Political Dislocation: A Voter-Level Measure of Partisan Representation and Gerrymandering

Nicholas Eubank[*], Jonathan Rodden[†]

June 20, 2019

Political Dislocation Maps for All States and Legislative Chambers can be found at *http://www.nickeubank.com/political_dislocation_maps/*.

Abstract

In *Gill v. Whitford*, the Supreme Court ruled that living in a state where electoral districts give an electoral advantage to one party is insufficient to give a voter standing to challenge a districting map. To show harm and thus establish standing, plaintiffs must show that their *own* district has been packed or cracked. Yet traditional measures of gerrymandering are unable to measure the degree to which packing or cracking have occurred in individual districts or neighborhoods. In this paper, we introduce a voter-level measure of packing and cracking. *Political dislocation* is a measure of the difference between the partisan composition of a voter's geographic nearest neighbors and that of her assigned district. Because gerrymandering entails carving up blocks of co-partisans or combining them in unnatural ways, gerrymandered districts consistently produce pronounced political dislocation of voters. Our measure thus serves to identify specific voters with standing to sue, and districts that might be subject to legal challenge, in addition to providing a scalable metric that might be useful for courts, special masters, or redistricting commissions.

[*]Post-Doctoral Fellow, Center for the Study of Democratic Institutions, Vanderbilt University nick@nickeubank.com

[†]Professor, Department of Political Science and Senior Fellow, Hoover Institution, Stanford University jrodden@stanford.edu

To the extent the plaintiffs alleged harm is the dilution of their votes, that injury is district specific. [...] In this gerrymandering context that burden arises through a voters placement in a "cracked" or "packed" district.
Chief Justice John Roberts, Majority Opinion, *Gill v. Whitford*

1 Introduction

In its 2018 decision in *Gill v. Whitford*, the Supreme Court ruled that individuals do not have standing to bring a gerrymandering case solely because they live in a state where electoral districts give one party an electoral advantage. Rather, Justice Roberts argued, "[t]o the extent the plaintiffs' alleged harm is the dilution of their votes, that injury is district specific. [...] In this gerrymandering context that burden arises through a voter's placement in a "cracked" or "packed" district."

This poses a challenge for gerrymandering litigants, as the measures of gerrymandering recently used in litigation are designed to detect gerrymandering by measuring *overall* inequalities in representation. And as a result of this global focus, they are poorly suited for identifying which *individual neighborhoods* have been packed or cracked in the creation of *individual districts*.

It might seem at first blush that identifying packed or cracked districts can be accomplished simply by looking at their partisan composition: one party will have a very high vote share in a packed district, and one party's vote share will be just below 50%) in a cracked district. But partisan composition turns out to be an insufficient statistic for this task because partisan geographic clustering — for example, that of Democrats in cities — may naturally give rise to districts in which one party has a very high vote share, not because of the political machinations of district architects, but instead because the party's members live in close proximity to one another. Similarly, if a party receives 45% of the vote in a district drawn by its opponent, its supporters may have been intentionally cracked, but it could just as well be the case that there were too few of them in that region of the state to form a majority.

To address this challenge, we present a measure of the degree to which an individual voter is the victim of packing or cracking. We measure the degree to which a voter's district is aligned with their immediate geographic neighbors. In particular, we examine the degree to which the *partisan composition* of a voter's actual electoral district differs from the partisan composition of their geographic neighborhood. Where these measures differ dramatically — where, for example, a voter whose k nearest neighbors (where k is the number of people in the voter's actual legislative district) are mostly Democrats, but despite this their district is mostly Republican — we term that voter *politically dislocated*.

As we will show in Section 4, *political dislocation* turns out to be a very good scalable measure of packing and cracking. Cases where voters are dislocated— that is, where they find themselves in districts with substantially different political compositions than their geographic neighborhoods—are nearly always districts in which voters have been carefully carved out of their more natural communities (i.e. they have been "cracked" or "packed") for electoral advantage. Moreover, our measure does *not* identify "naturally packed" districts, such as those emerging in the core of large, highly Democratic cities, where districts inevitably have large vote shares for a single party due to residential partisan clustering. In such cases, the partisan composition of the district is often consistent with that of voter's geographic neighborhoods.

Moreover, as shown in Section 5, states with high average values of political dislocation are also those that are generally identified as being gerrymandered using traditional global measures like the Mean-Median Difference. As such, this measure is well suited to help gerrymandering opponents identify potential plaintiffs as well as districts that might be challenged if federal or state courts embrace a "local" concept of representational harm. Moreover, local and global measures of political dislocation might also be useful metrics—beyond traditional measures of compactness and split jurisdictions—to assist commissions or courts in the construction of districts that reduce the inequalities in representation that motivate concerns about gerrymandering.

2 The Challenge of Measuring Cracking & Packing

Gerrymandering is often viewed as unfair because it allows a party to achieve a seat share far beyond its vote share, or to be a bit more sophisticated, beyond the seat share that would have been obtained with a non-partisan redistricting process. In the most obvious normative failure, a party with less than half of the statewide votes can receive more than half of the seats, which happens routinely in U.S. state legislatures. This is a global notion of representational harm, driven by the intuitive notion that the statewide vote-seat curve in a two-party system should be symmetric in its treatment of both parties. In this view of representation, courts should be suspicious of asymmetries in the transformation of votes to seats, and redistricting bodies should explicitly seek to draw symmetric plans.

Federal courts have expressed skepticism of the notion that the U.S. Constitution requires partisan symmetry, and have been reluctant to accept a role in measuring or enforcing it. It is clear that asymmetries can emerge in the transformation of votes to seats due to the geographic arrangement of partisans, even if the districts were drawn without partisan intent (Chen and Rodden 2013; Gudgin and Taylor 1979). For instance, in an evenly divided state, a party with a highly concentrated support base might end up with substantially less than half of the seats because it runs up large surpluses in core support areas where its voters are "packed"— e.g. Democratic candidates in large cities—while losing by smaller margins in the pivotal districts where its supporters are "cracked" as a result of residential patterns and the historical development of the party system. It seems unlikely that federal courts would be willing to strike down a map where partisan asymmetry cannot be clearly linked with intentional decisions of line-drawers. Thus in the context of gerrymandering litigation, the terms packing and cracking imply *partisan intent*.

In order to establish this, plaintiffs have developed a variety of techniques to sample from the very large number of potential alternative redistricting plans, with the goal of demonstrating that the partisanship of the enacted map was an extreme outlier relative to the ensemble of sampled maps. For overviews of these techniques, see Chen and Rodden (2015); Cho and Liu (2016); Magleby and Mosesson (2018); Mathematicians' Amicus Brief (2018); Mattingly and Vaughn (2014); Pegden (2017); Pegden, Rodden and Wang (2018).

This approach has been successful, but it is not without challenges. First, there are a variety of alternative techniques for sampling from the vast number of alternative plans. Some approaches are likely to sample only relatively compact plans, while others sample a much broader range of possible plans, with implications for whether specific plans under evaluation might end up being designated as outliers. There is no obvious way to decide which ensembles of plans are the "correct" baseline.

Another challenge is to decide what to do with an ensemble of alternative plans once one has generated it. What technique should one use for characterizing the partisanship of each district? Which precinct-level election results should be considered? What if presidential and attorney general elections lead to different inferences? Should some kind of swing, perturbation, or other hypothetical alternative election outcome be considered? Should the partisanship of each district be determined according to a discrete cut-point, or should one consider probabilities of victory for each party in each hypothetical district, perhaps based on an empirical model?

It would be helpful to have an alternative measure of intentional gerrymandering that sidesteps some of the controversies about sampling. Furthermore, it would be useful to have a metric, other than the hypothetical seat shares of the parties, along which to compare an ensemble of sampled plans with the plan that is being evaluated as a potential gerrymander.

Concerns about *global* representational harms are not the only basis for concern about gerrymandering, however. Fundamental to a political of single member districts is the idea that there is value in voters who live in the same area being represented by a single politician. Arguments for this are multifaceted — voters in the same area are likely to share political interests; voters in the same area are better able to communicate and coordinate with one another; politicians can better maintain connections with voters in the same area; voters in the same area are especially likely to belong to the same social communities — but all suggest the importance of voters being located in districts with their geographic peers. But for many voters, the reality falls far short of this ideal. Instead, efforts to gerrymander districts for political purposes results in clusters of voters being carved out of their natural communities and pooled with other voters in an effort to dilute their political influence. This may not only undermine the political effectiveness of these voters, but it may also deprive them of the benefits associated with belonging to a coherent constituency. Yet existing global measures of gerrymandering are poorly suited to identifying deviations from this ideal.

As Justice Roberts indicated in writing for the majority in *Gill* , the Court might be moving toward an exclusively local understanding of the representational harm associated with gerrymandering. The Court has already adopted such a view in evaluating cases in which plaintiffs allege *racial* gerrymandering. In such cases, the Court only considers district-by-district assessments. Plaintiffs do not request that entire plans be struck down based on global indicators of race-based redistricting. Rather, they must challenge specific districts, and carefully explain how it can be ascertained that race was the predominant factor in drawing each individual challenged district.

If the Court adopts a similar approach in gerrymandering cases, it will be useful to have a local measure of partisan predominance that corresponds to the notion of representational harm that Justice Roberts articulated in *Gill*. In other words, it would be useful to develop a local measure of intentional packing and cracking.

Such a measure might have other useful features even if federal courts ultimately decide that partisan gerrymandering is non-justiciable. First, voters in many states are taking matters into their own hands, and as in Missouri and Michigan, they have adopted constitutional reforms that call for a non-partisan redistricting process. A reliable, scalable measure of packing and cracking might prove to be a useful metric in the hands of commissioners. It might also be of use to state courts and special masters when they are called upon to consider, or create, new plans, or clusters of districts, after a plan or set of districts has been invalidated.

