Boundaries, Redistricting Criteria, and Representation in the U.S. House of Representatives

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Abstract: Many U.S. states require redistricting authorities to follow traditional districting principles (TDPs) which are explicitly geographic in nature, like the creation of compact districts and respecting the integrity of county and town boundaries. Reformers, academics and other redistricting experts have long suggested that following such districting principles may enhance representation. Yet very few academic studies have empirically examined these expectations. Using two measures of geographical compactness and a new measure of respect for political subdivisions (referred to as coterminosity) created with GIS, the connection between district boundaries and representation is tested. The results show strong evidence that the use of geographic districting principles can enhance dyadic representation, as more compact and more coterminous districts are associated with more positive evaluations of legislative responsiveness and greater citizen-representative communication. Violating TDPs to advance other goals in redistricting like strict population equality between districts thus comes with a clear representational cost.
Keywords: redistricting, representation, traditional districting principles, compactness, respect for political subdivisions, boundaries

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At least once every ten years in the United States, state legislators, commissioners, and bureaucrats undertake the exhaustive process of drawing and redrawing legislative district boundaries. As the U.S. employs exclusively single-member territorial districts for seats in the House of Representatives, redistricting is a necessary component of maintaining equal representation in the face of population movement and change (Gelman and King, 1994). But equal representation does not necessarily mean good representation, and much political effort has been exerted to mold the redistricting process to incentivize certain representational activities and limit others.

One such way this has been done is through the adoption of "traditional redistricting principles" (TDPs), which codify specific criteria to be used when drawing district maps. Two such criteria have received much attention from the courts, reformers, and scholars alike: geographical compactness and respect for political subdivisions like towns and counties. These TDPs are explicitly geographic in nature and are required by most U.S. states at either the subnational or federal levels.

Despite the important role TDPs like compactness play in the redistricting process in the U.S., scant academic attention has been paid to examining the consequences of their use. While TDPs have received extensive debate in the redistricting and voting rights literature, nearly all of this work is focused on expected, not tested, consequences and the desirability of pursuing them as a mechanism of redistricting reform. The few studies to attempt to measure the compactness of legislative districts or respect for political subdivisions have found, at best, mixed effects. Geographically compact districts have been associated only with increased voter turnout (Engstrom, 2000; Altman, 1998a), but even this effect has been questioned (Engstrom, 2005). Further, the ability of compactness standards to limit gerrymandering has been criticized by numerous scholars (Morrill, 1973; Webster, 2013; Altman, 1998b; Butler and Cain, 1992), and compactness standards do not appear to limit incumbent-protection gerrymanders (Forgette and Platt, 2005). Perhaps even more importantly, critics charge that compactness standards do active harm to the quality of representation by producing Republican-biased districting plans (Lowenstein and Steinberg, 1985; Altman, 1998b) and by making it more difficult to draw majority-minority districts (Barabas and Jerrit 2004). Respect for political subdivisions is associated with improved constituent knowledge about their member of Congress (MC) (Niemi et al., 1986; Winburn and Wagner, 2010), and may limit gerrymandering (Winburn, 2009; Forgette and Platt, 2005) but much of the rationale given for the TDP has gone untested.

This literature, particularly that on compactness, is surprising given that proponents of TDPs claim their adoption offers positive representational benefits for American democracy such as improving representation of the geographic constituency and strengthening the connection between citizens and their elected representatives. Thus the state of redistricting in the U.S. is somewhat paradoxical. While mapmakers are often charged with using geographic TDPs, the empirical rationale for their utilization is, at best, questionable. We need to know much more about the relationship between the use of redistricting criteria and representation, broadly construed.

This article examines the relationship between geographic districting principles and the experience of representation in congressional districts. The approach adopted here is purposefully broad: using the 2008 Cooperative Congressional Election Study (CCES), I identify measures of policy, service, and allocation responsiveness (Eulau and Karps, 1977) and multiple measures of the degree of citizen-legislator communication (Jewell, 1982). Respondent assessments of legislative

representation are merged with two congressional district compactness scores and a new measure of respect for political subdivisions referred to here as coterminosity. Using these measures, I examine the relationship between geographic TDPs and citizen assessments of a variety of House members' representational activities.

