The Effect of Electoral Geography on Competitive Elections and Partisan Gerrymandering

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Abstract:  
How does the size of a legislature affect the competitiveness of its districts' elections? This paper theoretically develops and empirically tests three hypotheses concerning the effect of legislative chamber size on electoral competition and partisan gerrymandering. First, in swing states, legislature size has a negative effect on the fraction of districts that are electorally competitive; the intuition here is that smaller districts are more politically homogenous and thus less competitive. Second, in those few states that are extremely Democratic (e.g., New York) or extremely Republican (e.g., Alabama), legislature size has a single-peaked relationship with electoral competitiveness: Moderate-sized legislative chambers produce the most competitive districts. Finally, because political gerrymanderers often seek to manipulate electorally vulnerable districts, a decline in competitive districts should cause a decrease in partisan gerrymandering. Therefore, among swing states, larger legislative chambers should exhibit less gerrymandering than smaller chambers.

To empirically test these three arguments, I first present data from state legislative election results during 1992-2002. I then conduct automated, repeated simulations of state legislature and Congressional districting across several states. These simulations allow us to isolate the effect of legislature size on electoral competitiveness, thus removing confounding factors such as gerrymandering, candidate quality, and incumbency advantage. Finally, in order to measure the extent of gerrymandering in each legislative chamber, I compare real-life districting plans against the simulated districting plans. By comparing these two sets of plans, I estimate the extent to which gerrymanderers politically manipulated legislative districts in the 2002 redistricting cycle.
How does the size of a legislature affect the quality of its electoral responsiveness to voters? Conventional wisdom holds that larger chambers, up to a reasonable extent, enhance the legislature’s ability to represent the interests of its citizens. George Washington famously advocated for a larger House of Representatives on the grounds that assigning at least one legislative seat per 30,000 citizens was necessary for constructing a legislative chamber that is sufficiently representative of the electorate (Van Doren, 1948). Echoing this argument nearly two centuries later, Dahl and Tufte (1973) argue for the representational benefits of dividing a legislature into a larger number of districts, with each legislator representing a smaller number of constituents. The authors warn that having too many citizens in each district would "make it more difficult to achieve an accurate match between the views of voters and politicians" (1973, 85). Under this classic theory, the only reasons for limiting the size of legislatures are practical concerns, such as the onerous "decision-making costs" of having an excessively large legislative body (Buchanan and Tullock 1962, 217).

This paper challenges this conventional wisdom concerning the hypothesized electoral benefits of constructing a larger legislature. In particular, I analyze the effect of legislature size on electoral responsiveness, as measured by the fraction of legislative districts that have close, competitive elections. I show that the relationship between legislature size and electoral responsiveness is complex and depends upon the geographic distribution of partisan voters across districts and upon the overall partisan split of the electorate.

Specifically, this paper theoretically explains and empirically tests three hypotheses: First, in swing states with a relatively balanced mix of Democrats and Republicans, a larger legislature causes a strict decrease in the fraction of districts that are competitive. The intuition behind this argument is as follows. If a swing state is divided into a single, statewide electoral
district, then this district is always competitive by assumption. But if the state is divided into a larger number of geographically smaller districts, then each of these districts possibly deviates from the statewide partisan split and thus becomes uncompetitive. Given that voters residually segregate themselves along lines that correlate with partisanship, such as race and income, a smaller district is more likely to comprise a local, politically homogenous neighborhood of voters, thus decreasing the district’s electoral competitiveness. In an extremely large legislature where the number of districts equals the number of voters, every voter represents himself or herself, so districts are entirely uncompetitive.

The second prediction is that in core Democratic or Republican states where one party dominates the electorate, a moderate-sized legislature maximizes the fraction of competitive districts; a larger or smaller legislature size causes a decline in competitive seats. The intuitive logic behind this argument is as follows. Suppose two-thirds of a state’s voters are Democratic. Hence, a single, statewide district would also be two-thirds Democratic and thus uncompetitive. But expanding the legislature to several, geographically compact districts would introduce variance in district-level partisanship, particularly if voters have segregated themselves into neighborhoods according to partisanship. While many of these districts would be heavily Democratic, a smaller fraction of districts would be more politically mixed and thus electorally competitive. Finally, expanding the number of districts to equal the number of voters would once again produce entirely uncompetitive districts. Hence, there exists a medium number of districts that optimizes the overall electoral competitiveness of the legislature. Thus, the relationship between legislature size and electoral competitiveness is single-peaked.

