February 8, 2022

To: Missouri Judicial Redistricting Commission (JRC)

Dear Judges Chapman, Gardner, Lynch, Martin, Quigless, and Sheffield,

My name is Ari Stern; I have been a math professor at Washington University in St. Louis for ten years, specializing in applied and computational mathematics. I have been interested in redistricting for several years, and especially in ways to improve outcomes with the use of public input and mathematical modeling. This year, I was one of the leaders of a team of mathematicians, data scientists, and geographers studying the possibilities for redistricting of the Missouri State Senate. The purpose of this comment is to present our findings, and to suggest how this might guide you in selecting the fairest possible map of State Senate districts for the new decade.

First, I will say just a few words about the main method. Rather than evaluating a proposed map (or small handful of maps) in isolation, we find that we gain great insight by having a *baseline* of how maps drawn only according to the rules tend to be structured. In recent years, courts have also found this to be an appealing method to understand the universe of legally valid alternatives. To do this, we employ randomized algorithms programmed with the state's rules and redistricting priorities, and can build thousands or millions of valid alternatives in a reasonable amount of time.

In Missouri, we have made 100,000 alternative Senate plans that are all contiguous and population balanced and that are programmed to favor compactness and the preservation of intact counties to the extent possible. This "ensemble" of alternatives should help us to understand the areas of strength and weakness for various proposed maps.
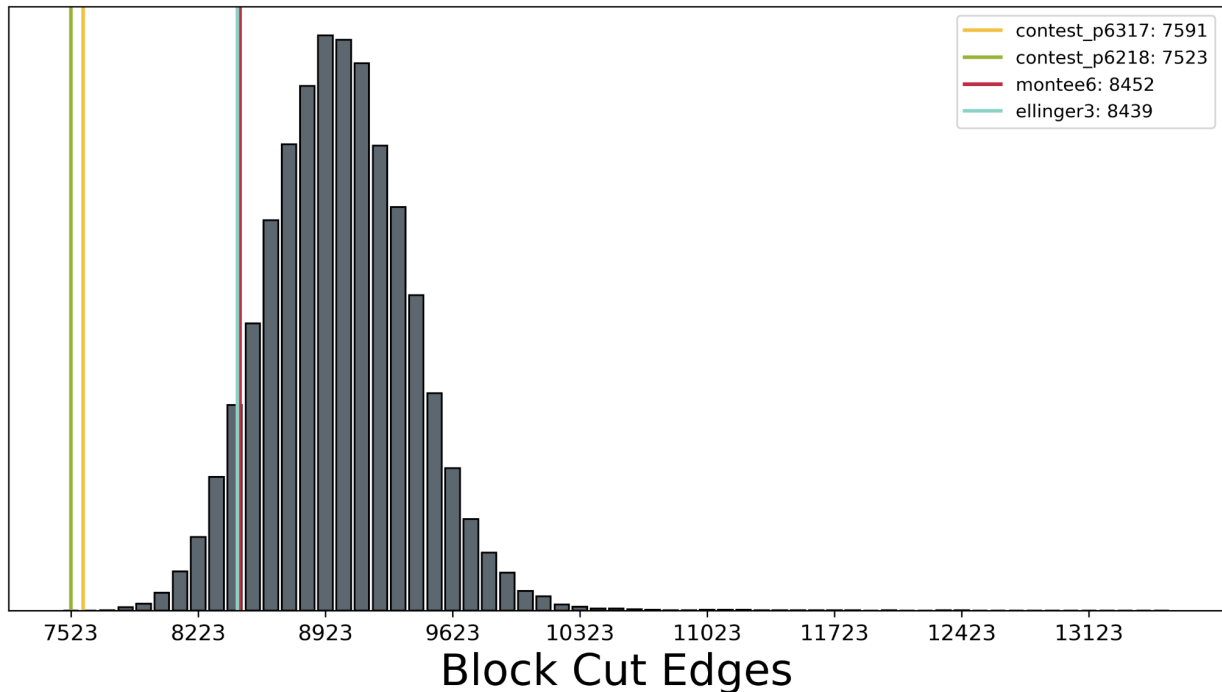
Additionally, we have the benefit of a human-made set of alternatives through the submissions to the mapping competition staged by the Fair Maps Missouri Coalition. Two submissions stood out as being best compliant with the rules and priorities: "[Fair State Senate Map](#)" (plan p6218) by Ryan Murphy of Jefferson County, and "[Maintaining Metros – State Senate](#)" (plan p6317) by Adam Kriz of Platte County.