In accordance with the expectations of reformers and redistricting experts, I argue that geographic districting can have meaningful, positive effects on citizen evaluations of and experiences with their elected representatives by unifying geographically-structured shared interests (Morrill, 1982) and by making districts more recognizable to voters and legislators (Grofman, 1985). Contrary to previous examinations of TDPs, most notably the research on compactness, TDPs are found here to have wide-ranging effects on the representational relationship.

This article makes a number of important contributions to the study legislative representation and redistricting. First, I develop a new measure of respect for political subdivisions. Previous ways of measuring the concept have focused exclusively on the congruence between districts and counties, but redistricting authorities also follow town and city boundaries, particularly in metropolitan areas. Using GIS, I calculate the proportion of a district that is coterminous with some other subdivision unit (town, county, or state), and the measure is valid for both rural and metropolitan areas. The new score is found to have an empirical pay-off: coterminosity is associated with more positive evaluations of MC constituent service and with a greater ability to recall MC's efforts to bring projects back to his or her district. Second, using two different measures of geographic compactness, the results presented here show that both compactness scores are related to differences in the relationship between legislators and constituents, but they do so in separate ways. The Polsby-Popper score, which primarily measures the complexity of a district's border, is more associated with citizen knowledge about and communication with their MC. The Reock score, which measures how dispersed a district is around a central point, is associated with legislative responsiveness. These findings make sense: complex boundaries confuse voters, making it more difficult for them to contact their MC and receive information from the MC. Likewise, districts which unify proximate voters into the same district also group together interests defined by geographic location and make it easier for MCs to be responsive to such interests. Finally, the results presented here are some of the strongest evidence to date that TDPs matter for representation across a broad range of factors. Respondents are more likely to positively evaluate their MC on multiple components of responsiveness and more likely to contact and retain information about their MC when districts are compact and coterminous with local subdivisions then when they are not. In other words, legislative representation (broadly construed) is enhanced in districts drawn in accordance with geographic districting principles.

Geography, Districts, and Traditional Districting Principles

America's tradition of territorial representation is as contentious as it is long. The very founding of the country saw the clash of two distinct conceptions of representation, one based on representation of place and the other representation of people (Zagarri, 1987). A consequence of this divide is the continued use of equal-population territorial districts. Throughout much of American history, legislative districts were aggregations of counties or townships and in some cases directly

apportioned to such subnational units (Ansolabehere and Snyder, 2008). But the great reapportionment cases and civil rights legislation of the 1960s forever changed American redistricting. Strict equal-population requirements, like those required by *Karcher* v. *Daggett*, constrain mapmakers and limit all secondary goals which may be sought (Grofman, 1985; McDonald, 2006; Cain, 1984; Morrill, 1973). Further, in order to create additional seats with a majority of racial/ethnic minority residents while protecting vulnerable white incumbents, some states (most famously North Carolina in 1992) have produced geographically tortured districts (Grofman, 1995; Bullock III, 2010). The result over time, despite formal redistricting criteria adopted across the states, has been increasing non-compactness of legislative districts and the increased splitting of counties and cities into multiple districts (Altman, 1998a; Ansolabehere and Snyder, 2008).[1]

While scholars have long recognized the consequences of drawing boundaries in one place rather than another for determining the partisan (e.g., Gelman and King, 1990, 1994; Cox and Katz, 2002; McDonald, 2004; Schaffner et al., 2004) or racial (Cameron et al., 1996; Lublin, 1999) composition of the district, recent research utilizing GIS has gone further, showing how districts play a key mediating function between citizens and representatives. For example, redistricting disrupts connections between incumbents and voters and weakens the personal vote of incumbents (Desposato and Petrocik, 2003; Ansolabehere et al., 2000) resulting in greater electoral competition in those new areas of the district (Crespin, 2005). Likewise, state legislators more likely to participate in a primary election for a congressional seat when the overlap between the legislator's current district and the congressional district is high than when it is low. They are also more likely to run in the general election and garner a greater proportion of the vote when their "constituency congruence" is high (Carson et al., 2011, 2012). Disrupting the representational linkage between legislators and constituents by moving residents out of one district and into another reduces the amount of information residents know about their incumbents and has consequences for turnout and candidate choice (McKee, 2008a,b; Hayes and McKee, 2009), polarization (Carson et al., 2007), and legislator behavior (Glazer and Robbins, 1985; Stratmann, 2000; Boatright, 2004; Hayes et al., 2010; Crespin, 2010). Mapmakers know these effects and manipulate boundary lines strategically to enhance or weaken such connections (Yoshinaka and Murphy, 2009; Makse, 2012b) and influence candidate emergence (Murphy and Yoshinaka, 2009) and electoral competition (Yoshinaka and Murphy, 2011). Clearly the placement of district boundaries can have electoral and representational consequences beyond the partisan and racial distribution of voters; how boundary lines group and divide the population into various districts has the potential to structure relationships between legislators and constituents.