Finally, it is possible that a future Supreme Court majority will rule that state legislatures do not have the authority to delegate the task of district-drawing to independent commissions. In that event, the only viable way to curb partisan gerrymandering would be through reforms like that implemented in Florida, where the legislature is still tasked with the job of drawing legislative district boundaries, but is forbidden from considering partisanship when doing so. In order to hold legislators accountable, it is necessary to establish an empirical indicator of intentional packing and cracking.

3 Measuring Political Dislocation

In sum, there is a clear need for a local but scalable measure of intentional cracking and packing that goes beyond anticipated overall seat shares and accounts for the underlying spatial distribution of voters. In this section, we formally introduce a measure designed to meet this goal: *political dislocation.* In simple terms, political dislocation is a measure the difference between the partisan composition of a voter's geographic neighborhood and the partisan composition of the district to which they have been assigned. More formally, for a voter v in district d as:

$$dislocation_v = dem\_vote\_share_d - \sum_{n \in N_v} \frac{\mathbb{1}_{n\,is\,Democrat}}{|N|} \tag{1}$$

Where N_v is the set of the k nearest neighbors of voter v, where k is the average number of people in the relevant electoral districts. Large positive values indicate individuals whose district is substantially more Democratic than their nearest neighbors, while large negative values are indicative of individuals in districts that are substantially more Republican than their nearest neighbors.

Data and Estimation

Following Eubank and Rodden (2018), estimation of the partisan composition of each voter's neighborhood is accomplished through a three-step process. First, precinct-level election returns from the 2008 Presidential election are used to estimate the spatial distribution of voters in each state.[1] This is done by creating a number of representative voter points within each precinct, where points are positioned uniformly at random within each precinct's catchment area, and the number of points in each precinct's

[1]Before calculating these intervals, we apply a uniform swing to account for McCain / Obama vote shares in our 2008 Presidential two-party vote share data. In particular, as McCain's two-party vote share was 46.31%, we apply a 3.69 percentage point uniform swing to all data, so that a Republican voter whose voter neighborhood is 46.31% co-partisan would be said to be in a perfect 50% co-partisan neighborhood. In Congressional races, Democratic victories have been quite rare in districts where McCain's 2008 vote share was higher than 46.31 percent, and Republican victories have been quite rare in districts where Obama's vote share was higher than 53.69 percent.

catchment area is proportional to the number of votes cast for each party.[2] While this down-sampling and placements of points randomly within precincts does introduce some noise, as discussed in Appendix A, the variability contributed to our dislocation measure is empirically very small. This analysis generates an estimate *for each representative-voter point* of the share of neighbors who are co-partisans.

Estimation of the partisan composition of the neighborhood around each of these representative-voter points is then calculated. In the nearest neighbor analysis, for each representative-voter point v of a given party $p \in \{D, R\}$, the partisanship of the neighborhood around v is equal to the share of the k nearest points who are democrats. The number of nearest neighbors considered – k – is set to ensure the included points represent the number of voters in the average district in *state* for chamber *chamber*. [3] This estimate is analogous to asking "if a circular electoral district of average district population were centered on this voter, what share of people in that district would be co-partisans?"

Finally, in order to ensure comparable estimates of the composition of a voter's geographic neighborhood with the partisanship of their legislative districts, estimation of the partisan composition of each voter's district is accomplished by overlaying post-2010 legislative district boundaries over the precinct returns used to estimate geographic neighborhood partisanship and aggregating these returns to estimate legislative district partisanship.[4]

[2]In particular, the number of points we generate in each precinct for each party is determined by taking a binomial draw from the total number of actual voters. The binomial probability varies by state-chamber, but is equal to $prob_k = \frac{numberofdistricts}{numberofvotersinstate} * k$, where k=1,000 for state legislative districts and 5,000 for US Congressional districts. This probability generates k voters per district in expectation. A larger number of points are used for US Congressional districts to adjust for the fact that the relatively small size of precincts with respect to US Congressional districts reduces the sampling probabilities in each precinct, increasing sampling variance for a given k.

[3]To illustrate, consider a state-chamber with 3 districts and 300,000 voters. The average district is home to 100,000 voters, and so the number of points considered in the nearest neighbor analysis should represent 100,000 voters. Note that because of how *prob* is constructed, this will always amount to examining the share of the 1,000 points around each person who are co-partisans.

[4]The same uniform swing applied to geographic neighborhoods is also applied here.

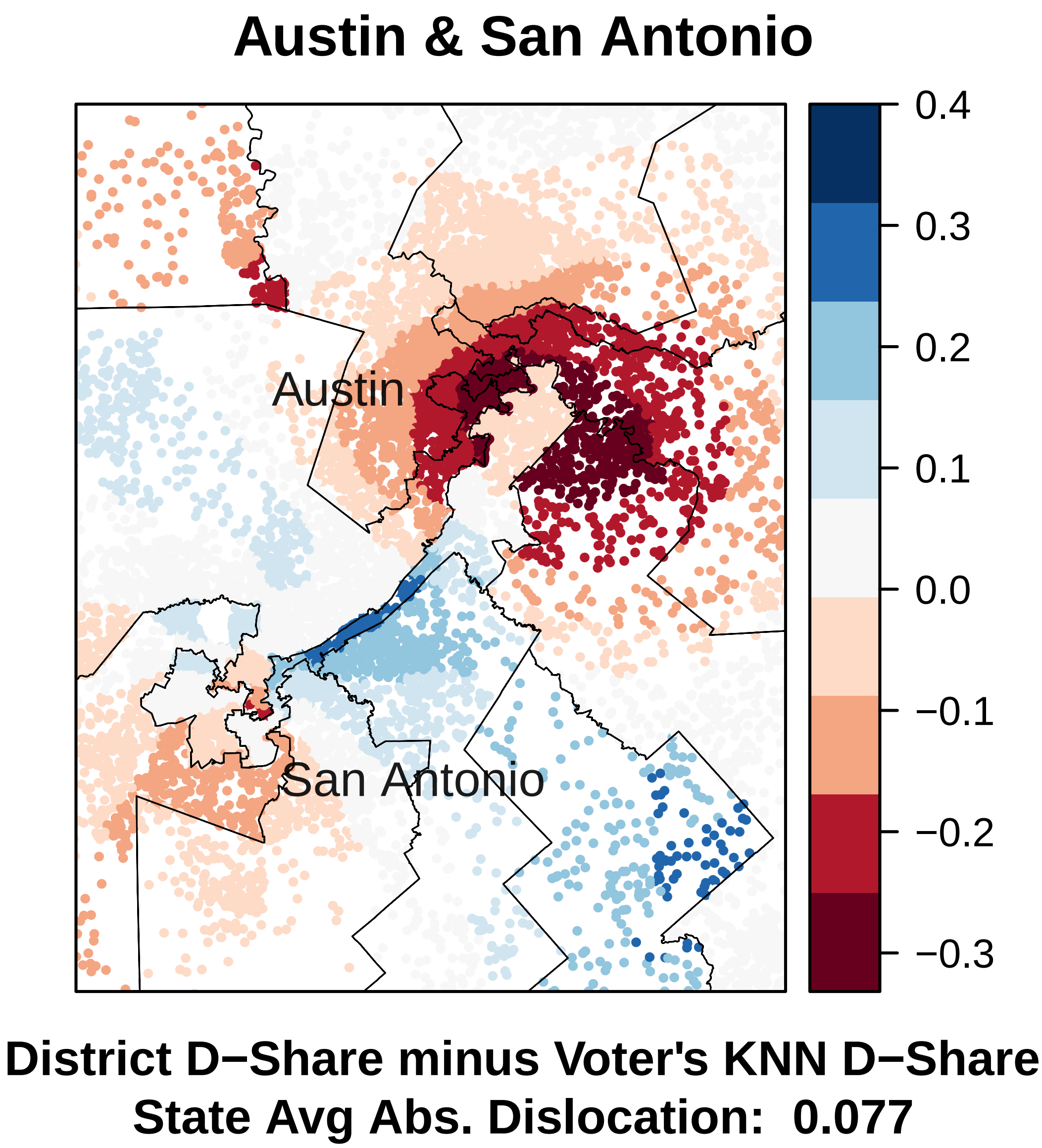
4 Political Dislocation, Packing and Cracking

In this section, we demonstrate the ability of this measure to detect incidents of deliberate packing and cracking, a task that is perhaps best illustrated by mapping out the distribution of politically dislocated voters in several states.

We begin by examining two of the most clear-cut cases of packing and cracking in the United States – the US House of Representatives electoral districts built around Austin, Texas (a clear case of cracking) and the US House of Representatives districts formed out of Baton Rouge and New Orleans in Louisiana (a clear case of packing). These two cases are illustrated below in Figures 1 and 2. Voters colored red are those who have been assigned to an electoral district that is substantially more Republican than their nearest neighbors, while voters colored blue are assigned to districts that are substantially more Democratic than their nearest neighbors. Lighter colors indicate voters for whom the difference between the partisanship of the voter's district and her nearest neighbors is small, while darker colors indicate greater dislocation. Note that the colors are unrelated to the *partisanship of the individual voter* – they reflect only the difference between the voter's community and that of her district.