I'll include some plots below that compare the work product of the Senate Independent Bipartisan Citizens Commission (specifically, the "Montee6" and the "Ellinger3" plans found [here](#)) with the citizen plans and our ensemble of 100,000 random maps built only according to the rules and priorities found in the [state constitution](#), as amended in 2020.

After population balance, minority opportunity to elect, and contiguity, the following criteria are presented: compactness, the preservation of communities (especially prioritizing intact counties), partisan fairness, and competitiveness.

All four plans are complete, contiguous, and population balanced to within the state's standard. Minority opportunity is notoriously hard to measure, but I will note that all four plans have four majority-minority districts. In Ellinger3 and Montee6, all four of these are majority-Black by voting age population, while in the citizen plans, two districts have Black majorities and the other two have majorities assessed as a coalition of minority groups.
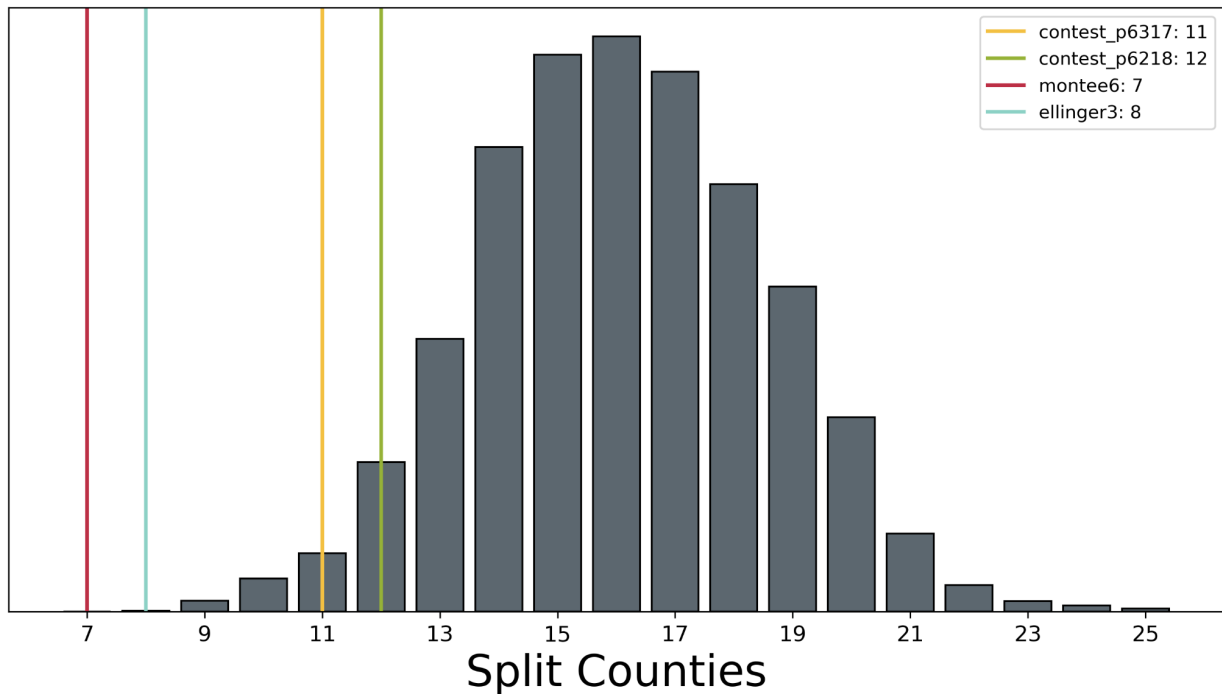
Compactness

"Cut edges" is a compactness score for which lower is better—all four plans are fairly compact with respect to this measure.[1] The competition plans by Murphy and Kriz are extraordinarily compact, but Montee6 and Ellinger3 are still significantly better on this metric than the typical plan produced by a random process designed to favor compact districts.