Third, these findings concerning electoral competitiveness have implications for partisan gerrymandering. Gerrymanderers typically seek to either create an electoral advantage for their
parties or to protect incumbent districts held by their parties' members. A gerrymanderer accomplishes these goals by taking an electorally vulnerable district and packing the district with partisan supporters, thus making the district more electorally safe. Hence, an opportunity for gerrymandering arises only when an existing legislative district is electorally marginal. Consequently, legislative chambers with more competitive districts will experience more severe partisan gerrymandering. Given this paper's first prediction, this argument implies that among swing states, smaller legislative chambers will have more partisan gerrymandering.

I illustrate these arguments in four ways. First, I present and analyze an agent-based model of electoral districts to theoretically illustrate the relationship between legislature size and the electoral competitiveness of districts. Second, I present basic state legislative election results during 1982-2002 to show that among swing states, legislative chambers with more districts tend to have fewer competitive elections. Third, to show that this empirical result is not the artifact of gerrymandering, candidate quality, or other confounding factors, I conduct a series of computer simulations of the redistricting process in several states, using precinct-level votes from the 2008 McCain-Obama election. These simulated districting plans allow for estimation of district-level competitiveness under a wide range of hypothetical legislature sizes. Fourth, I compare these simulated districting plans against the real-life districts in order to measure the extent of partisan gerrymandering in each legislature; these estimates confirm the prediction that gerrymandering occurs more extensively in legislative chambers with fewer districts.

1. An Agent-Based Model of Legislative Districting

This section presents an agent-based model in which voters across a grid are aggregated into a variable number of square-shaped, single-member districts. The results from this
computational model illustrate the theoretical logic of how legislature size affects electoral competitiveness at the district level. The model is presented under two scenarios: The basic model is set up under the assumption that a swing state's voters are split evenly between Democrats and Republicans. I then consider the model in a core state where two-thirds of voters are Democrats, showing how this different electoral context changes the main results regarding legislature size's effect on competitive elections.

**Setup:** Assume that the state consists of a square grid of 192 by 192 cells. Ten percent (3,686) of these cells are empty, and ninety-percent (33,178) of the cells are each occupied by a single voter. These voters consist of exactly 16,589 (50%) Democrats and 16,589 (50%) Republicans. At time $t=0$, the voters are randomly assigned to cells on the grid, with the empty cells randomly interspersed among the voters. The left side of Figure 1 illustrates the distribution of voters across the square grid at time $t=0$, with red cells depicting Republicans, blue cells depicting Democrats, and white spaces representing empty cells.

[FIGURE 1 HERE]

**Legislative Districts:** The legislature consists of $n$ legislative districts, where each district must comprise of a square subsection of the grid. Hence, $n$ is constrained to be any square number that is perfectly divisible by the total number of cells (36,864). The valid possible legislature sizes are therefore: $n = (1), (4), (9), (16), (25), (36), ... , (36,864)$.

As an example, Figure 1 illustrates the case in which the state is divided into $n=36$ square districts, with black lines representing the district boundaries. As the voters are randomly assigned to cells at $t=0$, every legislative district contains almost precisely a 50%-50% split between Republican and Democratic voters.
**Voter Sorting:** Voters are assumed to have a preference to not be in the partisan minority in their local neighborhood. At each time period \( t > 0 \), a single, random voter is chosen. The chosen voter evaluates the partisanship of all neighbors in the eight adjoining cells that surround hers. If fewer than 50% of the voters in this neighborhood share her partisanship, then she opts to leave and migrate to an empty cell, randomly chosen from across the entire grid.

