likely electoral consequences.[30]

The Court rejected disregard for traditional criteria as the test for partisan gerrymandering, in part because the Court thought that tradeoffs among these principles are rife. When they clash, the Court asked rhetorically, "how should mapdrawers prioritize competing criteria?"[31] Such prioritization, the Court suggested, can't be done defensibly and non-arbitrarily. By the same token, if a court had to evaluate districts' compliance with traditional principles, and if these criteria were at odds with one another, then "[a] court would have to rank the relative importance of . . . traditional criteria and weigh how much deviation from each to allow."[32] Again, the implication is that a court can't feasibly rank traditional principles and decide the extent to which each may be sacrificed.

The Court also invoked not tradeoffs *among* traditional criteria, but rather tradeoffs *between* them and partisan fairness, in rebuffing this proposal. Traditional principles, the Court observed, typically reflect "the 'natural political geography' of a State."[33] In turn, features of that geography, "such as the fact that urban electoral districts are often dominated by one political party," may "lead to inherently packed districts" and a bias against the urban party.[34] Further developing this point, the Court quoted extensively from the 2004 partisan gerrymandering case, *Vieth v. Jubelirer*.[35] "[P]acking and cracking," the *Vieth* plurality commented, skew district maps in partisan terms yet "are quite consistent with adherence to compactness and respect for political subdivision lines."[36] Concurring in *Vieth*, Justice Anthony Kennedy similarly maintained that "traditional criteria such as compactness and contiguity . . . 'unavoidably have significant political effect.'"[37]

*Rucho* held that *partisan* gerrymandering claims are nonjusticiable because of (among other things) the prevalence of tradeoffs among traditional principles. In a concurrence in a 2024 *racial* gerrymandering case, Justice Clarence Thomas argued that the same conclusion should

30. See, e.g., Redistricting Criteria, supra note 27 (distinguishing traditional criteria from various consequentialist criteria).

31. *Rucho*, 139 S. Ct. at 2501.

32. Id.

33. Id. at 2500.

34. Id.

35. 541 U.S. 267 (2004).

36. *Rucho*, 139 S. Ct. at 2500 (alteration in original) (internal quotation marks omitted) (quoting *Vieth*, 541 U.S. at 298 (plurality opinion)).

37. Id. (quoting *Vieth*, 541 U.S. at 308–09 (Kennedy, J., concurring in the judgment)).

follow for those challenges—and for the same reason.[38] As discussed below, racial gerrymandering plaintiffs must generally show that disputed districts flout traditional criteria.[39] But "[t]raditional districting principles often conflict with one another," Justice Thomas contended, "and there is no principled way for judges to resolve those conflicts."[40] To resolve them, "a court must 'rank the relative importance of those . . . criteria.'"[41] But such ranking is inherently subjective and so "ensnarls courts in a political thicket."[42] Accordingly, "the racial gerrymandering injury is not amenable to judicial resolution" because "these claims lack judicially manageable standards."[43]

Lower federal and state courts have also ruled against suits alleging violations of traditional principles due to these criteria's supposed tension with one another. In a 2022 case, a federal district court rejected a claim that Michigan's congressional plan unduly fragmented communities of interest.[44] Not only was this claim unrecognized by precedent, but there were "trade-offs between 'communities of interest' and the other districting criteria enumerated under Michigan law."[45] Such "[t]rade-offs among legitimate interests involve legislative judgments, not judicial ones."[46] In a 2012 case, likewise, the New Hampshire Supreme Court turned down a challenge to state house districts based on their splits of towns and wards.[47] "[P]erfect compliance with all of [the applicable] mandates is impossible," the court declared.[48] "A balance must be drawn" among dueling requirements.[49] "Trade-offs must be made."[50]

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38. See Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1253–56 (2024) (Thomas, J., concurring in part).

39. See infra Part I.D.

40. *Alexander*, 144 S. Ct. at 1255 (Thomas, J., concurring in part).

41. Id. (alteration in original) (quoting *Rucho*, 139 S. Ct. at 2484).

42. Id.

43. Id. at 1256.

44. See Banerian v. Benson, 589 F. Supp. 3d 735, 738–39 (W.D. Mich. 2022).

45. Id.

46. Id. at 739.

47. See City of Manchester v. Sec'y of State, 48 A.3d 864, 873–77 (N.H. 2012).

48. Id. at 877.

49. Id. (internal quotation marks omitted) (quoting Beaubien v. Ryan, 762 N.E.2d 501, 507 (Ill. 2001)).

50. Id. (internal quotation marks omitted) (quoting *Beaubien*, 762 N.E.2d at 507); see also, e.g., Holt v. 2011 Legis. Reapportionment Comm'n, 67 A.3d 1211, 1238 (Pa. 2013) (rejecting a claim that Pennsylvania's state legislative districts unduly divided political subdivisions because "multiple constitutional and practical (geography, demographic distribution) values must be balanced in this exercise in line-drawing").

Scholars, too, echo this judicial chorus about tradeoffs among traditional principles.[51] Earlier, I flagged a pair of examples in a footnote.[52] Professors David Butler and Bruce Cain write that "[t]here are both necessary and fortuitous conflicts between the various goals that most people think should be paramount in redistricting."[53] Professor Sam Hayes states that line-drawing "[c]riteria necessarily conflict with other potential criteria, and therefore choosing certain criteria precludes the option of using other criteria."[54] More such passages fill the academic literature. According to Professors James Gimpel and Laurel Harbridge-Yong, "among the traditional, long-standing criteria, there are regular conflicts."[55] "The process of legislative districting inherent[ly] involves tradeoffs between democratic normative values," say Professor Nicholas Goedert and his coauthors.[56] Professor Jacob Siegel is of the same mind: "The criteria tend to conflict with one another and there is no ordering . . . that all groups would consider fair."[57] "[I]mportant and inevitable trade-offs [exist] in the redistricting process," Professor Emily Rong Zhang agrees.[58]

There's a good explanation for courts' and scholars' view that tradeoffs among traditional principles are rampant. It's that instances of such tradeoffs can readily be conceived. Suppose a city is strangely shaped (like Columbus, Ohio; Houston, Texas; Los Angeles, California; and many more).[59] Then a district that adheres to the city's boundaries is likely to be noncompact, and a compact district is likely not to follow the city's borders. In other words, a tradeoff may exist between compactness and respect for political subdivisions. The same logic applies to oddly

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51. Some of these academic claims are limited to traditional criteria, see supra note 9 and accompanying text; others extend to all redistricting objectives, see Hayes, supra note 13, at 1435.

52. See supra note 13.

53. Butler & Cain, supra note 13, at 1; see also Bruce E. Cain, The Reapportionment Puzzle 73 (1984) [hereinafter Cain, The Reapportionment Puzzle] ("[T]he various formalist criteria often conflict with one another.").

54. Hayes, supra note 13, at 1433.

55. Gimpel & Harbridge-Yong, supra note 7, at 453.

56. Nicholas Goedert, Robert Hildebrand, Matt Pierson, Laurel Travis & Jamie Fravel, Black Representation and District Compactness in Southern Congressional Districts, 13 Pol. Grps. & Identities 265, 265 (2025) [hereinafter Goedert et al., Black Representation and District Compactness].

57. Jacob S. Siegel, Geographic Compactness vs. Race/Ethnic Compactness and Other Criteria in the Delineation of Legislative Districts, 15 Population Rsch. & Pol'y Rev. 147, 150 (1996) (citing Cain, The Reapportionment Puzzle, supra note 53, at 52–53).

58. Emily Rong Zhang, Bolstering Faith With Facts: Supporting Independent Redistricting Commissions With Redistricting Algorithms, 109 Calif. L. Rev. 987, 991 (2021).

59. See Alasdair Rae, The Shapes of Cities, Under the Raedar (Sep. 14, 2015), http://www.undertheraedar.com/2015/09/the-shapes-of-cities.html [https://perma.cc/4V9C-8L6Z] (discussing the shape of these cities).

shaped communities of interest (like Native American reservations in Arizona,[60] affluent enclaves along California's coast,[61] Hispanic neighborhoods in and around Chicago,[62] and many others). Odds are, a district can be either compact or congruent with one of these communities. It probably can't be both. And notice that these communities all straddle multiple municipalities. This gives rise to another potential tradeoff: between respecting political subdivisions and respecting communities of interest. A district that traces a municipality's boundaries is apt to split a community, and vice versa.

This analysis is fine as far as it goes, but it's inherently *local* in its scope. It involves the design of just one, or at most a few, districts in a particular geographic area. Even if traditional criteria are at odds in a region within a district map, however, these clashes might not extend to the map as a whole. Elsewhere, it could be possible, or even simple, to achieve multiple redistricting goals simultaneously. If so, local tradeoffs wouldn't necessarily become global tradeoffs when criteria are assessed on a map-wide basis. This is one reason to be skeptical of assertions of pervasive tradeoffs among traditional principles.

Another is that, even where local tradeoffs can't be avoided entirely, they can often be mitigated by certain district configurations. Go back to the scenario of the strangely shaped city (though the point holds for most situations in which traditional criteria conflict). A *highly* compact district that *closely* follows the city's borders can't be drawn here. But that doesn't mean that either compactness or congruence with political subdivisions must be abandoned entirely. Instead, in many circumstances, a *reasonably*-compact district that *roughly* follows the city's borders *can* be crafted. Where this is feasible, the tradeoff between these criteria need not be too stark. In fact, it can be quite mild, with minor drop-offs from maximal compactness and congruence with political subdivisions enabling solid scores on both axes.

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60. See Patrick Martin, Don't Judge a District by Its Shape, Medium (Jan. 7, 2022), https://medium.com/@patrickmartinaz/dont-judge-a-district-by-its-shape-28614f8b3039 [https://perma.cc/SJK4-MHBX] (discussing the shape of these reservations).

61. See, e.g., 2020 Cal. Citizens Redistricting Comm'n, Report on Final Maps 12 (2021) https://wedrawthelines.ca.gov/wp-content/uploads/sites/64/2023/01/Final-Maps-Report-with-Appendices-12.26.21-230-PM-1.pdf [https://perma.cc/2ZX3-PET4] (identifying "coastal" communities as one of the "geographies" that comprise "California's diverse population").

62. See, e.g., Julia Boland & Yurij Rudensky, Don't Judge a District by Its Shape: Can You Spot the Gerrymandered Districts?, Portside (Sep. 19, 2021), https://portside.org/2021-09-19/dont-judge-district-its-shape [https://perma.cc/LW6Q-9B3X] (discussing the shape of these neighborhoods).

### B. *Partisan Gerrymandering Justifications*

Thanks to *Rucho*, partisan gerrymandering claims may no longer be brought in federal court.[63] For decades prior to *Rucho*, though, these suits could be filed[64]—and were filed, in considerable numbers, especially in the 2010s redistricting cycle.[65] Additionally, even after *Rucho*, partisan gerrymandering claims remain available under many state constitutions.[66] In both federal cases before *Rucho* and state cases to this day, the doctrinal standard for unlawful gerrymandering has commonly included three elements.[67] First, the district plan must have been enacted with partisan intent: the aim of advantaging the mapmaking party and handicapping the opposing party.[68] Second, the plan must produce a large and durable partisan effect: a sizable bias in favor of the mapmaking party likely to endure under a range of electoral conditions.[69] And third, and most relevant here, there must be no "legitimate, non-partisan justification" for this substantial and persistent skew.[70]

At this final stage of the inquiry, the fundamental issue is whether a tradeoff exists between partisan fairness and one or more valid nonpartisan goals. By this point, a court has found that a district plan is intentionally, sharply, and durably tilted in favor of the mapmaking party. The defendant then argues that this bias has an innocent origin: in the words of an influential district court opinion, that "it can be explained by the legitimate state prerogatives and neutral factors that are implicated in the districting process."[71] These "legitimate state prerogatives" denote

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63. See Rucho v. Common Cause, 139 S. Ct. 2484, 2506–07 (2019).

64. See Davis v. Bandemer, 478 U.S. 109, 113 (1986) (recognizing this cause of action).

65. See Nicholas O. Stephanopoulos & Eric M. McGhee, Partisan Gerrymandering and the Efficiency Gap, 82 U. Chi. L. Rev. 831, 876–78 (2015) [hereinafter Stephanopoulos & McGhee, Partisan Gerrymandering] (tallying partisan gerrymandering claims by cycle).

66. See Redistricting Litigation Roundup, Brennan Ctr. for Just. (Dec. 20, 2021), https://www.brennancenter.org/our-work/research-reports/redistricting-litigation-roundup-0 [https://perma.cc/HR7M-UBFQ] (last updated Dec. 17, 2025) (summarizing these and other claims in the 2020s redistricting cycle).

67. See, e.g., *Rucho*, 139 S. Ct. at 2516 (Kagan, J., dissenting) (noting that courts "around the country[] used basically the same three-part test"); Grisham v. Van Soelen, 2023-NMSC-027, 539 P.3d 272, 289 (N.M. 2023) ("For an equal protection claim asserting a partisan gerrymander . . . we adopt the three-part test articulated by Justice Kagan in her *Rucho* dissent . . . .").

68. See *Rucho*, 139 S. Ct. at 2516 (Kagan, J., dissenting).

69. See id.

70. See id.

71. Whitford v. Gill, 218 F. Supp. 3d 837, 911 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018); see also, e.g., Common Cause v. Rucho, 318 F. Supp. 3d 777, 867 (M.D.N.C. 2018), vacated on other grounds, 139 S. Ct. 2484 (2019) ("The justifi-

nonpartisan criteria that a state is required or chooses to use.[72] Similarly, "neutral factors" refer to a state's "natural political geography": the spatial patterns of a state's voters.[73] As mentioned above, traditional principles typically reflect these spatial patterns.[74] When there's a tradeoff between partisan fairness and one or more permissible nonpartisan objectives, then, the challenged plan is upheld. In this situation, the plan couldn't be less skewed while still comparably furthering these objectives. Conversely, when partisan fairness doesn't conflict with these objectives, the plan is struck down. Here, the plan could be more balanced without compromising nonpartisan interests.

Note that the very presence of the justification stage assumes that tradeoffs between partisan fairness and legitimate nonpartisan ends sometimes occur. If such tradeoffs never arose, the stage would serve no purpose beyond adding to the time, expense, and complexity of litigation. The plaintiff would always win, upon establishing partisan intent and the requisite partisan effect, because an adequate justification for a plan's bias would never be available. Put differently, the possibility of tradeoffs is the foundation of the justification stage. Without that prospect, the stage would be a useless doctrinal addendum: the legal equivalent of an appendix.[75]

For their part, certain scholars contend that tradeoffs between partisan fairness and traditional criteria are not merely *possible* but rather *prevalent*. These academics often employ the same method on which this Article relies: computational redistricting, in particular, the random generation of many district maps that comply with traditional principles but ignore partisanship.[76] In some of these studies, the resulting maps are consistently tilted in a Republican direction according to quantitative measures of partisan bias.[77] As one prominent article concludes, "tradi-

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cation prong examines whether districts' discriminatory partisan effects are justified by a legitimate state districting interest or neutral explanation.").

72. See, e.g., *Whitford*, 218 F. Supp. at 921 (discussing the "traditional districting criteria" used by Wisconsin's mapmakers).

73. Id. at 911.

74. See supra note 33 and accompanying text.

75. This is how the *Rucho* Court viewed the justification stage, albeit for a different reason: its supposed overlap with the partisan intent element. See *Rucho*, 139 S. Ct. at 2504 (noting that "[i]t is hard to see what the [justification] prong . . . adds to the inquiry" because it "just restates the question" posed by the partisan intent prong).

76. See, e.g., Jowei Chen & Jonathan Rodden, Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures, 8 Q.J. Pol. Sci. 239, 248–51 (2013).

77. See, e.g., Jonathan A. Rodden, Why Cities Lose: The Deep Roots of the Urban–Rural Political Divide 165–96 (2019) ("Democrats were far more packed in the enacted congressional districting plans than in the simulated plans . . . . This is because of a complex combination of racial and partisan gerrymandering."); Chen & Rodden, supra note 76, at 260–64 ("Average bias in favor of Republicans is substantial — surpassing 5% of legislative seats — in around half the states for which simulations were possible.").

tional districting principles" reliably yield "substantial electoral bias in favor of the Republican Party."[78] This clash between partisan fairness and adherence to traditional criteria is said to be "driven by a partisan asymmetry in voters' residential patterns."[79] "Democrats live disproportionately in dense, homogeneous neighborhoods in large cities that aggregate into landslide Democratic districts."[80] Meanwhile, Republicans "live in more sparsely populated suburban and rural neighborhoods that aggregate into districts that are . . . more politically heterogeneous[] and moderately Republican."[81]

Scholars also frequently claim that partisan fairness is inversely related to minority representation: the volume of minority-preferred candidates elected to office. In fact, this argument is so widespread it has its own name: the "perverse effects" thesis.[82] As one article puts it, "a rough consensus" holds that "drawing districts that contain a majority of minority voters . . . hurts the Democratic Party more broadly."[83] The reasoning that leads to this view is as follows: Minority voters are a heavily Democratic cohort. Majority-minority districts therefore tend to be heavily Democratic, too, electing minority-preferred candidates by enormous, inefficient margins. Moreover, for minority voters to be placed in majority-minority districts, they must be removed from other adjacent districts. Those districts thus become less diverse and more conservative, potentially flipping from Democratic to Republican control. As long as the flipped districts outnumber any newly created Democratic majority-minority districts, the effort to elect more minority-preferred candidates skews the map in its entirety in a Republican direction.

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78. Chen & Rodden, supra note 76, at 264.

79. Id.

80. Id.

81. Id.

82. See, e.g., Joseph Simons & Daniel J. Mallinson, Party Control and Perverse Effects in Majority-Minority Districting: Replication Challenges When Using DW-NOMINATE, 6 Stat. Pol. & Pol'y 19, 21–23 (2015) ("There is a small, but vibrant, literature centered around the substantive outcomes of majority-minority districting . . . . Scholars argue that majority-minority districting was actually having a perverse-effect on substantive representation of Blacks.") (citations omitted) (citing David Lublin, The Paradox of Representation: Racial Gerrymandering and Minority Interests in Congress (1997); Carol M. Swain, Black Faces, Black Interests: The Representation of African Americans in Congress (1995); Charles Cameron, David Epstein & Sharyn O'Halloran, Do Majority-Minority Districts Maximize Substantive Black Representation in Congress?, 90 Am. Pol. Sci. Rev. 794 (1996); Kevin A. Hill, Does the Creation of Majority Black Districts Aid Republicans? An Analysis of the 1992 Congressional Elections in Eight Southern States, 57 J. Pol. 384 (1995); Keisuke Nakao, Racial Redistricting for Minority Representation Without Partisan Bias: A Theoretical Approach, 23 Econ. & Pol. 132 (2011)).

83. Adam B. Cox & Richard T. Holden, Reconsidering Racial and Partisan Gerrymandering, 78 U. Chi. L. Rev. 553, 555 (2011); see also, e.g., Election Law: Cases and Materials 235 (Daniel Hays Lowenstein et al. eds., 7th ed. 2022) (identifying a "tension between descriptive and substantive representation" for minority members).

Consequently, a tradeoff emerges between partisan fairness and minority representation.[84]

Like the earlier assertions about tradeoffs among traditional principles, these claims that partisan fairness conflicts with legitimate nonpartisan aims should be taken with a grain of salt. With respect to partisan fairness and traditional criteria, the country's political geography has recently changed.[85] Cities have grown somewhat less Democratic, suburbs have switched from majority-Republican to majority-Democratic, and exurban and rural areas have turned much more Republican.[86] Thanks to these shifts, it's no longer the case that Democratic districts are inherently more packed than Republican districts. Instead, both parties' districts now exhibit comparable partisan profiles.[87] Additionally, even when Democratic strongholds were bluer than Republican bastions were red, careful redistricting choices were still capable of producing fair (or even pro-Democratic) maps. Such maps may not have been the most *likely* outcomes of the line-drawing process, but they still tended to be *feasible* results.[88]

With respect to partisan fairness and minority representation, likewise, minority voters have become substantially less Democratic, and white voters marginally more so, over the last few elections.[89] These trends have made majority-minority districts less safe—and more efficient—for minority-preferred candidates than in prior periods.[90] These trends have also propelled some hotly contested majority-white districts from Republican to Democratic hands.[91] More fundamentally, *majority-minority* districts are usually unnecessary to elect minority-preferred candidates. Thanks to crossover support from white voters, these candidates can win, in many circumstances, even when districts have minority popu-

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84. For a longer discussion of this argument, see Nicholas O. Stephanopoulos, Aligning Election Law 210–17 (2024) [hereinafter Stephanopoulos, Aligning Election Law].

85. See Nicholas O. Stephanopoulos, Election Law for the New Electorate, 17 J. Legal Analysis 42, 70–71 (2025) [hereinafter Stephanopoulos, Election Law for the New Electorate].

86. See id. (documenting these trends).

87. See id. at 70 (discussing relevant empirical findings).

88. For example, states including California, Illinois, Minnesota, and New Jersey had mildly pro-Democratic congressional plans in the 2010s despite presumably having pro-Republican political geographies. See Score Electoral District Maps, U.S. House, 2012, PlanScore, https://planscore.org/#!2012-ushouse [https://perma.cc/Y84C-BCB2] (last visited Jan. 25, 2026).

89. See Stephanopoulos, Election Law for the New Electorate, supra note 85, at 55–61 (summarizing this partial racial depolarization).

90. In some cases, these trends have even led to minority-preferred candidates losing in majority-minority districts. See, e.g., id. at 58–59 (describing Texas's 23rd congressional district in the 2010s).

91. See, e.g., id. at 59 (describing Georgia's 7th congressional district in the 2010s).

lation shares below fifty percent.[92] Crucially, these crossover districts, unlike conventional majority-minority districts, aren't typically decided by huge, wasteful margins. These districts therefore attenuate, or even eliminate, the tradeoff between partisan fairness and minority representation. They make possible the election of more minority-preferred candidates without tilting the map as a whole toward Republicans.[93]

### C. *Racial Vote Dilution*

In partisan gerrymandering doctrine, the pursuit of minority representation is a potential *justification* for a district plan's bias. In racial vote dilution cases under Section 2 of the VRA, on the other hand, greater minority representation is the *objective* of the litigation. The claim in these cases is that minority voters are currently underrepresented by their preferred candidates—but would achieve adequate representation under a different electoral system, such as an alternative set of district lines. "The essence of a § 2 claim," the Supreme Court explained in the momentous 1986 case, *Thornburg v. Gingles*, "is that a certain electoral law . . . interacts with social and historical conditions to cause an inequality in the opportunities enjoyed by [minority] and white voters to elect their preferred representatives."[94]

Importantly, racial vote dilution plaintiffs must do more to prevail than merely show that greater minority representation is possible. Rather, under *Gingles*'s first prong, they must establish that at least one more "geographically compact" majority-minority district could be created.[95] This language suggests that compactness is the only criterion that an additional majority-minority district has to satisfy. In more recent cases, however, the Court has substituted "reasonably configured" for "compact."[96] "A district will be reasonably configured," the Court has

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92. See William D. Hicks, Carl E. Klarner, Seth C. McKee & Daniel A. Smith, Revisiting Majority-Minority Districts and Black Representation, 71 Pol. Rsch. Q. 408, 418 (2018) (displaying probabilities of electing Black legislators for districts of varying racial compositions in the deep South and border South).

93. For a longer version of this argument, see Jowei Chen & Nicholas O. Stephanopoulos, The Race-Blind Future of Voting Rights, 130 Yale L.J. 862, 941–46 (2021) [hereinafter Chen & Stephanopoulos, Race-Blind Future].

94. 478 U.S. 30, 47 (1986). The Supreme Court's recent decision in *Louisiana v. Callais*, Nos. 24-109, 24-110, 2026 WL 1153054 (U.S. Apr. 29, 2026), doesn't directly contradict this longstanding view, but it does frame the point of Section 2 much more as preventing purposeful racial discrimination. See, e.g., id. at *12 ("[T]he focus of § 2 must be enforcement of the Fifteenth Amendment's prohibition on *intentional* racial discrimination.").

95. *Gingles*, 478 U.S. at 50.

96. E.g., Allen v. Milligan, 143 S. Ct. 1487, 1503 (2023) ("With respect to the first *Gingles* precondition, the District Court correctly found that black voters could constitute a majority in a second district that was 'reasonably configured.'" (quoting Emergency Application for Stay at 253, *Allen*, 143 S. Ct. 1487 (No. 21-1086))); Wis. Legislature v. Wis.

elaborated, "if it comports with traditional districting criteria."[97] Under modern precedent, then, racial vote dilution plaintiffs must submit demonstration maps that include, relative to the status quo, at least one more majority-minority district that's compliant with traditional principles.[98]

Undergirding this requirement is an implicit view about redistricting tradeoffs: They must sometimes arise between greater minority representation and majority-minority districts' adherence to traditional criteria. When these tradeoffs exist, this part of *Gingles*'s first prong has real bite. In these situations, more majority-minority districts can be designed only by making them less respectful of traditional principles. If this drop-off is large enough, additional, reasonably-configured, majority-minority districts can't be drawn, meaning that plaintiffs can't succeed under Section 2. Conversely, if greater minority representation never clashed with majority-minority districts' compliance with traditional criteria, this aspect of *Gingles*'s first prong would lose much of its punch. In that case, plaintiffs could satisfy this element of the prong simply by showing that the minority population in an area could support more majority-minority districts.[99] By hypothesis, those districts would never be unreasonably configured. For this part of *Gingles*'s first prong to be a substantial hurdle, then, tradeoffs between additional majority-minority districts and their performance in terms of traditional principles must occur at least occasionally.

In the academy, some scholars argue that these tradeoffs occur frequently, not only sporadically. "Preserving county lines, requiring contiguity[,] and requiring geographic compactness clearly . . . disadvantage dispersed minorities," writes social scientist Micah Altman.[100] Focusing on explicit compactness criteria, Professors Jason Barabas and Jennifer Jerit find that the presence of a "compactness standard has a negative and statistically significant effect on the number of majority-minority

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Elections Comm'n, 142 S. Ct. 1245, 1248 (2022) (clarifying the *Gingles* first prong as "[t]he minority group must be sufficiently large and compact to constitute a majority in a *reasonably configured* district" (emphasis added)).

97. *Allen*, 143 S. Ct. at 1503; see also, e.g., Abrams v. Johnson, 521 U.S. 74, 92 (1997) ("[T]he § 2 compactness inquiry should take into account 'traditional districting principles such as maintaining communities of interest and traditional boundaries.'" (quoting Bush v. Vera, 517 U.S. 952, 977 (1996))).

98. In *Louisiana v. Callais*, the Court added the further requirement that plaintiffs' demonstration maps must achieve jurisdictions' political goals (which may include partisan advantage). See Nos. 24-109, 24-110, 2026 WL 1153054, at *13, *15 (U.S. Apr. 29, 2026).

99. After *Callais*, these additional majority-minority districts would also have to be compatible with the jurisdiction's political objectives.