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[1] More commonly cited compactness scores are the Polsby-Popper score and the Reock score, which can be averaged over the districts in a plan. For these, higher is better. For completeness, I include those scores here. Montee6: PP=.308, Reock=.3667; Ellinger3: PP=.3164, Reock=.378; Kriz: PP=.3881, Reock=.427; Murphy: PP=.3757, Reock=.4211.
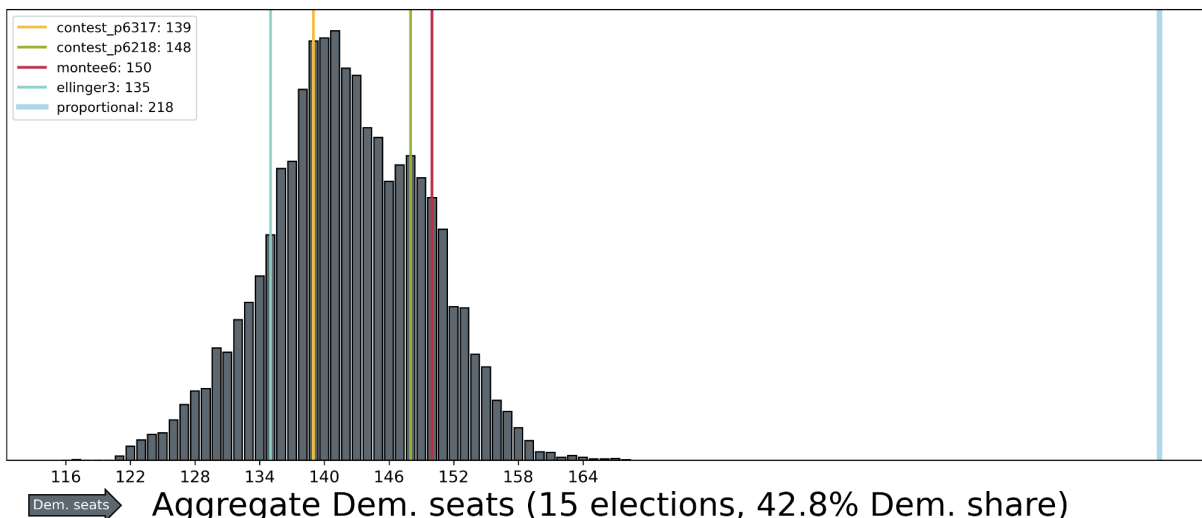
County Splits