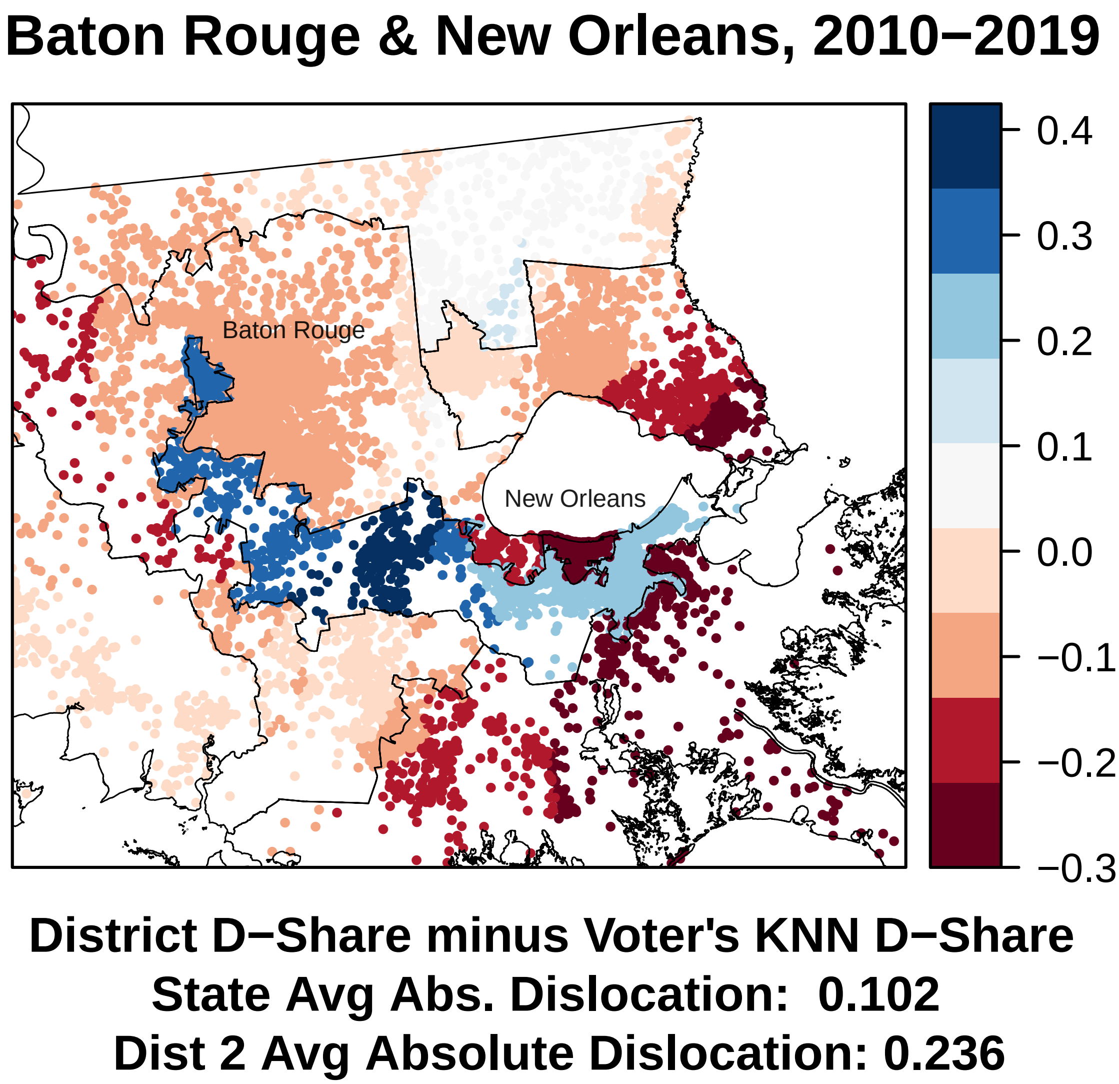
In Figure 1, it is clear to see how Austin has been effectively cracked into a set of pizza-wedge shaped districts, each of which grabs a portion of the (largely Democratic) residents of Austin and pools them with a rural population of Republicans to create Republican-majority districts. This cracking is evident in the high dislocation scores for residents of Austin, who live in highly Democratic communities but have nevertheless been carved up and placed in Republican districts. The lone exception to this pattern is the long, narrow district that pools a small collection of Austin voters with Democrats in San Antonio to create a packed district, a form of manipulation which is evident in the high dislocation scores of the voters in the middle of this long, narrow district – voters in rural Republican communities who these contorted districts have dislocated

Figure 1: Partisan Dislocation in Austin, Texas US House Districts



Notes: The above maps plot political dislocation scores for a set of representative voters. Dislocation is calculated as the difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3. Actual 2014 electoral district boundaries are also included.

Figure 2: Partisan Dislocation in New Orleans and Baton Rouge, Louisiana US House Districts



Notes: The above maps plot political dislocation scores for a set of representative voters. Dislocation is calculated as the difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3. Actual 2014 electoral district boundaries are also included.

in order to make this pooled district.

In Figure 2, we see an illustration of extreme packing in the district that pulls together New Orleans and Baton Rouge. Here we see that voters in both Baton Rouge and New Orleans have been placed in a district that is dramatically more Democratic than their local communities (as shown by regions of bright blue in both cities). At the same time, there is also evidence of cracking in the northern portion of New Orleans which has been carved away from the rest of the city and pooled with (more Republican) voters on the other side of Lake Pontchartrain.

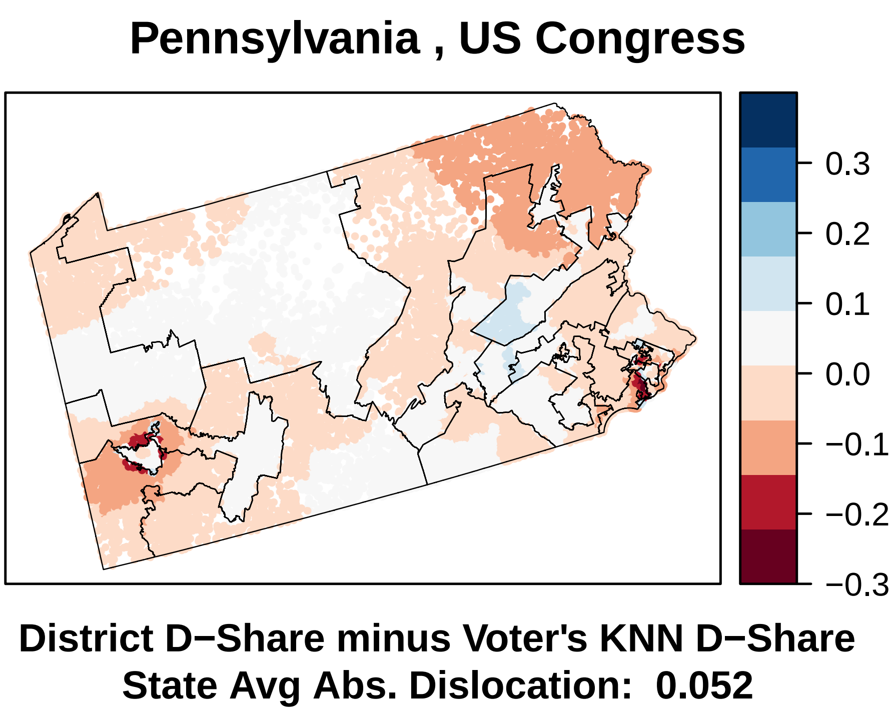
The cases of Baton Rouge and New Orleans also make it clear that while political dislocation is a strong indicator of deliberate district manipulation, it cannot speak to whether that manipulation is normatively desirable. In the case of Baton Rouge and New Orleans, for example, part of the rationale for this district is an effort to create a majority-minority district in order to comply with the Voting Rights Act.

With that said, what the political dislocation measure *can* do is evaluate whether majority-minority districts like the Louisiana 2nd district have been drawn in a manner that *minimizes* overall dislocation. As such, they offer a method for comparing proposals for potential majority-minority districts in a way that makes it possible to police the potential abuse of the majority-minority imperatives for political advantage. After conducting analysis to ascertain the desired racial characteristics of majority-minority districts, it would be possible to contrast dislocation scores among a variety of plans with the desired characteristics.

Looking at these figures, one might worry that dislocation is simply a proxy for district compactness. However, this is not the case. Not only are the measures theoretically distinct — one could draw a district with arbitrarily low or high compactness in a state where voters are uniformly distributed, and dislocation would always remain zero — but as discussed in Appendix C, they are also quite empirically distinct; more compact districts do tend to have lower levels of dislocation, but the correlation is only ~ 0.275.

While especially illustrative, these extreme examples are far from unique. Next, let us consider the state of Pennsylvania, a subject of extensive gerrymandering litigation. Figure 3 maps voter political dislocation for a representative set of voters. Note that similar patterns can be seen in a number of states who have been accused of gerrymandering in recent years. See Appendix B for analogous maps of North Carolina, Texas, Louisiana, and Maryland.

Figure 3: Partisan Dislocation in Pennsylvania US House Districts



Notes: The above maps plot political dislocation scores for a set of representative voters. Dislocation is calculated as the difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3. Actual 2014 electoral district boundaries are also included.