100. Micah Altman, Districting Principles and Democratic Representation 27 (Mar. 31, 1998) (Ph.D. dissertation, California Institute of Technology), https://thesis.caltech.edu/1871/9/dissertation_full.pdf [https://perma.cc/VTL3-9YQE].

congressional districts in a state."[101] Looking at districts' actual compactness (not whether this criterion is codified), Goedert and his coauthors "observe a negative correlation between Black representation and compactness in historical maps enacted since the 1970s."[102] And examining computer-generated maps, Professor Justin Levitt identifies a "tradeoff between compactness and [the] number of majority-minority seats," albeit one that lessens where there's "a higher degree of [residential] clustering by race."[103]

Why do courts and scholars think that greater minority representation often conflicts with majority-minority districts' adherence to traditional criteria? It might be because scenarios in which these goals are at odds are easy to devise. To illustrate, suppose minority residents are concentrated in several clusters that are separated by mostly white neighborhoods. Also assume these clusters are relatively small, so most or all of them must be combined to form a new majority-minority district. Then that district is likely to be shaped quite strangely, reaching this way and that to absorb the far-flung clusters. If the clusters are located in multiple jurisdictions or communities, the district must also breach these entities' boundaries in its effort to amass enough minority residents.

Moreover, these facts are far from fanciful. Instead, they characterize numerous Supreme Court cases involving racial gerrymandering claims (the subject of the next section). In a 1993 case, North Carolina crafted a new majority-Black district that wound "in snakelike fashion through tobacco country, financial centers, and manufacturing areas 'until it gobble[d] in enough enclaves of black neighborhoods.'"[104] In a 1995 case, a new majority-Black district in Georgia "connect[ed] the black neighborhoods of metropolitan Atlanta and the poor black populace of coastal Chatham County, though 260 miles apart in distance and worlds apart in culture."[105] In a 1996 case, Texas drew a new majority-Hispanic district that resembled a "sacred Mayan bird" and "exhibit[ed] utter disregard of city limits [and] local election precincts."[106] After all this high-profile litigation, it's unsurprising that many observers came to believe

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101. Jason Barabas & Jennifer Jerit, Redistricting Principles and Racial Representation, 4 State Pol. & Pol'y Q. 415, 422 (2004).

102. Goedert et al., Black Representation and District Compactness, supra note 56, at 267.

103. Justin Mark Levitt, Introducing "Clustering:" Redistricting in Geographic Perspective, at xvi, 130 (2016) (Ph.D. dissertation, University of California, San Diego) (on file with the *Columbia Law Review*).

104. Shaw v. Reno, 509 U.S. 630, 635–36 (1993) (quoting Shaw v. Barr, 808 F. Supp. 461, 476–77 (E.D.N.C. 1992) (Voorhees, C.J., concurring in part and dissenting in part)).

105. Miller v. Johnson, 515 U.S. 900, 908 (1995).

106. Bush v. Vera, 517 U.S. 952, 974 (1996) (plurality opinion) (internal quotation marks omitted) (quoting Michael Barone & Grant Ujifusa, Almanac of American Politics 1996, at 1335 (1995)).

that majority-minority districts' reduced compliance with traditional principles is regularly the price of greater minority representation.

Again, though, this belief shouldn't be taken as gospel. Some minority residents may reside in scattered clusters within mostly white regions. But many others live in large, relatively homogeneous communities, for example, in the cores of cities across the country.[107] In these places, it would be harder for majority-minority districts to *flout* traditional criteria than to heed them. Additionally, even where the local political geography features dispersed clusters of minority residents, majority-minority districts can sometimes incorporate these clusters without appearing too odd. One of the hallmarks of redistricting is the near-infinite number of possible district configurations. In this vast pool of options, mapmakers may be able to find majority-minority districts that link clusters of minority residents without relying on tentacles, protuberances, and the like.[108]

### D. *Racial Gerrymandering*

Racial vote dilution is one of the two causes of action that involve race and redistricting. The other is racial gerrymandering, which refers to designing a specific district for a predominantly racial reason. Under this doctrine, strict scrutiny applies if "race was the predominant factor motivating the legislature's decision to place a significant number of voters within or without a particular district."[109] Unlike a racial vote dilution claim, a racial gerrymandering claim doesn't overtly seek to improve minority representation. To the contrary, it's capable of *worsening* minority representation if it leads to the dismantling of a district, drawn for a predominantly racial reason, in which minority voters formerly elected their preferred candidate.

Racial gerrymandering plaintiffs may introduce several types of evidence to prove that race predominated over other redistricting factors. The most common of these, according to the Supreme Court, are indicia that "the State 'subordinated' race-neutral districting criteria such as compactness, contiguity, and core preservation to 'racial considerations.'"[110] Nonracial motives often induce jurisdictions to adhere to tradi-

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107. See Benjamin Elbers, Trends in U.S. Residential Racial Segregation, 1990 to 2020, Socius, 2021, at 2 (showing declining but still very high levels of residential racial segregation in the United States).

108. A nice example is that the bizarre district at issue in *Shaw* was eventually redrawn with a more regular shape that still included enough minority voters to elect a minority-preferred candidate. See Easley v. Cromartie, 532 U.S. 234, 258 (2001) (showing maps of the revised district).

109. *Miller*, 515 U.S. at 916.

110. Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1234 (2024) (quoting *Miller*, 515 U.S. at 916).

tional principles. If jurisdictions *don't* abide by these principles while achieving some racial goal, a reasonable inference is that race was the primary driver and nonracial factors were secondary in influence. As the Court has put it, "a conflict or inconsistency between the enacted [district] and traditional redistricting criteria" is "persuasive circumstantial evidence tending to show racial predomination."[111] Without such evidence, "in many cases," "challengers will be unable to prove an unconstitutional racial gerrymander."[112]

This aspect of racial gerrymandering law can be translated into this Article's terminology of tradeoffs. Plaintiffs have an incentive to demonstrate that a challenged district traded compliance with traditional principles for the realization of a racial objective. If plaintiffs can make this showing, the conclusion that the district was crafted for a predominantly racial reason likely follows.[113] In contrast, if plaintiffs *can't* identify a tradeoff between traditional criteria and a racial aim, they face a steep uphill struggle. "[T]here may be cases where challengers will [still] be able to establish racial predominance in the absence of an actual conflict" of this kind.[114] "In general," however, if traditional principles don't vie against a racial goal, "it may be difficult for challengers to find other evidence sufficient to show that race was the overriding factor."[115]

A "racial" goal in this context can be many things. It can be a wish to comply with Section 2 of the VRA, correctly understood.[116] It can be trying to satisfy Section 2 in cruder, more legally dubious ways, like setting numerical floors[117] or targets[118] for certain districts' proportions of minority voters. Or it can be using race as a rough proxy for partisanship,

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111. Bethune-Hill v. Va. State Bd. of Elections, 580 U.S. 178, 190 (2017).

112. Id.

113. Notably, a political motive like partisan advantage or incumbent protection can also explain a challenged district's disregard for traditional criteria. So such disregard doesn't necessarily establish racial predominance. See, e.g., Cooper v. Harris, 581 U.S. 285, 308 (2017) ("[P]olitical and racial reasons are capable of yielding similar oddities in a district's boundaries.").

114. *Bethune-Hill*, 580 U.S. at 191.

115. Id. at 190. "[T]his Court to date has not [ruled in favor of racial gerrymandering plaintiffs] without evidence that some district lines deviated from traditional principles." Id.

116. See, e.g., Allen v. Milligan, 143 S. Ct. 1487, 1511 (2023) (plurality opinion) (holding that "race did not predominate in [demonstration] maps" that properly construed Section 2).

117. See, e.g., Ala. Legis. Black Caucus v. Alabama, 575 U.S. 254, 276 (2015) (involving a policy of "maintaining the same population percentages in majority-minority districts as in the prior plan").

118. See, e.g., *Cooper*, 581 U.S. at 299 (involving a policy that "African-Americans should make up no less than a majority of the voting-age population").

unrelated to any concern about obeying Section 2.[119] Any of these purposes, if it entails the subordination of traditional criteria, can result in a district being ruled an unlawful racial gerrymander.

Note that tradeoffs function differently here than in other redistricting doctrines. In partisan gerrymandering and racial vote dilution cases, the objective that might be subject to a tradeoff is the very aspiration of the cause of action: reduced partisan bias and greater minority representation, respectively. Here, on the other hand, a racial motive is inherently *suspect*, not *desirable*—a presumptive violation of the Equal Protection Clause's colorblindness principle if it predominates over nonracial factors.[120] Relatedly, the *defendant* wins in partisan gerrymandering and racial vote dilution cases if the right sort of tradeoff is present. This makes sense because, in these situations, the aim of the legal theory can't be attained without collateral damage. Here, however, the *plaintiff* is apt to prevail if a challenged district spurns traditional principles for a racial reason. Again, this follows from the nature of the claim because a racial reason is, doctrinally, something to be avoided—not pursued at the cost of nonracial ends.[121]

As discussed above, some enacted districts have plainly subordinated traditional criteria to racial considerations. The 1990s, in particular, were a decade when numerous mapmakers sacrificed compactness and respect for political subdivisions' and communities' borders in order to create new majority-minority districts.[122] Once more, though, the fact that these tradeoffs *have* been made doesn't mean they should be expected to regularly *recur*. In certain places, voters' spatial patterns make it straightforward to achieve racial goals without disregarding traditional principles.[123] In others, the simultaneous realization of racial and nonracial objectives takes more work but can still be done thanks to the huge volume of potential district configurations.[124] In both these settings, the tradeoffs at the heart of most (successful) racial gerrymandering suits are unneces-

119. See, e.g., id. at 308 n.7 ("[I]f legislators use race as their predominant districting criterion with the end goal of advancing their partisan interests . . . their action still triggers strict scrutiny.").

120. See, e.g., Students for Fair Admissions, Inc. v. President and Fellows of Harvard Coll., 143 S. Ct. 2141, 2175 (2023) (approvingly citing Justice Harlan's famous statement that "[o]ur Constitution is color-blind") (quoting Plessy v. Ferguson, 163 U.S. 537, 559 (1896) (Harlan, J., dissenting)).

121. A further, subtler distinction is that, in partisan gerrymandering and racial vote dilution cases, the issue is whether the relevant tradeoff arises in hypothetical maps. In racial gerrymandering cases, in contrast, the issue is whether an enacted district trades compliance with traditional criteria for the achievement of a racial goal.

122. See supra notes 104–106 and accompanying text.

123. See supra note 107 and accompanying text.

124. See supra note 108 and accompanying text.

sary. Mapmakers may still *choose* to make the tradeoffs here—but, if so, these are discretionary, not obligatory, decisions.

## II. IDENTIFYING TRADEOFFS

Much of redistricting *law* is built on the prospect of tradeoffs among line-drawing criteria. But the same can't be said of redistricting *scholarship*. Few studies explicitly examine redistricting tradeoffs: how changes along one dimension are linked (or not) to changes along one or more other parameters. The little work in this genre is also limited in several respects. Pieces typically address only a single state. They tend to consider just one pair of criteria. And they never analyze large numbers of district maps that accurately reflect the relevant map universe.

In this Part, I first survey the small existing literature on redistricting tradeoffs. Despite its drawbacks, it does suggest (consistent with my findings here) that tradeoffs among line-drawing objectives are often mild, not severe. I then introduce the Article's methods. The core of this project is a new collection of state-of-the-art map ensembles. These ensembles are, in several respects, the most comprehensive created to date, including 14.7 billion total maps for twenty-one congressional delegations and state legislative chambers. Unlike most other publicly available ensembles, each of these sets is also demonstrably representative of the near-infinite number of maps that could be drawn for each delegation or chamber pursuant to the specified parameters. After generating the ensembles, the next step is scoring the resulting maps. I focus on the maps' performance along five dimensions. Two correspond to traditional criteria: compactness and congruence with political subdivisions. The other three involve maps' electoral consequences: partisan fairness, competitiveness, and minority representation.

### A. *Prior Literature*

The view that redistricting tradeoffs are an underexplored subject isn't mine alone. "There is little scholarly research on the inability of one criterion to constrain another," write Micah Altman and Professor Michael McDonald.[125] "[L]ittle scholarship . . . empirically assesses how the application of one criterion affects another not just in theory but in real-world map drafting," concur Gimpel and Harbridge-Yong.[126] Levitt similarly comments that "the literature on tradeoffs is rather conjectural" because "many tradeoffs . . . have never been properly studied."[127]

125. Altman & McDonald, Redistricting by Formula, supra note 7, at 107.

126. Gimpel & Harbridge-Yong, supra note 7, at 453.

127. Levitt, supra note 103, at 64.

Much of the extant work on the relations among line-drawing criteria is restricted to a single state. For instance, Altman and McDonald are the authors of two articles on redistricting tradeoffs. One scrutinizes Florida congressional maps in the 2010s;[128] the other looks at Ohio congressional maps in the same decade.[129] Likewise, data scientist Rahul Swamy is the lead author of two more pertinent papers. One uses Arizona congressional maps in the 2020s as a case study,[130] while the other investigates Wisconsin congressional maps in the same cycle.[131] Slightly broader in scope, a couple pieces evaluate tradeoffs in two states, not just one. State house maps for Arizona and Washington in the 2000s are Justin Levitt's topic,[132] while data scientist Zachary Schutzman's is congressional maps for North Carolina and Pennsylvania in the 2010s.[133] In this modest literature, the only more expansive studies are by Goedert and his coauthors (covering congressional maps for nine southern states)[134] and by data scientist Wes Gurnee and Professor David Shmoys (tackling congressional maps for thirty-eight states).[135]

Most work in this area is limited in not just its geographic range but also the line-drawing criteria that are considered. Both Gurnee and Shmoys[136] and Schutzman[137] solely examine the connection between compactness and partisan fairness. Goedert and his coauthors only analyze the tradeoff between compactness and minority representation.[138] One of the articles by Swamy's team addresses the link between compactness and competitiveness alone,[139] while the other probes the correlations among compactness, partisan fairness, and competitiveness.[140]

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128. See Altman & McDonald, Paradoxes of Political Reform, supra note 8, at 173.

129. See Altman & McDonald, Redistricting by Formula, supra note 7, at 110.

130. See Swamy et al., A Practical Optimization Framework, supra note 9, at 2.

131. See Rahul Swamy, Douglas M. King & Sheldon H. Jacobson, Multi-Objective Optimization for Politically Fair Districting: A Scalable Multilevel Approach, 71 Operations Rsch. 536, 537 (2022) [hereinafter Swamy et al., Multi-Objective Optimization]; see also, e.g., Cain et al., supra note 10, at 3 (considering California congressional and state legislative maps in the 2000s).

132. See Levitt, supra note 103, at 67.

133. See Zachary Schutzman, Trade-Offs in Fair Redistricting, in Proceedings of the 2020 AAAI/ACM Conference on AI, Ethics, and Society 159, 162 (2020).

134. See Goedert et al., Black Representation and District Compactness, supra note 56, at 265–66.

135. See Wes Gurnee & David B. Shmoys, Fairmandering: A Column Generation Heuristic for Fairness-Optimized Political Districting 9 (June 25, 2021) (unpublished manuscript), https://arxiv.org/pdf/2103.11469 [https://perma.cc/GU62-HS8P].

136. See id. at 8–9.

137. See Schutzman, supra note 133, at 162–64.

138. See Goedert et al., Black Representation and District Compactness, supra note 56, at 276–91.

139. See Swamy et al., A Practical Optimization Framework, supra note 9, at 13–16.

140. See Swamy et al., Multi-Objective Optimization, supra note 131, at 553–59.

Levitt assesses the tradeoffs among compactness, competitiveness, and minority representation.[141] Only Altman and McDonald take into account a fuller set of redistricting goals (for Ohio congressional maps): compactness, congruence with county boundaries, partisan fairness, competitiveness, and minority representation.[142]

One more shortcoming of this literature is its reliance on district maps that don't faithfully mirror the relevant map universe. Most studies generate maps using *optimization* algorithms that seek to *maximize* performance in terms of one or two parameters. This is the approach taken by Goedert and his coauthors (optimizing for compactness and minority representation),[143] Gurnee and Shmoys (optimizing for partisan fairness),[144] Levitt (optimizing successively for various objectives),[145] Schutzman (optimizing for compactness and partisan fairness),[146] and Swamy's team (optimizing for compactness and competitiveness).[147] Optimization algorithms have their advantages, but the maps they produce are necessarily unrepresentative of the universe of *non*-optimized maps. A few other studies peruse maps designed by humans (not computers). Cain and his coauthors craft maps themselves for California.[148] Altman and McDonald inspect maps proposed during Florida's[149] and Ohio's[150] 2010s rounds of redistricting. These human-drawn maps almost certainly don't reflect all the lawful maps that could have been created for each congressional delegation or state legislative chamber.

Notwithstanding these methodological concerns, this work consistently points in the same substantive direction. Namely, tradeoffs among redistricting criteria appear to be mostly gentle, not steep. For example, in Gurnee and Shmoys' analysis of congressional maps for thirty-eight states, the correlations between compactness and partisan fairness gener-

141. See Levitt, supra note 103, at 75–78.

142. See Altman & McDonald, Redistricting by Formula, supra note 7, at 113–23 (also considering population equality); see also Altman & McDonald, Paradoxes of Political Reform, supra note 8, at 173–81 (considering the same criteria except for competitiveness); cf. Cain et al., supra note 10, at 33–36 (reporting, but not directly analyzing, scores along multiple dimensions).

143. See Goedert et al., Black Representation and District Compactness, supra note 56, at 278.

144. See Gurnee & Shmoys, supra note 135, at 6–7.

145. See Levitt, supra note 103, at 67–68 (compactness, competitiveness, or minority representation).

146. See Schutzman, supra note 133, at 162.

147. See Swamy et al., A Practical Optimization Framework, supra note 9, at 8–11.

148. See Cain et al., supra note 10, at 3.

149. See Altman & McDonald, Paradoxes of Political Reform, supra note 8, at 173.

150. See Altman & McDonald, Redistricting by Formula, supra note 7, at 114.

ally hover around zero.[151] Based on these results, the authors surmise that "compactness and fairness are orthogonal attributes of a district plan."[152] Similarly, in the study by Goedert and his coauthors of congressional maps for nine southern states, the Pareto frontiers for compactness and minority representation are relatively flat.[153] This indicates that, "while there is a slight trade-off necessary between these two dimensions," "we can come close to maximizing both goals simultaneously if we are willing to make minimal sacrifices on both ends."[154]

The absence of sharp tradeoffs is also the theme of the articles that cover one or two states. Altman and McDonald find that, in Ohio, "the Pareto frontier is quite flat" for each pair among partisan fairness, competitiveness, and minority representation.[155] Accordingly, "not much trade-off is required across these criteria," and "one can do relatively well on all three criteria at once."[156] Schutzman shows that, in North Carolina and Pennsylvania, "the general shapes of the observed Pareto frontiers are the same" for compactness and partisan fairness.[157] In these states, "one can dramatically increase the achiev[able] compactness score by relaxing the demand for a high partisan [fairness] score a little bit."[158] And Swamy's team plots both all their algorithmically created maps for Arizona and just maps on the Pareto frontier for compactness and competitiveness.[159] In the plot of all maps, the correlation between these variables is modest.[160] Their Pareto frontier is fairly flat as well.[161]

Again, given the limitations of this literature, these conclusions should be seen as tentative at best. But they do start to challenge the judicial and academic consensus portrayed in the previous Part: that tradeoffs among redistricting criteria are prevalent. Not so, at least with respect to the few states, the few criteria, and the unrepresentative maps assessed to date. These conclusions also support a working hypothesis that common line-drawing objectives tend to be weakly related. The point of this project is to test this hypothesis much more rigorously than

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151. See Gurnee & Shmoys, supra note 135, at 9.

152. Id. at 8.

153. See Goedert et al., Black Representation and District Compactness, supra note 56, at 276, 282.

154. Id. at 280.

155. Altman & McDonald, Redistricting by Formula, supra note 7, at 119.

156. Id.; see also Altman & McDonald, Paradoxes of Political Reform, supra note 8, at 176 (showing scatter plots for different pairs of criteria for Florida congressional maps, in which the correlations between variables are generally weak).

157. Schutzman, supra note 133, at 162.

158. Id.

159. See Swamy et al., A Practical Optimization Framework, supra note 9, at 15.

160. See id.

161. See id.

prior work has done. I therefore turn next to describing the Article's methods and data.

### B. *Methodology*

1. *District Map Ensembles.* — It's no exaggeration that computational redistricting—the use of computer algorithms to generate large numbers of district maps—has revolutionized the field. In her dissent in *Rucho*, Justice Elena Kagan endorsed "what might be called the 'extreme outlier approach'" to identifying aggressive partisan gerrymanders.[162] This refers to "lin[ing] up those [algorithmically produced] maps on a continuum" and then "see[ing] where the State's actual plan falls on the spectrum."[163] Partisan gerrymandering cases both before and after *Rucho* have relied heavily on this technique.[164] Likewise, in racial vote dilution suits under Section 2 of the VRA, plaintiffs sometimes use race-conscious algorithms to find maps that satisfy *Gingles*'s first prong.[165] In the 2023 Supreme Court case, *Allen v. Milligan*, Alabama also argued (unsuccessfully) that the output of a *race-blind* algorithm should be the benchmark for measuring this type of dilution.[166] In racial gerrymandering suits, too, plaintiffs increasingly compare enacted districts to corresponding districts in algorithmically created maps.[167] In the 2024 case, *Alexander v. South Carolina State Conference of the NAACP*, the Court accepted this method—so long as the algorithm includes all the jurisdiction's nonracial criteria.[168]

Outside the courtroom, as well, computational redistricting has obvious applications. Think of a "good" mapmaker (maybe an independent commission or court) who wants to comply with traditional criteria while fairly representing partisan and racial groups. This might be difficult for an unassisted human in certain circumstances. But the task

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162. Rucho v. Common Cause, 139 S. Ct. 2484, 2518 (2019) (Kagan, J., dissenting).

163. Id.

164. See, e.g., id. (noting that this technique "also has recently been used in Michigan and Ohio litigation"); Jonathan Cervas, Bernard Grofman, Scott Matsuda & Justine Kawa, Partisan Gerrymandering Cases in State Supreme Courts in the 2020 Redistricting Round, 87 Alb. L. Rev. 1089, 1119–29 (2024) (discussing the evidence cited by state supreme courts in 2020s partisan gerrymandering cases).

165. See, e.g., Brief of Computational Redistricting Experts as *Amici Curiae* in Support of Appellees and Respondents at 33–36, Allen v. Milligan, 143 S. Ct. 1487 (2023) (Nos. 21-1086, 21-1087), 2022 WL 2873387, at *33–36 (discussing this approach).

166. See *Allen*, 143 S. Ct. at 1506–07 (describing Alabama's proposal).

167. See, e.g., Brief for *Amici Curiae* Nicholas O. Stephanopoulos and Jowei Chen in Support of Appellees at 6–19, Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221 (2024) (No. 22-807), 2023 WL 5671010, at *6–19 (summarizing racial gerrymandering cases where this technique was used).

168. See *Alexander*, 144 S. Ct. at 1243 (stating that, to be probative, this method must not "'ignore[] certain traditional districting criteria' such as geographical constraints and the legislature's partisan interests.") (quoting *Allen*, 143 S. Ct. at 1512)).

could be greatly facilitated by a computer algorithm able to efficiently explore far more of the relevant map universe.[169] Or, since this technology is morally agnostic, take an inveterate gerrymanderer who wishes to disguise a biased plan by shaping districts that satisfy traditional criteria. Again, it might be hard for a human, alone, to craft an effective "stealth" gerrymander—but markedly easier with the aid of an algorithm that quickly surveys the vast landscape of possible maps.[170]

The new map ensembles that are the basis of this project are generated by an algorithm known as "Recombination" (or "ReCom").[171] This algorithm begins with a randomly drawn seed map composed of the appropriate number of contiguous, reasonably-compact districts of roughly the same population.[172] The algorithm then makes a (very) long series of iterative changes to this starting map. In each iteration, two adjacent districts are randomly selected, merged, and then randomly repartitioned to form two new districts.[173] ReCom thus produces a chain of maps in which each map is the same as its immediate predecessor except for the two districts that were joined and then split anew. ReCom can run for as long as a user wants, yielding a map chain whose length has no necessary limit.[174]

ReCom has several properties that make it more attractive than earlier redistricting algorithms. Each of its iterations makes a much larger change to the prior map in the chain than the "Flip" algorithm that used to be common in this context.[175] (Each Flip step simply switches one geographic subunit, such as a precinct, from one district to another adjacent district.[176]) ReCom can also incorporate a range of line-drawing criteria including contiguity, compactness, population equality, respect for the boundaries of geographic subunits, partisan goals, and compliance with Section 2 of the VRA.[177] In contrast, less advanced algorithms can

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169. See Zhang, supra note 58, at 1012 ("[A]lgorithms can also perform optimization functions to more directly help commissions find good maps.").

170. Cf. Jowei Chen & Nicholas O. Stephanopoulos, Democracy's Denominator, 109 Calif. L. Rev. 1019, 1054 (2021) [hereinafter Chen & Stephanopoulos, Democracy's Denominator] (programming an algorithm "to maximize the numbers of Democratic or Republican districts while still complying to the same extent with all of the nonpartisan criteria specified previously").

171. See Tapp et al., supra note 11, at 1; Daryl DeFord, Moon Duchin & Justin Solomon, Recombination: A Family of Markov Chains for Redistricting, Harv. Data Sci. Rev., Winter 2021, at 1 (introducing this algorithm).

172. See DeFord et al., supra note 171 at 14 (discussing seed plan maps).

173. See id. at 19–21 (discussing the ReCom step that characterizes this algorithm).

174. See id. at 49 (discussing ReCom "runs of varying lengths").

175. See, e.g., id. at 10 (noting that "many of the techniques used in litigation have been Flip-based").

176. See, e.g., id. at 18–19 (discussing the Flip algorithm).

177. See id. at 14–16 (discussing available ReCom parameters); see also, e.g., Chen & Stephanopoulos, Democracy's Denominator, supra note 170, at 1045 (using ReCom with

only be instructed to consider a subset of these criteria.[178] And most importantly, ReCom is relatively efficient at generating map ensembles that are representative of the target distribution of maps that satisfy the specified objectives. In one exercise, ten thousand ReCom iterations achieved representativeness, while one billion Flip steps failed to do so.[179]

ReCom has four basic parameters that can be adjusted, of which two relate to districts' compactness, one is how closely districts adhere to county (or other subunit) boundaries, and one is districts' degree of population equality.[180] The defaults for this project's map ensembles are as follows: Both knobs pertaining to districts' compactness are set to favor more over less compact districts.[181] The county-preservation knob is set at an intermediate level that tends to produce comparable numbers of county splits to those seen in many enacted plans.[182] And the population-equality knob is set at plus or minus one percent for congressional maps and plus or minus five percent for state legislative maps (thresholds close to what the law requires).[183] Because these defaults might have substantive implications, however, I also conduct robustness checks in which I analyze map ensembles created with different settings for each parameter.

It bears noting that these defaults are similar, but not identical, to the redistricting criteria used by many states.[184] For instance, a state

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partisan goals); Chen & Stephanopoulos, Race-Blind Future, supra note 93, at 932–33 (using ReCom with racial goals).

178. See, e.g., Chen & Rodden, supra note 76, at 249–51 (incorporating only contiguity, compactness, and population equality).