Based on similar reasoning, proponents of TDPs have made various claims about their impact on American politics. This article tests these claims using a unique dataset measuring the compactness of congressional district boundaries and introducing a new measure of respect for subdivisions, referred to here as coterminosity. These measures are merged with survey data about

[1]The U.S. Supreme Court responded in *Shaw* v. *Reno* and its subsequent cases by rejecting extreme racially gerrymandered districts like North Carolina's 12th (1992). In the majority opinion in *Shaw*, Justice O'Connor explicitly appealed to traditional districting principles. Following TDPs, O'Connor argued, lets mapmakers avoid the appearance of racial gerrymandering. While not requiring a compactness or subdivision standard for legislative districts, the Court gave tacit approval to geographic TDPs as a way to protect states from legal challenges. Further, the decisions suggested there might be some representational goods resulting from TDPs.

Americans' perceptions of representation in the U.S. House. In the next section, I introduce the TDPs of compactness and respect for political subdivisions, present the rationale for their adoption, and discuss their measurement.

Compactness

Geographical compactness is the extent to which districts cluster geographically proximate residents into the same district, thus avoiding irregular or bizarrely-shaped districts in favor of shapes like circles, squares, or hexagons. Compactness is usually supported as a limit on gerrymandering (Polsby and Popper 1993), yet nearly every examination of compactness raises doubts about its efficacy. Altman's (1998b) simulation study of compactness criteria finds that most standards are very weak constraints on gerrymandering. Additionally, several authors argue that compactness standards will do active harm to the representation of racial minority groups (Lowenstein and Steinberg, 1985; Altman, 1998b; Barabas and Jerit, 2004), since it may be necessary to draw contorted boundaries in order to link two or more distinct populations of racial minorities into the same district.[2] If compactness is not an effective limit on the gerrymander (Forgette and Platt, 2005), and compactness standards may harm the representation of racial minorities and encourage partisan bias in the districting system, what is the rationale for its continued use? Proponents of compactness tend to use representational arguments based on propinquity, efficiency and communication.

The propinquity argument is rooted in shared interests from geographic proximity (Butler and Cain, 1992). Since governments provide public goods, districts which reinforce shared common interests should lead to better representation of those interests, as those who are most effected by the public policies are grouped together for representation. In a sense, these shared interests imply increased within-district homogeneity. According to Gilligan and Matsusaka (2006), a districting plan so constituted should result in reduced aggregate policy bias over a districting system made up of noncompact districts.[3]

Compactness is also supported as a way to make legislative activities, campaigning in particular, more efficient. For example, Grofman (1985, 90) mentions the ease of traveling to all parts of a district as a reason legislators may prefer compact districts over noncompact ones. Similarly, compact districts allow certain types of campaigning, like door-to-door canvasing and zip-code mass mailings to be used effectively (Engstrom, 2000). Finally, compact districts may reduce voter confusion. Highly irregular districts make it difficult for voters to place themselves within the districting system (Morrill, 1982; Engstrom, 2000).

The few studies to test the relationship between compactness and legislative representation have found mixed results. Engstrom (2000) finds some evidence in support of the efficiency argument by showing that respondents living in compact districts are more likely to vote in U.S. House races but discerns no noticeable effect of compactness in a later study (Engstrom, 2005). Altman (1998a) finds a similar connection between compactness and turnout but finds no relationship between

[2]Indeed, this issue was at the heart of the *Shaw* v. *Reno* ruling and its following discussion in the academic literature.

[3]Of course, the validity of this conclusion rests on the assumption that compactness results in greater homogeneity of legislative districts, something Gilligan and Matsusaka suggest but do not test.

compactness and trust in the federal government or respondent assessments of whether MCs stay in touch.