The consequence of this voter sorting is that, after many iterations, voters become geographically segregated by party across local neighborhoods. The right side of Figure 1 illustrates the extent of this partisan segregation at time \( t = 600,000 \). Figure 2 traces the extent of the partisan segregation by plotting the likelihood that two randomly-chosen and adjoining neighbors share the same partisanship. This plot illustrates that across time, voters become much more likely to be surrounded by other voters of similar partisanship, with the probability

**Legislative District Competitiveness:** Figure 2 also illustrates the fraction of legislative districts that are electorally competitive, with competitive districts defined as ones in which the two parties' shares of the district's votes are within 15% of one another. Figure 2 calculates this fraction for a wide range of reasonable legislature sizes, ranging from \( n = 4 \) districts to \( n = 576 \) districts, and across four different points in time.

[FIGURE 2 HERE]

The results illustrate that the negative relationship between legislature size and electoral competitiveness emerges and strengthens over time, as voters become more segregated by party. At the outset of the model, \( t = 0 \), there is no partisan segregation, so under any reasonable legislature size, all districts contain a fairly even partisan split of voters and are therefore competitive. But as partisan voters become more segregated across time, the smaller districts become more polarized, as a smaller district is more likely to be dominated by a local
neighborhood of one party's segregated voters. Consequently, a larger legislature with smaller districts is more likely to have extreme, polarized districts that are therefore uncompetitive. Meanwhile, in a smaller legislature with larger districts, these larger districts are more likely to aggregate several polarized neighborhoods; hence, larger districts tend to have more balanced partisanship and are therefore more likely to be competitive. Consequently, as voters become more segregated across neighborhoods, the negative relationship between legislature size and electoral competitiveness becomes more pronounced.

*Alternative Model with Democrat-Dominated Electorate:* This section considers an alternative version of the model with the modified assumption that two-thirds of the voters are Democrats, while one-third are Republicans. Figure 3 illustrates the distribution of voters at time $t = 0$ and at time $t = 300,000$ under this alternative assumption.

This modified assumption of Democratic dominance across the state has significant implications for electoral competition. At time $t = 0$, before voter re-sorting has occurred, most districts are not electorally competitive. If the legislature consists of a small number of very large districts ($n = 4$), then each district approximately simply reflects the statewide partisan split of 67% Democrats, so the districts are electorally uncompetitive. As before, if the number of districts equals the number of voters, then each district contains a single voter and is therefore uncompetitive. But if the legislature is of a moderate size, then the districts are moderately sized, with some variation in district-level partisanship. While the districts will, on average, contain 67% Democrats, these moderately-sized districts exhibit enough random variation such that some districts will happen to be electorally competitive. Therefore, a moderately-sized
legislature creates the only opportunity for having some competitive districts that deviate in partisanship from the 67% Democratic vote share.

[FIGURE 4 HERE]

As voters become more segregated after a large number of iterations, this single-peaked relationship between legislature size and electoral competitiveness persists, although the optimal legislature size decreases. Figure 4 illustrates this shifting relationship by depicting the fraction of electoral districts that are competitive at three points in time across a wide range of legislature sizes. At time $t = 400,000$, electoral competitiveness is maximized when the legislature contains exactly $n = 36$ districts. With this legislature size, 16 (45%) of 36 of districts are electorally competitive. The intuition behind this result is that as voters form partisan neighborhoods across the grid, a 36-seat legislature has districts large enough such that these partisan neighborhoods sometimes cancel each other out within a single district, thus creating a politically balanced and competitive district. But with a very small legislature, individual districts are so large that most districts approach the statewide vote share of 67% Democrats and are thus uncompetitive. Meanwhile, with an extremely large legislature, districts are largely uncompetitive because every district falls squarely within either an extremely Democratic neighborhood or an extremely Republican neighborhood. Therefore, a moderate-sized legislature of 36 seats optimizes the fraction of districts that are competitive.

This model has thus considered two scenarios, producing two different predictions about the effect of legislature size on competitive elections. In a swing state with relatively balanced partisanship, smaller legislatures will have more competitive districts. Only in lopsided states, dominated by one party, does the relationship between legislature size and competitiveness
become single-peaked. The following sections use both observed election results and simulated legislative districting plans to empirically test these predictions.

2. The Electoral Competitiveness of State Legislative Elections

As a first empirical test of the model's prediction that swing states should produce a negative relationship between legislature size and competitiveness, this section considers election results from state legislative races during 1992-2002. I consider only legislatures that exclusively employed single-member districts during this period. For each legislative district, I calculate the fraction of elections during the decade in which the winner and runner-up candidate received vote shares within 15% of one another. This fraction serves as a basic measure of electoral competitiveness. Because it is problematic to directly compare state legislative election vote shares across states, I initially make no distinction between swing states and core states. I later use McCain-Obama vote shares to distinguish states that are reasonably balanced in partisanship.