179. See DeFord et al., supra note 171, at 27–28.

180. This is true of the faster Rust implementation of ReCom. See frcw.rs (Fastest ReCom Chain in the West), GitHub, https://github.com/mggg/frcw.rs [https://perma.cc/6EUJ-P5PD] (last visited Jan. 24, 2026); see also Recom (frcw), GerryTools, https://gerrytools.readthedocs.io/en/latest/user/mgrp/#recom-frcw [https://perma.cc/7A4D-4EN6] (last visited Jan. 24, 2026). The Python implementation of ReCom is somewhat more flexible. See GerryChain, GitHub, https://github.com/mggg/GerryChain [https://perma.cc/TJJ3-M8TH] (last visited Jan. 24, 2026).

181. See Tapp et al., supra note 11, at 4–5. Technically, the Kruskal (not the Wilson) algorithm is used for generating random spanning trees, and the cut edges (not the district pairs) method is used for randomly combining districts. See, e.g., Sarah Cannon, Moon Duchin, Dana Randall & Parker Rule, Spanning Trees and Redistricting: New Methods for Sampling and Validation 13 (Nov. 18, 2025) (unpublished manuscript) (on file with the *Columbia Law Review*) (discussing these options).

182. Technically, a 0.75 value (on a scale from 0 to 1) is used for the region surcharge parameter.

183. See Brown v. Thomson, 462 U.S. 835, 842 (1983) ("[A state legislative] apportionment plan with a maximum population deviation under 10% falls within this category of minor deviations."); Wesberry v. Sanders, 376 U.S. 1, 7–8 (1964) ("[A]s nearly as is practicable one man's vote in a congressional election is to be worth as much as another's.").

184. For a helpful list of these criteria, see Redistricting Criteria, supra note 27.

might not possess a compactness or a county preservation requirement (or might enforce one more or less stringently than the algorithm generically does). Or a state could follow additional rules not taken into account here, such as adhering to the boundaries of municipalities or communities of interest.[185] For these reasons, this project's map ensembles should be seen as suggestive, not authoritative, as to the distributions of maps that fully comply with states' respective criteria. To make more confident claims about how maps typically perform in a given state, a more tailored appraisal based on the state's specific requirements is advisable.

Each new ensemble for this project is made up of twenty thousand maps sampled at an interval of every twenty-five hundred iterations from a chain of fifty million maps.[186] These chains are *very* long compared to most ReCom chains generated in past scholarship and litigation.[187] The rationales for sampling from the chains (rather than using them in their entirety) are twofold. First, it's impractical (in that it takes too long) to score all the chains' maps (whose total volume is close to fifteen billion). Second, a sampling interval of every 2,500 steps ensures that each map is independent of the immediately preceding map in the ensemble. To illustrate, Figure 1 plots the average Reock compactness of the districts in each map in the default North Carolina congressional ensemble versus the average compactness of the districts in the immediately preceding map.[188] (For reasons I explain below, I use North Carolina at the congressional level as my principal case study in this Article.[189]) As is visually apparent, essentially no relationship exists between the mean compactness of each map and that of the map before it. The Spearman correlation between these variables is close to zero (0.01), and the locally weighted best fit line is nearly flat.[190]

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185. ReCom can certainly implement these and other rules (if, for instance, communities of interest are identified so the algorithm can avoid splitting them). See supra note 177 and accompanying text.

186. See Tapp et al., supra note 11, at 4.

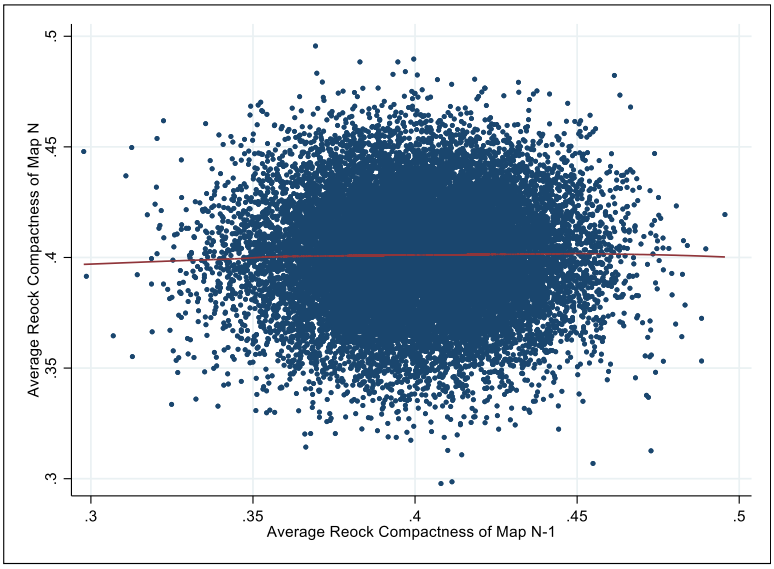
187. See, e.g., DeFord et al., supra note 171, at 7, 28, 49 (running Recom for one-hundred thousand, ten thousand, and twenty thousand steps, respectively).

188. Reock compactness is a measure of how circular (as opposed to oblong or elongated) a district is. See, e.g., Ernest C. Reock, Jr., A Note: Measuring Compactness as a Requirement of Legislative Apportionment, 5 Midwest J. Pol. Sci. 70, 71 (1961).

189. See infra section III.A.

190. See Tapp et al., supra note 11, at 9 (also using "autocorrelation measurements to help indicate whether the sample is sufficient"). For a similar demonstration that maps in another ensemble are independent of their immediately preceding maps, see Chen & Stephanopoulos, Race-Blind Future, supra note 93, at 895–96.

FIGURE 1. AVERAGE REOCK COMPACTNESS OF MAP N VS. AVERAGE REOCK COMPACTNESS OF MAP N-1, DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE




This project covers new congressional, state senate, and state house ensembles for seven priority states.[191] Three of these are highly competitive swing states: Michigan, North Carolina, and Wisconsin. Two are large and Democratic-leaning states: Illinois and New York. Two more are big states that tilt toward Republicans: Florida and Ohio. Together, these ensembles include many more maps, produced using many more parameters, than any prior, publicly available collection.[192] These ensembles, supplemented by the ALARM sets of maps, are also by far the largest ever used to investigate tradeoffs among line-drawing criteria.[193] For each delegation or chamber, fourteen new ensembles are created.[194] Of these, ten

191. See Tapp et al., supra note 11, at 3.

192. By comparison, the ALARM ensembles include a total of only about 200,000 maps, or 0.001% of the maps produced for this project. See McCartan et al., supra note 12.

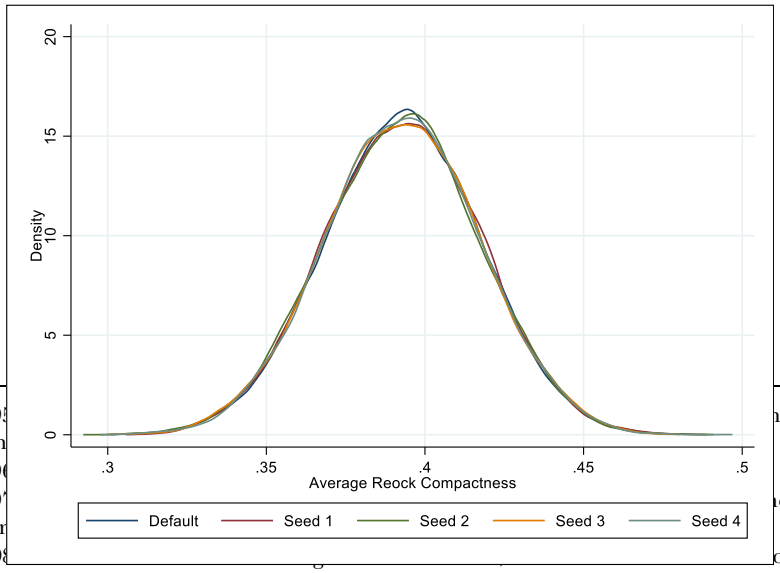
193. See supra section II.A (discussing earlier work in this genre).

194. See Tapp et al., supra note 11, at 4–5. Again, in contrast, the ALARM Project uses a pair of chains to create a single default map ensemble for each congressional delegation. See McCartan et al., supra note 12.

vary the settings for ReCom's four basic parameters (two involving compactness, one for county preservation, and one for population equality). Another four ensembles use the default setting for each parameter but begin from different seed maps.[195]

The motivation for generating the additional ensembles from different seed maps is to confirm that the resulting distributions of maps are the same no matter where each chain began.[196] These distributions *should* be the same if the algorithm is, in fact, briskly and randomly exploring the relevant map universe. To show that the distributions *are* the same, for North Carolina at the congressional level and for average district compactness, Figure 2 displays density curves of the mean compactness of the maps in the default ensemble[197] and in the four ensembles stemming from different seed maps. It's again clear to the eye that these curves are virtually identical, exhibiting nearly indistinguishable shapes. A statistical test verifies that the curves are drawn from the same underlying distribution, namely, the universe of maps produced with the default ReCom settings.[198]

FIGURE 2. DENSITY CURVES OF AVERAGE REOCK COMPACTNESS, NORTH CAROLINA CONGRESSIONAL ENSEMBLES

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19 …o samples come from the same underlying distribution. See, e.g., Benjamin Fifield, Kosuke Imai, Jun Kawahara & Christopher T. Kenny, The Essential Role of Empirical Validation in Legislative Redistricting Simulation, 7 Stat. & Pub. Pol'y 52, 63, 67 (2020) (using the Kolmogorov-Smirnov test in the context of redistricting algorithms). With respect to the average Reock compactness of the maps in each pair of ensembles, the Kolmogorov-Smirnov test produces a statistically insignificant p-value, indicating no meaningful difference between these distributions. See also Tapp et al., supra note 11, at 8 (using similar "convergence heuristics to provide robust evidence that our samples were independent of the initial seed plans and sufficient for drawing statistical conclusions").

One more test using these map ensembles examines their respective variances in terms of quantities of interest. If the within-ensemble variances are very similar and the between-ensemble variance is very small, the ensembles are said to have "converged," or attained the properties of the target distribution. Conversely, if the within-ensemble variances differ and the between-ensemble variance is substantial, convergence has not been reached.[199] This test, too, indicates that the algorithm is operating as intended—both for North Carolina at the congressional level and for all other congressional delegations and state legislative chambers.[200]

2. *Redistricting Criteria.* — *Creating* the new map ensembles for this project is only half the battle. The other half is *scoring* all the maps along various dimensions. This is done by software unrelated to the redistricting algorithm itself, which runs after the algorithm generates the desired number of maps. This software harnesses three types of data. The first is geographic data about the locations and boundaries of precincts, districts, and counties.[201] The second is data from the U.S. Census about the total population and population by racial or ethnic group of each geographic unit. And the third is electoral data at the precinct level, generally averaging presidential, senatorial, gubernatorial, and state attorney general election results from 2016 to 2020.[202]

With all this data, the maps in the ensembles can be scored along many axes.[203] I focus on five categories of criteria that feature prominently in the doctrine and scholarship on redistricting. The first is districts' *compactness*: how regularly or irregularly they're shaped. Reock compactness—the ratio between a district's area and the area of the smallest circle that completely encloses the district—is my primary measure here.[204] A district has a higher (better) Reock score when its form is more circular, and vice versa.[205] Alternatively, I consider Polsby-Popper

199. The value produced by this test is known as the Gelman-Rubin statistic. See, e.g., Fifield et al., supra note 198, at 63, 65–66 (reporting the Gelman-Rubin statistic in the context of redistricting algorithms).

200. See Tapp et al., supra note 11, at 9 ("[F]or each state, chamber and score, the Gelman-Rubin $\check{R}$-statistic is less than 1.00045 for all pairs of the five ensembles.").

201. This data consists of unpublished GeoJSON files generously made available by Dave's Redistricting.

202. For more on this election composite, see Alec Ramsay, Election Composites, Medium (Feb. 7, 2020), https://medium.com/dra-2020/election-composites-13d05ed07864 (on file with the *Columbia Law Review*). The electoral data itself comes from the Voting and Election Science Team. See Brian Amos, Steven Gerontakis & Michael McDonald, United States Precinct Boundaries and Statewide Partisan Election Results, Sci. Data, Oct. 29, 2024, at 4–6, https://www.nature.com/articles/s41597-024-04024-2 (on file with the *Columbia Law Review*).

203. See Tapp et al., supra note 11, at 5–6.

204. See Reock, supra note 188, at 71.

205. See id.

compactness: the ratio between a district's area and the area of a circle whose circumference is equal to the district's perimeter.[206] A district has a higher (better) Polsby-Popper score when its borders are smoother, and vice versa.[207]

The second category is districts' *congruence with counties*. I use counties instead of other political subdivisions (like municipalities) because of counties' greater significance in redistricting. As Professor James Gardner observes, "the basic unit of legislative representation was widely understood throughout [much of American history] to be the county."[208] I primarily operationalize district-county congruence through a county-splitting metric that captures the extent to which districts divide counties in a map. This metric weights county splits by how many people they affect and ranges upward from 1.0 (denoting no divided counties). Alternatively, I employ a *district*-splitting metric that indicates the degree to which *counties* divide *districts* in a map. This metric is otherwise identical to the first one.[209]

The third category is the *partisan fairness* of district maps: how neutrally they treat political parties. My primary measure here is the efficiency gap, which refers to the difference between parties' shares of "wasted" votes (votes cast for losing candidates or for winning candidates in excess of the threshold for victory).[210] The partisan gerrymandering techniques of cracking and packing waste the votes of the targeted party's supporters, respectively, by dispersing these voters among many districts and concentrating them in a few districts.[211] As an alternative metric, I use the declination, which first requires plotting a plan's districts in order from lowest to highest vote share. Two lines are then

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206. See Daniel D. Polsby & Robert D. Popper, The Third Criterion: Compactness as a Procedural Safeguard Against Partisan Gerrymandering, 9 Yale L. & Pol. Rev. 301, 348–51 (1991). Polsby-Popper compactness is my alternative (not my primary) measure because (1) it's sensitive to the resolution of districts and (2) jagged district borders can be the result of natural features (like coastlines) or congruence with other units (like counties or municipalities) that themselves have uneven perimeters. See Stephen Ansolabehere & Maxwell Palmer, A Two Hundred-Year Statistical History of the Gerrymander, 77 Ohio St. L.J. 741, 747 (2015) ("[Polsby-Popper scores] are extremely sensitive to the resolution of the map . . . . [T]here is not an easy adjustment to correct for complex geography.").

207. See Polsby & Popper, supra note 206, at 350 ("[D]istricts with appendages or indentations will always score worse than those without.").

208. James A. Gardner, Foreword: Representation Without Party: Lessons from State Constitutional Attempts to Control Gerrymandering, 37 Rutgers L.J. 881, 918 (2006).

209. For more information on these metrics, see Alec Ramsay, Measuring County & District Splitting, Medium (June 3, 2020), https://medium.com/dra-2020/measuring-county-district-splitting-48a075bcce39 (on file with the *Columbia Law Review*).

210. See Stephanopoulos & McGhee, Partisan Gerrymandering, supra note 65, at 850–53 (introducing the efficiency gap).

211. See id. (discussing how the efficiency gap captures the sum of a map's cracking and packing choices).

drawn, one between the mean Democrat-won district and the fifty percent axis and another between the mean Republican-won district and the fifty percent axis. The angle between these lines is the declination.[212]

Fourth, I look at districts' *competitiveness*: how close their elections tend to be. I primarily evaluate competitiveness by calculating the average margin of victory of the winning candidates in all districts.[213] A lower average margin of victory means a district map is more competitive, on net, and vice versa.[214] Alternatively, I compute the share of districts in a map that are won by fewer than ten percentage points. The higher this fraction, the more competitive the map is as a whole, and vice versa.[215]

Fifth, I examine *minority representation* under each map: the extent to which minority-preferred candidates are likely to be elected. My primary measure here is the share of all districts that are minority-opportunity districts, that is, districts in which minority voters are usually able to elect their candidates of choice.[216] Consistent with prior work, I define an opportunity district as one where (1) the minority-preferred candidate wins the general election, and (2) minority voters who support the minority-preferred candidate outnumber white voters backing that candidate, provided that (3) minority voters of different racial groups are aggregated only if each group favors the same candidate.[217] The necessary data to implement this definition is produced through ecological inference.[218] In this context, this method leverages information about precincts' election results and demographic compositions to predict how

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212. See Gregory S. Warrington, Quantifying Gerrymandering Using the Vote Distribution, 17 Election L.J. 39, 41–42 (2018) (introducing the declination). I use the declination over other measures of partisan fairness because, unlike them, it's usable in all electoral environments. See Nicholas O. Stephanopoulos & Eric M. McGhee, The Measure of a Metric: The Debate over Quantifying Partisan Gerrymandering, 70 Stan. L. Rev. 1503, 1561 (2018) [hereinafter Stephanopoulos & McGhee, Measure of a Metric] (finding that other metrics "become less usable as elections grow less competitive statewide"). I use the efficiency gap as my primary metric here because of its high profile and strong performance along several dimensions. See id. at 1516–35, 1557–67.

213. More specifically, I average the difference between the winning candidate's vote share in each district and fifty percent.

214. See, e.g., Stephanopoulos & McGhee, Measure of a Metric, supra note 212, at 1522–24 (analyzing competitiveness using the average margin of victory).

215. See Alec Ramsay, Competitiveness, Medium (June 13, 2020), https://medium.com/dra-2020/competitiveness-1bcbe4e2d788 [https://perma.cc/8WMQ-VTA2] (discussing this measure of competitiveness).

216. The term "minority-opportunity districts" is derived from the language of Section 2 of the VRA, which imposes liability when minority "members have less opportunity . . . to elect representatives of their choice." 52 U.S.C. § 10301(b) (2018).

217. See Nicholas Stephanopoulos, Eric McGhee & Christopher Warshaw, Non-Retrogression Without Law, 2023 U. Chi. Legal F. 267, 281–83 (discussing this definition of opportunity districts in more detail).

218. See Gary King, A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data 7–27 (1997) (introducing ecological inference).

members of different racial groups voted.[219] I rely on a separate precinct-level model for each state.[220] Each model yields distinct estimates of Black, Hispanic, and other (mostly white) votes for Democratic and Republican candidates in each precinct.

As an alternative metric of minority representation, I use the share of all districts that are majority-minority districts: districts in which adult minority citizens comprise a majority of the citizen voting-age population. The Supreme Court has warned against designing districts with an "announced racial target," for example, that "African-Americans should make up no less than a majority of the voting-age population."[221] But the Court has also held that, in racial vote dilution cases under Section 2 of the VRA, the first *Gingles* prong is satisfied "[o]nly when a geographically compact group of minority voters could form a *majority* in a single-member district."[222] Given these dueling precedents, it seems appropriate to consider the share of majority-minority districts—but to deprioritize this fraction compared to the share of minority-opportunity districts.

One last point: As noted above, the first *Gingles* prong refers to minority-opportunity (or majority-minority) districts' compliance with traditional criteria.[223] I therefore supplement the measures of *all* districts' average compactness and county splitting with analogous scores for minority-opportunity (or majority-minority) districts *alone*.[224] These scores for subsets of districts enable analyses of how the volume of minority representation is related to minority-opportunity (or majority-minority) districts' adherence to traditional requirements.

## III. ANALYZING TRADEOFFS

Having set the stage, I now present the Article's findings about tradeoffs among redistricting criteria. First, I conduct a thorough case study of congressional maps for North Carolina. Second, I discuss (in somewhat less detail) *all* the new map ensembles on which this project

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219. See Gary King, Ori Rosen & Martin A. Tanner, Information in Ecological Inference: An Introduction, *in* Ecological Inference: New Methodological Strategies 1, 1–2 (Gary King, Ori Rosen & Martin A. Tanner eds., 2004) (discussing ecological inference in the context of estimating racial groups' voting behavior).

220. Each is a hierarchical multinomial-Dirichlet model for ecological inference in R × C tables, as developed in Ori Rosen, Wenxin Jiang, Gary King & Martin A. Tanner, Bayesian and Frequentist Inference for Ecological Inference: The R × C Case, 55 Statistica Neerlandica 134 (2001), and implemented using the eiPack in R.

221. Cooper v. Harris, 581 U.S. 285, 299–300 (2017).

222. Bartlett v. Strickland, 556 U.S. 1, 26 (2009) (plurality opinion) (emphasis added).

223. See supra section I.C.

224. I only use the district-splitting metric for these districts because the county-splitting metric is inappropriate for a subset of a map's districts.

relies. Third, I confirm that my conclusion that tradeoffs among line-drawing goals are generally mild holds when I consider the completely different ALARM map ensembles. Fourth, I use a recent court-drawn North Carolina congressional plan to demonstrate that *local* tradeoffs among redistricting criteria *do* exist—but fade and eventually vanish as more districts are reshaped. Finally, I explore the Pareto frontiers of the map ensembles and show that, for the most part, they're both flat and distant from enacted plans.

### A. *North Carolina Congressional Ensembles*

Both legally and politically, North Carolina is a natural place to start examining redistricting tradeoffs. As to law, remarkably, the state was the defendant in arguably the most important Supreme Court cases in the areas of racial vote dilution, racial gerrymandering, *and* partisan gerrymandering. In *Gingles* in 1986, the Court struck down several multimember state legislative districts in North Carolina and announced the framework that has governed racial vote dilution suits under Section 2 of the VRA ever since.[225] In the 1993 case of *Shaw v. Reno*, the Court recognized a cause of action for racial gerrymandering and strongly suggested that, under this theory, North Carolina's Twelfth Congressional District was unconstitutional.[226] And in *Rucho* in 2019, the Court upheld North Carolina's congressional plan against a partisan gerrymandering challenge and deemed such claims nonjusticiable under the federal Constitution.[227]

Politically, the state is similar to the country in terms of partisanship and race. In the most recent presidential election, the popular vote in North Carolina was within two percentage points of the popular vote nationwide.[228] North Carolina's racial composition is even closer to that of the United States; in both, non-Hispanic white individuals account for slightly more than sixty percent of the population.[229] Of course, North

225. See Thornburg v. Gingles, 478 U.S. 30, 48–51, 80 (1986).

226. 509 U.S. 630, 635–36, 642–52 (1993).

227. See Rucho v. Common Cause, 139 S. Ct. 2484, 2491–92, 2508 (2019).

228. See Election 2024: Presidential Results, CNN Politics, https://www.cnn.com/election/2024/results/president?admin1=37&election-data-id=2024-PG&selected-election-data-id=2024-PG-NC&election-painting-mode=projection-with-lead&filter-key-races=false&filter-flipped=false&filter-remaining=false [https://perma.cc/U9S2-B722] (last visited Feb. 12, 2026) (showing that Donald Trump won North Carolina's popular vote by 3.2 percentage points and the popular vote nationwide by 1.5 percentage points in 2024).

229. See QuickFacts North Carolina, U.S. Census Bureau, https://www.census.gov/quickfacts/fact/table/NC/PST045224 (on file with the *Columbia Law Review*) (last visited Feb. 12, 2026); QuickFacts United States, U.S. Census Bureau, https://www.census.gov/quickfacts/fact/table/US/PST045224 (on file with the *Columbia*

Carolina is a relatively large state, too, with more than eleven million residents and fourteen congressional districts.[230] Congressional redistricting in the state thus has a nontrivial impact on the national balance of power.

Figure 3, then, includes a series of scatter plots for the maps in the default North Carolina congressional ensemble, each displaying the maps' scores along two dimensions. In sum, the primary criteria I listed earlier could be paired in more than twenty ways.[231] Instead of perusing all these pairings, I highlight seven that are especially salient in the case law and literature on redistricting.[232] One of these is the association between the traditional requirements of compactness and county congruence. Four more are the links between partisan fairness and various factors that might affect it: compactness, county congruence, competitiveness, and minority representation. The last two are the connections between minority representation and the compactness and county congruence of minority-opportunity districts. In each scatter plot, each point denotes a map in the ensemble and a locally weighted best fit line captures the (smoothed) relationship between the variables.

In most of these charts, few if any signs of tradeoffs between redistricting criteria are evident. Take the traditional requirements of compactness and county congruence. The relevant scatter plot (in the top row) is an amorphous blob of points. The Spearman correlation between maps' average Reock compactness and county splitting is very weak (-0.06).[233] The locally weighted best fit line is close to flat. And in the vast majority of the map ensemble, simultaneous improvement along both criteria is possible. Except at the lower right frontier, that is, alternative maps exist that are both more compact and more respectful of county boundaries than any given map.

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*Law Review*). However, compared to the United States as a whole, North Carolina's population is more African American and less Hispanic. See id.

230. See QuickFacts United States, supra note 229.

231. See supra section II.B.2 (identifying seven primary criteria that could be paired in twenty-one ways).

232. See supra Part I & section II.A (discussing these materials).

233. All correlations reported in this Part are Spearman correlations, which are preferable to conventional Pearson correlations when data isn't normally distributed and relationships between variables may not be linear. See Data Science and Beyond, Choosing the Right Correlation: Pearson vs. Spearman vs. Kendall's Tau, Medium (Oct. 3, 2023), https://ishanjainoffical.medium.com/choosing-the-right-correlation-pearson-vs-spearman-vs-kendalls-tau-02dc7d7dd01d [https://perma.cc/J6HL-UX98] ("Kendall and Spearman [correlations] are more robust to outliers and non-linear relationships compared to Pearson.").

The story is the same for the first three partisan fairness charts, plotting the absolute value of the efficiency gap[234] versus average Reock compactness, county splitting, and the average margin of victory. Each of these charts is comprised of a scattershot barrage of points. The correlation between each pair of variables is slight (respectively, 0.08, 0.00, and 0.14). Each locally weighted best fit line is more or less horizontal. And almost everywhere in the map ensemble, there are other maps that, compared to a particular map, are both fairer in partisan terms and superior along the other dimension (compactness, county congruence, or competitiveness).

In the fourth partisan fairness chart, however, a nontrivial relationship appears between the absolute value of the efficiency gap and the share of minority-opportunity districts.[235] As minority representation increases, partisan fairness tends to improve as well. But this link is the *opposite* of the one posited by many courts and scholars. They typically expect minority representation and partisan fairness to be *substitutes*, not *complements*.[236] Moreover, too much shouldn't be made of this seeming connection. The correlation between the absolute efficiency gap and the share of minority-opportunity districts is still modest (-0.36). And except where minority representation is near its apogee, alternative maps can concurrently perform better (or worse) than any given map along both these axes.

This leaves the two minority representation charts, plotting the share of minority-opportunity districts versus their average Reock compactness and district splitting. On the whole, these charts show no consistent relationships between these variables. The correlations between the variable pairs are insubstantial (respectively, 0.01 and 0.02). And it's almost always possible to replace a particular map with other maps containing more minority-opportunity districts that are more compliant with traditional requirements. These charts' locally weighted best fit lines, though, do reveal some nonlinear links. As minority-opportunity districts grow more compact, minority representation initially tends to rise but then begins to fall. Minority representation exhibits the same up-then-down pattern as counties divide more minority-opportunity districts. These nonlinear associations are certainly interesting, but they don't alter the preliminary conclusion that redistricting tradeoffs are largely absent here.

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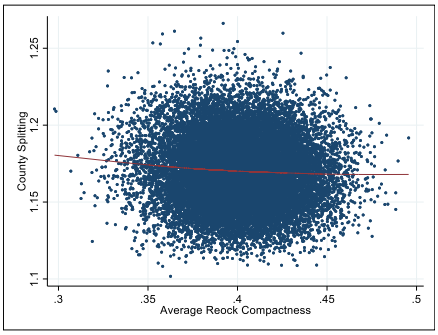
234. While the net efficiency gap indicates which party benefits from redistricting, the absolute efficiency gap denotes the size of a map's bias (no matter whom it favors). See Stephanopoulos & McGhee, Partisan Gerrymandering, supra note 65, at 871.