Both Montee6 and Ellinger3 excel in their preservation of counties, which is of great importance in the constitutional rules. Montee6 especially is far better than the range observed in the 100,000 alternatives generated with county preservation as a priority.
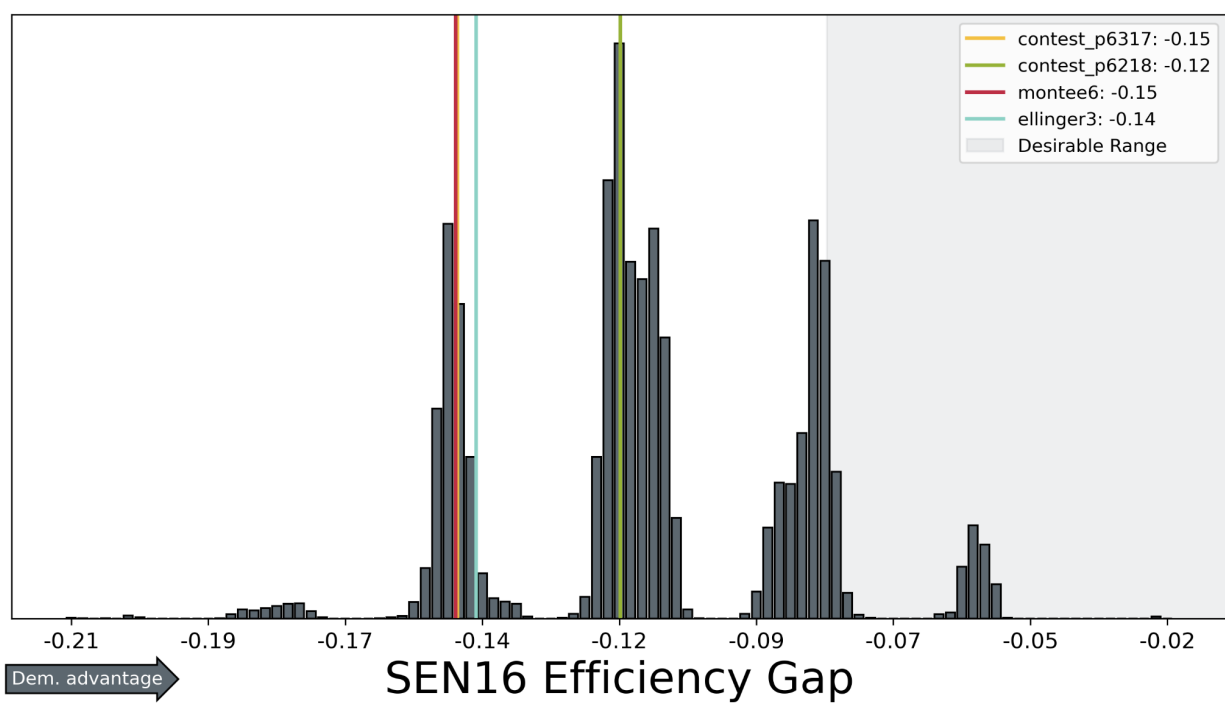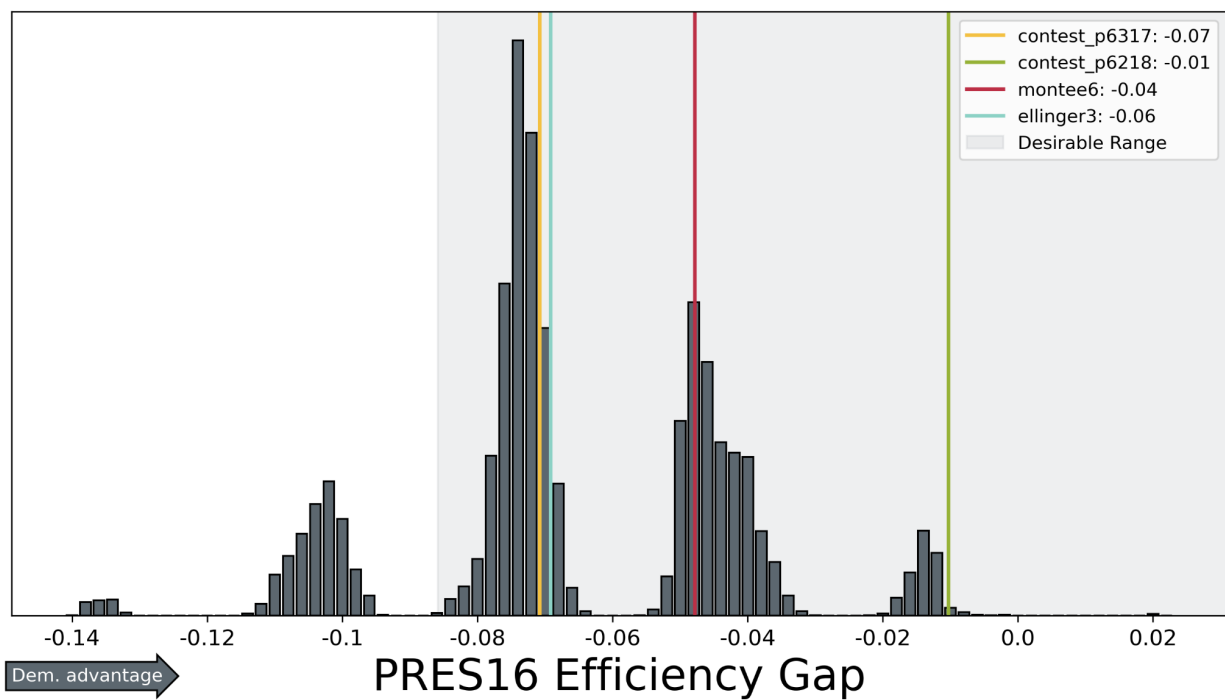
Partisan Fairness