[FIGURE 5 HERE]

Figure 5 presents two plots illustrate the basic relationship between legislature size and electoral competitiveness. The left plot considers only the lower chambers of states legislatures and shows that larger chambers generally produce close elections in a smaller fraction of districts. The dashed line in this plot represents a least-squares fit, finding that an increase in legislature size from the smallest (40, Alaska) to the largest (203, Pennsylvania) chamber is associated with a significant decline, from 13% to 3%, in the fraction of districts that are competitive.
A second test of the seats-to-competitiveness relationship relies upon the fact that in every state legislature, the upper chamber (Senate) is always smaller than the lower chamber (House). Therefore, in politically balanced states, state senate races should generally be more competitive than state house races. The right plot in figure 5 illustrates this empirical result by considering all states that employ single-member districts in both chambers. This plot depicts state house competitiveness with dots and state senate competitiveness with red triangles. In general, the plot illustrates that in the vast majority of states, the legislature's senate contains a greater fraction of competitive districts than the house. Three states are exceptions to this finding: Delaware and Connecticut, which are heavily Democratic states with over 61% Obama vote share in 2008, and Wyoming, a heavily Republican state with 65% McCain vote share. The partisan extremity of these three states suggests that they do not follow the uniformly negative seats-to-competitiveness relationship that applies only to swing states. The following section of this paper uses districting simulations to test the hypothesized single-peaked relationship between legislature size and competitiveness for these politically lopsided states.

In general, the empirical data strongly confirm the hypothesized negative relationship between legislature size and competitiveness across states and across chambers within the same state. But these legislative election results are potentially confounded by several factors. First, different degrees of political and racial gerrymandering may explain the lack of competitive elections in various legislatures. Second, senate races may be more competitive than house races simply because senate races attract more higher quality candidates and greater attention from parties, campaigns, and voters. Finally, differences across states in legislative professionalism and incumbency advantage may further account for differences in the competitiveness of the state legislative elections. In sum, an ideal test of the hypothesized effect of legislature size
should isolate and remove the effect of gerrymandering and should not rely upon the observed legislative election results themselves to measure district-level competitiveness.

**3. Computer Automated Simulations of State Legislative Redistricting**

To address the confounding factors noted in the previous section, I conduct legislative districting simulations in each state using precinct-level maps and voting results from the 2008 McCain-Obama election. These simulation results provide a baseline to estimation the partisanship of districts that emerge in each state, given the natural geographic distribution of voters in the state. Because the simulated districts are drawn by computer without any partisan or racial intent, they isolate the effect of legislature size. Using McCain-Obama vote shares at the precinct level allows the simulated estimates to remove the effects of differences in quality challengers and other local-level campaign strategies.

*The Automated Districting Algorithm:* I implement a computer simulation algorithm that is designed to draw geographically compact, contiguous, and equally apportioned districts. This section explains this algorithm by illustrating its implementation in Indiana.

As of the November 2008 election, Indiana consisted of 5,925 voting precincts. These precincts are the smallest geographic unit at which election results are publicly announced, so they are used as the building block for the districting simulations. Hence, a complete districting plan consists of assigning each one of Indiana's precincts to a single legislative district.

The simulation proceeds as follows. Suppose Indiana is to be divided into 9 districts, the current size of Indiana's Congressional delegation. First, nine precincts are randomly chosen and assigned to be the respective "seeds" for each of the 9 eventual districts. At this point, there are
5,916 unassigned precincts. Each of these remaining precincts are then assigned to the same
district as the geographically nearest of the nine original "seeds."

At this point, Indiana has been divided into 9 geographically contiguous districts. These
districts are quite compact but not guaranteed to be equally apportioned by population. The
computer then calculates the most under-populated district, denoted as district $i$. The computer
then identifies the district bordering district $i$ that contains the largest population. This bordering
district is denoted as $j$. Among the set of precincts within $j$ that border district $i$, the computer
randomly selects one precinct and reassigns it from district $j$ to district $i$. Hence, all districts
remain contiguous and relatively compact but are now slightly less malapportioned. This process
is repeated, often for at least several hundred iterations, until every district is within 5% of the
ideal target population of a district.