235. Because minority-opportunity district status is binary, the share of minority-opportunity districts is necessarily a discrete, not a continuous, variable.

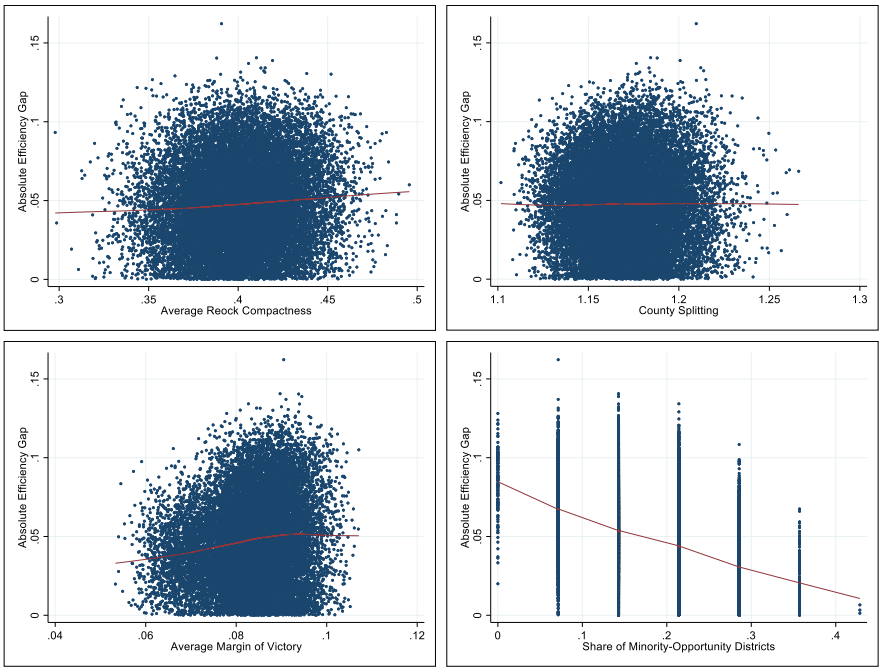
236. See supra notes 82–84 and accompanying text.

FIGURE 3. SCATTER PLOTS OF PRIMARY CRITERIA PAIRS, DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE

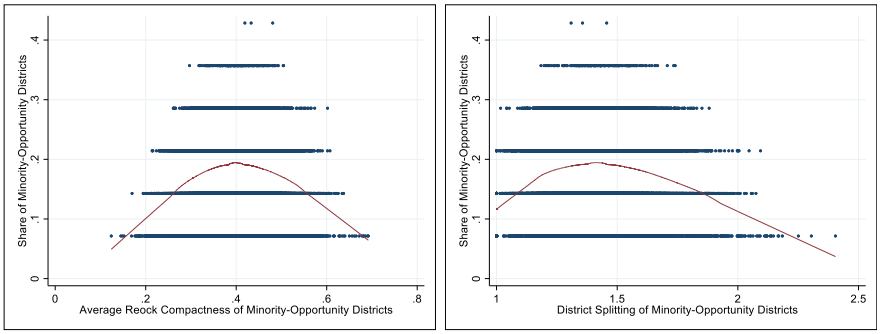
(a) Traditional Criteria




(b) Partisan Fairness



(c) Minority Representation




I call this conclusion preliminary because it has yet to be tested by different methods or data. First off, remember that this project includes numerous map ensembles per congressional delegation or state legislative chamber—not just the default ensemble. Again, these other ensembles are generated using alternative settings for ReCom's basic parameters or alternative seed maps.[237] One might worry that the results presented to this point are idiosyncratic to the default North Carolina congressional ensemble. In other words, tradeoffs among line-drawing criteria could be more common in the other ensembles, which some observers may prefer to the default set of maps.

To address this concern, Appendix A displays a separate chart of correlations for each of the seven pairs of variables described above.[238] Each chart plots these relationships for each of the ten North Carolina congressional ensembles (including the default ensemble) that vary ReCom's basic parameters. (The four ensembles that vary the seed map are omitted because they're virtually identical to the analogous ensemble produced from the usual starting point.[239] These charts are also omitted here in the interest of space.)

Like the correlations for the default North Carolina congressional ensemble, most of the correlations for the other ensembles are very weak. Fully forty-three of these sixty-three correlations are smaller (in their absolute value) than 0.1. Only nine are larger than 0.3—a common threshold for a moderate relationship[240]—all for the absolute efficiency gap versus the share of minority-opportunity districts. The correlations for the other ensembles are also very similar in magnitude to those for

237. See supra notes 194–195 and accompanying text.

238. See supra note 232 and accompanying text.

239. See supra notes 197–198 and accompanying text.

240. See, e.g., Haldun Akoglu, User's Guide to Correlation Coefficients, 18 Turk. J. Emergency Med. 91, 92 (2018) (showing assessments of correlations of different strengths by field).

the default ensemble. In six of the seven charts in Appendix A, no other ensemble's correlation for the given pair of variables differs from the default ensemble's correlation by more than 0.1. The only exception is for county splitting versus average Reock compactness, for which the ensembles sort into two groups based on whether they place some or no weight on following county boundaries. Consequently, widening the analytical lens from one ensemble to ten makes almost no substantive difference. Redistricting tradeoffs are no more perceptible in the alternative ensembles than in the default set of maps.

Next, recall that I rely on a primary *and* a secondary measure within each category of criteria. To reiterate, the secondary measures are Polsby-Popper compactness, district splitting, the declination, the share of competitive districts, and the share of majority-minority districts.[241] Might there be tradeoffs among *these* metrics (in the default North Carolina congressional ensemble), even though there mostly aren't among the primary metrics? Appendix B indicates that the answer is no. It consists of seven scatter plots identical to those in Figure 3 (and again omitted here to save space) except that their axes are the secondary measures, not the primary ones. In six of these seven charts, there are no appreciable links between the variables. The points are scattered widely; the correlations are anemic (below 0.2); the locally weighted best fit lines are nearly flat; and simultaneous improvement relative to any given map is almost always possible.[242]

The sole exception is the plot of district splitting versus average Polsby-Popper compactness, in which more compact districts tend to be divided by fewer counties. But this isn't a tradeoff at all. Less district splitting and greater compactness are both *desirable* (all else equal). If they often go hand in hand, this makes mapmakers' jobs easier, not harder. Additionally, the correlation between these variables is still far from impressive (-0.32). And in most parts of the map ensemble, a particular level of district splitting or compactness is compatible with a wide range of scores along the other dimension. This nontrivial connection, then, hardly undermines the overall narrative of infrequent redistricting tradeoffs.

A further threat to this narrative might be the bivariate nature of all the relationships I've probed so far. Perhaps tradeoffs seldom arise when two criteria are considered in isolation—but *do* commonly materialize when other variables are controlled for. To dispel this doubt, I run a series of regressions in which the dependent variables are, respectively, county splitting, the absolute efficiency gap, and the share of minority-

241. See supra section II.B.2.

242. The charts involving the share of majority-minority districts also aren't very meaningful because, in the default North Carolina congressional ensemble, this fraction only ever has two values corresponding to one majority-minority district or none.

opportunity districts (that is, the variables on the y-axes in Figure 3). The independent variables are all the other measures in my set of primary criteria. The results of these regressions show how each pair of criteria is connected when other variables are held constant, not allowed to vary freely.

According to these results, there *are* statistically significant associations between most pairs of criteria (all but the share of minority-opportunity districts versus their district splitting). But this statistical significance is an artifact of the large volume of maps in the default North Carolina congressional ensemble and doesn't indicate that the links are *practically* meaningful. To illustrate, in the regression in which county splitting is the dependent variable, the coefficient for average Reock compactness is negative and statistically significant. But when the output of this regression is used to plot predicted county splitting for different values of compactness (holding all other variables at their means), these predictions are essentially indistinguishable from the linear best fit line for these variables. Moreover, both the predicted values and the linear best fit line are nearly flat. Put another way, the substantive conclusion is the same—that no material tradeoff exists between county splitting and compactness—whether other variables are fixed or fluctuate at random. Appendix C includes both this chart and comparable ones for the other pairs of criteria (once more omitted here for the sake of space).

A final objection might be that, even if few tradeoffs exist between *pairs* of criteria, concurrent progress along *multiple* dimensions could often be impossible. Mapmakers, of course, must heed a range of factors when they draw district lines, not just two. Maybe tradeoffs do become inevitable when this full set of criteria is taken into account. To investigate this possibility, in Figure 4, I start by plotting county congruence versus compactness for all maps in the default North Carolina congressional ensemble. So far, the chart is identical to the first one in Figure 3. I then impose a series of increasingly strict conditions: whether maps score in the top quartile in partisan fairness; whether they score in the top quartile in partisan fairness *and* competitiveness; and whether they score in the top quartile in partisan fairness, competitiveness, *and* minority representation. The maroon points are maps that satisfy the partisan fairness condition. The green points are maps that satisfy the joint partisan fairness and competitiveness condition. And the gold points are maps that satisfy the joint partisan fairness, competitiveness, and minority representation condition.

Figure 4 demonstrates that many North Carolina congressional maps simultaneously score well along all these dimensions. Look at the lower right quadrant, in which maps exhibit both high compactness and high county congruence. There are hundreds of maroon, green, and gold points in this quadrant, denoting maps that also perform strongly in terms of partisan fairness (maroon), partisan fairness and competitiveness (green), and partisan fairness, competitiveness, and

minority representation (gold). The overall distributions of the maroon, green, and gold points are also notable. If compactness and/or county congruence generally had to be sacrificed to score well on other axes, these distributions would be skewed toward the left (low compactness) and/or the top (low county congruence). But almost no such skewing is visible in the chart.[243] Instead, the distributions of the maroon, green, and gold points closely resemble the pattern of the navy points, representing maps on which no conditions are imposed. Not only are high compactness and high county congruence *compatible* with good scores on all other measures, then, but compliance with traditional criteria only mildly even *constrains* the pursuit of other goals.

While Figure 4 establishes that many North Carolina congressional maps avoid even multivariate tradeoffs, some readers may wish to see examples of these high-performing maps. Figure 5 therefore shows the actual district boundaries of four maps. These maps all score in the top quartile in compactness, county congruence, and competitiveness, and in the top *decile* in partisan fairness and minority representation.[244] In numerical terms, the maps have an average Reock compactness of at least 0.42, a county-splitting score no higher than 1.15, an average margin of victory no higher than 7.9 percent, an absolute efficiency gap no higher than 1.3 percent, and a minority-opportunity district share of at least 28.6 percent.[245] Significantly, the maps also achieve these excellent results in quite different ways. Their district configurations are plainly distinct, not minor variations on a single theme. At least at the North Carolina congressional level, multiple line-drawing strategies can thus yield similarly strong scores on an array of metrics.

243. Squinting a bit, the distribution of the gold points includes somewhat fewer maps with excellent county-splitting scores.

244. I tighten the conditions for partisan fairness and minority representation both because these ends are frequently the goals of redistricting plaintiffs and to reduce the number of sample maps to a manageable number.

245. These numerical scores are necessarily excellent by North Carolina standards—their excellence is why these maps were chosen—but are hard to assess in any more general sense.

FIGURE 4. COUNTY SPLITTING VS. AVERAGE REOCK COMPACTNESS, MAPS SATISFYING CERTAIN CONDITIONS IN DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE

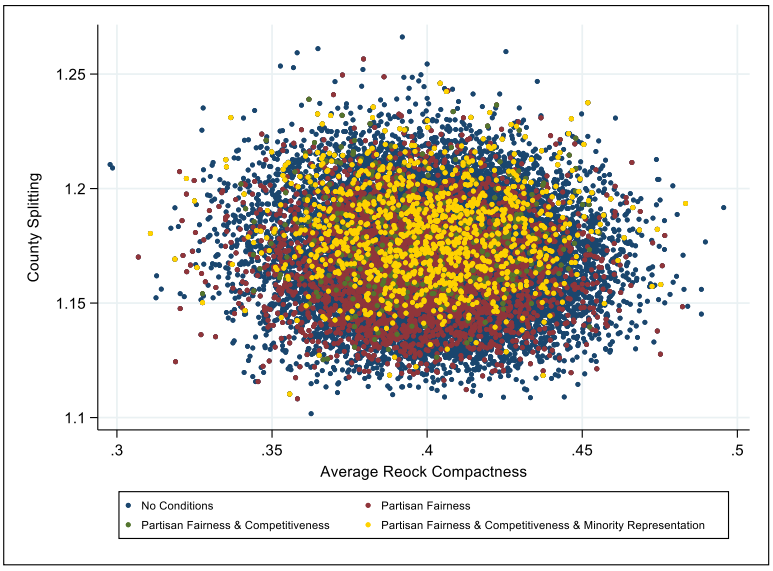
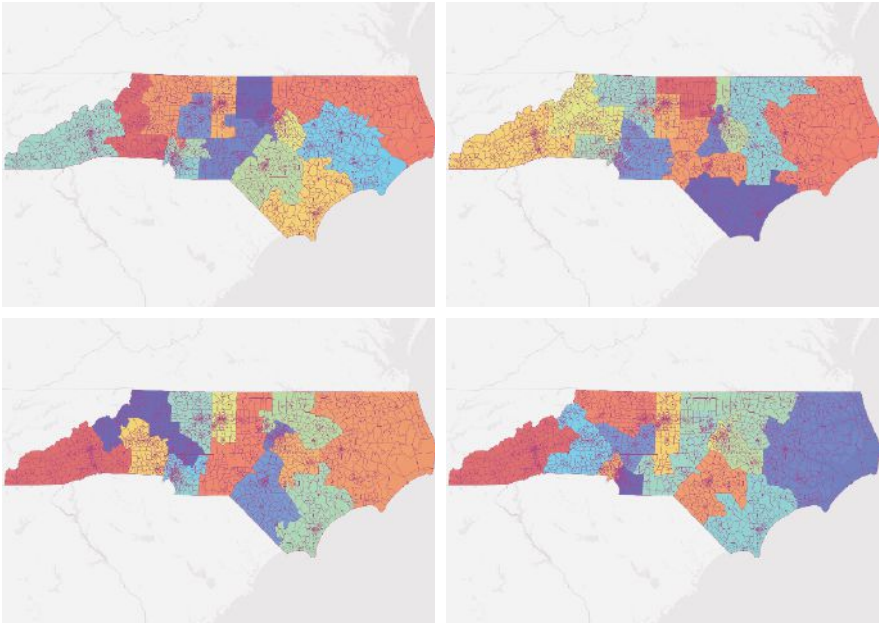



FIGURE 5. EXAMPLES OF NORTH CAROLINA CONGRESSIONAL MAPS WITH STRONG SCORES ON ALL DIMENSIONS



B. *Priority State Ensembles*

Congressional redistricting in North Carolina is an apt case study because of its doctrinal prominence and the state's size and representativeness. But the new map ensembles on which this project relies span six more states (Florida, Illinois, Michigan, New York, Ohio, and Wisconsin) and not just congressional delegations but also state senates and state houses. Could tradeoffs among line-drawing criteria appear in the maps for these states and electoral levels, despite being largely absent in the North Carolina congressional ensembles? To find out, I use the default ensembles for these additional states and legislative bodies as well as my set of primary criteria. But these methodological choices are inconsequential; as above, the results are nearly identical when other ensembles and metrics are analyzed instead.

Based on the default ensemble for each state and electoral level, I calculate the correlation between each pair of primary criteria (county splitting versus average Reock compactness; the absolute efficiency gap versus average Reock compactness, county splitting, the average margin of victory, and the share of minority-opportunity districts; and the share of minority-opportunity districts versus their average Reock compactness and district splitting). Figure 6 displays these correlations by pair of criteria, state, and electoral level. For instance, the navy, maroon, and green markers in the top chart are the correlations between county splitting and average Reock compactness for congressional, state senate, and state house maps, respectively, in each state.

The main takeaway from Figure 6 is that the correlations between the pairs of criteria are generally weak. Put differently, few redistricting tradeoffs—and few complementarities—are observable in these map ensembles for seven states at three electoral levels. Of the 143 correlations I could compute,[246] about three-quarters (105) are smaller (in their absolute value) than 0.1. Almost nine-tenths (128) are smaller than 0.2. Only nine correlations exceed 0.3 and thereby indicate at least a moderate relationship.[247] Additionally, for six of the seven pairs of criteria, their median correlation (across all electoral levels) is very close to zero. In the typical ensemble, that is, essentially no connection exists between maps' county congruence and compactness; between maps' partisan fairness and compactness, county splitting, or minority representation; or between the share of minority-opportunity districts and their compactness or district splitting.

246. I couldn't compute four correlations for Ohio's and Wisconsin's congressional maps because these maps only ever include one minority-opportunity district or none. I also measured minority representation in Florida using the share of majority-minority (not minority-opportunity) districts because the data to calculate my primary metric was unavailable.

247. See supra note 240 and accompanying text.

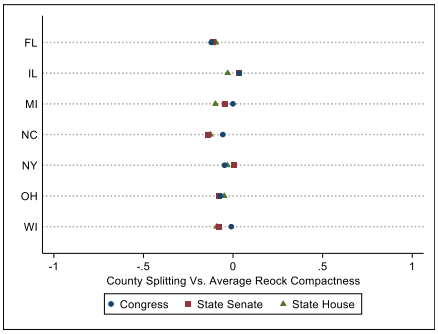
The only criteria whose median correlation is appreciably different from zero are partisan fairness and competitiveness. But this figure is positive (0.14), meaning that these criteria tend to be complements, not substitutes. As the average margin of victory declines (so competitiveness rises), maps' absolute efficiency gap also usually falls (so partisan fairness improves). To be sure, there are *some* hints of tradeoffs in this vast dataset. In the Wisconsin congressional ensemble, greater county congruence is correlated with less partisan fairness (-0.35). In the New York congressional and state senate ensembles, greater competitiveness is correlated with less partisan fairness (respectively, -0.58 and -0.31). And in the Ohio congressional ensemble, greater minority representation is correlated with less partisan fairness (0.32). But what's striking about these tradeoffs is how few are present: just four correlations above 0.3 (and in an adverse direction) out of 143. And even these tradeoffs are far from inevitable, since in all these cases, many maps are available that perform better along both relevant dimensions.

The last salient point about Figure 6 is that the correlations for congressional maps (the navy markers in the charts) are often more dispersed than the analogous statistics for state senate and state house maps (respectively, the maroon and green markers). In the first three partisan fairness charts, in particular, the correlations for congressional maps tend to be farther from zero (in both directions) than their state legislative counterparts. In contrast, the correlations for congressional maps less frequently exhibit values near zero. As discussed in the next section, the likely explanation is the smaller number of districts in congressional maps (compared to state legislative ones). Fewer districts are associated with stronger (and more variable) correlations between redistricting criteria.[248]

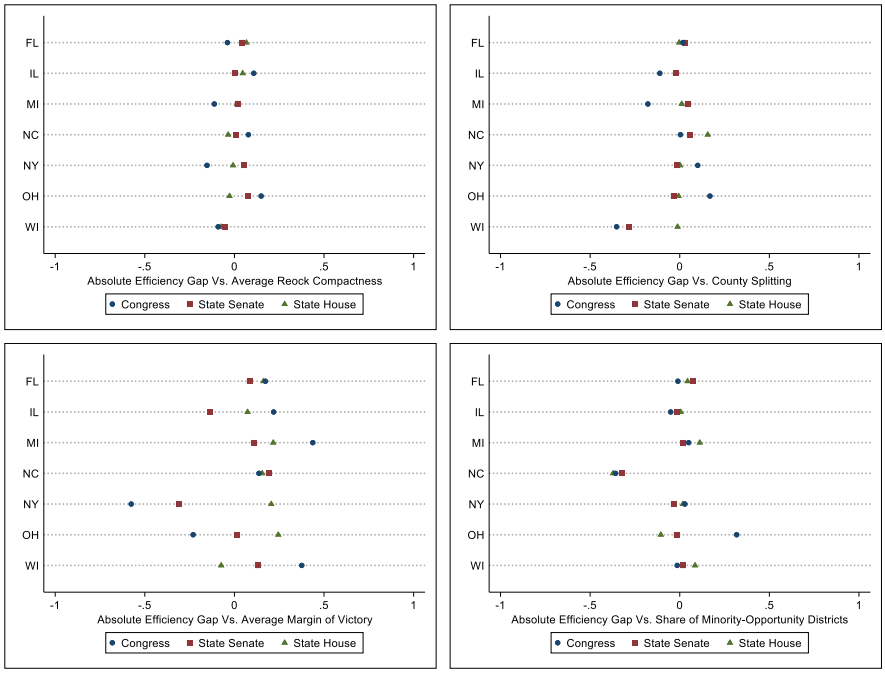
248. See infra note 260 and accompanying text.

FIGURE 6. CORRELATIONS BETWEEN PRIMARY CRITERIA PAIRS, DEFAULT PRIORITY STATE ENSEMBLES

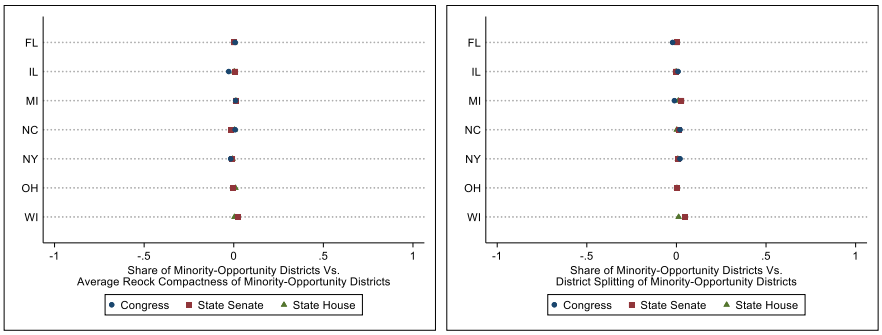
(a) Traditional Criteria




(b) Partisan Fairness



(c) Minority Representation




## C. *ALARM Congressional Ensembles*

While the new map ensembles for the seven priority states are illuminating, they're plainly limited in their geographic coverage. I therefore supplement them with the ALARM congressional ensembles, which are available for all forty-four states with two or more congressional districts.[249] The ALARM ensembles are generated by an algorithm that creates *many* chains of maps—not (like ReCom) a single map chain. Each map in each ALARM ensemble is thus the endpoint of a separate map chain, in which a merge-split process akin to ReCom is used to advance from one map to the next.[250] Each ALARM ensemble is comprised of five thousand congressional maps.[251] To produce these maps, the algorithm's population-equality and county-preservation parameters are fixed for all states, while its compactness, municipality-preservation, and VRA parameters are calibrated to approximate the performance of each state's enacted plan (as of 2022).[252]

The maps in the ALARM ensembles are scored along axes of which some are the same as, while others diverge from, my primary measures.[253]

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249. See 50-State Data Descriptor, ALARM Project, https://alarm-redist.org/posts/2022-06-23-fifty-states-data-descriptor/index.html [https://perma.cc/KP9Z-X2MK] (last visited Jan. 24, 2026).

250. For more information on this sequential Monte Carlo algorithm, see generally Cory McCartan & Kosuke Imai, Sequential Monte Carlo for Sampling Balanced and Compact Redistricting Plans, 17 Annals Applied Stat. 3300 (2023).

251. See 50-State Simulations FAQ, ALARM Project, https://alarm-redist.org/fifty-states/about/ [https://perma.cc/KP9Z-X2MK] (last visited Jan. 24, 2026).

252. See id.

253. See Cory McCartan, Christopher T. Kenny, Tyler Simko, George Garcia III, Kevin Wang, Melissa Wu, Shiro Kuriwaki & Kosuke Imai, Simulated Redistricting Plans for the Analysis and Evaluation of Redistricting in the United States, Sci. Data, Nov. 11, 2022, at 4–7, https://www.nature.com/articles/s41597-022-01808-2 [https://perma.cc/26YM-TMG4] (describing the measures used to score the ALARM maps).

Identical metrics for partisan fairness and competitiveness are available: respectively, the absolute efficiency gap and the average margin of victory.[254] For compactness, however, I use my secondary measure, Polsby-Popper compactness, because Reock compactness isn't included in the ALARM scores.[255] Similarly, I assess county congruence using the total number of counties split by a district map because the county-splitting metric is unavailable. And I estimate minority representation using my secondary measure, the share of majority-minority districts, because the share of minority-opportunity districts, too, is omitted from the ALARM scores.[256]

Figure 7 resembles Figure 6, then, in that it plots the correlations for each pair of redistricting criteria. But the maps for which the correlations are shown are the ones in the ALARM ensembles, and the criteria that are paired are the ones just described. In these forty-four states' congressional ensembles, the correlations between the pairs of criteria are mostly weak. Out of 203 total correlations,[257] about half (96) are smaller (in absolute terms) than 0.1. Roughly three-quarters (152) are smaller than 0.2. Only thirty-three correlations are at least moderate in strength in that they exceed 0.3.[258] Moreover, for five of the six pairs of criteria, their median correlation (denoted by the dashed red line in each plot) is near zero. In the typical state, that is, congressional maps' partisan fairness is effectively unrelated to their compactness, county congruence, competitiveness, or minority representation. There's also no material link between the share of majority-minority districts and their compactness.

The only criteria with a median correlation that nontrivially differs from zero are county congruence and compactness. But this figure is negative (-0.17), signifying that these criteria are usually complements, not substitutes. As the average Polsby-Popper compactness of congressional maps in the typical state increases, they usually split fewer counties, not more. The correlations for partisan fairness and competitiveness are also distributed fairly widely around their near-zero median. But close to half these correlations are positive, again revealing relationships that are complementary, not substitutional. In these states with positive correla-

254. The absolute efficiency gap is simply the absolute value of the raw efficiency gap. I calculate the average margin of victory myself using the ALARM vote share estimates for districts.

255. See 50-State Simulations FAQ, supra note 251 ("We measure geographic compactness with the Polsby-Popper compactness score . . . .").

256. Additionally, these are majority-minority districts in terms of their voting-age population (VAP), not their citizen voting-age population (CVAP). I'm only able to evaluate majority-minority districts' compliance with traditional criteria using their average Polsby-Popper compactness.

257. I couldn't calculate correlations in cases where either variable in the pair exhibits no variation across the maps in the relevant ensemble.

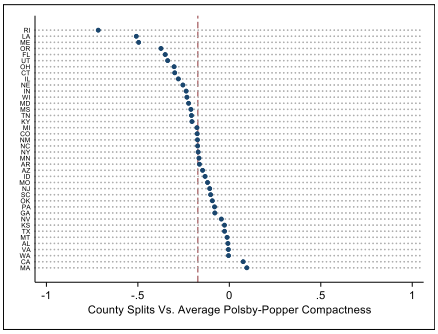
258. See supra note 240 and accompanying text.

tions, as the average margin of victory tightens, the absolute efficiency gap of congressional maps tends to decline in tandem.[259]

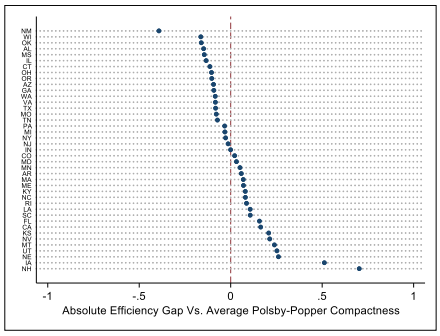
259. As discussed below, correlations between redistricting criteria are more reliable for more populous states with nine or more congressional districts. See infra note 260 and accompanying text. Among these states, the only correlations above 0.3 (and in an adverse direction) are between partisan fairness and competitiveness in California, Tennessee, and Virginia (respectively, -0.30, -0.35, and -0.48); and between the share of majority-minority districts and their compactness in California (-0.44).