Measuring Compactness

The majority of empirical work on compactness has addressed its formal measurement (Reock, 1961; Schwartzberg, 1965; Young, 1988; Niemi et al., 1990; Horn et al., 1993; Altman, 1998a,b). Despite the richness of this work, there is no agreed-upon measurement of compactness that is accepted by the courts or the academy. However, we do know that the choice between compactness scores is not arbitrary. Different measures appear to tap into distinct aspects of the concept. There are (at least) two key aspects of compactness: the dispersion of the district around its center and the complexity of its perimeter (Niemi et al., 1990).

Districts rated as very compact on dispersion measures have district boundaries roughly equidistant from their centroid. For example, compare two hypothetical districts, District A and District B. District A is a circle, and District B is an oval. By definition, District A has minimal dispersion; all points along the boundary are equidistant from the centroid. District B, however, is more dispersed than it could be, since some parts of the district's boundary are further from the centroid than others. Dispersion compactness scores should rate District A as more compact than District B.

Perimeter compactness scores are sensitive to the complexity of a district border. Think of two hypothetical districts, District C and District D, whose areas are identical. Both have circular shapes, but District C is a perfect circle with a smooth boundary, and District D's boundary is jagged. In this scenario, District D is less compact than District C because D has a longer perimeter than is necessary given the area of district.

Using GIS software, I calculated two different compactness scores for every congressional district in the 110th Congress (2006-2008), one generally thought of as a dispersion measure (the Reock score (Reock, 1961)), and the other measuring the complexity of the district's perimeter (the Polsby-Popper score (Polsby and Popper, 1993)).[4] Both scores are ratios of a district's area to the area of a circle, based on the notion that a circle is the most compact shape. The scores differ, however, in how they draw the comparison circle. For the Reock score, the comparison circle is the smallest circle into which the whole district can fit, or the minimum circumscribing circle. The two panels on the left side of Figure 1. display the Reock scores for Missouri's 2nd district (top panel) and Georgia's 7th district (bottom panel). The figure shows both the shape of the districts and the size of the minimum circumscribing circles. For MO2, the district has an area of 1288 square miles, and the minimum circumscribing circle has an area of 3746 square miles. Thus the Reock score is:

$$\begin{aligned} R_{MO2} &= 1288/3746 \\ &= .34 \end{aligned}$$

[4]Like most compactness scores, the Polsby-Popper is sensitive to *both* dispersion and complexity of perimeter, but it is particularly sensitive to perimeter noncompactness (Horn et al., 1993).

Likewise, for GA7:

$$\begin{aligned} R_{GA7} &= 978/1697 \\ &= .58 \end{aligned}$$

Visually, GA7 certainly appears more compact than MO2. The latter is elongated without a clear central point to the district. The former, on the other hand, has a clear centroid and its appendages do not jut out far from the main body of the district.

Figure 1. here

The Polsby-Popper is also a comparison of district area to the area of a circle, but the circle here is created by setting the circle's circumference to the perimeter of the district. In a sense, the circle here represents the maximum amount of area the district *could* cover given a perimeter of its size. The creation of Polsby-Popper scores for MO2 and GA7 are illustrated in the right-side panels of Figure 1. For MO2, both the district and the comparison circle have perimeters of 323 miles. The district area, however, is only 1288 square miles, while the comparison circle has an area of 8350 square miles. So the Polsby-Popper compactness score is:

$$\begin{aligned} PP_{MO2} &= 1288/8350 \\ &= .15 \end{aligned}$$

And for GA7:

$$\begin{aligned} PP_{GA7} &= 978/3887 \\ &= .252 \end{aligned}$$

The geographic distribution of the compactness scores is presented in Figure 2, with the Reock score shown in the top panel and the Polsby-Popper score shown in the bottom. There is a fair amount of overlap between the two scores, as the at-large congressional districts in the northwestern U.S. receive high scores on both, and Appalachian districts receive low scores on both. In fact, the two scores are highly correlated (Pearson's $r = .67, p < .001$, two-tailed test).[5]

Figure 2. here

Respect for Political Subdivisions

Respecting local governmental units in redistricting plans has been supported for many of the same reasons as geographical compactness. Keeping local units intact, particularly counties, may effectively limit gerrymandering by constraining where lines can be drawn (Forgette and Platt, 2005; Winburn, 2009). Further, political units like counties and towns, but also, in some cases, wards or neighborhoods, can be thought of as natural communities of interest (Winburn and Wagner, 2010; but see Makse, 2012). Residents of the same city share much in common - the same taxation levels, the same public problems and the same municipal government. Even if they differ on partisan

[5]The seven at-large states represent both the high and low ends of the compactness spectrum. Wyoming is one of the most compact districts (first using the Polsby-Popper score and fifth using Reock), while Alaska is one of the fifteen least compact districts on both scores.

preferences or political ideology, there are some interests which residents share simply because of their common government and place of residence. District boundaries which keep these political units together should make it easier for voters to hold their representatives accountable for representing those shared interests and may result in a districting system more reflective the diversity of interests within a state (Butler and Cain, 1992).