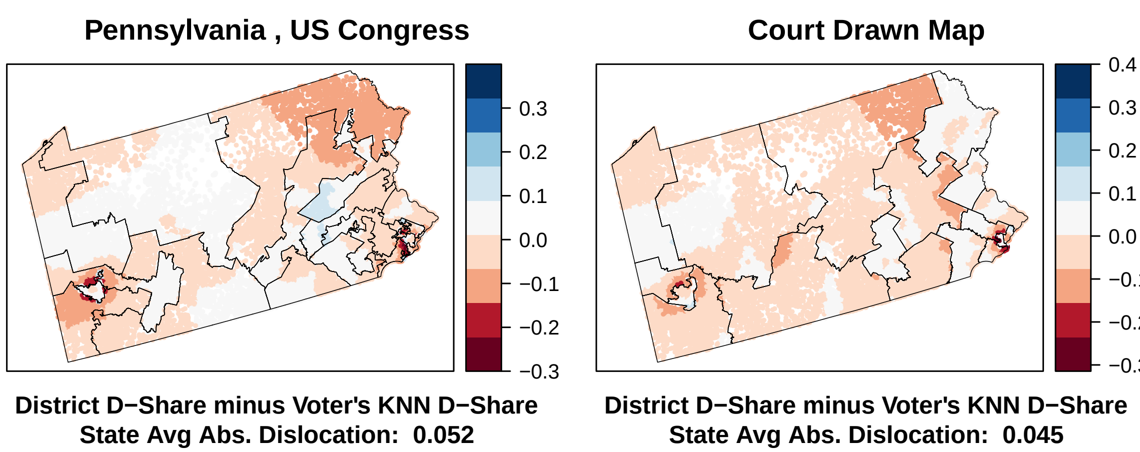
The Pennsylvania map indicates a high level of dislocation in the inner suburbs around Pittsburgh (in southwest Pennsylvania). Note that voters in the urban core of Pittsburgh experience low levels of dislocation. They are overwhelmingly Democratic, and the legislature drew an extremely Democratic urban Pittsburgh district. However, Democrats in Pittsburgh's inner ring of suburbs experience high rates of dislocation. These are the kinds of neighborhoods in which Justice Roberts seems to indicate that representational rights may have been abridged. There are large, relatively densely populated areas that are extremely Democratic, but the legislature's redistricting plan in 2012 embedded them in comfortably majority-Republican districts.

It is easy to see that the Pittsburgh metropolitan area could have been carved up in alternative ways that would have dramatically reduced the striking discontinuity in political dislocation on the edges of districts. If a redistricting commission or special master had been tasked with the job of minimizing political dislocation, it would have been possible to divide the city in a way that included more Democrat-leaning suburbs with Democratic urban neighborhoods. This would have led to two rather than one Pittsburgh-oriented districts, but such an arrangement could still involve relatively compact districts. In short, in this instance, it appears that an effort to minimize dislocation could also have produced a map with other desirable qualities, including more competitive districts that are less biased against the geographically concentrated Democrats.

In Eastern Pennsylvania, the legislature's gerrymandering efforts involved the creation of meandering districts that aimed not only to pack Democrats into urban Philadelphia, but also to crack Democratic neighborhoods in the educated suburbs, and to prevent smaller Democratic post-industrial cities from stringing together. Again, we see telltale signs of gerrymandering, such as sharp discontinuities in levels of dislocation at district boundaries, such that members of the party drawing the districts (the Republicans) were far less likely to be dislocated than their opponents.

Figure 4 places this map – with districts devised by Republican lawmakers that were later struck down by the Pennsylvania State Supreme Court – beside the map drawn by a Special Master, Stanford Law Professor Nathaniel Persily, at the Court's request. As the figure shows, the map drawn by the Special Master shows substantially lower levels of political dislocation. This illustrates a point we explore more systematically in Section 5: high political dislocation scores are not just indicative of individually gerrymandered districts. Because they are an indicator of districts that carve up communities in unnatural ways, states with high dislocation scores tend to be ones in which district manipulation has resulted in one party winning a share of seats that is significantly out of line with their overall vote share, even after controlling for the spatial distribution of voters.

Figure 4: Pennsylvania Republican-Drawn and Court-Drawn Districts

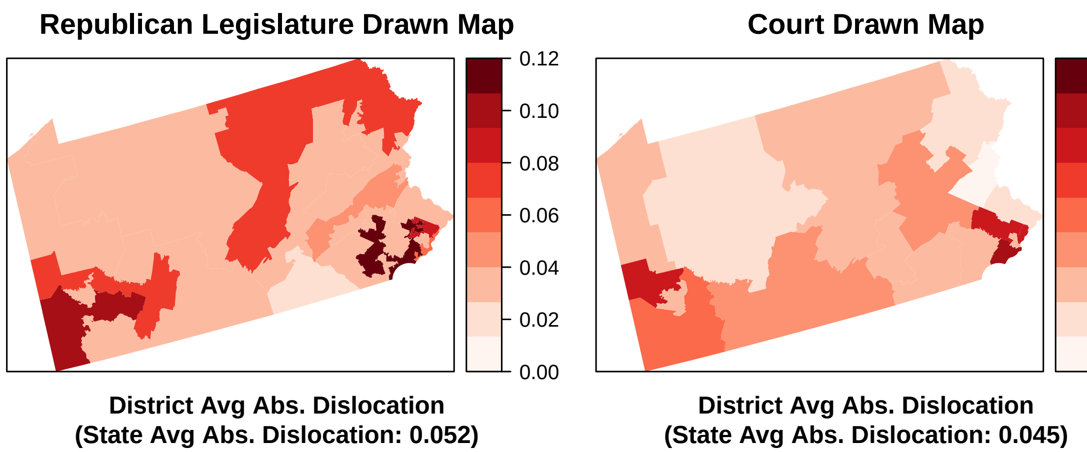


Notes: The above maps plot political dislocation scores for a set of representative voters. Dislocation is calculated as the difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3. Actual 2014 electoral district boundaries are also included.

District-Level Averages

In addition to measuring voter-level dislocation, we can also aggregate these measures to identify packed and cracked *districts*. In Figure 5, for example, we again show the contrast between Pennsylvania's old maps and those drawn by the Special Master.

Figure 5: Pennsylvania Republican-Drawn and Court-Drawn Districts

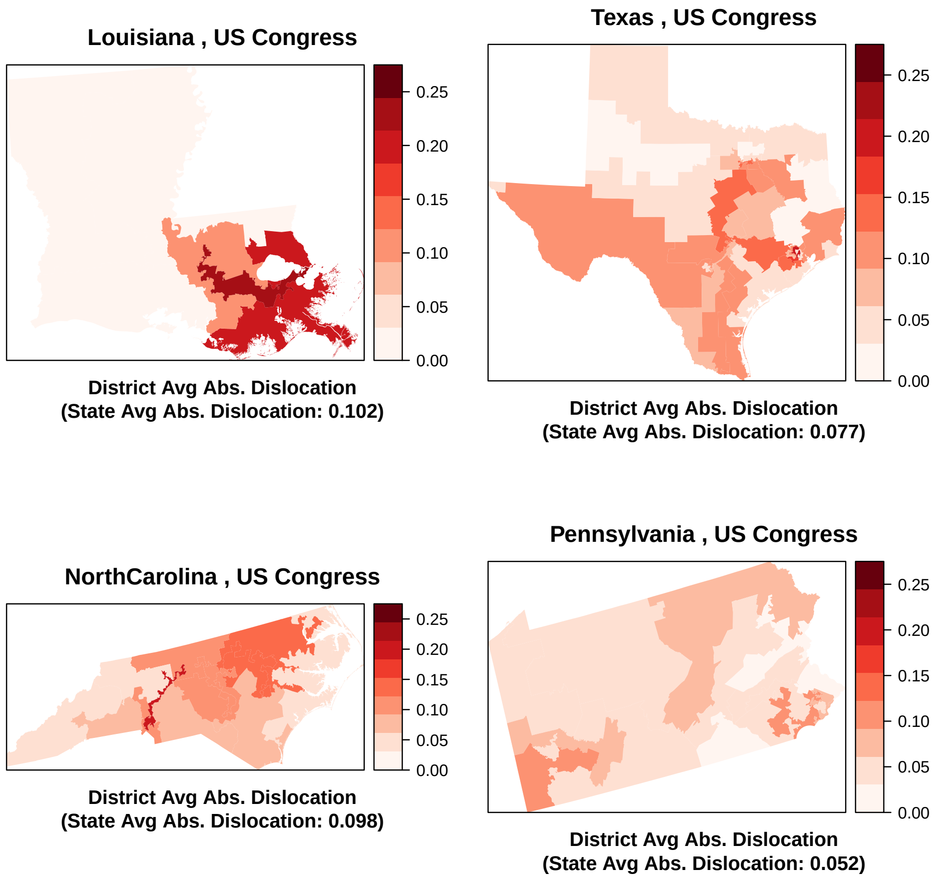


Notes: The above maps plot 2014 electoral districts and their average absolute dislocation scores. Absolute average dislocation is calculated as the average (over all district voters) of the absolute difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3.

The Special Master's map not only reduces extreme incidences of dislocation around Pittsburgh and in Eastern Pennsylvania, it also reduces *overall* dislocation. By averaging the absolute magnitude of each voter's dislocation across the entire state, we can get an overall measure of how much an entire map dislocates voters. In the case of Pennsylvania, for example, we see that the Persily map decreases average absolute dislocation by 12.5 % (from 0.052 to 0.045).

In Figure 6 below, for example, we plot each district's average *absolute* dislocation score. Again, we see that dislocation might be a useful guide to the identification of districts where the notion of local representational harm identified by Justice Roberts is most severe.

Figure 6: District Average Absolute Dislocation



Notes: The above maps plot 2014 electoral districts and their average absolute dislocation scores. Absolute average dislocation is calculated as the average (over all district voters) of the absolute difference in the Democratic vote share of each voter's assigned district and the Democratic vote share of her k nearest neighbors, where k is the average number of people assigned to each electoral district. District vote shares and the partisanship of nearest neighbors are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3.

5 Political Dislocation and Global Measures of Gerrymandering

As previously noted, one normative basis for concern about gerrymandering is that it generates global representational inequalities. In the most obvious normative failure, a party with less than half of the statewide votes can receive more than half of the seats, which happens routinely in U.S. state legislatures. This is a global notion of representational harm, driven by the intuitive notion that the state-wide vote-seat curve in a two-party system should be symmetric in its treatment of both parties.