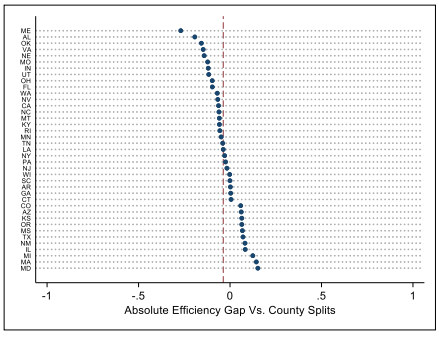
FIGURE 7. CORRELATIONS BETWEEN CRITERIA PAIRS, ALARM CONGRESSIONAL ENSEMBLES

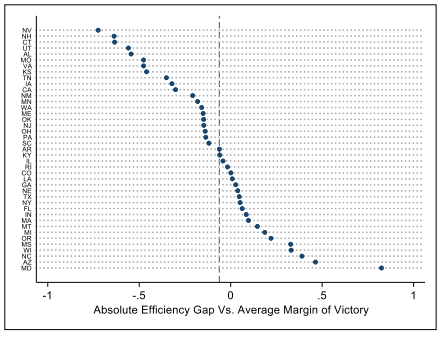
(a) Traditional Criteria

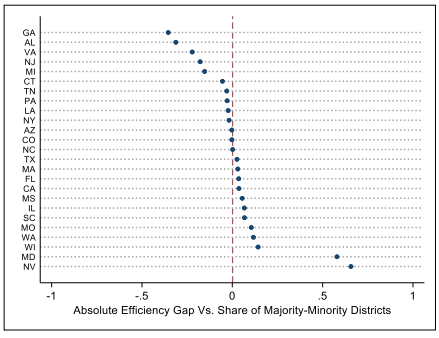



(b) Partisan Fairness

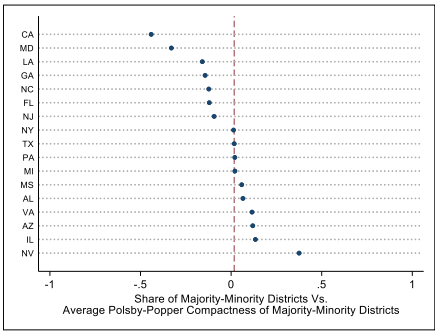


(c) Minority Representation




What accounts for this pattern in which most correlations between criteria are weak but a few are more substantial? To begin to work toward an answer, the upper left chart in Figure 8 plots the median absolute value of the correlations between criteria for each state versus each state's number of congressional districts. I use the absolute (rather than the signed) values of the correlations to capture the magnitude of each link, whether it's positive or negative. And I use the median of these absolute values to capture their central tendency.

The upshot of this chart is that states with fewer congressional districts typically exhibit stronger correlations between criteria. All states with median correlations greater than 0.2 (Iowa, Maine, Maryland, Nevada, New Hampshire, and Utah) have eight or fewer districts. As a group, states with eight or fewer districts have a median correlation of 0.14. The corresponding figure for states with nine or more districts is 0.08, nearly fifty percent lower. One reason for this difference may be that there are fewer possible district configurations when the number of districts is smaller. With fewer district maps available, tighter connections between criteria may be more likely to emerge. Less speculatively, metrics that incorporate seats won and lost—here, the efficiency gap and the share of majority-minority districts—are necessarily "lumpier" when there are fewer seats.[260] It's unsurprising that these metrics are more correlated with other variables when they're limited to a few values than when they can vary over a broader range.

In the same spirit as the upper left chart, the other three charts in Figure 8 plot the median absolute value of the correlations between criteria for each state versus each state's population density, minority popu-

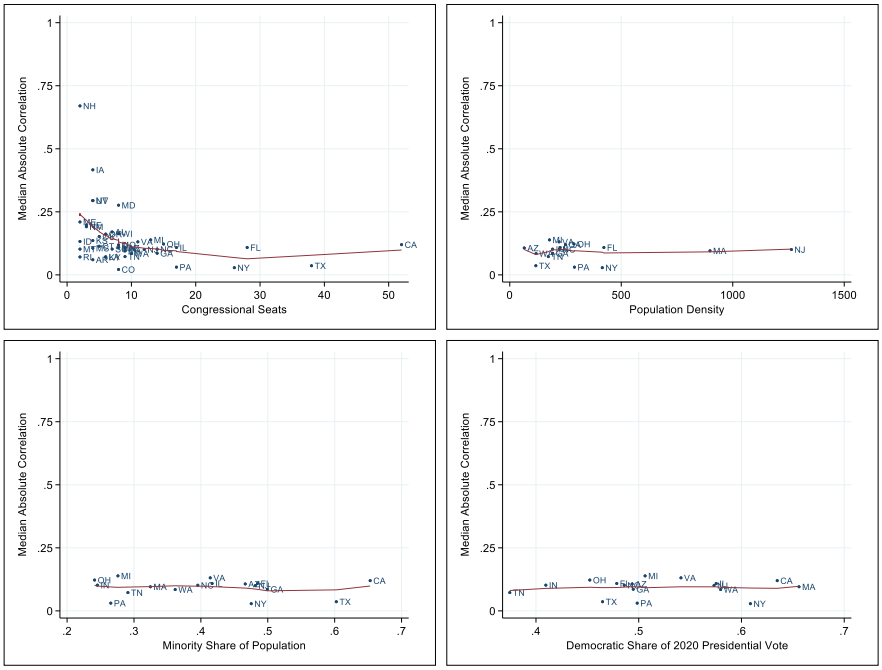
260. For this reason, the efficiency gap was originally calculated only for states with at least eight congressional districts. See Stephanopoulos & McGhee, Partisan Gerrymandering, supra note 65, at 868.

lation share, and Democratic vote share in the 2020 presidential election. These charts are limited to states with nine or more congressional districts, whose correlations are more reliable. The variables on these charts' x-axes are all ones that might be thought to influence the relationships between redistricting objectives.[261]

But these variables turn out to have no discernible impact on how line-drawing criteria are linked to each other. In all three charts, the locally weighted best fit line is almost perfectly flat, barely budging as states' population density, minority population share, and Democratic vote share go up or down. The best fit line is also flat at a low level (around 0.1), indicating that the median correlation between criteria is consistently weak whether states are urban or rural, racially diverse or homogeneous, or electorally blue, purple, or red. This initial effort to investigate variations in redistricting associations, then, uncovered only one clue. These ties are *stronger* in states with fewer congressional districts. But they're otherwise impervious to factors that might be expected to affect mapmakers' choices.

261. See, e.g., Nicholas Goedert, Robert Hildebrand, Laurel Travis & Matt Pierson, Asymmetries in Potential for Partisan Gerrymandering, 49 Legis. Stud. Q. 551, 576–78 (2024) (finding that states' population density and Hispanic population share have significant effects on the partisan bias of computer-generated maps).

FIGURE 8. MEDIAN ABSOLUTE CORRELATIONS BETWEEN CRITERIA PAIRS VS. STATE CHARACTERISTICS




## D. *Local Tradeoffs*

The analysis to this point has demonstrated that tradeoffs among redistricting criteria are generally mild to nonexistent. This is true for county congruence versus compactness, for partisan fairness versus numerous potential drivers, and for minority representation versus minority-opportunity districts' compliance with traditional principles. It's true using alternative map ensembles, using alternative measures of the same criteria, controlling for other variables, and incorporating multiple conditions simultaneously. And it's true for congressional maps in North Carolina, congressional and state legislative maps in seven priority states, and congressional maps in forty-four states according to the ALARM ensembles.

In light of all this evidence, a natural question is why many courts and scholars wrongly believe that redistricting tradeoffs are common. One answer may be that, when contemplating the prospect of tradeoffs, these observers tend to fixate on particular plans comprised of particular district boundaries. If these boundaries are adjusted, the observers may reason, tradeoffs will indeed materialize between different objectives. Put another way, plans enacted into law (or seriously considered) typically aim to achieve multiple goals. The observers may imagine tinkering with these plans' districts, only to realize that doing so would further one aim

at the expense of others—or even worsen plans' performances in all respects.[262]

For an example of this logic, return to the *Shaw* litigation that birthed the cause of action for racial gerrymandering. To satisfy the VRA, the Attorney General suggested that North Carolina create "a geographically compact district in the southeastern portion of the State" that would be majority-Black.[263] The Democratic legislature rejected this proposal and decided, instead, to sacrifice compactness in drawing a majority-Black district. Specifically, the legislature opted for "the winding contours of District 12 over the more cartographically pleasant boundaries proposed by the Attorney General."[264] Why did the legislature choose to craft a less compact district? To improve the plan's performance in partisan terms: that is, to make the plan as a whole more favorable to Democrats. The legislature's "decision not to create the more compact southern majority-minority district" was "a result of partisan considerations": "incumbency protection and the enhancement of Democratic partisan interests."[265]

Certain Justices in the *Shaw* cases thus perceived a local tradeoff between compactness and partisan advantage, using the DOJ's suggested plan as a benchmark. To make that plan more pro-Democratic while continuing to comply with the VRA, the new majority-Black district had to be less compact.[266] To investigate empirically how different metrics vary when a map is revised—incrementally at first, but then more extensively—I rely on a different North Carolina congressional plan: the one in place for the 2022 election. This plan was designed by court-appointed special masters after the North Carolina Supreme Court held that the legislature's plan was an unlawful partisan gerrymander.[267] The special masters' plan was an archetypal good government map. It was "the most non-dilutive plan in partisan terms of any map submitted to the [c]ourt,"

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262. A related hypothesis, not directly tested here, is that observers may think of a variety of granular political goals achieved by enacted plans: protecting incumbents from challenges, satisfying incumbents' idiosyncratic preferences about their districts' forms, keeping certain communities in certain districts, and so on. All these additional considerations may substantially limit line-drawers' degrees of freedom and cause tradeoffs to emerge when existing districts are altered.

263. Shaw v. Hunt, 517 U.S. 899, 936 (1996) (Stevens, J., dissenting).

264. Id.

265. Shaw v. Reno, 509 U.S. 630, 673 n.10 (1993) (White, J., dissenting) (internal quotation marks omitted) (quoting App. to Jurisdictional Statement, Complaint in Pope v. Blue, 809 F. Supp. 392 (W.D.N.C. 1992) (3:92CV71-P), 1992 WL 12012092).

266. For an example of a scholar similarly arguing that significant tradeoffs exist, using as a benchmark a hypothetical district map that he then repeatedly revises, see Cain, The Reapportionment Puzzle, supra note 53, at 34–43.

267. See Harper v. Hall, 881 S.E.2d 156, 162–71 (N.C. 2022), withdrawn and superseded on reh'g by 886 S.E.2d 393 (N.C. 2023) (discussing the procedural history of this litigation).

scoring nearly perfectly on several partisan fairness measures.[268] It also satisfied the VRA while performing well on traditional criteria like "maintaining the number of county splits, retaining equal populations, compactness, and contiguity, as well as respecting municipal boundaries."[269]

To evaluate the effects of successive changes to the special masters' plan, I use that plan as the starting point for one hundred separate ReCom chains, each running for one hundred steps. The reason for limiting these chains to one hundred steps—compared to the fifty million steps of the chains discussed earlier—is to prevent them from traveling too far from the seed map. One hundred ReCom iterations suffice to scramble the special masters' plan without obliterating its distinctive characteristics. The reason for running one hundred separate chains (and then averaging their scores for each metric at each step) is the inherent (and desirable) randomness of the algorithm. Any individual chain might trace an idiosyncratic path from its starting point. But, together, one hundred chains are likely to tell a more coherent story about the implications of sequentially reshaping the seed map.

Figure 9, then, plots the average scores of the hundred ReCom chains at each of their hundred steps for county splitting and mean Reock compactness. The point marked "0" indicates these (non-averaged) scores for the special masters' plan. The point marked "50," for example, denotes these (averaged) scores for the hundred chains at each of their fiftieth steps. The points are connected to show the algorithm's typical movement from its starting point in terms of county congruence and compactness.

It's obvious from the chart that North Carolina congressional maps tend to become less respectful of county boundaries and less compact as they proceed further from the special masters' plan.[270] In fact, the relationship between county congruence and compactness is nearly linear in that both measures steadily worsen as maps' distance from the seed map grows. On its face, this result appears incompatible with this Article's claim that redistricting tradeoffs are usually gentle—and consistent with the views of judges and academics who believe that simultaneous improvement relative to the status quo is rarely possible. Here, not only do amended maps never score better than the special masters' plan in terms of *both* county congruence and compactness, they almost never score better in terms of *either* metric. The special masters' plan thus

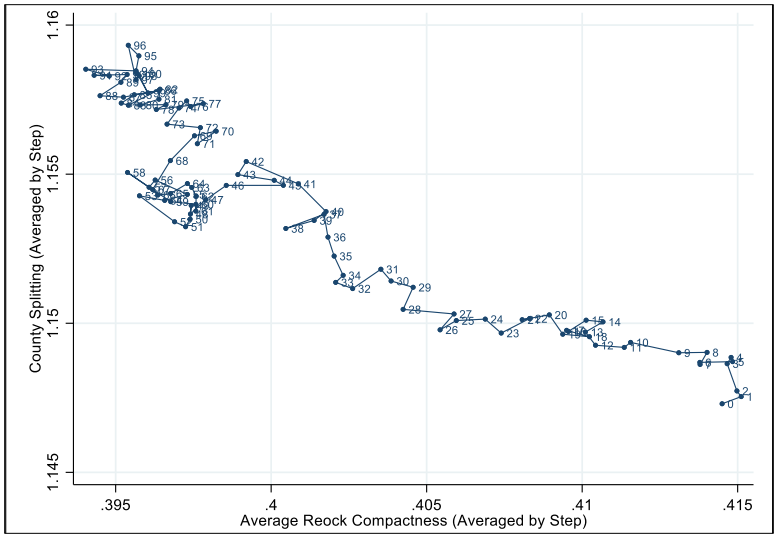
268. Id. at 169 (internal quotation marks omitted) (quoting Dr. Bernard Grofman, Special Masters' Advisor).

269. Id. (quoting the Special Masters' Report).

270. To reiterate, higher compactness and lower county-splitting scores are better. See supra section II.B.2.

seems like an optimum, compared to which successive changes only make things successively worse.

FIGURE 9. COUNTY SPLITTING VS. AVERAGE REOCK COMPACTNESS, AVERAGED BY STEP OVER ONE HUNDRED RECOM CHAINS



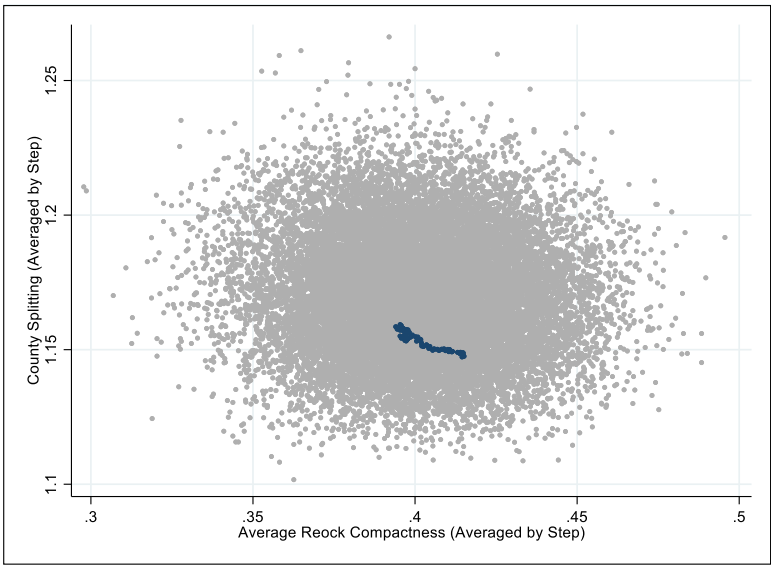

But remember that the universe of district maps—even maps complying with a range of conditions—is almost incomprehensibly vast. A hundred ReCom iterations suffice to venture reasonably far from the special masters' plan. They're nowhere near enough, though, to thoroughly explore the entire universe of relevant maps. The possibility thus emerges that the special masters' plan might merely be a *local* optimum, superior only to the maps fairly close to it in the map universe. The plan might not be a *global* optimum, superior even to maps that take very different approaches to partitioning North Carolina.

To compare local to global relationships between redistricting criteria, Figure 10 superimposes Figure 9 on top of the first scatter plot from Figure 3. So the connected points in navy again show the typical progression of the hundred ReCom chains, in terms of county congruence and compactness, as they move a hundred steps from the special masters' plan. And the points in gray represent maps in the default North Carolina congressional ensemble. To reiterate, this ensemble is made up of twenty thousand maps sampled at an interval of every 2,500 iterations from a chain of fifty million maps. The seed map for this ensemble is also a randomly generated map, not an enacted plan.[271]

271. See supra section II.B.1.

Two points leap out from Figure 10. First, the hundred ReCom chains, over their hundred steps, typically cover only a small fraction of the area captured by the default North Carolina congressional ensemble. The connected points in navy are engulfed by the large mass of gray points sprawling in every direction. Second, the special masters' plan is indeed a local, not a global, optimum. In the default North Carolina congressional ensemble, there are many maps (948, to be precise) that improve on the special masters' plan in terms of both county congruence and compactness. This finding exposes the flaw in the thinking of many courts and scholars about redistricting tradeoffs. Yes, they do often arise when local adjustments are made to a specific plan's boundaries. Sometimes, a specific plan is even better across the board than maps near it in the map universe. But these tradeoffs tend to diminish, eventually to nothing, as maps more distant from the benchmark plan are considered. Globally, as opposed to locally, simultaneous improvement along multiple dimensions *is* generally possible.

FIGURE 10. COUNTY SPLITTING VS. AVERAGE REOCK COMPACTNESS, ONE HUNDRED RECOM CHAINS AND DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE




Of course, county congruence and compactness are just one of the pairs of criteria I examine in this Article. Appendix D includes charts analogous to Figures 9 and 10 for each of the other pairs. Locally, two of these pairs (partisan fairness and compactness, and partisan fairness and county congruence) resemble county congruence and compactness. That is, the maps in the hundred ReCom chains typically perform worse than the special masters' plan in terms of both criteria. With respect to partisan fairness and competitiveness, the special masters' plan is subject to a local tradeoff. The maps in the hundred chains are typically more biased, but also more competitive, than that plan. In terms of partisan fairness and minority representation, the maps in the hundred chains are typically more biased than the special masters' plan and comparable in their shares of minority-opportunity districts. With respect to minority representation and minority-opportunity districts' compactness, the maps in the hundred chains are typically comparable to the special masters' plan on the former criterion and better on the latter. And in terms of minority representation and minority-opportunity districts' district splitting, the maps in the hundred chains form a tangled skein, neither better nor worse overall than the special masters' plan.

Globally, the charts in Appendix D tell a simpler story. In each case, the maps in the hundred ReCom chains occupy a sliver of the territory staked out by the default North Carolina congressional ensemble. And in each case, many maps in this ensemble score better than the special masters' plan along both criteria. This is helpful confirmation that there's

nothing quirky about the pair of criteria I focus on here (county congruence and compactness). All the other pairs also indicate that apparent tradeoffs (or even optima) disappear when maps in a local neighborhood are replaced by maps representative of the whole relevant universe.

### E. *Pareto Frontiers*

Another reason why judges and academics may suspect that redistricting tradeoffs are widespread has to do with the limits of what's possible. Sure, these observers may concede, simultaneous improvement along two (or more) dimensions may be achievable *for a while*. But a point must *eventually* come at which a district map can no longer score better on both (or all) axes. At this point, if we're focusing on two criteria, a stronger performance on one measure necessitates a weaker performance on the other, and vice versa. At this point, in other words, a tradeoff between redistricting objectives becomes inescapable.

In statistical parlance, the zone in a bivariate scatter plot in which a tradeoff is unavoidable is known as the Pareto frontier.[272] All cases *not* on the Pareto frontier are "dominated" by one or more other cases in that the latter beat the former in terms of both variables. All cases *on* the Pareto frontier *aren't* dominated by any other cases.[273] Courts and scholars are right that Pareto frontiers exist for most pairs (and multivariate sets) of redistricting criteria. But this insight doesn't vindicate their position about the importance of line-drawing tradeoffs. These inevitable tradeoffs at the peripheries of map ensembles tend to be quite mild. Most enacted plans are also nowhere near Pareto frontiers—so, with respect to the status quo, much simultaneous improvement is usually feasible.

To begin assessing Pareto frontiers,[274] Figure 11 displays the (now-familiar) plot of county congruence versus compactness for the maps in the default North Carolina congressional ensemble. The gray points are the vast majority of maps that aren't on the Pareto frontier for these criteria. The maroon point is the court-drawn plan used in North Carolina's

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272. See, e.g., Yang et al., supra note 14, at 15–16.

273. For good discussions of Pareto frontiers in the context of redistricting, see Ram Gopalan, Lee Hachadoorian, Steven O. Kimbrough & Frederic H. Murphy, Selecting Good Redistricting Plans from a Large Pool of Available Plans Using the Efficient Frontier, Omega, Apr. 2024, at 3–5 (2024); Cory McCartan, Finding Pareto Efficient Redistricting Plans with Short Bursts 2–3 (May 27, 2024) (unpublished manuscript), https://arxiv.org/pdf/2304.00427 [https://perma.cc/82ET-SK7F].

274. I only assess Pareto frontiers for particular map ensembles. These are highly unlikely to be true Pareto frontiers for all possible district maps. Nor are they necessarily similar to Pareto frontiers derived from optimization (rather than sampling) algorithms. But see McCartan, supra note 273, at 5, 7 (also finding a convex Pareto frontier (with respect to compactness and population deviation) using an optimization algorithm to create congressional maps for Iowa).

2022 congressional election. And the eleven navy points are the maps on the Pareto frontier because no other map outperforms them in terms of both county splitting and average Reock compactness. These points are connected to plot the Pareto frontier. A rectangle is also drawn based on the two endpoints of the Pareto frontier. The area below the Pareto frontier and inside the rectangle is gridded, while the area above the frontier and inside the rectangle is clear.

A Pareto frontier can be convex (bulging outward, like a ball) or concave (curving inward, like a bowl). A convex Pareto frontier denotes a gentler tradeoff between measures in that a substantially better score on one metric requires only a slightly worse score on the other.[275] Conversely, a concave Pareto frontier signifies a steeper tradeoff. A rectangle like that in Figure 11 illustrates the most convex and the most concave possible Pareto frontiers between two endpoints. The most convex Pareto frontier follows the rectangle's bottom and right sides; the most concave traces its top and left edges. In combination, a Pareto frontier and its corresponding rectangle enable the overall extent of the tradeoff at the frontier to be calculated. The area beyond the Pareto frontier and within the rectangle is divided by the rectangle's total area. The lower this ratio is (on a scale from zero to one), the more convex the Pareto frontier is, and the milder the tradeoff is between the two variables.[276]

In Figure 11, the Pareto frontier between county congruence and compactness is obviously convex. It's well to the right of an imaginary line between the rectangle's bottom left and top right endpoints, indicating neither convexness nor concaveness but rather a perfectly proportional tradeoff. A look at the chart's axes confirms that, in the lower left of the Pareto frontier, a large increase in average Reock compactness demands only a small rise in county splitting. Likewise, in the upper right of the Pareto frontier, significantly better county congruence comes at the cost of only marginally worse compactness. In quantitative terms, too, the gridded area is merely 16.5 percent of the size of the rectangle—much closer to zero (maximum convexness) than one (maximum concaveness).

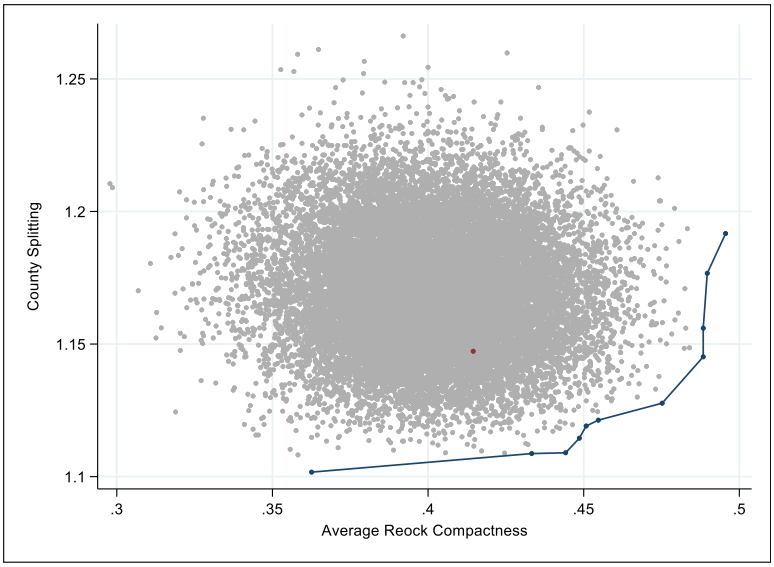
With respect to the court-drawn plan, the maroon point is neither on the Pareto frontier between county congruence and compactness nor particularly close to it. To reach the Pareto frontier, holding constant the plan's average Reock compactness, its county splitting would have to fall from 1.15 to roughly 1.11. To make it to the Pareto frontier, maintaining

275. More specifically, a convex Pareto frontier has this property when starting at either end of the frontier and moving toward its center. It has the opposite property when starting at the center of the frontier and moving towards its ends.

276. For a very similar analysis of Pareto frontiers, see Goedert et al., Black Representation and District Compactness, supra note 56, at 289–91.

the plan's county splitting, its average Reock compactness would need to go up from 0.41 to about 0.49. In sum, as mentioned above, almost a thousand maps in the ensemble dominate the court-drawn plan in terms of both county congruence and compactness.

FIGURE 11: PARETO FRONTIER FOR COUNTY SPLITTING VS. AVERAGE REOCK COMPACTNESS, DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE




County congruence and compactness are just one pair of criteria, however, and North Carolina's congressional delegation is just one electoral level for one priority state. To generalize beyond this example, I compute the Pareto frontier tradeoff ratio for each pair of primary criteria using the default map ensemble for each legislative body in each priority state. (Again, the priority states are Florida, Illinois, Michigan, New York, North Carolina, Ohio, and Wisconsin; and the legislative bodies are congressional delegations and state legislative chambers.) Figure 12 shows these Pareto frontier tradeoff ratios by pair of criteria, state, and electoral level. For instance, the navy, maroon, and green markers in the top chart are the Pareto frontier tradeoff ratios for county splitting and average Reock compactness for congressional, state senate, and state house maps, respectively, in each state.