To assess partisan fairness, we begin by considering the aggregate of the 15 statewide general elections that are in our corrected dataset.[2] These are actually observed—not simulated!—recent elections in Missouri (President, U.S. Senate, Governor, Lt. Governor, Secretary of State, Treasurer, Attorney General, and State Auditor elections from 2016–2020). Across all 15 of these elections, the average Democratic performance is to receive 42.8% of the major-party vote. We counted the total number of districts in each plan where the Democratic candidate got more votes than the Republican, and added this up over all of these elections in the dataset. This gives a robust view of how the plan gives opportunity to the candidates from the major parties.
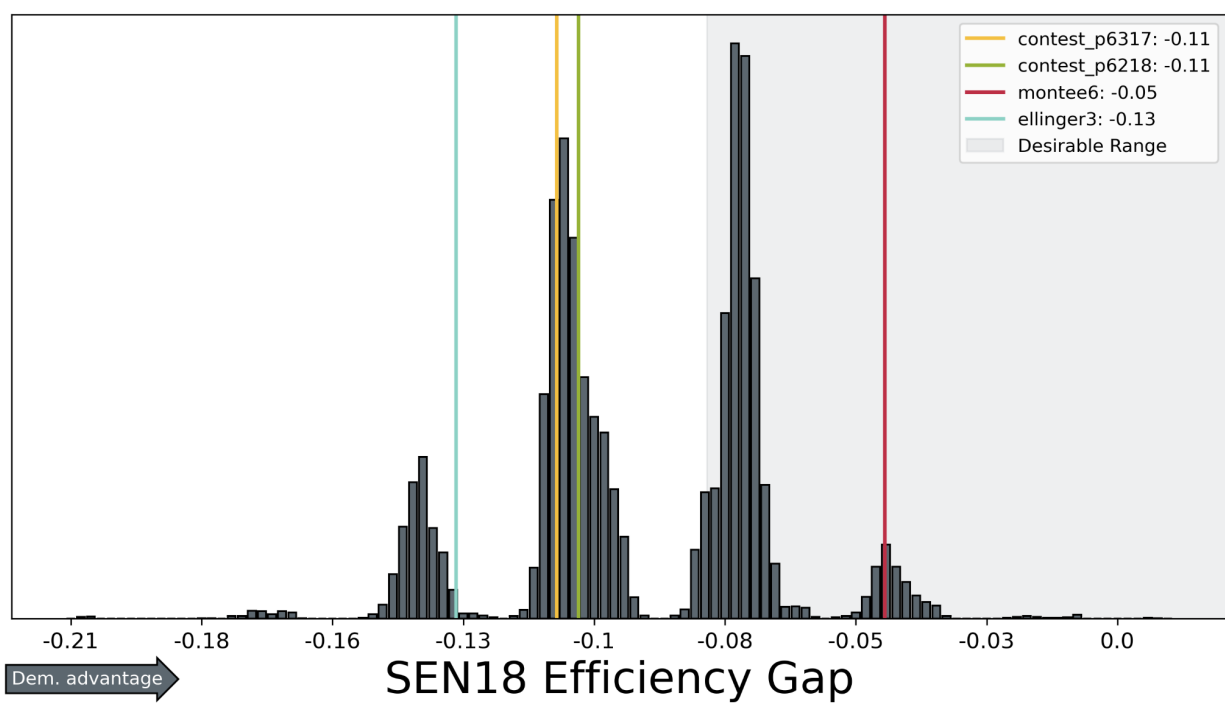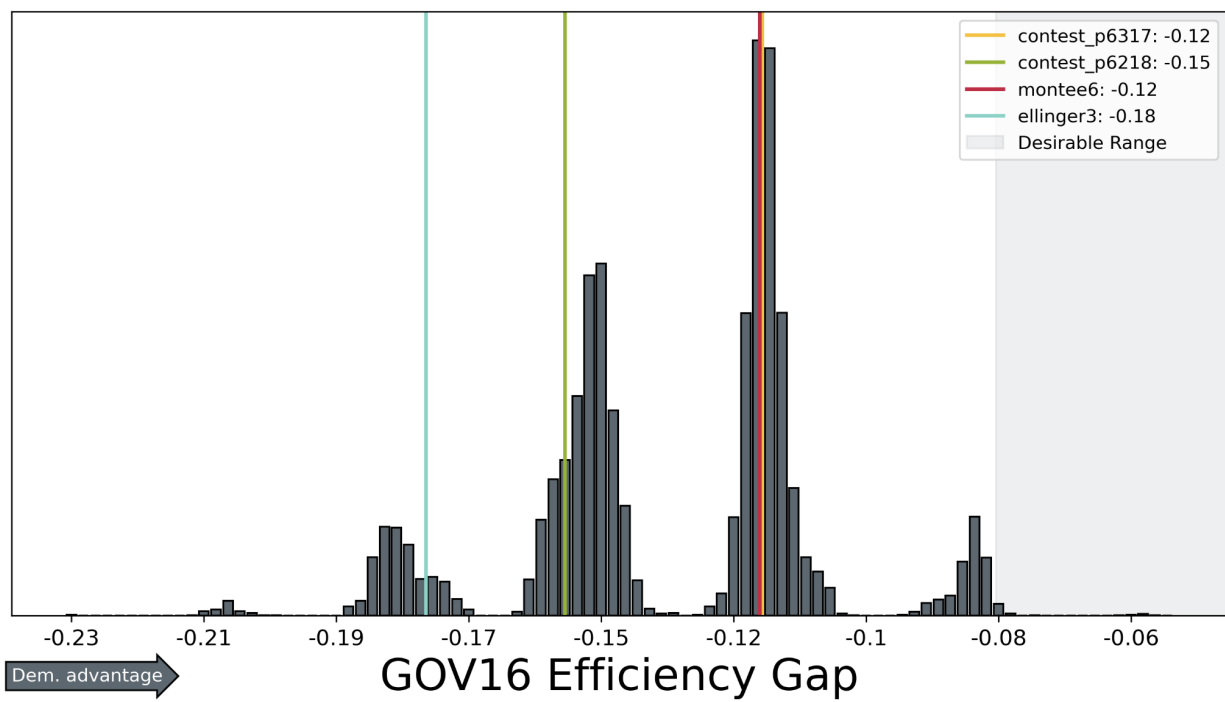
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[2] The election data released by the Office of Administration (OA) has numerous inconsistencies for elections prior to 2016. However, for the 2016, 2018, and 2020 elections, the OA provided additional precinct-level data from the Secretary of State which made it possible to correct the data for those three elections. The illustrations in this note use the cleaned and corrected dataset.