For those whose primary concern about gerrymandering is this type of global representational inequality, the movement to local measures of gerrymander is potentially worrying. As we show in this section, however, high absolute values of political dislocation tend to go hand-in-hand with global measures of representational inequality, suggesting that efforts to minimize political dislocation may also lead to reductions in global representational inequality.

To examine the relation between political dislocation and global measures of gerrymandering, we briefly consider whether absolute dislocation is also meaningful if aggregated to the level of an entire state. First, we present summary statistics for partisan dislocation scores in each state, when calculated based on Congressional districts, upper chamber districts, and lower chamber districts. And second, we explore whether average levels of dislocation are correlated with traditional global measures of partisan fairness.

Figure 7 plots the distribution of district-level average *absolute* dislocation scores for each state. The use of absolute dislocation scores ensures that large dislocations of people into Republican districts do not offset dislocations of people into Democratic districts, and can best be thought of as a measure of average *overall* dislocation for a state. Several things stand out. First, the mean and variance of partisan dislocation scores are relatively high in states that have attempted to draw majority-minority districts in order to comply with the Voting Rights Act. Examples include Alabama, Louisiana, Mississippi, the Carolinas, Virginia, and Texas. Second, partisan dislocation is relatively pronounced in many of the districting plans that have been challenged in court as either partisan or racial gerrymanders. Examples of the former include the North Carolina, Maryland, Ohio, Pennsylvania, and Michigan Congressional plans, and the lower chamber plan in Wisconsin. Examples of the latter include Congressional plans in Alabama, Georgia, and Louisiana, and state legislative plans in North Carolina, Mississippi, Texas, and Virginia.

Indeed, as shown in Table 1 below, average absolute dislocation scores also tend to be highest in states where district maps were drawn under unified party control.[5] This is especially true when districts were drawn under unified Republican control, reflecting the success of Republican lawmakers in their efforts to maximize the opportunities presented by redistricting in the early 2010s.

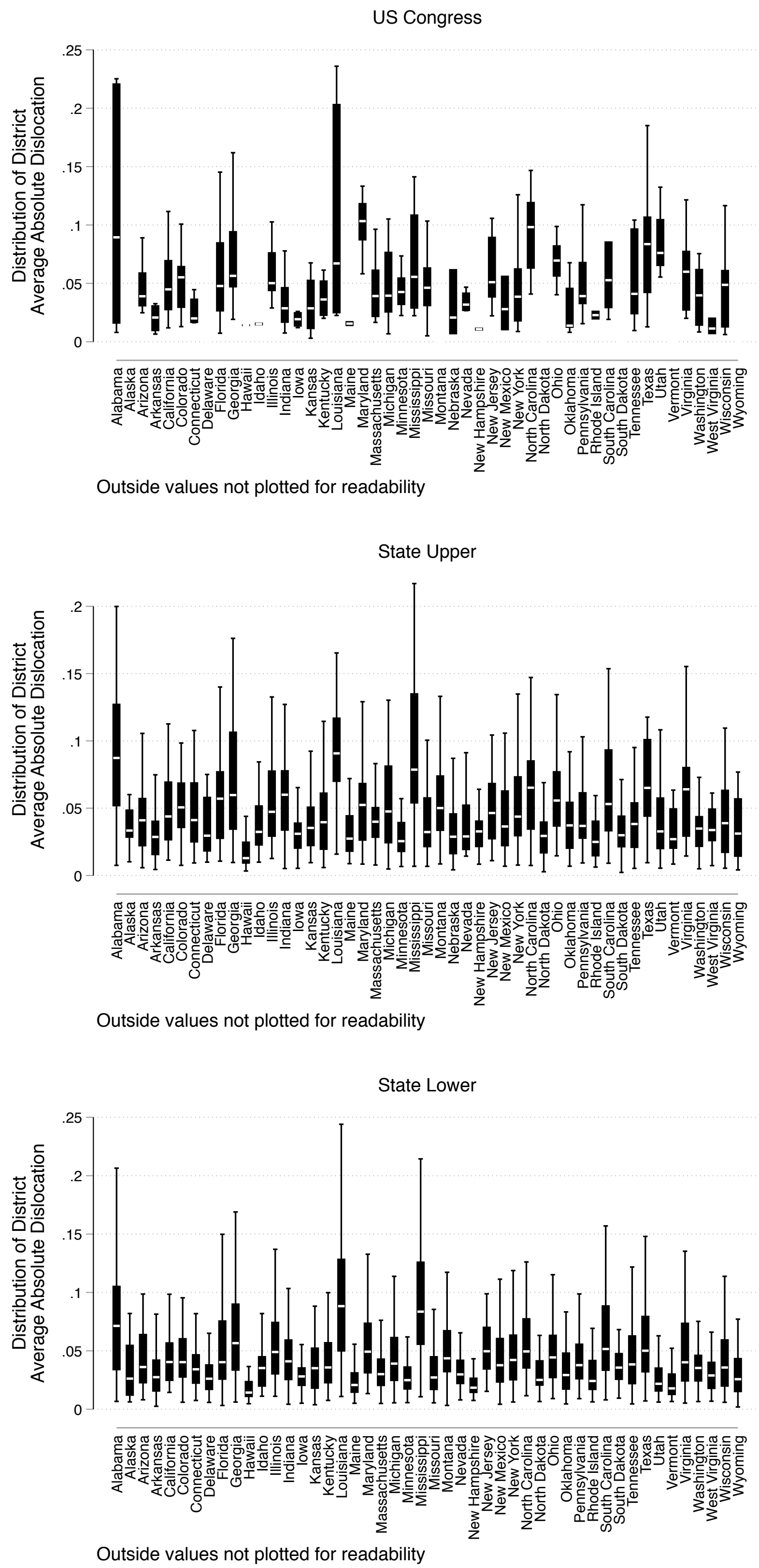
Table 1: State Average Absolute Dislocation by District Creators

	State Lower	State Upper	US House	Overall Avg
Unifed Republican Control	0.051	0.055	0.053	0.053
Unified Democratic Control	0.037	0.041	0.045	0.041
Non-Unified or Independent	0.041	0.044	0.037	0.041

Next, in Figure 8, we plot the average absolute dislocation score for each districting plan against what is perhaps the simplest and least controversial of the global measures of partisan fairness: the absolute value of the difference between the partisanship of the median district and the cross-district mean, calculated using the same vote data employed in our primary analysis (precinct-level returns from the 2008 presidential election

[5]Data on who drew districts in each state comes from *http://redistricting.lls.edu/*.

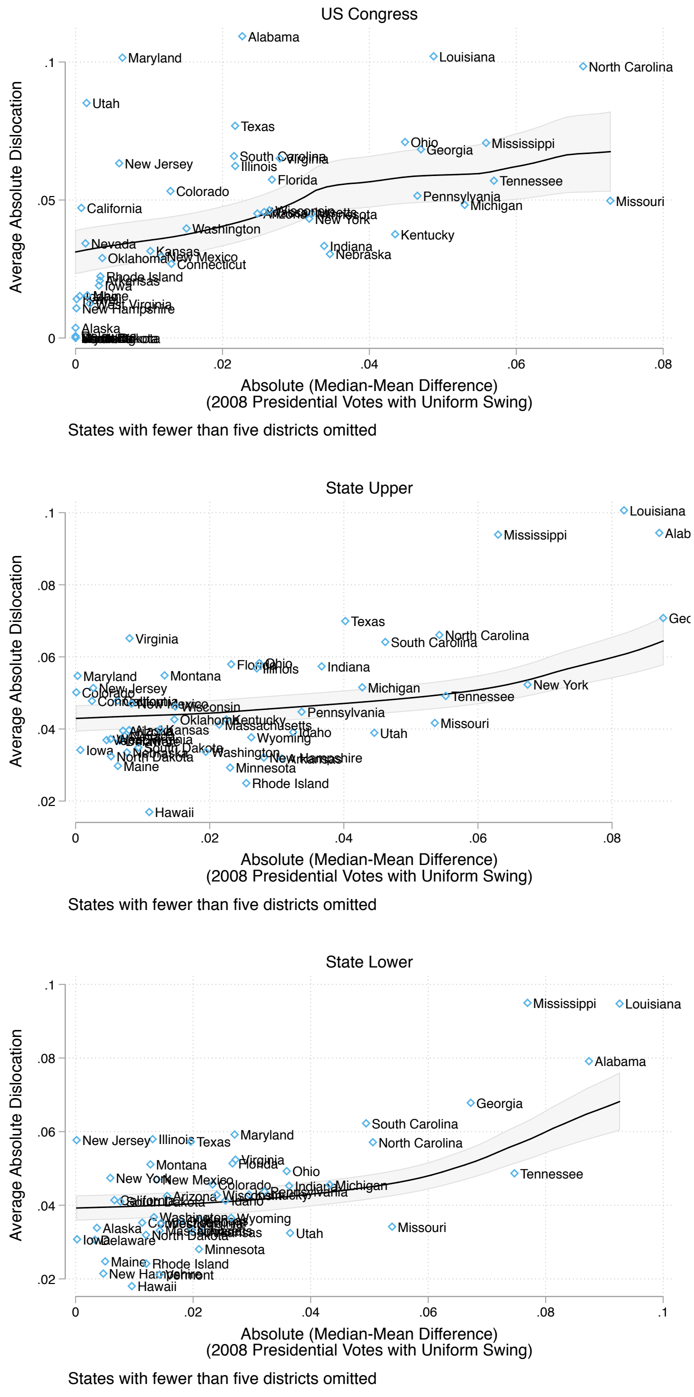
Figure 7: Distribution of District-Level Dislocation by State



with a uniform swing applied). This is a simple measure of the skew in partisanship across districts. For a review of this and other global measures and some of their limitations, see Katz, King and Rosenblatt (N.d.)). Intuitively, the median-mean difference is large in states like North Carolina and Missouri, where the cross-district distribution of partisanship has a long tail composed of overwhelmingly Democratic districts. As a result, Democrats are harmed in the transformation of votes to seats because too many of their votes are "wasted." However, this intuition cannot be applied in highly non-competitive states. A party with a very low statewide vote share actually benefits from a large gap between its mean and median vote share, since its only path to winning seats involves clustering a sufficient number of its voters in the tail of the cross-district distribution Gudgin and Taylor (1979). Democrats in Alabama, for instance, or Republicans in Massachusetts, cannot win any Congressional seats if their mean and median vote shares are similar. For this reason, one should be cautious about simple cross-state comparisons of global measures like the mean-median difference, which have different interpretations depending on the statewide vote share.