The key point about Figure 12 is that the vast majority of the Pareto frontier tradeoff ratios are quite small. So tradeoffs between pairs of criteria are typically gentle, not steep, even at the fringes of map ensembles

where tradeoffs have to be made. Of the 143 Pareto frontier tradeoff ratios I could calculate,[277] more than ninety-five percent (137) fall below the 0.5 value that's the threshold between convexness and concaveness. More than sixty percent (90) are smaller than 0.25, at which point a major gain along one axis necessitates only a minor loss along the other.[278] Additionally, for six of the seven pairs of criteria, their median Pareto frontier tradeoff ratio (across all electoral levels) is below 0.25. In the usual ensemble, then, even when the Pareto frontier is reached, its shape is highly convex—close to the outer boundaries of the corresponding rectangle.

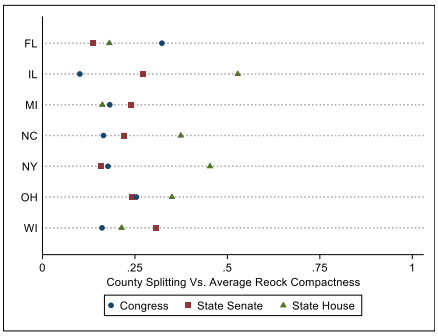
The share of minority-opportunity districts and their average Reock compactness are the sole pair of criteria whose median Pareto frontier tradeoff ratio is somewhat larger. Even this figure (0.37) is considerably smaller than 0.5, though, meaning that, at the Pareto frontier for these measures, more minority representation tends to require only somewhat less compact minority-opportunity districts, and vice versa. As for the handful of individual Pareto frontier tradeoff ratios that exceed 0.5, they seem more or less random. No state is responsible for more than two of these concave Pareto frontiers. No pair of criteria accounts for more than two of them either. The main pattern apparent in this data is that four of the six Pareto frontier tradeoff ratios above 0.5 are for state house map ensembles. This result warrants further study but in no way hints that tradeoffs at most Pareto frontiers are anything but mild.

277. I couldn't calculate four ratios for Ohio's and Wisconsin's congressional maps because these maps only ever include one minority-opportunity district or none. I also measured minority representation in Florida using the share of majority-minority (not minority-opportunity) districts because the data to calculate my primary metric was unavailable.

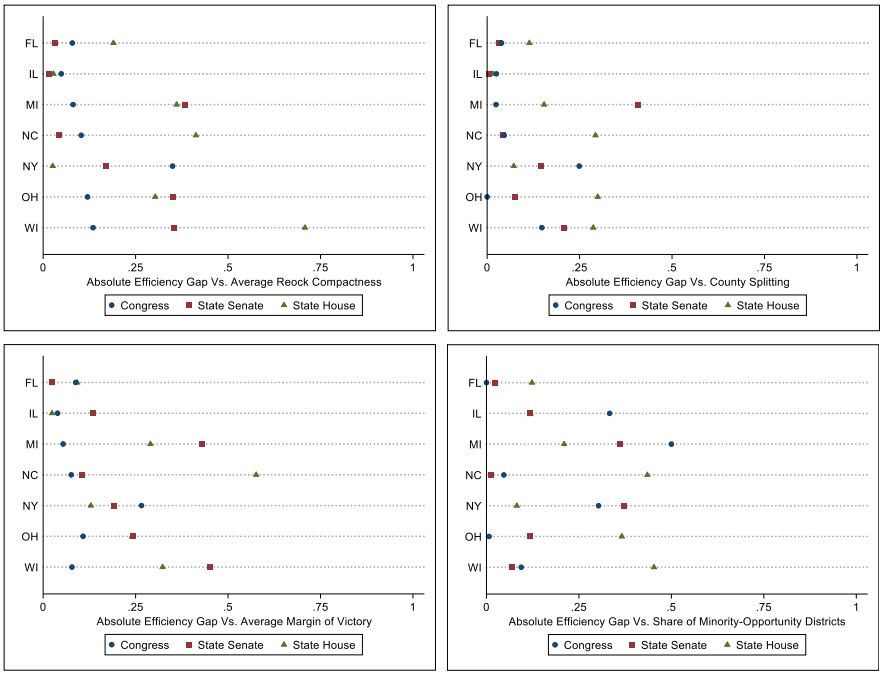
278. See, e.g., Goedert et al., Black Representation and District Compactness, supra note 56, at 289 (using a mathematically equivalent threshold to this 0.25 cutoff).

FIGURE 12. PARETO FRONTIER TRADEOFF RATIOS FOR PRIMARY CRITERIA PAIRS, DEFAULT PRIORITY STATE ENSEMBLES

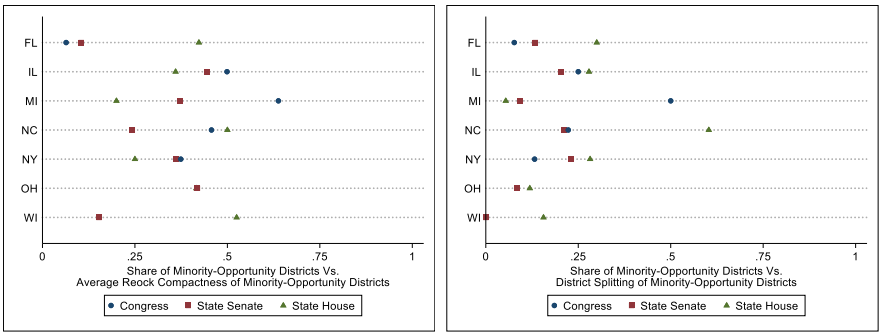
(a) Traditional Criteria




(b) Partisan Fairness



(c) Minority Representation




Turning to enacted plans (as of 2022), they generally aren't located on Pareto frontiers. Of the 143 cases I could analyze (each pairing a plan with a Pareto frontier for two primary criteria), around four-fifths (114) involve a plan that's dominated by at least one map (and often many more) in the relevant ensemble. Of the twenty-nine cases involving a plan that *isn't* dominated by any other map (and so is on the Pareto frontier), five are North Carolina state legislative plans paired with Pareto frontiers for county congruence and/or compactness. Another four are Ohio state legislative plans paired with Pareto frontiers for county congruence. Twenty more are plans paired with Pareto frontiers for minority representation. Thanks likely to the VRA, this is the one dimension along which real-world line-drawers commonly perform as well as computer-generated maps.

Of course, enacted plans could be off but *near* Pareto frontiers. Such plans would become subject to tradeoffs if they moved modestly from their current positions. To measure plans' proximity to Pareto frontiers, I standardize plans' scores on all primary criteria, thereby converting all units to standard deviations. I then compute each plan's two-dimensional distance from each map on the applicable Pareto frontier. The smallest of these values is the plan's minimum distance from the Pareto frontier.[279] Appendix E depicts these minimum distances by pair of criteria, state, and electoral level. To illustrate, the navy, maroon, and green markers in the top chart are the minimum distances between the enacted plan in each state and the Pareto frontier for county splitting and average Reock compactness at the congressional, state senate, and state house levels, respectively.

279. I don't include minimum distances for the few enacted plans that are on the Pareto frontiers for certain pairs of criteria.

Appendix E reveals that most enacted plans are far from Pareto frontiers. Over the 114 usable pairs of a plan with a Pareto frontier,[280] the median minimum distance between them is more than four standard deviations. Illinois's congressional plan averages a minimum distance of more than *ten* standard deviations from the full set of Pareto frontiers for that state and electoral level. Five additional plans (both of Illinois's state legislative plans, New York's state house plan, and both of Wisconsin's state legislative plans) average a minimum distance of more than five standard deviations. With respect to such plans, the contours of Pareto frontiers are immaterial because the plans are nowhere near the zones where tradeoffs must be made. On the other hand, some plans not on Pareto frontiers are still fairly close to them. Of the 114 cases examined here, roughly thirty percent (or thirty-two) involve a plan with a minimum distance of less than two standard deviations from a Pareto frontier. The court-drawn congressional plan for North Carolina impressively averages a minimum distance of only one standard deviation from the full set of Pareto frontiers for that state and electoral level. For plans like these, the shapes of Pareto frontiers *are* germane because, with relatively minor revisions, the plans could plausibly reach the frontiers and encounter their tradeoffs.

Until now, this discussion of Pareto frontiers has been limited to the map ensembles for the seven priority states. Appendices F and G indicate that these findings extend to the ALARM congressional ensembles for all forty-four states with two or more congressional districts. Of the 192 Pareto frontier tradeoff ratios I could calculate for these ensembles, more than eighty-five percent (164) are smaller than the 0.5 value that's the threshold between convexness and concaveness. These Pareto frontiers therefore also tend to be gentle rather than steep. Similarly, out of 205 pairs of an enacted congressional plan with a Pareto frontier for two criteria, more than eighty-five percent (178) involve a plan that's not located on the frontier. These plans, too, are thus mostly outside the areas where tradeoffs are unavoidable. And over the 176 usable pairs of a plan with a Pareto frontier, the median minimum distance between them is more than three standard deviations. So when these plans aren't on Pareto frontiers, they're typically quite far from them, to boot.

## IV. IMPLICATIONS FOR LAW AND POLICY

A mountain of empirical evidence establishes that tradeoffs among redistricting criteria are generally weak to nonexistent. This conclusion has major implications for the justiciability of partisan gerrymandering, the justification stage of this cause of action, the *Gingles* framework for

280. These 114 pairs are the 143 total cases I could analyze minus the 29 cases in which an enacted plan was on a particular Pareto frontier.

racial vote dilution claims under Section 2 of the VRA, and the determination of racial predominance in racial gerrymandering cases. More abstractly, the usual lack of redistricting tradeoffs raises the possibility that legal doctrine could simply demand progress in a certain direction, without worrying about complications posed by countervailing goals. It also suggests that public-regarding line-drawers could simultaneously achieve all their aims in most settings, crafting maps that compromise on neither traditional criteria, nor partisan fairness, nor minority representation.

### A. *Partisan Gerrymandering Justiciability*

As explained earlier, in *Rucho*, the Supreme Court was presented with a proposal that disregard for traditional redistricting principles should be the standard for unconstitutional partisan gerrymandering.[281] The Court rejected this proposal for (among others) two reasons pertaining to tradeoffs. First, according to the Court, traditional requirements are often "competing," and in this situation, no court can non-arbitrarily "rank the relative importance of . . . traditional criteria."[282] Second, in the Court's view, compliance with traditional principles "unavoidably [has] significant political effect," particularly by skewing maps in Republicans' favor through the creation of "inherently packed [Democratic] districts" in urban areas.[283]

This Article's findings refute both these arguments. As to the first, the traditional criteria most amenable to quantification—compactness and county congruence—*aren't* frequently "competing."[284] In the new map ensembles for the seven priority states, the median correlation between compactness and county congruence is very close to zero.[285] In the ALARM congressional map ensembles, the median correlation is actually negative, meaning that these objectives tend to be complementary, not conflicting.[286] Consequently, a partisan gerrymandering standard that deems maps unlawful if they're highly noncompact or highly disrespectful of county boundaries would be eminently manageable—that is, justiciable.[287] In nearly all cases, many maps would exist that are both sufficiently compact and attentive enough to county borders. So,

281. See supra section I.A.

282. Rucho v. Common Cause, 139 S. Ct. 2484, 2501 (2019).

283. Id. at 2500 (internal quotation marks omitted) (quoting Vieth v. Jubelirer, 541 U.S. 267, 309 (2004) (Kennedy, J., concurring in the judgment).

284. Id. at 2501.

285. See supra section III.B.

286. See supra section III.C.

287. See, e.g., *Rucho*, 139 S. Ct. at 2491 (equating justiciability with the existence of "judicially manageable standards for deciding . . . claims").

almost always, courts could insist on adequate performance along both these axes and avoid having to "rank [their] relative importance."[288]

As to the Supreme Court's second rationale, adherence to traditional principles turns out to have little partisan impact—certainly not the "significant political effect" posited by the Court.[289] In the new map ensembles for the seven priority states, greater compactness is consistently uncorrelated with the size of maps' partisan bias.[290] The same is true for greater congruence with county boundaries.[291] The same is also true, for both these criteria, in the ALARM congressional map ensembles.[292] This pattern of few meaningful relationships further holds when (in results not reported here) I substitute the *direction* of maps' partisan bias for this variable's *magnitude*.[293] The Court is right, then, that a tradeoff between compliance with traditional principles and partisan fairness would be deeply unfortunate and a proper basis for not adopting a partisan gerrymandering test focused on such compliance. But the Court is flatly wrong to assert that this tradeoff is "unavoidabl[e]."[294] In fact, it's entirely absent in most states and at most electoral levels.

To be clear, my position isn't that the Court *should* have made disregard for traditional criteria the standard for unlawful partisan gerrymandering in *Rucho*. Traditional principles are, by definition, nonpartisan principles.[295] And with the aid of modern redistricting technology, it's child's play for line-drawers to design maps that are both respectful of traditional criteria and severely and durably skewed in their party's favor.[296] My point, instead, is that the *Rucho* Court gave bad reasons for rejecting this proposal. Disregard for traditional principles is a flawed test because it doesn't inhibit much gerrymandering. It *isn't* deficient because of tradeoffs either among traditional criteria or between them and partisan fairness.

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288. Id. at 2501. In the rare event that a challenged plan is already on the Pareto frontier for two or more traditional criteria, a court could simply uphold the plan.

289. Id. at 2500.

290. See supra section III.B.

291. See supra section III.B.

292. See supra section III.C.

293. See Stephanopoulos & McGhee, Partisan Gerrymandering, supra note 65, at 871 (distinguishing between the net and the absolute efficiency gap). I use the absolute efficiency gap (and the absolute declination) in my empirical analyses because the net versions of these variables lack meaningful Pareto frontiers.

294. *Rucho*, 139 S. Ct. at 2500.

295. See supra notes 26–30 and accompanying text.

296. See, e.g., Whitford v. Gill, 218 F. Supp. 3d 837, 889 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018) ("Highly sophisticated mapping software now allows lawmakers to pursue partisan advantage without sacrificing compliance with traditional districting criteria.").

Having just addressed the first implication of this Article's findings, this is an appropriate place to acknowledge a number of caveats. They apply not only here but throughout this Part's discussion of redistricting law and policy. First, whenever I refer to line-drawing "tradeoffs," one could append the qualifier, "necessary," before that term. My subject, in other words, is compromises among redistricting objectives that can't be escaped (or can be eluded only with great difficulty). I'm not concerned with *discretionary* tradeoffs: mapmakers' choices to sacrifice some goals, while attaining others, in contexts when these sacrifices could easily have been avoided. Discretionary tradeoffs are made all the time by mapmakers uninterested in certain aims, most notably partisan fairness and competitiveness.[297] These decisions are outside this Article's scope because they're neither inevitable nor even (for the most part) facilitated by states' geographic and political features.

Second, my thesis that redistricting tradeoffs are rare is limited to *global* criteria: measures computed on a map-wide basis. Most of the metrics I introduced and analyzed in Parts II and III are properties of an entire district map. The only exceptions are the compactness and county congruence of minority-opportunity districts,[298] which comprise a subset of a map's districts. But even these variables are often calculated for multiple districts in multiple regions of a state. I therefore make no claim about the prevalence of tradeoffs among *local* criteria. Such tradeoffs, restricted to a small number of districts in a specific area, may or may not be widespread. This Article simply sheds no light on this distinct issue.

Third, while I include the most prominent traditional principles in this study—compactness and county congruence[299]—I don't take into account respect for communities of interest or for the cores of prior districts. Community boundaries are famously hard to pin down.[300] That's why there's *no* standard measure of adherence to these borders, in contrast to the dozens of compactness, partisan fairness, and competitiveness metrics.[301] Respect for prior districts' cores is a relatively unusual

297. This is apparent in how distant most enacted plans are from Pareto frontiers that include partisan fairness or competitiveness. See supra section III.E.

298. Throughout this Part, I sometimes use "minority-opportunity districts" as shorthand for both these districts and majority-minority districts.

299. Contiguity is an even more common traditional criterion, see Redistricting Criteria, supra note 27, but it's satisfied by all the districts in the map ensembles I analyze.

300. For an article-length treatment of communities of interest, see generally Nicholas O. Stephanopoulos, Redistricting and the Territorial Community, 160 U. Pa. L. Rev. 1379 (2012).

301. For one effort to quantify districts' congruence with communities of interest using American Community Survey data, see generally Nicholas O. Stephanopoulos, Spatial Diversity, 125 Harv. L. Rev. 1903 (2012).

criterion, required or explicitly allowed by only eleven states.[302] Were it to be incorporated into a computer algorithm, though, it might dramatically shrink the universe of available maps. Only a fraction of maps satisfying an algorithm's other parameters are also likely to strongly resemble the previous enacted plan. This sharp contraction of the relevant map universe would have uncertain consequences for the existence and extent of redistricting tradeoffs.

Fourth, the electoral data on which I rely is fairly recent, coming from the 2016–2020 period.[303] Large changes in voter behavior occurred in this era, which was dominated by Donald Trump as the Republican presidential candidate in both 2016 and 2020. Income receded as an electoral cleavage; an enormous "diploma divide" emerged between more and less educated voters; the gap between urban and rural voters grew; and minority voters moved modestly in a Republican direction.[304] These shifts have no effect on compactness or county congruence, which are both computed without considering election results. But all the other measures I employ *do* depend on electoral data and thus are sensitive to which elections are used. Accordingly, my conclusion that partisan fairness, competitiveness, and minority representation are subject to few tradeoffs could be different in other political environments.

Finally, this Article's results are based on map ensembles generated by a pair of computer algorithms. These ensembles have several attractive qualities: comprehensiveness, representativeness, and satisfaction of most legal criteria.[305] But many other sets of maps could be consulted instead, and they might lead to divergent verdicts about redistricting tradeoffs. For example, tradeoffs may well be rife in plans actually enacted into law. As observed above, human line-drawers habitually make discretionary tradeoffs, and plans reflecting these choices may exhibit strong correlations among criteria as well.[306] Similarly, more tradeoffs might appear in maps produced by optimization algorithms. By design, these algorithms

302. See Redistricting Criteria, supra note 27 (listing Alabama, Arkansas, Kansas, Louisiana, Nebraska, New Mexico, New York, Oklahoma, South Carolina, Utah, and West Virginia as states which allow or require consideration of such factor).

303. See supra note 202 and accompanying text.

304. See Stephanopoulos, Election Law for the New Electorate, supra note 85, at 45, 47, 55, 62 (internal quotation marks omitted) (quoting Joshua N. Zingher, Diploma Divide: Educational Attainment and the Realignment of the American Electorate, 75 Pol. Rsch. Q. 263, 263 (2022)).

305. See supra section II.B.

306. See, e.g., Goedert et al., Black Representation and District Compactness, supra note 56, at 266 (finding a negative historical relationship between Black representation and the compactness of congressional districts in the South).

push maps toward Pareto frontiers: the very zones where tradeoffs can't be evaded.[307]

### B. *Partisan Gerrymandering Justifications*

Returning to the implications of my findings, recall that, in states that recognize a cause of action for partisan gerrymandering, it commonly includes a justification stage.[308] This stage is reached only if a plaintiff first proves that a district plan is intentionally, severely, and durably biased in favor of the line-drawing party. The defendant may then try to show that this skew has an innocent explanation: a desire to achieve a *nonpartisan* objective such as compliance with traditional criteria, competitiveness, or minority representation. If the court agrees that the plan's tilt is attributable to "legitimate state prerogatives and neutral factors," the plan is upheld.[309] If not, the plan is deemed unconstitutional.

Based on this Article's analyses, there's seldom a convincing justification for a highly biased plan. That is, legitimate nonpartisan goals can rarely account for a plan's large partisan skew. Toward the beginning of Part III, I displayed scatter plots of the size of North Carolina congressional maps' partisan bias versus their compactness, county congruence, competitiveness, and minority representation.[310] In each of these plots, there are *many* maps—hundreds or thousands of them—that are both nearly perfectly fair in partisan terms and exemplary in their performance on the nonpartisan dimension. An aspiration to do well on that dimension therefore can't explain any plan's sharp partisan tilt. Any plan could score strongly, even superbly, on that dimension while still creating a level playing field for the major parties.

Moreover, North Carolina congressional maps are hardly atypical in this regard. For most states and electoral levels, scatter plots of the size of maps' partisan bias versus their compactness, county congruence, competitiveness, and minority representation look quite similar. These plots also tend to feature many maps that excel in terms of both partisan fairness and the applicable nonpartisan criterion.[311] The main exceptions are a handful of heavily Democratic or Republican states with few congressional districts (like Hawaii and Idaho). In these states, all congres-

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307. But see supra section II.A (reviewing existing studies of redistricting tradeoffs, of which several use optimization algorithms yet report generally weak relationships among criteria).

308. See supra notes 70–75 and accompanying text.

309. Whitford v. Gill, 218 F. Supp. 3d 837, 911 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018).

310. See supra Figure 3.

311. I'm unable to display these (many hundreds of) plots here, or even in the Appendix, due to space constraints.

sional districts are won by the same party no matter how the lines are drawn, meaning that maps with poor scores on measures like the efficiency gap are inevitable.[312] But these states represent only a small fraction of Congress—and an even smaller share of partisan gerrymandering litigation[313]—so their odd circumstances are mostly irrelevant.

Faced with the availability of maps that score well on both partisan fairness and whichever objective is offered as a justification for a highly biased plan, a defendant might contend that these maps are unusual. *In general*, a defendant might claim, accomplishing its nonpartisan objective *does* result in a significant partisan skew. Legally, this logic is dubious. The existence of the alternative maps is what matters, because it demonstrates that the defendant's nonpartisan goal doesn't actually necessitate such a severe partisan tilt. The relative volume of the alternative maps is beside the point.[314]

Empirically, too, this argument is, in essence, an assertion that partisan fairness is negatively correlated with a strong showing on the nonpartisan dimension cited by the defendant. But this Article's results indicate that this assertion is normally incorrect. In the new ensembles for the seven priority states, the median correlations between the size of maps' partisan bias and their compactness, county congruence, and minority representation are infinitesimal: smaller than 0.01.[315] The median correlation between the size of maps' partisan bias and their competitiveness is somewhat larger (0.14)—but this means that partisan fairness and competitiveness are mild complements, not substitutes.[316] In the ALARM congressional ensembles, likewise, the median correlations between the size of maps' partisan bias and their compactness, county congruence, competitiveness, and minority representation are all very weak: below 0.1.[317]

To make this discussion more concrete, consider North Carolina's current congressional plan, which replaced the court-drawn plan used in the 2022 election.[318] The current plan was enacted by the state's

312. To illustrate, in the ALARM congressional ensembles, every Hawaii map has a pro-Democratic efficiency gap of 11.8 percent and every Idaho map has a pro-Republican efficiency gap of 18.8 percent.

313. See Stephanopoulos & McGhee, Partisan Gerrymandering, supra note 65, at 879–84 (showing district plans challenged in partisan gerrymandering litigation).

314. See *Whitford*, 218 F. Supp. 3d at 921 (holding that the pro-Republican bias of a Wisconsin state house plan was unjustified based on the existence—not the volume—of "alternative district plans that performed satisfactorily on traditional districting criteria but secured a materially smaller partisan advantage").

315. See supra section III.B.

316. See supra section III.B.

317. See supra section III.C.

318. North Carolina's current congressional plan was enacted in 2025, tweaking the plan adopted in 2023 to make it even more pro-Republican. See North Carolina, All About

Republican legislature, and by some metrics, it's more skewed in Republicans' favor than any other congressional plan in the country.[319] So if a partisan gerrymandering challenge were brought against the current plan, and if this litigation reached the justification stage, how might this stage unfold? The state could aver that the plan's tilt is attributable to adherence to traditional criteria against the backdrop of Democratic and Republican voters' spatial patterns.[320] But the scatter plots in Figure 3 repudiate this explanation. Again, there are many maps that are simultaneously fair in partisan terms—not hugely skewed in a Republican direction—and highly compliant with traditional principles. The correlations between the partisan fairness of North Carolina congressional maps and their compactness and county congruence are also near zero.[321]

Alternatively, the state could say it was trying to promote competitiveness when it reshaped its congressional districts.[322] But this excuse is implausible on its face; the ten Republican candidates elected to the U.S. House in 2024 won their races by a median of almost twenty percentage points.[323] The applicable scatter plot in Figure 3 further reveals many maps with outstanding partisan fairness and competitiveness scores, as well as a negligible correlation between these measures.[324] One more rationale might be securing the minority representation necessary to satisfy Section 2 of the VRA.[325] But this defense, too, is hard to take seriously given the North Carolina legislature's view that "no VRA districts [are]

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Redistricting, https://redistricting.lls.edu/state/north-carolina [https://perma.cc/8Y8F-M2TH] (last visited Jan. 24, 2026) (discussing North Carolina's congressional plans in the 2020s).

319. See Nicholas O. Stephanopoulos, Eric McGhee & Christopher Warshaw, Opinion, The House's Republican Edge Is Gone. But the Gerrymander Lives., Wash. Post, Mar. 3, 2025, https://www.washingtonpost.com/opinions/interactive/2025/house-gerrymandering-bias-republicans-democrats/ (on file with the *Columbia Law Review*) (showing that, measured in congressional seats, North Carolina's pro-Republican efficiency gap is the largest in the country).

320. For an example of a state offering this kind of defense, see Whitford v. Gill, 218 F. Supp. 3d 837, 921 (W.D. Wis. 2016), vacated on other grounds, 138 S. Ct. 1916 (2018) (noting Wisconsin's argument that the use of "traditional districting criteria" given the state's "political geography . . . explains [the challenged plan's] partisan effect").

321. See supra Figure 3.

322. For an example of a state offering this kind of defense, see Adams v. DeWine, 195 N.E.3d 74, 86 (Ohio 2022) (noting Ohio's argument that its congressional plan "maximizes the number of competitive districts").

323. See Election Results Dashboard, N.C. St. Bd. of Elections, https://www.ncsbe.gov/results-data/election-results [https://perma.cc/7X6M-YFY6] (last visited Feb. 12, 2026) (reporting these election results).

324. See supra Figure 3.

325. For an example of a state offering this kind of defense, see Common Cause v. Rucho, 318 F. Supp. 3d 777, 879 (M.D.N.C. 2018), vacated on other grounds, 139 S. Ct. 2484 (2019) (noting North Carolina's argument that "compliance with the Voting Rights Act" justified its plan's pro-Republican bias).

required" in the state.[326] Nor can this defense overcome the obstacles posed by the relevant scatter plot in Figure 3, which shows many fair maps with abundant minority-opportunity districts as well as a complementary relationship between partisan fairness and minority representation.[327]

Again, North Carolina congressional maps are entirely ordinary in these respects. In other states, and at other electoral levels, most attempts to justify highly biased plans would be equally unlikely to succeed. These efforts would typically run into the same roadblocks of (1) many alternative maps that are much less skewed yet perform at least as well on the proffered nonpartisan dimension; and (2) no correlation, or at worst a weak one, between partisan fairness and the nonpartisan aim.[328] In light of this evidence, a reasonable question is whether the justification stage of a partisan gerrymandering suit should simply be scrapped. Why keep a defense that few jurisdictions can establish—an element that protracts and complexifies litigation but infrequently changes its outcome?

I'm sympathetic to this critique. A defense based on the prospect of redistricting tradeoffs seems pointless if line-drawing criteria, in fact, rarely conflict. On the other hand, *rarely* isn't the same as *never*. There are a few cases in which partisan fairness is at odds with the achievement of another global objective. As noted in the last section, there could be even more cases in which districts in a specific area can have a fair partisan configuration only if nonpartisan goals are locally sacrificed.[329] The justification stage has value in these unusual scenarios, preventing liability from being found if correcting a plan's tilt would necessarily cause a nonpartisan injury. This value is modest, due to these scenarios' scarcity, but it isn't zero.