In addition to representational gains due to maintaining units of shared interest, preserving local government boundaries should have administrative and communication benefits. Preserving political subdivisions takes "advantage of the community's potential as an information pathway" (Engstrom, 2005, 67). Fragmenting communities into multiple districts makes it very difficult for legislators to communicate with constituents since the media and community organizations through which political communication flows are structured at the municipal or county level. By fragmenting municipalities, boundaries may divorce a legislator from the mechanisms through which effective communication can happen (Jewell 1982, 59; Niemi, Powell and Bicknell 1986). Finally, it is often asserted that preserving county and town boundaries when possible has the added benefit of reducing confusion among voters (Morrill, 1987; Butler and Cain, 1992). While many citizens may not know the location of district boundary lines, most people do know their county and town of residence. When districting plans follow these boundaries, which have real meaning in everyday life for voters, then the district becomes grounded in pre-existing understandings of politics and community structure. These expectations have some support in the empirical literature. Survey respondents are more likely to recall and recognize the names of their House members when residing in districts with greater county-district congruence (Niemi et al., 1986; Winburn and Wagner, 2010).

Measuring Respect for Subdivisions

The preservation of political subdivisions appear in statute as prohibitions against unnecessarily splitting counties or cities into multiple districts (Cain, 1984). Following this general concept, Winburn (2009) calculates the percentage of counties in eight states which lie below the average constituency size of state legislative districts and are split into multiple districts. Niemi, Powell and Bicknell (1986) use a similar measure: a count of the number of congressional districts each county is split into. Some recent work has improved on these measures to create continuous measures of county-district congruence (Engstrom, 2005; Winburn and Wagner, 2010). But all of these measures, even the continuous ones, ignore city and town boundaries which are regularly used in congressional redistricting. Particularly in suburban and urban areas, strict population equality across districts makes it impossible to use counties as building blocks for districts.

The problem of measuring respect for political subdivisions is more general. Counties and cities have overlapping jurisdictions. A district drawn with respect to city boundaries will likely not be drawn according to county ones; likewise, estimates of county-district congruity cannot capture city-district congruence and vice-versa. Only one subdivision level (the county or the municipality) can be selected when using area congruence measures.

Figure 3. here

A different approach is taken here. Instead of examining the overlap between county area and district area, a new measure was created that examines the congruence between district *boundaries* and subdivision *boundaries*. Using boundary files from the U.S. Census Bureau, all subdivision units were converted from polygons to lines and merged into a master file containing all county, city, and town boundaries in the United States. These boundaries are all treated the same; the spatial data simply records the location of all subdivision boundaries. Using GIS, the intersection of these lines and congressional district boundaries in the 110th Congress was calculated. The final score is the proportion of a district's boundaries which are drawn over pre-existing subdivision boundary lines. In other words, the measure is the proportion of a district that is coterminous (has the same end point) with a political subdivision. Figure 3 illustrates the process of creating such a score in Illinois and Indiana. The dark gray lines with black outlines display congressional district boundaries which overlap with some subdivision boundary (light gray lines), while the dark gray lines are congressional district boundaries which are not coterminous with some other subdivision boundary. Figure 3 also shows the calculation of the coterminosity score for Indiana's 1st and 2nd districts. The 1st, following both the IL-IN border and the Lake Michigan shoreline, deviates from subdivision boundaries only in the far northeast portion of the district and receives a coterminosity score of .914. The 2nd, however, generally follows county boundaries but deviates to pick up portions of Elkhart in the northeast corner of the district and Kokomo in the southeast corner. The district receives a coterminosity score of .749, indicating that just under three-quarters of the distict's boundary is drawn over a municipal, county, or state boundary line.

The geographical distribution of respect for subdivisions, measured as coterminosity, is displayed in Figure 4. Sparsely populated areas which enable the use of counties as district building blocks in the Great Plains states show highly coterminous boundaries, although significant across-state variation exists even in rural areas. This can be clearly seen in states like Illinois, Arizona and Pennsylvania.