There is a consistent, albeit not overwhelming, positive relationship between the mean-median difference and the dislocation score. By no means would we expect a tight connection. The cross-district distribution of partisanship could be skewed for reasons having little to do with partisan gerrymandering, while our measure takes into account voter geography and attempts to capture deliberate gerrymandering. Nevertheless, it is worth noting that especially in state legislatures, states with relatively high levels of partisan dislocation also demonstrate skewed distributions of partisans across districts. Note that some of the outliers in Figure 8 are non-competitive states like Maryland, Alabama, and Utah, where the mean-median difference is not a very satisfying measure of partisan fairness.

Figure 8: Absolute Average Dislocation and Absolute Median-Mean Scores



Notes: The above figures plot the average absolute dislocation score for states (averaged across all voters) against each state's Absolute Mean-Median Difference. Mean-Median Differences are calculated as the absolute difference between the Democratic vote share of the median 2014 district and the average democratic vote share across all districts. District vote shares and the political dislocation scores are estimated using precinct-level 2008 US Presidential vote shares adjusted with a 3.69% uniform swing as detailed in Section 3. Results are very similar using Democratic vote shares from 2012 to calculate Absolute Mean-Median Differences.

6 How Much is Too Much?

While interesting, these raw cross-state comparisons of average dislocation scores may not be very helpful in identifying gerrymandered redistricting plans. If political dislocation is to become a standard for evaluating political gerrymandering, the question of "how much is too much?" must also be addressed. As with global indicators like the mean-median difference, it can be difficult to know how to characterize a "high" overall dislocation score. For instance, while the Pennsylvania Supreme Court has decided that its Congressional map was unreasonably gerrymandered, and we have shown above that partisan dislocation was quite extreme in parts of Pennsylvania in the map drawn by the legislature relative to a map drawn by a court-appointed special master, the average absolute dislocation score for Pennsylvania's gerrymandered Congressional plan was not especially high relative to other states (see Figure 6 where states are plotted with on a common scale).

Due to aspects of natural and human geography, different states will have different baseline levels of partisan dislocation. Above all, given the concentration of Democrats in cities and the typical American pattern whereby Republican voting increases with the distance from the city center, it will be quite difficult to avoid partisan dislocation when drawing the boundaries of districts in urban areas. Some suburban Republican neighborhoods will find themselves in Democratic urban districts, and some overwhelmingly Democratic inner-ring suburbs will end up in districts where the overall vote share is relatively Republican due to the inclusion of outer-ring suburbs. Dislocation hot-spots might be unavoidable along district boundaries in some cities. Options for district-drawers to minimize dislocation will be limited when big cities are located— as they so often are— on lakes, oceans, or the borders of other states. Some cities, like Memphis and Philadelphia, are located in the corner of the state. And small Democratic cities that are surrounded by a larger Republican periphery might simply be destined for dislocation no matter how the districts are drawn.

Another way to see the importance of geography is to imagine a state where voters are uniformly distributed in space. No matter how one draws districts in such a state, dislocation will have a value of zero, but there would also be no way to gerrymander for political advantage. As voters become less uniformly distributed, opportunities for dislocation and gerrymandering expand.

Thus raw cross-state comparisons of global measures should be approached with caution. It is necessary to take the geographic arrangement of voters into account when setting thresholds for acceptable levels of global or local political dislocation. One promising approach is to build on recent computational advances that allow researchers to draw large samples from the space of feasible redistricting plans. The typical practice is to compare these alternative plans with the plan being evaluated by contrasting expected seat shares. A valuable alternative is to evaluate the plans according to partisan dislocation. A gerrymandered plan will have an unusually high level of dislocation relative to the sampled plans. This metric avoids some of the complexities of trying to contrast hypothetical seat shares for the parties in the enacted and sampled plans. And if a *local* measure of gerrymandering is desired, voter-level dislocations from each of the thousands of sampled plans can be aggregated to the level of the districts in the plan under evaluation, and it will be possible to get a clear indication of whether the level of dislocation in each individual district can be characterized as an outlier relative to the sampled plans. In other words, we will have a rigorous district-level measure of gerrymandering that is fully informed by the unique geography of the area.

Our measure also has potential in cases where courts might need to disentangle the dictates of the Voting Rights Act and efforts at partisan gerrymandering. One might be able to examine, for instance, a large number of alternative plans with similar levels of minority voting-age population in the districts of a given region, to see if the plan under evaluation has an unusually high level of partisan dislocation relative to those alternatives.

Additionally, local and global partisan dislocation measures in a large number of sampled redistricting plans can help illuminate the relationship between political geography and representation. In particular, it may be the case that certain voter geographies require different political dislocation thresholds to achieve similar results in terms of other desirable properties, like representational equality or district compactness.

And finally, it is possible that political dislocation could be used as a meaningful constraint on the ability of sophisticated district architects to gerrymander for partisan advantage. A redistricting commission or legislature might be charged with the task of keeping the level of dislocation below some specified threshold. Further research is needed to determine whether, for instance, dislocation-minimizing plans have other desired features in terms of partisan bias, responsiveness, and respect for communities of interest. At first blush, it might seem to be the case that dislocation-minimizing plans would simply lead to overwhelming Democratic majorities in urban districts. However, dislocation-minimizing plans around cities might end up combating the tendency for extremely Democratic inner- and middle-ring suburbs to be joined with, and overwhelmed by, Republican exurbs, which might under some conditions facilitate fairer and more competitive districts. If so, the minimization of partisan dislocation might be more politically palatable as a goal for redistricting reform than notions of global partisan symmetry that ultimately boil down to potentially controversial projections about how many seats the parties "deserve" given some projections about future vote shares. But first, it will be necessary to explore the relationship between political dislocation and various quantities of interest in a variety of metro areas and states using a large number of sampled plans.

7 Conclusion

Partisan gerrymandering is difficult to measure, and it is conceptually distinct from partisan fairness, which is typically measured globally rather than locally. It is evident that courts would benefit from a measure that focuses clearly on intentional packing and cracking, rather than fairness, and does so at the level of specific districts. We have developed such a measure, called *political dislocation*, and we have shown that it seems well-suited to the identification of voters that have been cracked or packed. At the level of states, an aggregated measure of dislocation is weakly correlated with global measures of fairness.

Political dislocation might be useful for future litigants wishing to establish that plaintiffs have been directly harmed by being placed in packed or cracked districts. Political dislocation comports with intuitions about how gerrymandering is accomplished, identifies deliberate district manipulations, and seems ideally suited to meet demands of standing requirements laid out in *Gill v. Whitford*. Moreover, it allows for rigorous district-specific gerrymandering analysis.

This concept has potential to improve efforts to disentangle the impact of political geography and intentional gerrymandering. First, it provides an alternative to redistricting simulations for scholars wishing to characterize the extent to which a districting plan deviates from some baseline level of asymmetric partisan clustering in a state. Instead of drawing thousands of alternative plans, this approach imagines each voter to be at the center of a bespoke district. Second, and perhaps more important, our approach is a complement rather than a substitute for the sampling approach, in that it provides a valuable metric for evaluating a specific plan in relation to a large ensemble of alternative plans. A gerrymandered plan will exhibit significantly higher levels of dislocation than a sample of non-partisan plans, and this analysis can allow for the identification of gerrymandered regions, districts, and even neighborhoods.

Finally, political dislocation has potential as a metric not only in post-hoc policing of partisan manipulation, but also as a guidepost in the process of district drawing. Dislocation could even be calculated on the fly by redistricting software. Considerable additional research is needed, but it is plausible that by trying to minimize dislocation, for instance in a particular metro area, a district-drawer would also be producing a plan with other desirable qualities, including partisan fairness and competitiveness. However, redistricting inevitably involves trade-offs. The next stage in this research agenda involves sampling a large number of districts in varying geographic contexts in order to establish those trade-offs.

References

Chen, Jowei and Jonathan Rodden. 2013. "Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures." *Quarterly Journal of Political Science* 8(3):239–269.

Chen, Jowei and Jonathan Rodden. 2015. "Cutting Through the Thicket: Redistricting Simulations and the Detection of Partisan Gerrymanders." *Election Law Journal* 14(4):331–345.

Cho, Wendy K. Tam and Yan Y. Liu. 2016. "Toward a Talismanic Redistricting Tool: A Computational Method for Identifying Extreme Redistricting Plans." *Election Law Journal* 15:351.

Eubank, Nicholas and Jonathan Rodden. 2018. "Who is my Neighbor? The Spatial Efficiency of Partisanship." *Working Paper* .

Gudgin, Graham and P.J. Taylor. 1979. *Seats, Votes, and the Spatial Organisation of Elections*. London: Pion Limited.