Once the computer has divided all of Indiana into 9 districts, the districting simulation is
complete. After completing this districting simulation, I aggregate the precinct-level McCain-
Obama vote counts within each district, and I determine whether the McCain and Obama vote
shares within each district are within 15% of one another. Such a district is characterized as
electorally competitive, and I calculate the fraction of districts that are competitive across 200
independent districting plans. I perform 200 such repeated simulations for every
legislature size observed in Indiana (9 Congressional districts, 50 State Senate districts, and 100
State House districts).

*Electoral Competitiveness in the Simulated Districting Plans:* To test this paper's main
theoretical predictions concerning the effects of legislature size, I compare the simulated
districting results of the two chambers within each state. For example, I compare the electoral
results from dividing Indiana into 50 simulated House districts against the results from dividing
Indiana into 100 Senate districts. These results indicate that in Indiana's Senate, 54% of the simulated districts are electorally competitive, on average. But in the Indiana House, only 47% of simulated districts are competitive. As these simulations are conducted using the same precinct-level maps and McCain-Obama votes, the inference is that differences in legislature size explain why Senate districts are slightly more competitive than House districts in Indiana.

[FIGURE 7 HERE]

Figure 7 presents analogous simulation results across all states for which precinct-level election results are available and in which simulations can be conducted. This plot compares the simulated electoral competitiveness in each state's House the state's Senate. States are divided into two groups: The swing states, with McCain and Obama's vote shares within 15% of one another, appear in the lower half of the plot. Meanwhile, the upper half of the plot lists core Democratic or Republican states, with wide vote margins in the 2008 presidential election.

The simulated results confirm the earlier findings from observed state legislative election results. Among swing states, every state except for New Jersey exhibits more simulated competitive districts in its Senate than in its counterpart House. As every Senate has fewer seats than its associated House, this pattern corroborate the main prediction that in swing states, larger legislatures produce less competitive districts. This pattern is noticeably absent among the electorally lopsided states, which is consistent with the predictions of the agent-based model: Among the lopsided states of Oklahoma (66% McCain vote) and Michigan (58% Obama vote), the state Senate actually exhibits a smaller fraction of competitive districts than the state House. These mixed results are consistent the prediction of the model that in politically extreme states, legislature size should exhibit a single-peaked relationship with the fraction of districts that are competitive.
To test this prediction more directly, I conduct legislative districting simulations for every possible reasonable legislature size within a single state. Figure 9 illustrates such results for Alabama, a state that is lopsidedly Republican, with McCain winning 62% of the 2-party presidential vote in 2008. Using Alabama's precinct-level maps and presidential election results, I conduct 200 simulations each for every hypothetically possible legislature size, ranging from $n = 2$ districts to $n = 105$ districts (the size of Alabama's State House).

The Figure 9 plot illustrates how the average simulated share of districts that are competitive changes as a function of legislature size. When the legislature is small ($n=2$), the two simulated districts are extremely large and, in both cases, each exhibit a partisan composition close to Alabama's statewide 62% McCain vote share. Only 9% of these districts are ever electorally competitive. But as the legislature becomes larger in Figure 9, a larger fraction of the districts deviate from the 62% Republican vote share, and hence a larger fraction of the districts emerge as electorally competitive. In fact, electoral competition is maximized at $n = 23$ districts, where 29% of the simulated districts are competitive. As the legislature expands beyond 23 districts, the simulated districts typically become more politically homogeneous and thus uncompetitive. Hence, Alabama exhibits a single-peaked relationship between legislature size and simulated electoral competitiveness.

It is noteworthy that this optimal legislature size of $n = 23$ districts is significantly larger than Alabama's Congressional delegation of 7 districts. Both the Congressional delegation and the State Senate (50 districts) are predicted to produce less than the optimal fraction of competitive districts. The Congressional delegation is too small, while the Senate is too large.
Nevertheless, these two legislature sizes are still significantly superior to Alabama's State House (105 districts) in terms of maximizing electoral competition.