Additionally, the data that thwarts most justification defenses comes from maps generated randomly by computer algorithms. If partisan gerrymandering plaintiffs wouldn't otherwise run these algorithms, the justification stage would add significant time and expense to their cases. But many plaintiffs in these suits *already* lean heavily on computational redistricting. They use the greater bias of the challenged plan, compared to many randomly created maps, as both circumstantial evidence of partisan intent and direct proof of partisan effect.[330] For plaintiffs with existing access to this data, the justification stage poses a relatively minor inconvenience. Their experts merely have to make a few more calculations and

326. Harper v. Hall, 886 S.E.2d 393, 444 (N.C. 2023).

327. See supra Figure 3.

328. See supra sections III.B–.C.

329. See supra section IV.A.

330. See, e.g., Rucho v. Common Cause, 139 S. Ct. 2484, 2518 (2019) (Kagan, J., dissenting) (observing that computational redistricting "also has recently been used in Michigan and Ohio litigation").

produce a few more charts to demonstrate that the challenged plan's skew is unwarranted.

The justification stage not only has some value, then, but also imposes few extra costs on litigants. These are sufficient bases, in my view, to save this element from the scrapheap. But partisan gerrymandering plaintiffs should be aware of their strong position: their ability to decisively refute most nonpartisan rationales put forward by jurisdictions. By the same token, defendants should realize that most of their attempts to explain their highly biased plans are doomed to failure. Put differently, even if the justification stage remains part of the doctrine, it's still a sideshow. The doctrine's other elements are the site of the real action.[331]

### C. *Racial Vote Dilution*

Changing gears from party to race, the first prong of the *Gingles* framework for racial vote dilution claims under Section 2 of the VRA is analytically similar to the justification stage of partisan gerrymandering litigation.[332] In both contexts, plaintiffs seek a representational end: here, greater minority representation; there, improved partisan fairness. In both contexts, plaintiffs also lose if their desired end requires tradeoffs with other legitimate aims: here, ones limited to minority-opportunity districts; there, local or global objectives. In particular, *Gingles*'s first prong isn't satisfied if more minority-opportunity districts can be drawn only by rendering one or more of them "[un]reasonably configured."[333] To vault this hurdle, plaintiffs must prove that more minority-opportunity districts that "comport[] with traditional districting criteria" are possible.[334]

This Article's findings indicate that plaintiffs should often be able to make this showing. Revisit the scatter plots in Figure 3, of which the last two display the share of minority-opportunity districts in North Carolina congressional maps on the y-axis and, respectively, the compactness and county congruence of these districts on the x-axis. In most portions of each plot, there exist alternative maps that, relative to any given map,

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331. The justification stage might be analogized to the partisan intent element when a single party has full control of the redistricting process. In this situation, "it should not be very difficult to prove that the likely political consequences of the reapportionment were intended." Davis v. Bandemer, 478 U.S. 109, 129 (1986) (plurality opinion), abrogated by *Rucho*, 139 S. Ct. 2484. So, the key issue is whether "there was []sufficient discriminatory effect to constitute an equal protection violation." Id. at 141–42.

332. See supra note 95 and accompanying text.

333. E.g., Allen v. Milligan, 143 S. Ct. 1487, 1503 (2023).

334. Id. After Louisiana v. Callais, Nos. 24-109, 24-110, 2026 WL 1153054 (U.S. Apr. 29, 2026), plaintiffs must further prove that these additional minority-opportunity districts are compatible with the jurisdiction's political goals (which may include partisan advantage). See, e.g., id. at *13, *15.

include more minority-opportunity districts that are more compliant with the applicable criterion.[335] Section 2 plaintiffs could submit one or more such maps to carry their burden under *Gingles*'s first prong.[336]

For instance, North Carolina's court-drawn 2022 congressional plan had three minority-opportunity districts (slightly more than twenty percent of the state's fourteen districts), whose average Reock compactness was just above 0.3 and whose district-splitting score was about 1.4.[337] In a Section 2 challenge to this plan, plaintiffs could have identified many maps in the first scatter plot with four, five, or even six minority-opportunity districts that were more compact, on average, than the plan's three minority-opportunity districts. Likewise, plaintiffs could have pointed to many maps in the second scatter plot with four to six minority-opportunity districts that, as a group, more closely followed county boundaries than did the plan's three minority-opportunity districts.[338]

Once more, North Carolina congressional maps are typical of most other states and electoral levels. In the new ensembles for the seven priority states, alternative maps with more numerous and more compact minority-opportunity districts than the enacted plan are available in fourteen of nineteen cases.[339] Alternative maps with more numerous minority-opportunity districts that are more congruent with counties exist in twelve of nineteen cases.[340] Similarly, in the ALARM congressional ensembles, alternative maps with more numerous and more compact majority-minority districts are present in twelve of seventeen cases.[341] In all these settings, Section 2 plaintiffs could potentially satisfy *Gingles*'s first prong.[342] That is, they could potentially offer demonstration maps that, compared to the status quo, include more

335. See supra Figure 3.

336. However, these maps wouldn't necessarily satisfy *Callais*'s requirement of matching the existing plan's political performance.

337. I lack comprehensive data for North Carolina's current congressional plan (which likely includes fewer minority-opportunity districts than the court-drawn 2022 plan anyway).

338. As noted above, I use minority-opportunity (not majority-minority) districts as my primary measure of minority representation. See supra notes 216–224 and accompanying text. That said, North Carolina's court-drawn 2022 congressional plan had one majority-minority district with a Polsby-Popper compactness of about 0.38. According to the relevant ALARM ensemble, there exist maps with two majority-minority districts whose average Polsby-Popper compactness is about 0.39. And again, after *Callais*, all demonstration maps must achieve the existing plan's political goals (though this would not have been a major hurdle with respect to the court-drawn 2022 plan).

339. See supra section III.E.

340. See supra section III.E.

341. See supra section III.E.

342. See supra note 95 and accompanying text.

minority-opportunity districts that are themselves more reasonably configured.[343]

In the Section 2 context, it's also clear that such demonstration maps are all that plaintiffs need (under *Gingles*'s first prong). Plaintiffs *don't* have to prove that most or all computer-generated maps improve on the enacted plan in terms of both minority representation and adherence to traditional principles. In *Allen*, Alabama proposed that a "race-neutral benchmark" based on maps churned out by a computer algorithm "should serve as the point of comparison in § 2 cases."[344] The Supreme Court squarely rejected this idea, deeming it "compelling neither in theory nor in practice."[345] The Court went on to approve *race-conscious* demonstration maps, "created with an express [racial] target in mind."[346] The ReCom algorithm on which I mainly rely in this Article, however, is race-blind.[347] While it *can* incorporate race, here, all its parameters are nonracial.[348] Consequently, the ReCom-produced maps I discuss in this section are free from legal doubt according to *Allen*. They'd be valid even if they were race-conscious, but many of them manage to beat enacted plans without taking race into account.[349]

At the risk of gilding the lily, even if broader patterns in map ensembles were relevant to *Gingles*'s first prong, they'd generally favor Section 2 plaintiffs, not defendants. In the new map ensembles for the seven priority states, the median correlations between the share of minority-opportunity districts and their compactness and county congruence are miniscule: smaller than 0.01.[350] In the ALARM congressional map ensembles, the median correlation between the share of majority-minority districts and their compactness is an almost equally tiny 0.02.[351] So not only are there many individual maps with more numerous and more reasonably-configured minority-opportunity districts, relative to enacted plans, but the ensembles in their entirety exhibit few signs of the

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343. To satisfy *Callais*'s revision of *Gingles*'s first prong, these demonstration maps would also have to achieve jurisdictions' political goals (which may include partisan advantage).

344. Allen v. Milligan, 143 S. Ct. 1487, 1506 (2023).

345. Id. at 1507.

346. Id. at 1512 (plurality opinion).

347. In contrast, under the ALARM algorithm, "simulations are encouraged to accept plans that have a concentrated minority share . . . in accordance with the Voting Rights Act." 50-State Simulations FAQ, supra note 251.

348. See supra notes 180–183 and accompanying text.

349. In Louisiana v. Callais, however, the Court stated that, "in drawing illustrative maps, plaintiffs cannot use race as a districting criterion." Nos. 24-109, 24-110, 2026 WL 1153054, at *15 (U.S. Apr. 29, 2026). This might require a redistricting algorithm like the one on which I mainly rely.

350. See supra section III.B.

351. See supra section III.C.

tradeoffs that undergird *Gingles*'s first prong. In the ensembles, the extent of minority representation is mostly unrelated to minority-opportunity districts' compliance with traditional criteria.

All this evidence prompts a version of the question I asked earlier about the justification stage of a partisan gerrymandering claim: Should *Gingles*'s first prong be amended so that Section 2 plaintiffs merely have to establish that an alternative map could increase minority representation compared to the status quo?[352] Since minority representation is seldom linked to minority-opportunity districts' adherence to traditional principles, it seems superfluous to insist that plaintiffs prove the absence of a tradeoff between these measures. As above, I'm openminded about this reform but I ultimately prefer the law as it currently stands. First, there are some cases in which enacted minority-opportunity districts' compactness or county congruence *isn't* surpassed by any map in the applicable ensemble that has more minority-opportunity districts. In these cases, *Gingles*'s first prong might do real work. It could prevent plaintiffs from prevailing by forcing them to submit minority-opportunity districts that may be unreasonably configured, at least relative to their enacted analogues.

Second, while *Gingles*'s first prong blocks few *necessary* tradeoffs—because few exist—it stops many *discretionary* ones. Left to their own devices, Section 2 plaintiffs would likely offer, and jurisdictions would likely adopt, many minority-opportunity districts that needlessly flout traditional criteria. We know this because that's exactly what these actors did in the early 1990s. Before the Supreme Court developed its doctrine on *Gingles*'s first prong, bizarre minority-opportunity districts proliferated across the country.[353] These strange shapes weren't required to increase minority representation—that's this Article's key finding about Section 2—but they did facilitate incumbent protection and partisan gerrymandering.[354] As now construed, *Gingles*'s first prong bars these gratuitous breaches of traditional principles. It thus constrains some political abuses while also making less probable the racial gerrymandering violations that are the subject of the next section.

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352. I'm bracketing *Callais*'s additional requirement of matching the challenged plan's political performance here. This new condition applies only if a jurisdiction asserts a political objective, and it's uncertain how often this will occur (or exactly which goal will be specified).

353. See Richard H. Pildes & Richard G. Niemi, Expressive Harms, "Bizarre Districts," and Voting Rights: Evaluating Election-District Appearances After *Shaw v. Reno*, 92 Mich. L. Rev. 483, 486–89 (1993) (describing redistricting in this period).

354. See supra notes 261–265 and accompanying text (discussing how political factors helped explain the bizarre shape of the original *Shaw* district).

*Gingles*'s first prong has enough value, then, to be kept in its current form.[355] But Section 2 litigants should know that, by harnessing the power of modern redistricting technology, plaintiffs will often be able to show that compromises of traditional criteria are unnecessary to create more minority-opportunity districts. To be sure, it will be impossible to draw more minority-opportunity districts in some cases, because jurisdictions have already maximized this variable.[356] Where this variable hasn't been maximized, though, increasing it infrequently demands tradeoffs with traditional principles.

### D. *Racial Gerrymandering*

The final cause of action I address here, racial gerrymandering, also involves race and redistricting. It involves the same types of tradeoffs as racial vote dilution doctrine, too, between race-related objectives like attaining certain levels of minority representation and minority-opportunity districts' compliance with traditional criteria. In this context, however, the existence of tradeoffs, and their embrace by jurisdictions designing districts, benefit plaintiffs, not defendants. To succeed in a racial gerrymandering claim, a plaintiff must prove that race predominantly motivated a district's formation.[357] A plaintiff may usually carry this burden only if a jurisdiction "subordinated"—traded off—"race-neutral districting criteria . . . to 'racial considerations.'"[358]

This Article's results indicate that states uncommonly have to subordinate traditional principles in order to achieve their race-related goals. In other words, states can typically achieve those goals while still adhering adequately, even scrupulously, to traditional criteria. To recap, in both the new ensembles for the seven priority states and the ALARM congressional ensembles, there tend to be many maps with abundant minority-opportunity districts that are quite compact and congruent with county boundaries.[359] In both sets of ensembles, there also tends to be no material relationship between the volume of minority-opportunity districts and their regard for traditional principles.[360] In general, states therefore have many options for simultaneously realizing their racial and

355. To reiterate, its current form while bracketing *Callais*'s addition to the prong. See supra note 352.

356. This scenario accounts for many of the cases in which alternative maps that improve on the enacted plan in terms of both minority representation and minority-opportunity districts' compliance with traditional criteria are unavailable. See supra notes 339–341 and accompanying text.

357. See Miller v. Johnson, 515 U.S. 900, 916 (1995) (coining the "predominant factor" standard).

358. Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1234 (2024) (internal quotation marks omitted) (quoting *Miller*, 515 U.S. at 916).

359. See supra sections III.B–.C.

360. See supra sections III.B–.C.

nonracial aims. In most cases, states don't even face any pressure (in the form of an adverse correlation between these aims) to subordinate nonracial to racial ends.

That said, to steer clear of racial gerrymandering liability, states do need to *choose* maps that avoid "conflict or inconsistency between [race-related objectives] and traditional redistricting criteria."[361] While many maps in the ensembles aren't subject to the tradeoffs at issue here, many others feature high levels of minority representation paired with minority-opportunity districts that do contravene traditional principles.[362] States don't have to select these maps given all the alternatives that match or beat them in both racial and nonracial terms. But if states nevertheless pick these inferior maps, they risk being found to have drawn one or more districts for predominantly racial reasons. Put another way, the usual absence of necessary tradeoffs means that most states *can* accomplish their race-related goals without undermining their race-neutral aims. But this usual absence protects states from legal danger only if they take advantage of it. If they decide, instead, to *make* discretionary tradeoffs between their racial and nonracial ends, they may well find themselves on the losing end of racial gerrymandering litigation.

Another point is that this Article examines only a couple race-related objectives: attaining certain levels of minority representation, as measured by either minority-opportunity districts or majority-minority districts. These have indeed been states' rationales for considering race in numerous racial gerrymandering cases (often framed as satisfying the VRA, not securing minority representation for its own sake).[363] But states have also used racial targets[364] and floors[365] in ways not plausibly required by the VRA. States have been accused, too, of relying on race as a rough proxy for partisanship.[366] This Article's analyses can't say whether there are tradeoffs between *these* race-related goals and minority-opportunity districts' compliance with traditional criteria. It seems doubtful, given the

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361. Bethune-Hill v. Va. State Bd. of Elections, 580 U.S. 178, 190 (2017).

362. See supra sections III.B–.C.

363. In *Shaw v. Reno* itself, for example, North Carolina argued that one of the "purposes" motivating the challenged district was "complying with the Voting Rights Act." 509 U.S. 630, 638 (1993); see also, e.g., League of United Latin Am. Citizens v. Perry, 548 U.S. 399, 518 (2006) (Scalia, J., concurring in part and dissenting in part) (agreeing that Texas had to create a challenged district "to comply with its obligations under § 5 of the Voting Rights Act").

364. See, e.g., Cooper v. Harris, 581 U.S. 285, 299 (2017) (racial target of fifty percent African American).

365. See, e.g., Ala. Legis. Black Caucus v. Alabama, 575 U.S. 254, 276 (2015) (racial floors of districts' prior demographic makeups).

366. See, e.g., Alexander v. S.C. State Conf. of the NAACP, 144 S. Ct. 1221, 1231 (2024) (noting, but disagreeing with, the district court's conclusion that "the legislature deliberately sought to maintain a particular [racial composition]" in order to "produce[] the sought-after partisan goal").

few tradeoffs found in Part III across many states, electoral levels, and redistricting parameters. But another study would be helpful to confirm that these racial aims are no different from the ones evaluated here.

Based on this discussion, my tentative judgment that the racial gerrymandering cause of action should be preserved should be unsurprising. Yes, this theory is likely to be futile whenever a state chooses a map that combines a certain degree of minority representation with minority-opportunity districts that abide by traditional principles. But states do sometimes make unnecessary, discretionary tradeoffs between these values, and in these circumstances, the racial gerrymandering claim has real teeth. The claim could have even more bite were future research to show (improbably) that other race-related objectives *are* subject to inescapable tradeoffs.

To this point, I've commented only on my findings' implications for the *law* of redistricting. This focus is sensible because federal and state law pervasively regulate redistricting, sharply limiting mapmakers' discretion and spawning endless litigation. But it's also worth flagging what this Article means for line-drawers when they make decisions that *aren't* legally driven. In this situation, the academic literature maintains that tradeoffs are ubiquitous: "necessary and fortuitous" according to Butler and Cain,[367] "inherent" per Goedert and his coauthors,[368] "important and inevitable" in Zhang's words.[369] To the contrary, this Article establishes that redistricting tradeoffs tend to be weak to nonexistent. By and large, progress along one dimension compels no regression along another axis (until the typically distant Pareto frontier is reached).

The upshot is that public-regarding mapmakers can (nearly) have it all. They can enact plans that simultaneously adhere to traditional criteria, treat the major parties fairly, lead to competitive elections, and properly represent minority voters. Line-drawers can't *maximize* all these variables at the same time, but concurrent high scores on all parameters are generally well within their reach.[370] This conclusion applies to not just redistricting but also legislative representation, which is heavily influenced by mapmaking choices. Dyadic (district-specific) representation is widely thought to be better when districts are compact, congruent with

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367. Butler & Cain, supra note 13, at 1.

368. Goedert et al., Black Representation and District Compactness, supra note 56, at 265, 271.

369. Zhang, supra note 58, at 991.

370. See Bruce E. Cain, Wendy K. Tam Cho, Yan Y. Liu & Emily R. Zhang, A Reasonable Bias Approach to Gerrymandering: Using Automated Plan Generation to Evaluate Redistricting Proposals, 59 Wm. & Mary L. Rev. 1521, 1554 (2018) (agreeing that "automated plan generation offers the option of combining both political fairness and formal criteria to generate maps that meet or exceed the values of the maps that were previously approved by the courts").

political subdivisions, and competitive.[371] Likewise, collective (jurisdiction-wide) representation largely boils down to legislatures that accurately reflect electorates in partisan and racial terms.[372] Thanks to the usual lack of redistricting tradeoffs, line-drawers can promote both dyadic and collective representation. They can incentivize both individual legislators and legislatures in their entirety to effectively represent their constituents.

## CONCLUSION

"[T]here are no solutions," the economist Thomas Sowell writes, "there are only trade-offs."[373] In most areas of life, this is surely true. People have many goals, these aims regularly conflict, so certain ends must be prioritized over others. Redistricting, though, is unlike most other practices. Because of the near-infinite number of district maps, as a rule, tradeoffs among line-drawing criteria *don't* have to be made. Mapmakers can simultaneously achieve all their objectives (until they arrive at faraway Pareto frontiers). This reality promises to reshape the redistricting subfields that are based on the prospect of common tradeoffs. Defendants should rarely be able to prove that plans' partisan biases or low levels of minority representation are necessitated by other factors. Plaintiffs should seldom manage to show that other factors were subordinated to race when districts were designed. More fundamentally, this reality offers us a compelling democratic future. We can draw districts that foster all kinds of representation, dyadic and collective alike. At least, we can do so if we decide that this political world—not our status quo of myriad needless tradeoffs—is the one we want.

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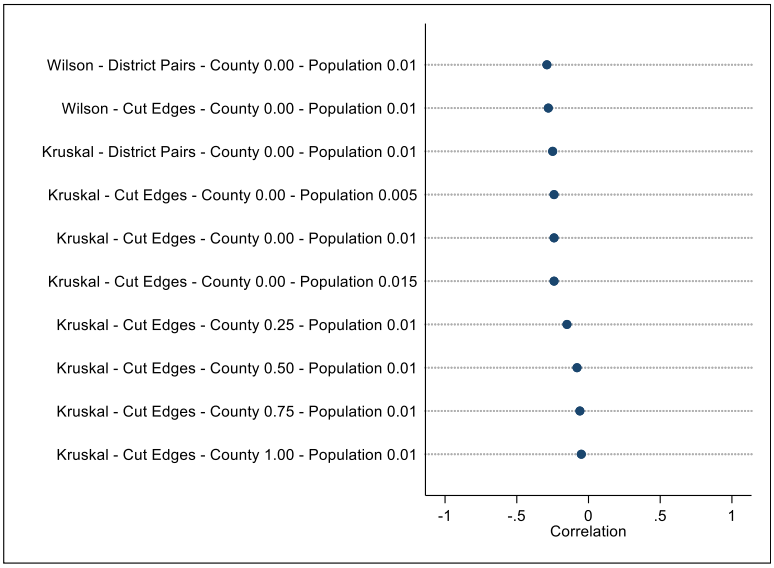
371. See, e.g., Stephanopoulos, Aligning Election Law, supra note 84, at 198–203 (summarizing relevant findings).

372. For a classic article on dyadic versus collective representation, see generally Robert Weissberg, Collective vs. Dyadic Representation in Congress, 72 Am. Pol. Sci. Rev. 535 (1978).

373. Tom Giovanetti, Tradeoffs, Inst. for Pol'y Innovation (Jan. 24, 2024), https://www.ipi.org/ipi_issues/detail/tradeoffs [https://perma.cc/55AE-8JMR] (quoting Thomas Sowell).