Katz, Jonathan, Gary King and Elizabeth Rosenblatt. N.d. "Theoretical Foundations and Empirical Evaluations of Partisan Fairness in District-Based Democracies.".

Magleby, Daniel and Daniel Mosesson. 2018. "A New Approach for Developing Neutral Redistricting Plans." *Political Analysis* 26(2):147–167.

Mathematicians' Amicus Brief, Rucho v. Common Cause. 2018. "Amicus Brief of Mathematicians, Law Professors, and Students in Support of Appelleees and Affirmance." Amicus Brief, Supreme Court of the United States, Rucho et al. v. Common Cause et al.

Mattingly, Jonathan C. and Christy Vaughn. 2014. "Redistricting and the Will of the People." https://arxiv.org/abs/1410.8796.

Pegden, Wesley. 2017. "Pennsylvania's Congressional Districting is an Outlier: Expert Report.". Expert report submitted in Leage of Women Voters of Pennsylvania v. Commonwealth of Pennsylvania.

Pegden, Wesley, Jonathan Rodden and Samuel Wang. 2018. "Brief of Amici Curiae Professors Wesley Pegden, Jonathan Rodden, and Samuel Wang in Support of Appellees." Supreme Court of the United States.

A Sampling Variability

As noted in Section 3, our estimates of voter dislocation are subject to two forming of sampling variability: downsampling the number of voters, and then placement of these voters within each precinct.

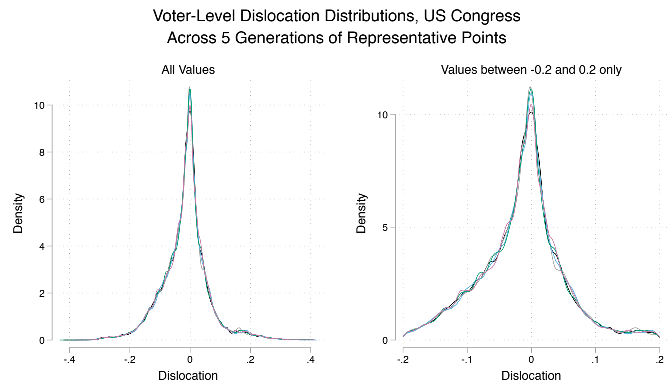
The first source of variance comes from our need to downsample the universe of all US voters for computational tractability. In particular, we create a set of "representative voters" in each precinct for each party by taking a binomial draw from the total number of actual voters for each party in each precinct. The binomial probability varies by state-chamber, but is equal to $prob_k = \frac{number of districts}{number of voters in state} * k$, where k=1,000 for state legislative districts and 5,000 for US Congressional districts. This probability generates k voters per district in expectation. This downsampling makes it computational feasible to calculate the partisan composition each representative voter's k nearest neighbors. A larger k is used for US Congressional districts as they are much larger with respect to individual precincts, resulting in lower binomial draw probabilities for each precinct, thus increasing sampling variance.

The second source of variance comes from distributing points uniformly within each precinct. Thankfully, US precincts are generally quite geographically compact, limiting the amount of variation introduced by this process.

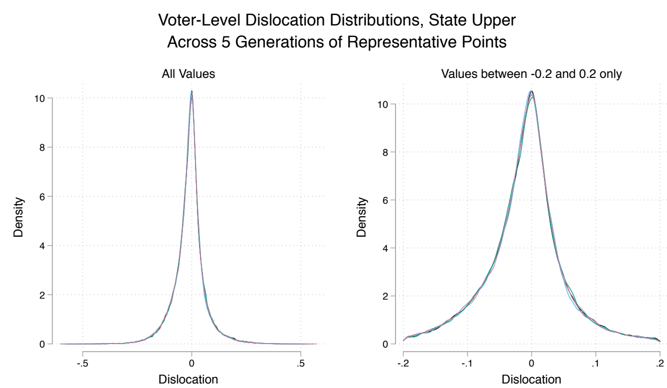
To evaluate the impact of these sources of variability, Figure 9 below plots the distribution of (representative) voter-level dislocation scores across five rounds of representative-voter point generation. As the Figures show, variation across each round is extremely small, especially within respect to cross-voter simulation: between-round standard deviations constitute only 0.101 %, 0.103 %, and 0.104 % of total variation for these five rounds for state lower, state upper, and US House chambers respectively.

Figure 10 presents analogous diagnostic distribution at the level of legislative districts (plotting the distribution district-level average absolute dislocation scores). Again, between-round standard deviations constitute only 1.11 %, 0.99 %, and 1.67 % of total variation for these five rounds for state lower, state upper, and US representative chambers respectively.

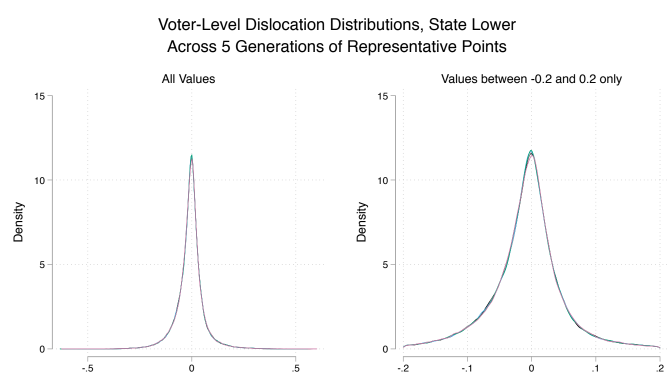
Figure 9



Within Simulation Std. Dev.: 0.0776, Between Simulation Std. Dev.: 0.0001
Between As Pct of Total Std. Dev.: 0.104%
Kernel densities plotted from 10% sample; variance decomposition from full sample.

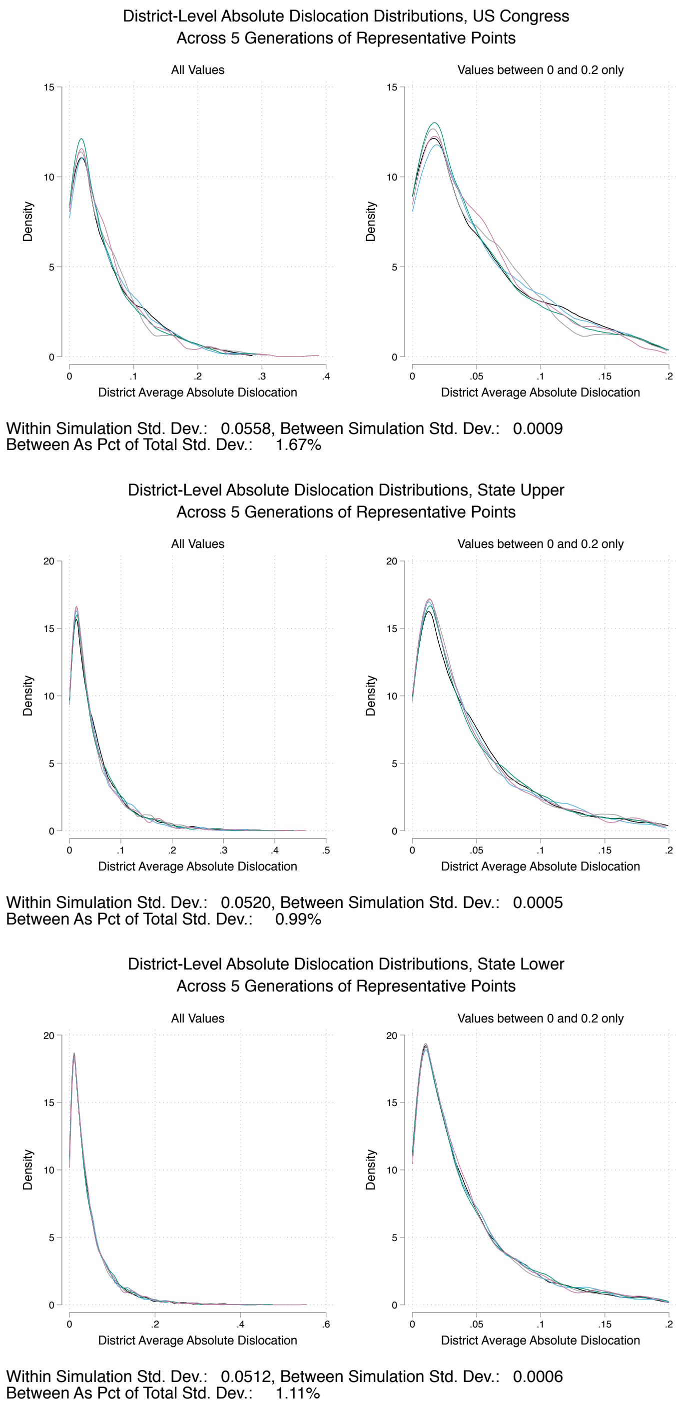


Within Simulation Std. Dev.: 0.0709, Between Simulation Std. Dev.: 0.0001
Between As Pct of Total Std. Dev.: 0.103%
Kernel densities plotted from 10% sample; variance decomposition from full sample.



Within Simulation Std. Dev.: 0.0659, Between Simulation Std. Dev.: 0.0001
Between As Pct of Total Std. Dev.: 0.101%
Kernel densities plotted from 10% sample; variance decomposition from full sample.