4. The Implications for Partisan Gerrymandering

Most political gerrymandering strategies involve taking electorally vulnerable districts and turning them into safer, more partisan seats for the party that controls legislative redistricting. This strategy implies that fruitful opportunities for partisan gerrymandering arise whenever an existing district is electorally close, and creative boundary-drawing can manipulate it into a more politically imbalanced district. The earlier results illustrated that the proportion of electorally close legislative districts varies widely across states and is negatively influenced by the number of districts in the chamber. Hence, we should expect that legislative chambers with more districts should generally experience less political gerrymandering, as these chambers present fewer close districts with fruitful opportunities for gerrymandering.

To empirically test this prediction, I measure gerrymandering in each legislative chamber by comparing the simulated districting maps against the real-life legislative districting maps enacted in 2002. Figure 10 presents an illustration, using Florida's Congressional delegation, of how these comparisons of simulated and actual districting results are performed.

[FIGURE 10 HERE]

To produce Figure 10, I first perform 200 independent districting simulations, each of which divides Florida's 5,965 precincts into 25 districts (the size of Florida's Congressional delegation as of the 2002 redistricting cycle). For each of the 200 simulated plans, I then calculate the Bush-Gore (November 2000) vote within each of the 25 districts, and I arrange the districts in order from least Republican (lowest Bush vote share) to most Republican (highest
Bush vote share). Next, I average over all 200 simulated plans in order to calculate the mean Bush vote share in the least Republican districts, the mean Bush vote share in the second least Republican districts, and so on. These calculations produce 25 mean Bush vote shares, representing the 25 districts produced in each simulated plan. Figure 10 plots these 25 simulated district-level Bush vote shares in black circles, arranged from least to most Republican. The vertical bars indicate the full range (minimum to maximum) of Bush vote shares produced for the district across the 200 simulations.

Finally, I compare these 25 averages to the actual Congressional district-level Bush vote shares from the real-life districting plan enacted by Florida in 2002. In order to calculate these 25 actual Bush vote shares, I overlay a GIS map of Florida's Congressional districts onto a map of Florida's 5,965 precincts. I then aggregate the precinct-level Bush-Gore votes within each actual district to calculate its Bush vote share. These real-life district-level Bush vote shares are plotted in red triangles in Figure 10.

By comparing the actual district-level vote shares (red triangles) against the simulated district-level vote shares (black circles), we can observe the partisan manipulation of districts in the enacted districting plan, and we can infer the political intent of the gerrymander. In Figure 10, the districts ordered from #9 to #15 in the plot were each very close to being evenly split, at 50-50, between Bush and Gore voters in the simulated plans. But in the real-life enacted plan, these seven districts were disproportionately enhanced with more Republican voters in order to create seven moderately safe Republican seats. Meanwhile, in order to balance out these enhanced Republican seats, the six most Democratic-tiling districts, ordered from #1 to #6 on the plot, were "packed" with even more Democrats. This "packing" strategy effectively turned
six already-safe Democratic seats into yet more lopsided Democratic seats, while creating seven safe Republican seats in what might otherwise have been vulnerable districts.

To measure the severity of gerrymandering in this enacted districting plan, I compare the Bush vote shares in each of the 25 districts in the enacted and simulated plans, as ordered in Figure 10. For example, the most Democratic-leaning district (district #1) has an average vote share of 25% in the simulated plans. But in the real-life districting plan, the most Democratic-leaning district produced a 16% Bush vote share. This difference of 9% indicates the extent to which this district was gerrymandered. I then average this difference for all 25 districts, thus producing a single measure of the extent of gerrymandering for the entire Florida congressional delegation.

I use this procedure to measure gerrymandering in each legislative chamber in all states. Figure 11 displays the extent of gerrymandering in each state state's two legislative chambers, plotted against the number of districts per capita in the chamber. Both the left plot (lower chambers) and the right plot (upper chambers) reveal a significantly negative relationship between legislature size and gerrymandering, confirming this paper's prediction that smaller legislative districts are less likely to be electorally competitive, thus limiting opportunities for partisan gerrymandering. The substantive impact of legislature size on gerrymandering is large as well: Moving from the lower chamber with largest districts (Ohio) to the chamber with the smallest districts (New Mexico) is associated with approximately a 50% decline in the average disparity between the district-level partisanship of the simulated and actual districting plans, indicating substantially less gerrymandering.