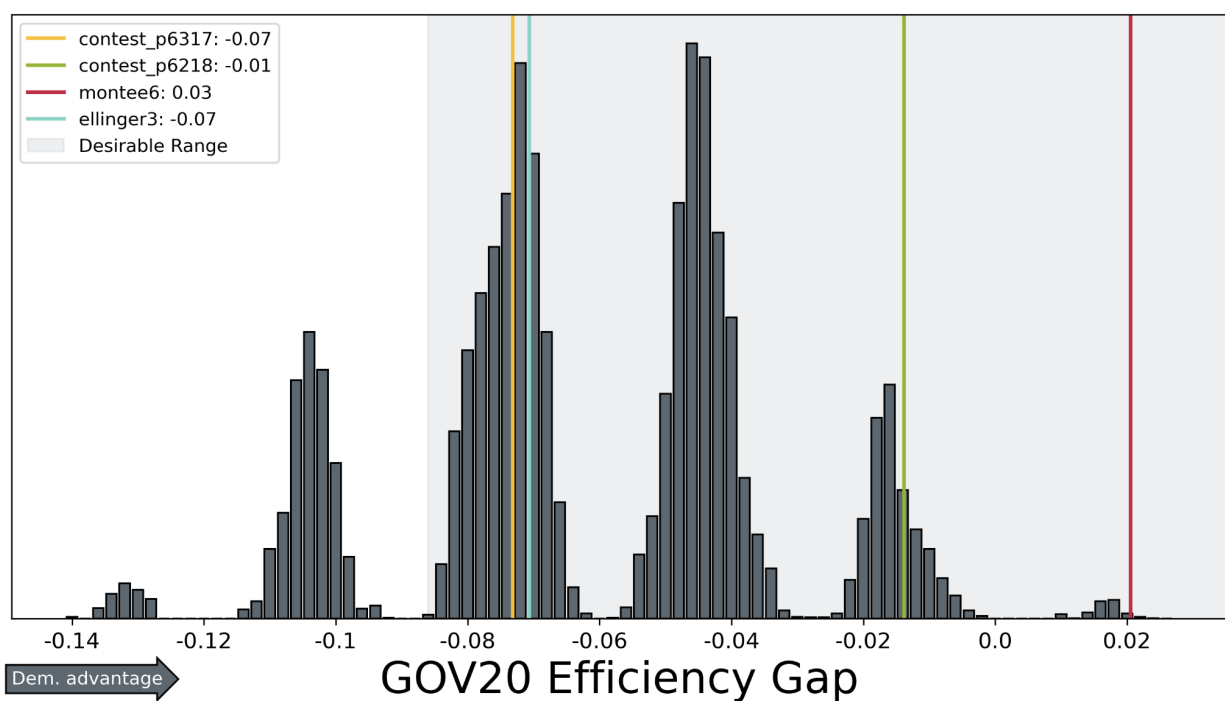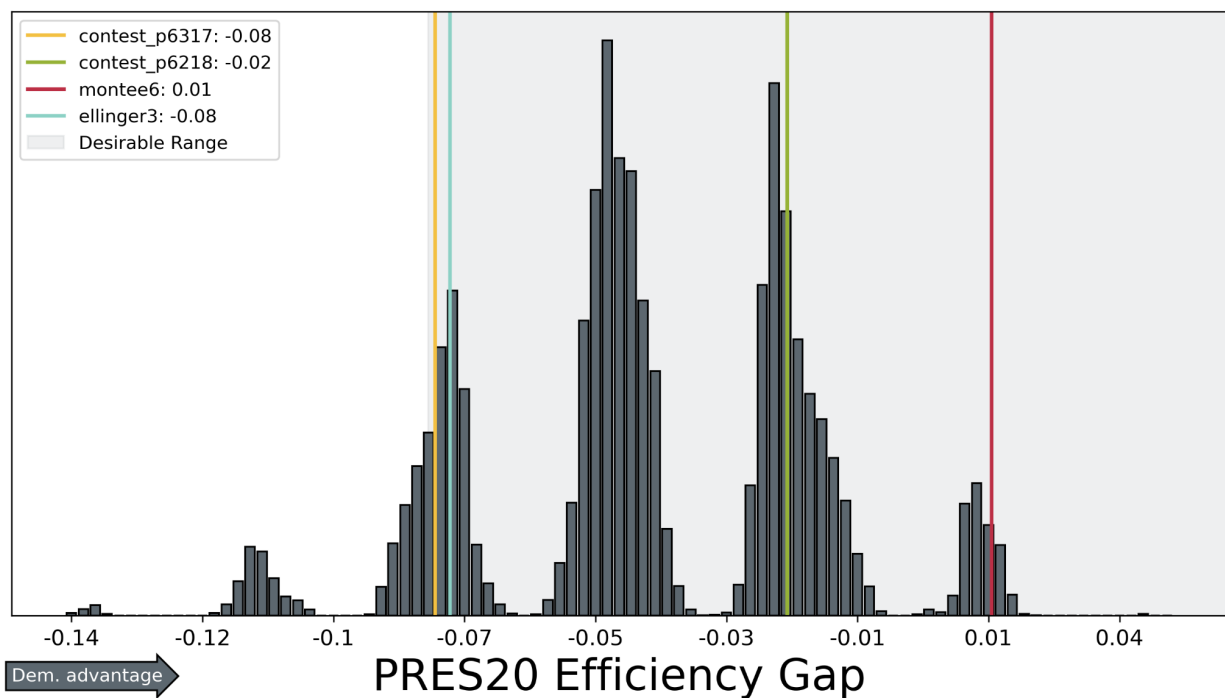Aggregate Dem. seats (15 elections, 42.8% Dem. share)