Figure 10



District-Level Absolute Dislocation Distributions, US Congress
Across 5 Generations of Representative Points
All Values
Values between 0 and 0.2 only
Density
District Average Absolute Dislocation
Within Simulation Std. Dev.: 0.0558, Between Simulation Std. Dev.: 0.0009
Between As Pct of Total Std. Dev.: 1.67%
District-Level Absolute Dislocation Distributions, State Upper
Across 5 Generations of Representative Points
All Values
Values between 0 and 0.2 only
Density
District Average Absolute Dislocation
Within Simulation Std. Dev.: 0.0520, Between Simulation Std. Dev.: 0.0005
Between As Pct of Total Std. Dev.: 0.99%
District-Level Absolute Dislocation Distributions, State Lower
Across 5 Generations of Representative Points
All Values
Values between 0 and 0.2 only
Density
District Average Absolute Dislocation
Within Simulation Std. Dev.: 0.0512, Between Simulation Std. Dev.: 0.0006
Between As Pct of Total Std. Dev.: 1.11%

B Additional Political Dislocation Maps

Figure 11: Partisan Dislocation in Texas US House Districts

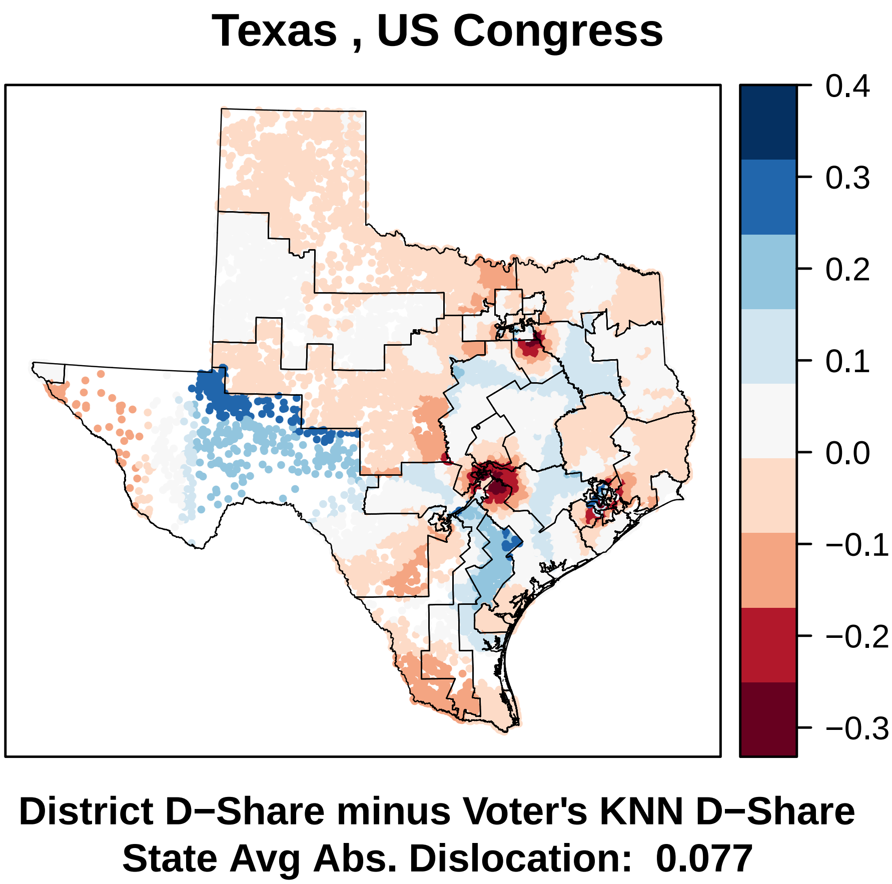


Figure 12: Partisan Dislocation in Louisiana US House Districts

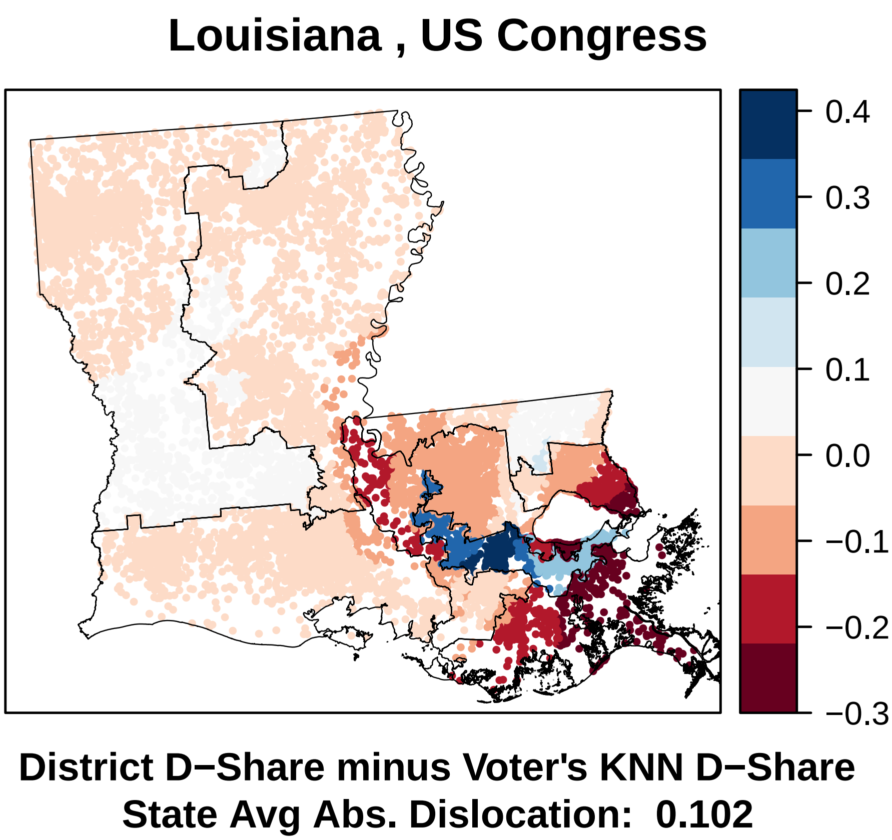


Figure 13: Partisan Dislocation in North Carolina US House Districts

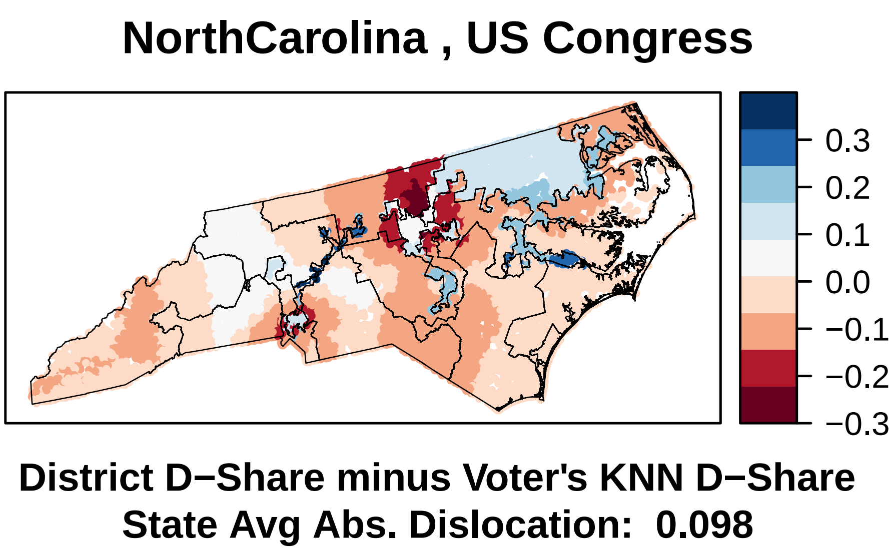
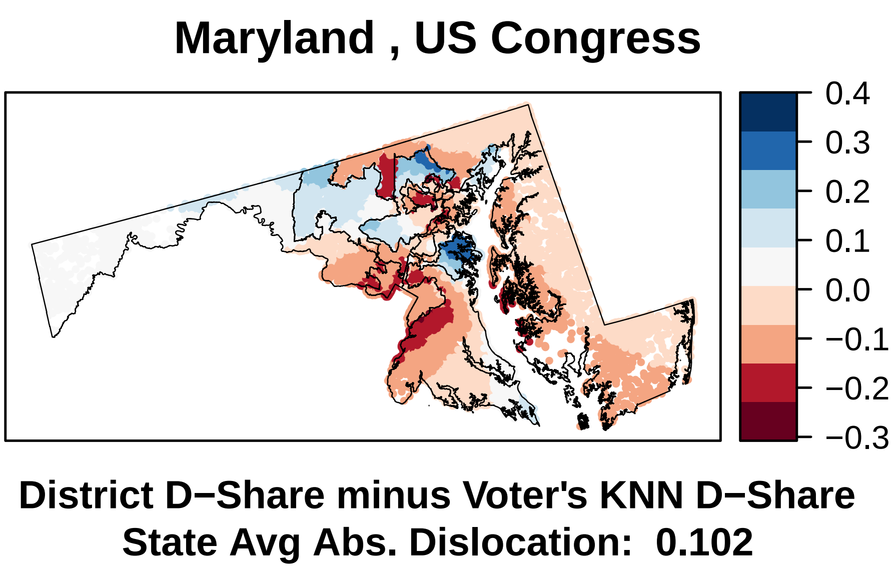


Figure 14: Partisan Dislocation in Maryland US House Districts



C Political Dislocation and Compactness

As political dislocation contrasts the partisan composition of a voter's actual district to what would be the composition of a perfectly compact (circular, modulo boundary reflections) district centered on the voter, once might worry that dislocation simply measures deviations from compactness. As shown in Figure 15 below, while it is the case that dislocation and compactness are related (as we would expect, given the types of deliberately gerrymandered districts dislocation aims to identify) the relationship between the two factors is weak: the correlation is only around ~ -0.275 at all district levels.

Figure 15: District Average Absolute Dislocation and District Compactness With and Without Scatter Overlay