This paper's theoretical prediction concerning legislature size's negative effect on gerrymandering also implies that State Senates should exhibit more extensive gerrymandering
than State Houses, while Congressional delegations should have the most gerrymandering of all. To test these predictions, Figures 12 and 13 compare the extent of gerrymandering across the three legislative chambers within each state. Together, these two Figures find evidence that is generally consistent with these predictions. Congressional districting plans in most states exhibit more evidence of severe gerrymandering than their corresponding state houses and state senates. The comparison of state upper and lower chambers (Figure 13) produces somewhat more mixed evidence, but in most states, the Senate districting plan has been more extensively gerrymandered than the House, corroborating this paper’s theory that larger legislatures produce less gerrymandering.
Figure 1: Distribution of Voters in Agent-Based Model with 50% - 50% Partisan Split

Voter Grid at time $t=0$:

Voter Grid at time $t=600,000$: 
Figure 2: Results of Agent-Based Model with 50%-50% Partisan Split

Average Partisan Similarity of Each Individual’s Neighbors

Legislature Size and Electoral District Competitiveness
Figure 3: Distribution of Voters in Agent-Based Model with 66.7% Democrats and 33.3% Republicans
Figure 4: Results of Agent-Based Model with 66.7% Democrats and 33.3% Republicans

**Legislature Size and Electoral District Competitiveness**

<table>
<thead>
<tr>
<th>Legislature Size (# of Districts)</th>
<th>Percent of Electoral Districts with Under 15% Vote Margin</th>
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<tbody>
<tr>
<td>4</td>
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<tr>
<td>9</td>
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<td>4096</td>
<td></td>
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<td>9216</td>
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</tbody>
</table>

- **period t=0**
- **period t=200,000**
- **period t=400,000**
Figure 5: Electoral Competitiveness in State Legislative Chambers, 1992-2002

<table>
<thead>
<tr>
<th>Fraction of Chamber's Districts Averaging Under 15% Vote Margin (1992−2002 Elections)</th>
<th>State</th>
</tr>
</thead>
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<tr>
<td>0%</td>
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</tr>
<tr>
<td>5%</td>
<td>CO, UT</td>
</tr>
<tr>
<td>10%</td>
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</tr>
<tr>
<td>15%</td>
<td>PA, SC, TX, GA</td>
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<td>20%</td>
<td>PA</td>
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</table>


Legend:
- ● Lower Chambers (House/Assembly)
- △ Upper Chambers (Senate)
Figure 6: Example of a Simulated Districting Plan in Indiana (9 Congressional Districts)
Figure 7: Simulated Fraction of Competitive Legislative Districts in State Legislative Chambers

Simulated Electoral Competitiveness in State Legislative Chambers (McCain–Obama Votes)

Legend:
- ● Upper Chambers (Senate)
- △ Lower Chambers (House/Assembly)

Statewide McCain 2-Party Vote Share (November 2008)

Fraction of Legislative Districts Averaging Under 15% Vote Margin (McCain–Obama Vote)
Figure 8: Simulated Fraction of Competitive Legislative Districts in Congressional Delegations and State Legislatures
Simulated Electoral Competitiveness in Alabama
(2008 McCain–Obama Votes)

Figure 9: Simulated Fraction of Competitive Legislative Districts in Alabama
Figure 10: Gerrymandering in Florida's Congressional delegation

Partisanship of Simulated Versus Actual Districts, Florida: 25 Congressional Districts

Legend:
- Simulated Districts
- Actual Districts

Bush Vote Share (November 2000) of District

Districts Ordered by Partisanship
Figure 11: Gerrymandering in State Legislative Chambers
(Districting Plans Enacted in 2002)


The Severity of Partisan Gerrymandering in State Upper Chambers (2008)
Figure 12: Gerrymandering in Congressional Districting Plans versus State Legislative Districting Plans
(Districting Plans enacted in 2002)

The Severity of Partisan Gerrymandering in Congressional Delegations and State Houses (2008)


Legend:
- Lower Chambers (House/Assembly)
- Upper Chambers (Senate)
- Congressional Delegation