As the ensemble evidence makes clear, the political geography of Missouri significantly favors Republicans on the whole. Among 100,000 plans drawn with the rules and priorities of Missouri redistricting, the typical plan has about 143 seats with a Democratic advantage (out of 510 opportunities to win a seat, since 34 × 15 = 510), far short of the proportional performance of 218 seats. However, the Ellinger3 plan gives *even less* opportunity to Democrats than this already disfavorable landscape would provide.

To see this in more detail, we can look at the *efficiency gap* across all of these elections. Efficiency gap is a measure for studying how votes are converted to seats, and it registers an advantage for one political party when the other party "wastes" more votes in packed or cracked districts. The authors of the efficiency gap standard proposed a cutoff of 8%—when the efficiency gap gets higher than that in either the positive or the negative direction, that is a flag for a possible gerrymander. The Missouri constitution describes a looser standard, with a cutoff of a 15% gap between the parties, for permissible plans. In either case, the constitution specifies the goal of "approximately equal efficiency"; that is, a gap of approximately 0%. The six elections for President, Governor, and U.S. Senator since 2016 are shown in the figures below.

PRES16 Efficiency Gap

Legend (top panel):
- contest_p6317: -0.07
- contest_p6218: -0.01
- montee6: -0.04
- ellinger3: -0.06
- Desirable Range

Dem. advantage

SEN16 Efficiency Gap

Legend (bottom panel):
- contest_p6317: -0.15
- contest_p6218: -0.12
- montee6: -0.15
- ellinger3: -0.14
- Desirable Range

Dem. advantage

GOV16 Efficiency Gap

Dem. advantage

contest_p6317: -0.12	
contest_p6218: -0.15	
montee6: -0.12	
ellinger3: -0.18	
Desirable Range	