## APPENDIX A: CORRELATIONS BETWEEN PRIMARY CRITERIA PAIRS, NORTH CAROLINA CONGRESSIONAL ENSEMBLES

### FIGURE A.1. COUNTY SPLITTING VS. AVERAGE REOCK COMPACTNESS




### FIGURE A.2. ABSOLUTE EFFICIENCY GAP VS. AVERAGE REOCK COMPACTNESS

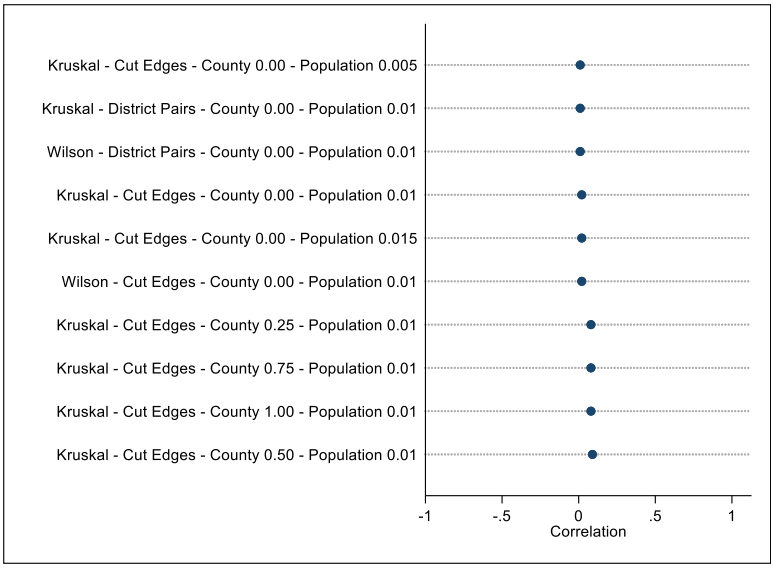


FIGURE A.3. ABSOLUTE EFFICIENCY GAP VS. COUNTY SPLITTING

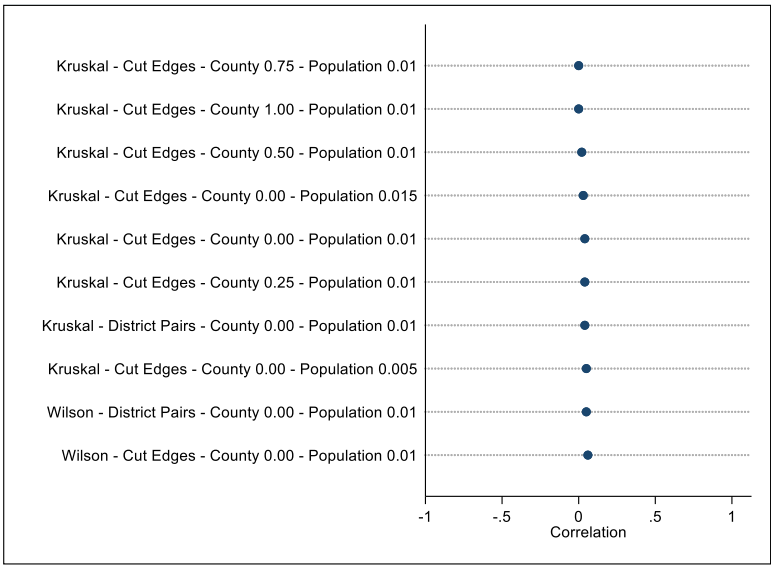



FIGURE A.4. ABSOLUTE EFFICIENCY GAP VS. AVERAGE MARGIN OF VICTORY

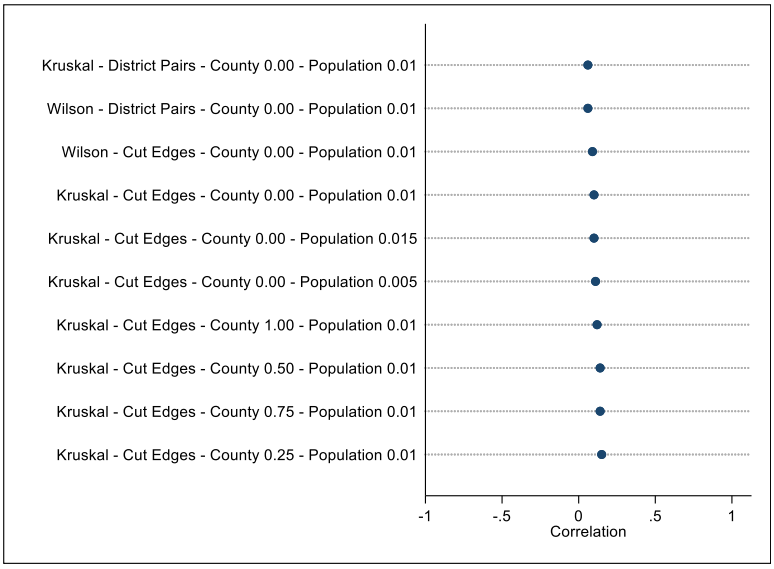


FIGURE A.5. ABSOLUTE EFFICIENCY GAP VS. SHARE OF MINORITY-OPPORTUNITY DISTRICTS

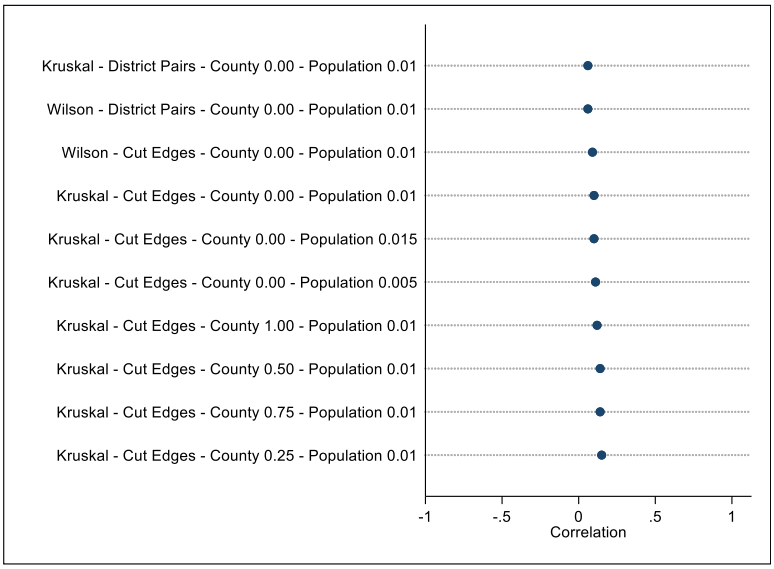



FIGURE A.6. SHARE OF MINORITY-OPPORTUNITY DISTRICTS VS. AVERAGE REOCK COMPACTNESS OF MINORITY-OPPORTUNITY DISTRICTS

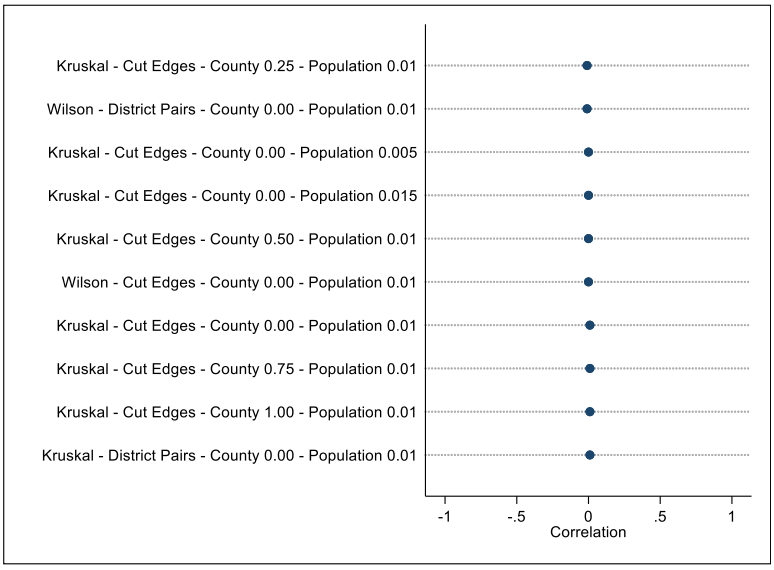
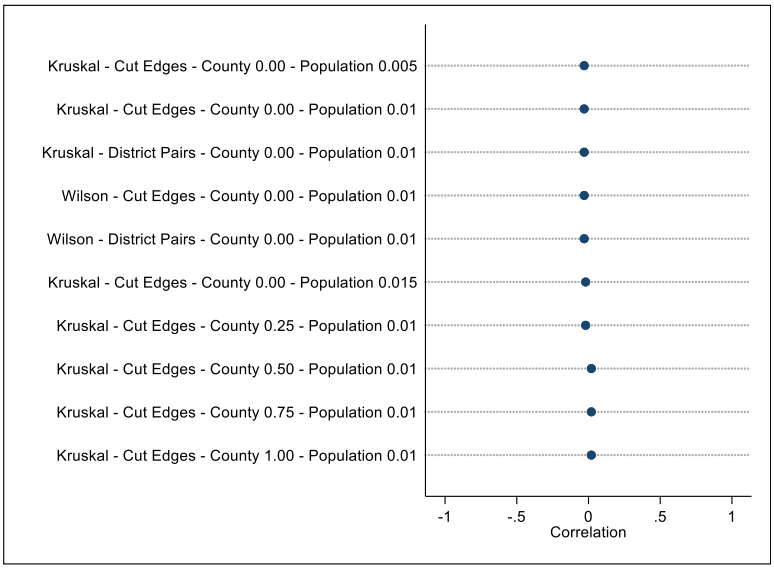
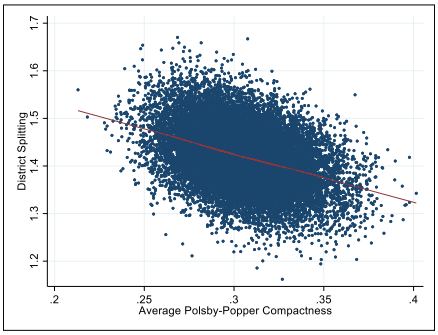


FIGURE A.7. SHARE OF MINORITY-OPPORTUNITY DISTRICTS VS. DISTRICT SPLITTING OF MINORITY-OPPORTUNITY DISTRICTS

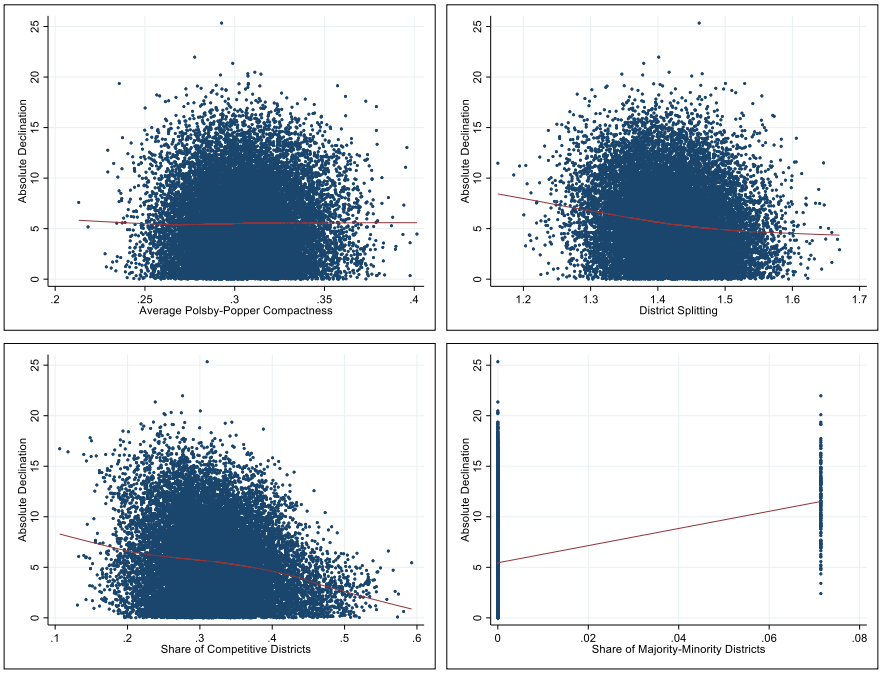


## APPENDIX B: SCATTER PLOTS OF SECONDARY CRITERIA PAIRS, DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE

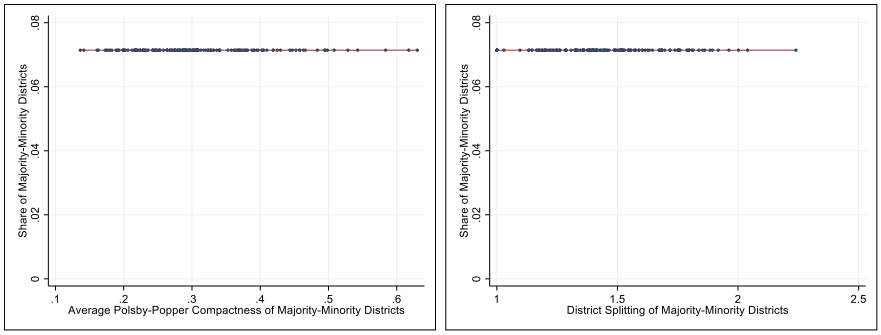
(a) Traditional Criteria




(b) Partisan Fairness

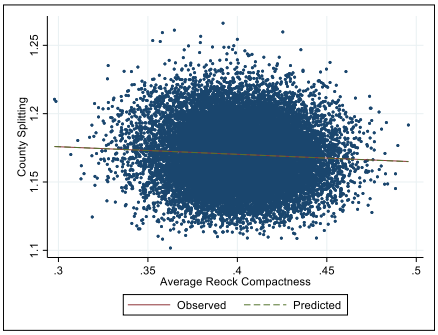


(c) Minority Representation

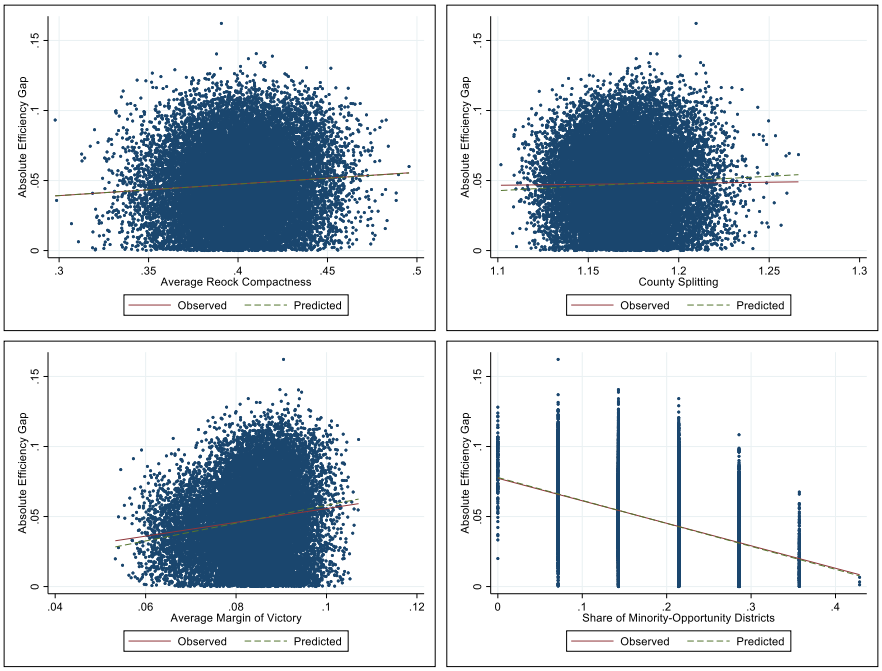


## APPENDIX C: OBSERVED AND PREDICTED RELATIONSHIPS BETWEEN PRIMARY CRITERIA PAIRS, DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE

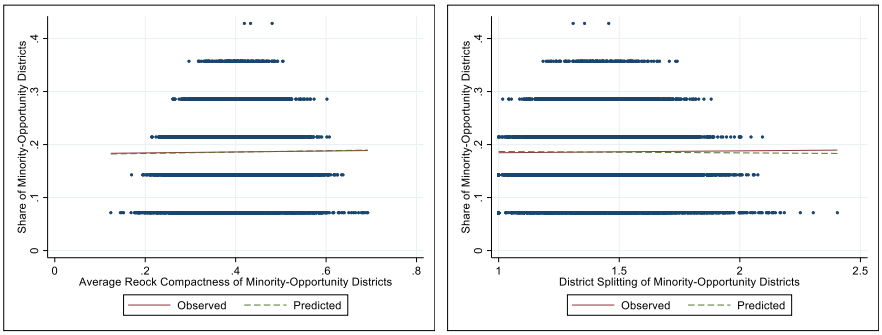
(a) Traditional Criteria




(b) Partisan Fairness



(c) Minority Representation



## APPENDIX D: SCATTER PLOTS OF ADDITIONAL CRITERIA PAIRS, ONE HUNDRED RECOM CHAINS AND DEFAULT NORTH CAROLINA CONGRESSIONAL ENSEMBLE

FIGURE D.1. ABSOLUTE EFFICIENCY GAP VS. AVERAGE REOCK COMPACTNESS

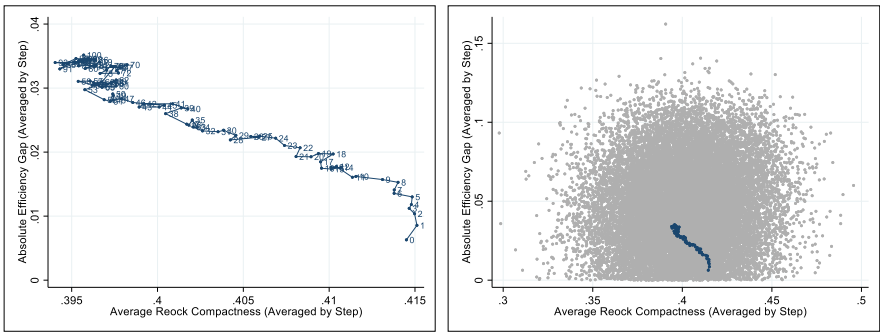



FIGURE D.2. ABSOLUTE EFFICIENCY GAP VS. COUNTY SPLITTING

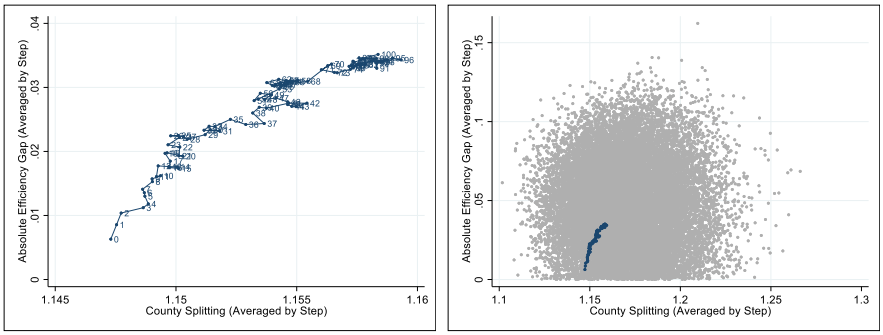



FIGURE D.3. ABSOLUTE EFFICIENCY GAP VS. AVERAGE MARGIN OF VICTORY

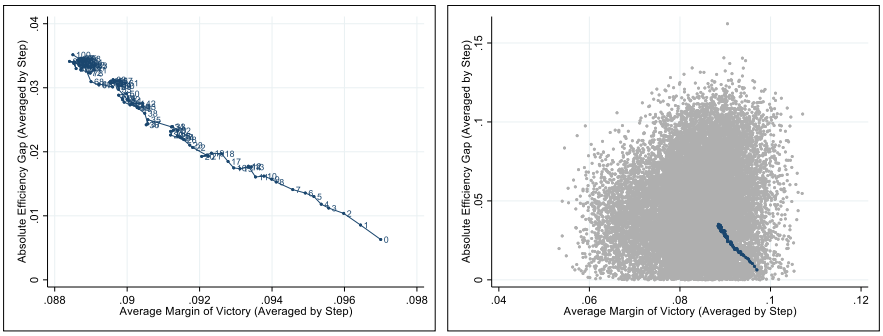


FIGURE D.4. ABSOLUTE EFFICIENCY GAP VS. SHARE OF MINORITY-OPPORTUNITY DISTRICTS

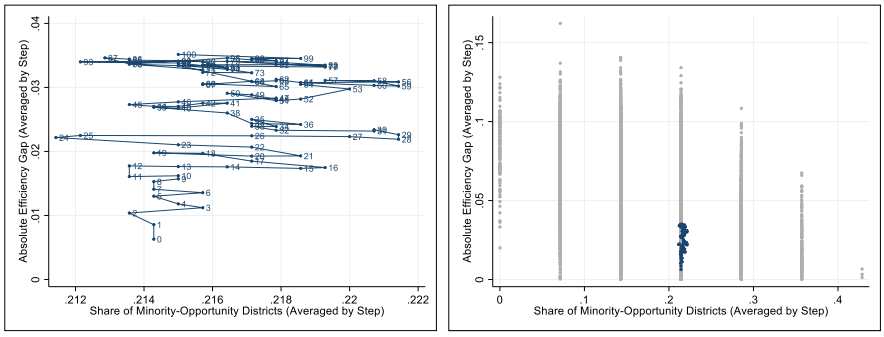



FIGURE D.5. SHARE OF MINORITY-OPPORTUNITY DISTRICTS VS. AVERAGE REOCK COMPACTNESS OF MINORITY-OPPORTUNITY DISTRICTS

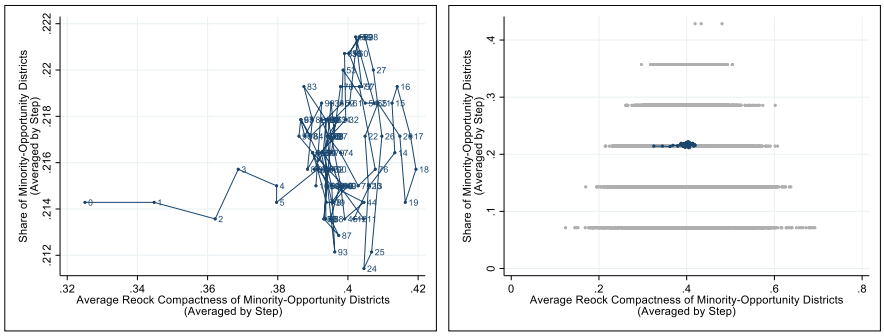
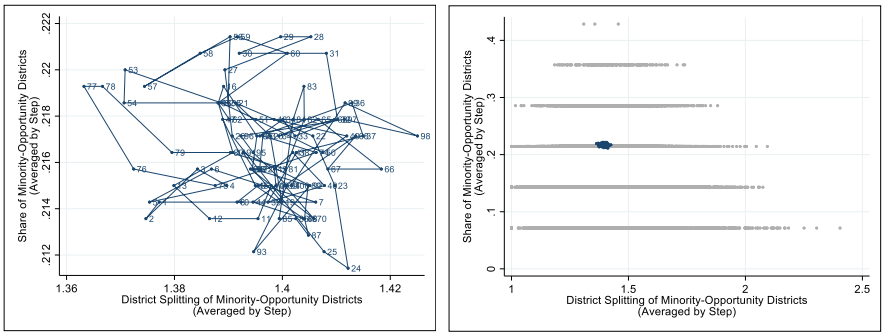
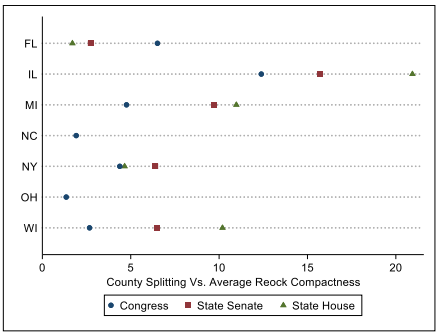



FIGURE D.6. SHARE OF MINORITY-OPPORTUNITY DISTRICTS VS. DISTRICT SPLITTING OF MINORITY-OPPORTUNITY DISTRICTS

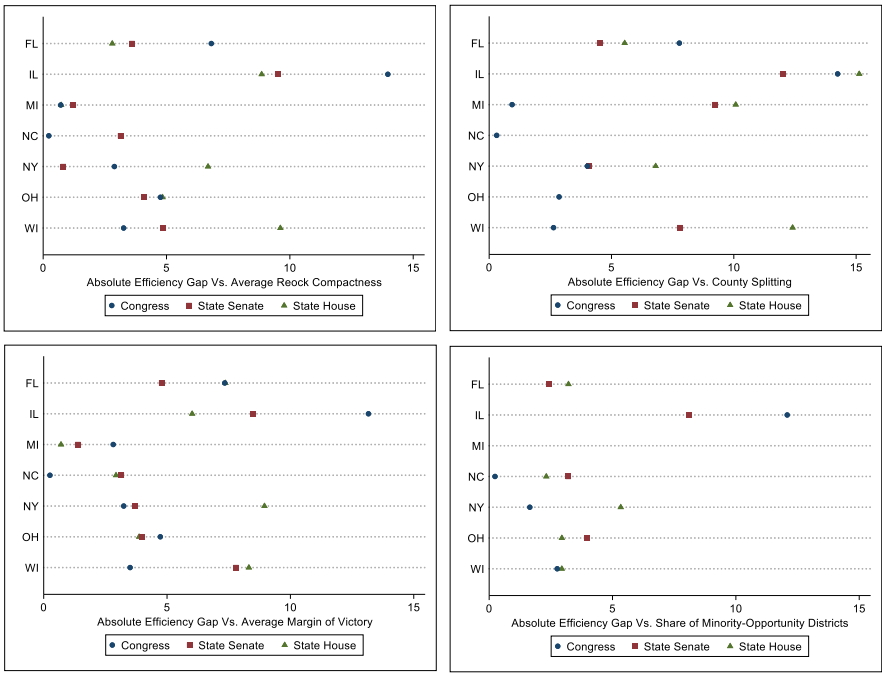


## APPENDIX E: ENACTED PLANS' MINIMUM DISTANCES (IN STANDARD DEVIATIONS) FROM PARETO FRONTIERS FOR PRIMARY CRITERIA PAIRS, DEFAULT PRIORITY STATE ENSEMBLES

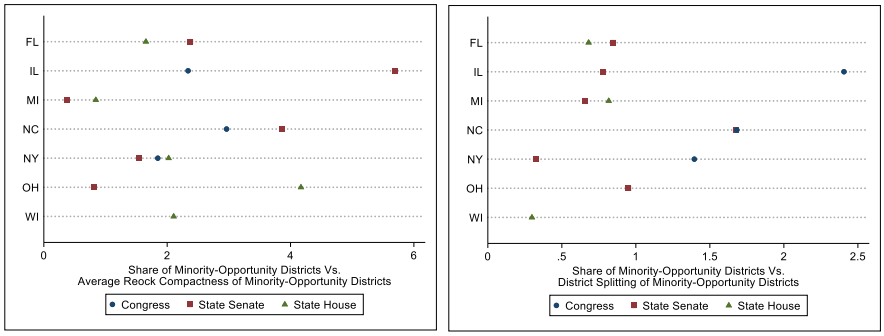
### (a) Traditional Criteria




### (b) Partisan Fairness

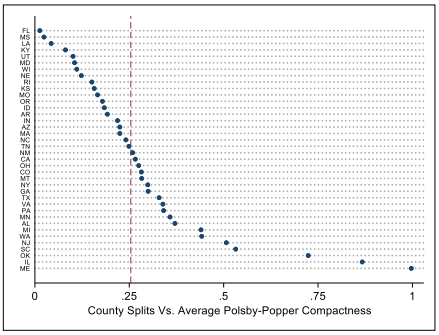


(c) Minority Representation

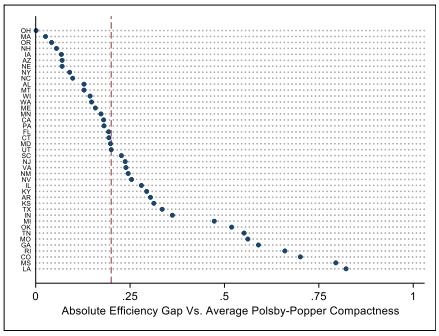


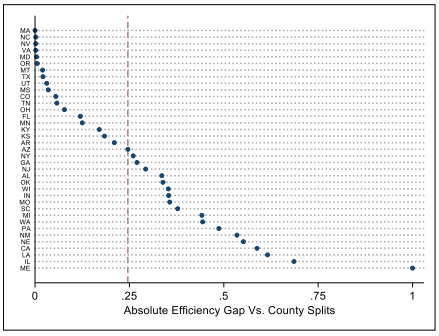
## APPENDIX F: PARETO FRONTIER TRADEOFF RATIOS FOR CRITERIA PAIRS, ALARM CONGRESSIONAL ENSEMBLES

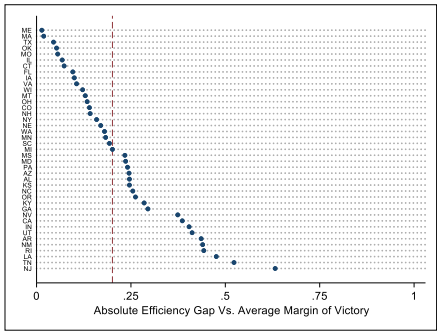
(a) Traditional Criteria

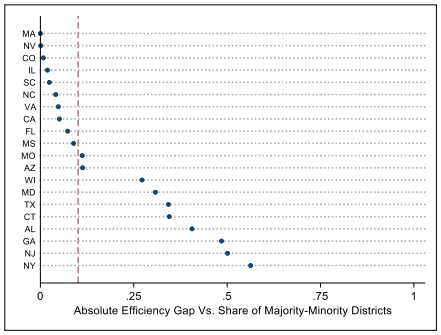



(b) Partisan Fairness

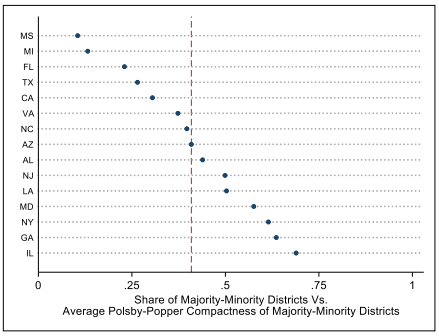


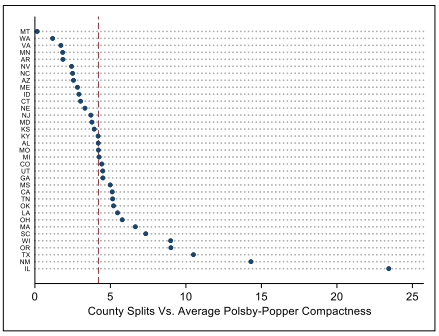



(c) Minority Representation

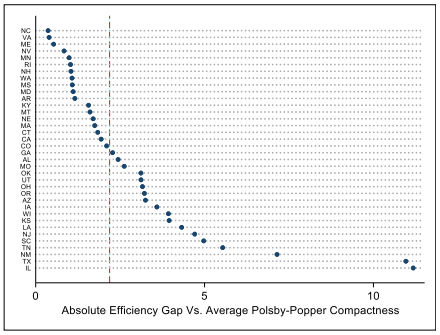


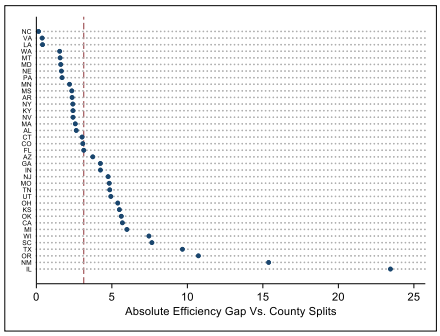
## APPENDIX G: ENACTED PLANS' MINIMUM DISTANCES (IN STANDARD DEVIATIONS) FROM PARETO FRONTIERS FOR CRITERIA PAIRS, ALARM CONGRESSIONAL ENSEMBLES

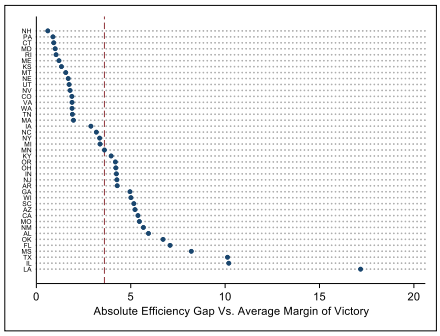
### (a) Traditional Criteria

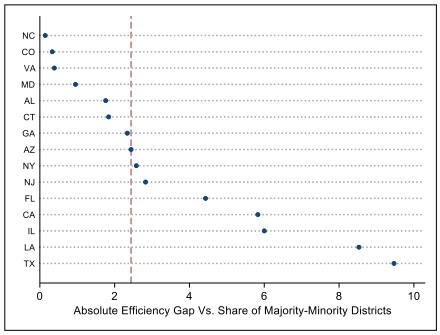



### (b) Partisan Fairness



(c) Minority Representation