Combatting Gerrymandering with Social Choice: The Design of Multi-member Districts

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> This bill requires (1) that ranked choice voting . . . be used for all elections for Members of the House of Representatives, (2) that states entitled to six or more Representatives establish districts such that three to five Representatives are elected from each district, and (3) that states entitled to fewer than six Representatives elect all Representatives on an at-large basis—Fair Representation Act, H.R. 4000, 2019.

The Fair Representation Act, first introduced in 2017 and reintroduced in 2019 and 2021, would mandate the use of multi-member districts (MMDs) to elect members to the United States House of Representatives, i.e., having fewer, larger districts each with multiple representatives. The bill is supported by good governance organizations such as FairVote; the American Academy of Arts and Sciences in 2020 released a report advocating states to use multi-member districts – however, "on the condition that they adopt a non-winner-take-all election model." Despite the popular focus on single-member district (SMD) elections, such MMDs have a long history in the United States, especially at the state and local level. In 1962, 41 state legislatures had MMDs, often with winner-take-all models; even today, 10 state legislatures elect representatives for at least one chamber in such a manner. City councils, state parties, and other organizations often adopt more sophisticated techniques, using variations on Ranked Choice Voting (RCV) to elect multiple winners from each of several districts.

This paper considers the design of such multi-member districts and, in the process, opens a rich research agenda at the intersection of two well-studied, but hitherto distinct, aspects of the design of representative democracies: redistricting, and social choice for multiple winners. The redistricting literature assumes winner-takes-all in SMDs and, given a fixed set of voters, studies how to divide the voters into districts such that the set of winners across districts satisfies desirable properties (e.g., for a gerrymandering party, maximizing the number of winners belonging to their party; for a neutral rule-maker, devising rules to ensure 'proportionality,' such that the fraction of winners of each party matches the fraction of voters). The social choice literature, on the other hand, considers a single district and studies voting rules (functions from voter rankings to a set of winners) such that the set of winners in that district satisfies similar properties, including proportionality. A map consisting of multiple MMDs (e.g., 30 two-member districts in Arizona) requires *both* partitioning voters into districts *and* devising how each district collects and aggregates votes. The challenge cannot be decomposed: drawing districts depends on the social choice function, and the same social choice function has different effects depending on district size and composition.

We study this joint challenge, carrying out large-scale empirical analyses for the U.S. House of Representatives under MMDs with different social choice functions, under maps that could be drawn by either partisan gerrymanderers or independent commissions. We show that indeed the choices of (how many and which) districts to draw and which voting method to use cannot be made independently. For example, while MMDs with winner-take-all elections are commonly believed to be discriminatory against minorities when compared

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to SMDs, we find that MMDs with more proportional voting methods support political minorities. We further find that 'interior' solutions in this joint optimization – with neither SMDs nor one large MMD – often best balance the multiple objectives promoted by good governance groups. In more detail, our contributions and findings are as follows.

Methodological contributions. We provide a scalable, empirical methodology to algorithmically study partisan gerrymandering and fair redistricting under multi-member districts. We leverage an efficient way to calculate partisan outcomes under Single Transferable Voting (a common variant RCV for multiple winners) and extend an algorithm by Gurnee and Shmoys 2021 to efficiently calculate near-optimal multi-member maps, under a variety of objective functions and social choice rules. We further develop a voter-file-based methodology to study intra-party effects of rank choice voting.

Our results, using geographic- and individual-level data from across the United States, further illustrate how theoretical social choice guarantees heterogeneously translate to practice, away from the asymptotic regimes in which they are often studied.

Outside the context of multi-member districts for legislatures in the United States, we believe that this work and methodological approach opens up a substantive new research area in the design of representative democracies at the intersection of redistricting and social choice, across both the computer and political sciences.

Application oriented findings. We apply our methods to consider the design of MMDs, focusing empirically on the House of Representatives in the United States. We primarily study *proportionality*, as a function of the number of districts and the voting rule used. Surprisingly, our results indicate that two-member or three-member districts with proportional voting rules are often sufficient to prevent the worst gerrymanders by an adversary and to enable independent commissions to find a proportional map – even small MMDs are enough to eliminate "natural" gerrymandering, in which geography and the distribution of citizens leads to a natural advantage for one party, and purposeful ones.

On the other hand, we find that poor design constraints (in *either* the number of districts *or* the voting rule used) enable more extreme gerrymanders than is possible with SMDs. These effects occur because MMDs with appropriate social choice functions protect concentrated (political) minorities by making packing and cracking more difficult, and support diffuse minorities by joining them in the same large multi-member district, with a lower threshold to win a seat. We further analyze H.R. 4000 and show that it achieves an effective balance in the MMD design space—though, as emphasized above, its prescribed three to five member districts are larger than are necessary; this part of the bill could be relaxed without sacrificing its proportionality goals.

Finally, we study how MMDs affect *intra-party* diversity, measuring two competing claims: that small SMDs protect diverse, geographically-correlated interests within a party (e.g., urban, Black Democrats versus suburban, white Democrats), and conversely that RCV with large MMDs enable ideological differences within a party. We find, under reasonable assumptions on how voters rank candidates within a party, that two- or three-member districts preserve geographic compactness, and thus the notion that legislature members *represent* a geographically cohesive set of voters.

Full paper: https://arxiv.org/abs/2107.07083.

CCS Concepts: • **Theory of computation** → **Algorithmic game theory and mechanism design**; • **Applied computing** → **Law**; • **Computing methodologies** → *Modeling and simulation.*

Additional Key Words and Phrases: Computational Redistricting, Multi-member Districts, Policy Analysis, Gerrymandering, Social Choice, Optimization

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