SEN18 Efficiency Gap

Dem. advantage

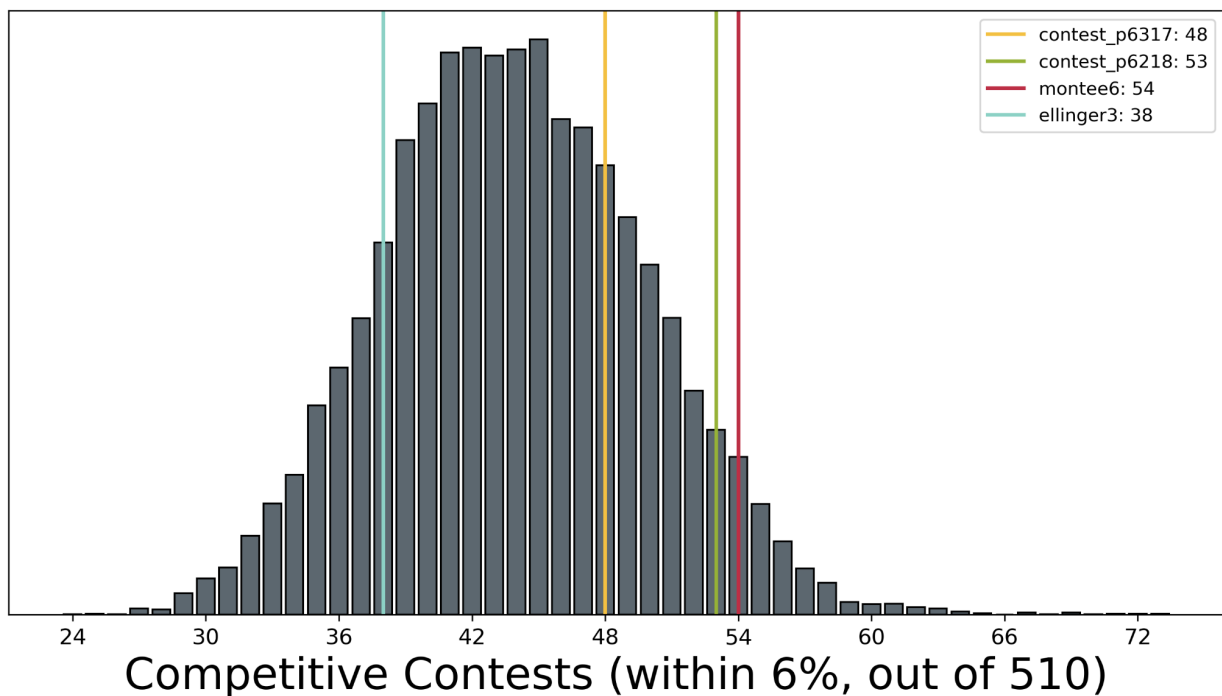|	
contest_p6317: -0.11	
contest_p6218: -0.11	
montee6: -0.05	
ellinger3: -0.13	
Desirable Range	

PRES20 Efficiency Gap

GOV20 Efficiency Gap

I will briefly summarize these six contests.

- Pres16: Murphy and Montee6 are closest to EG=0.
- Gov16: Montee6 and Kriz are closest to EG=0. Murphy and Ellinger3 have EG exceeding 15% (favoring Republicans), which is unacceptable by both the original authors' threshold and even by the looser standard in the constitutional language.

- Sen16: Murphy is closest to EG=0, while the other three plans are similar. All four are outside of the acceptable range in the original standard and borderline for the looser standard.
- Sen18: Montee6 is closest to EG=0 and is the only acceptable plan by the original standard.
- Pres20: Montee6 and Murphy are closest to EG=0.
- Gov20: Murphy and Montee6 are closest to EG=0.

Overall, Montee6 is *by far* the best plan at upholding partisan fairness in the terms presented by the constitutional language.

Competitiveness

Competitive Contests (within 6%, out of 510)

Finally, the constitutional language directs us to consider competitiveness. To provide this comparison, I considered the 510 district-level contests (15 elections across 34 districts) and asked how often the major-party contest was decided by a margin of less than 6 points. Here, the Montee6 plan is strongest, followed closely by Murphy's contest submission, with Ellinger3 lagging far behind. In fact, Ellinger3 is not only less competitive than the other three plans, but it is the only one of the four that provides less opportunity for competition than a typical plan drawn with no partisan data at all.

Redistricting always requires tradeoffs among competing goals and priorities, such as balancing competitiveness with compactness, which may not always be possible in the same plan. Having conducted an extensive analysis of the principles named in the Missouri constitution, it is my strong conclusion that the Montee6 plan best achieves these goals and requirements, as compared to the Ellinger3 plan and even to two excellent alternatives from a citizen mapping competition. It checks the boxes of equal population, contiguity, and reasonable compactness while excelling in county preservation, partisan fairness, and competitiveness.

If you have any questions, please do not hesitate to reach out at stern@wustl.edu.

Sincerely,

Ari Stern
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Washington University in St. Louis