Average Difference in District-Level Partisanship (McCain–Obama Vote) Between Simulated and Actual Districts
Figure 13: Gerrymandering in State Senate versus State House Districting Plans (Enacted in 2002)

The Severity of Partisan Gerrymandering in State House and Senate Chambers (2008)

Legend:
- Lower Chambers (House/Assembly)
- Upper Chambers (Senate)

Average Difference in District-Level Partisanship (McCain–Obama Vote) Between Simulated and Actual Districts
The Severity of Partisan Gerrymandering in Congressional Delegations and State Houses (2008)

Average Difference in District-Level Partisanship (McCain–Obama Vote)
Between Simulated and Actual Districts

Legend:
- Lower Chambers (House/Assembly)
- Congressional Delegations

Swing States
- CA
- CO
- CT
- DC
- DE
- FL
- GA
- HI
- ID
- IL
- IN
- IA
- ME
- MD
- MA
- MI
- MN
- MS
- MO
- MT
- NE
- NH
- NJ
- NM
- NV
- NY
- NC
- ND
- OH
- OK
- OR
- PA
- RI
- SC
- SD
- TN
- TX
- UT
- VA
- VT
- WA
- WV
- WI
- WY

Safe Democratic or Republican States
- AK
- AZ
- AR
- KY
- MS
- AL
- CO
- CT
- DE
- DC
- FL
- GA
- HI
- ID
- IL
- IN
- IA
- KS
- KY
- LA
- ME
- MI
- MN
- MS
- MO
- MT
- NE
- NV
- NH
- NJ
- NM
- NY
- NC
- ND
- OH
- OK
- OR
- PA
- RI
- SC
- SD
- TN
- TX
- UT
- VA
- VT
- WI
- WY

Lower Chambers (House/Assembly)
- AK
- AZ
- AR
- KY
- MS
- AL
- CO
- CT
- DE
- DC
- FL
- GA
- HI
- ID
- IL
- IN
- IA
- KS
- KY
- LA
- ME
- MI
- MN
- MS
- MO
- MT
- NE
- NV
- NH
- NJ
- NM
- NY
- NC
- ND
- OH
- OK
- OR
- PA
- RI
- SC
- SD
- TN
- TX
- UT
- VA
- VT
- WI
- WY

Average Difference in District−Level Partisanship (McCain−Obama Vote)
Between Simulated and Actual Districts

(50.1%)
(44.8%)
(44.7%)
(49.6%)
(49.5%)
(45.5%)
(48.3%)
(49.9%)
(47.7%)
(43.3%)
(55.7%)
(48.6%)
(57.3%)
(56.7%)
(50.8%)
(37.3%)
(57.9%)
(42.2%)
(42.3%)
(66.5%)

Average Difference in District−Level Partisanship (McCain−Obama Vote) Between Simulated and Actual Districts

Legend:
- Upper Chambers (Senate)
- Congressional Delegation

Statewide McCain 2−Party Vote Share (November 2008)

- Safe Democratic or Republican States

Swing States
- WA
- NM
- NE
- OK
- KS
- MI
- IL
- MD
- TN
- LA
- AL
- IA
- MN
- PA
- CO
- NJ
- IN
- MO
- AZ
- VA
- NC
- OH
- SC
- FL
- MS
- GA

Scatter plot showing the severity of partisan gerrymandering in congressional delegations and state senates.
The Severity of Partisan Gerrymandering in State House and Senate Chambers (2008)

Average Difference in District-Level Partisanship (McCain–Obama Vote) Between Simulated and Actual Districts

Legend:
- Lower Chambers (House/Assembly)
- Upper Chambers (Senate)

Swing States
- Safe Democratic or Republican States
- Swing States
- Safe Democratic or Republican States

Statewide McCain 2-Party Vote Share (November 2008)

- (66.5%)
- (42.3%)
- (42.2%)
- (57.9%)
- (37.3%)
- (60.8%)
- (50.1%)
- (44.7%)
- (44.8%)
- (49.6%)
- (49.5%)
- (45.5%)
- (48.3%)
- (49.9%)
- (47.7%)
- (55.7%)
- (48.6%)
- (57.3%)
- (56.7%)