Figure 4. here

Measuring district coterminosity, rather than district-county area congruence, has two distinct advantages. First, district boundaries drawn to keep cities and towns intact receive high coterminosity scores in areas where counties are too populous to use as district building blocks. Second, coterminosity is extendable to incorporate other notions of community. Highways, rivers, mountain ridges, lake shores, and wards could all be represented as existing boundaries, converted to lines and added to the base subdivision shapefile, allowing district boundaries drawn along such real geographic and political boundaries to be counted in the coterminosity score. Such flexibility is simply not possible with other measures.

Hypotheses

These various expectations regarding compactness and respect for subdivisions can be understood more generally using Morrill's concept of identification with the district (Morrill, 1982) and Grofman's (1985) notion of "cognizability". If district boundaries divide real units with which voters

identify, like a county or a neighborhood of shared interest, voters may "feel that their interests as a place or a group are unrepresented" (Morrill, 1982, 364). Because places have meaning for individuals, districts can become "meaningful entities which have legitimate collective interests" (Morrill, 1987, 253), but districting without regard to place may lead the representative to ignore these interests.

Similarly, Grofman (1985; 1993; 1995) advocates for the notion of "cognizability" as a useful way to understand the role of geography in districting. Cognizability is "the ability to characterize the district boundaries in a manner that can be readily communicated to ordinary citizens of the district in commonsense terms based on geographic referents" (Grofman 1993, 1262). Since the U.S. has the political and cultural tradition of territorial districts, the conduct of campaigns, the structure of community organizations, and the mobilization of residents for collective action are enhanced when districts are cognizable. Grofman is very clear on this point: drawing unrecognizable districts "vitiates the principle that representatives are to be elected from geographically defined districts and vitiates the advantages of such districts as the basis of electoral choice" (Grofman 1993, 1263).

Both arguments made about geographic TDP in the redistricting literature as well as the theorizing of Morrill and Grofman suggest two clear mechanisms through which geographic districting might matter for representation. First, by embracing the geographic and political communities which structure human interaction, compactness and respect for local units should heighten some set of geographically determined shared interests, making it more likely that members of Congress will adequately represent these issues. Second, geographic TDPs should make the districting system more comprehensible for voters and make outreach efforts of candidates and legislators more effective, resulting in a stronger constituent-legislator linkage characterized by increased communication and information transmission. These relationships are stated formally as Hypotheses 1 and 2:

Hypothesis 1: Survey respondents in compact (coterminous) districts are more likely to give positive evaluations of the responsiveness of their House member than are respondents from non-compact (non-coterminous) districts.

Hypothesis 2: Survey respondents in compact (coterminous) districts show more communication with and knowledge about their House member than do respondents from non-compact (non-coterminous) districts.

Partisans and Representation

If districts are not drawn according to geographic principles, how would they be drawn? One expectation is that district lines would be created for partisan purposes (McDonald, 2004; Owen and Grofman, 1988). Such plans, whether partisan or incumbent protection gerrymanders, structure constituent interests in partisan terms only since geographic interests are weakened by the location of district boundaries.

Partisans are well-represented when a member of their party serves in Congress or the state legislature, while independents and out-party partisans are not. For example, while MCs are more

ideologically extreme than even their party's voters in their districts, MCs are much closer to co-partisans than to the state median voter (Bafumi and Herron, 2010). The broader act of representation can even be thought about in two ways, with legislators "serving two masters" - the constituency and the party (Masket and Noel, 2012). When districts are significantly redrawn, thus weakening the personal vote for MCs, voting by displaced constituents is more heavily influenced by partisanship and broad macro-level electoral conditions (McKee, In Press) and MC behavior in Congress is more polarized along party lines (Carson et al., 2007). Not surprisingly, electoral winners (those voting for the winning candidate) have greater political efficacy (Clarke and Acock, 1989), more positive assessments of legislator responsiveness (Clarke and Kornberg, 1992), more trust in the political system (Anderson and LoTempio, 2002), and less support for redistricting reform (Tolbert et al., 2009). In short, there is ample reason to expect partisans represented by a co-partisans to be satisfied with the representation provided by their MC.[6]

Geographic TDPs, by making it more difficult to segment the population based on party and by creating districts of shared interest, will likely benefit those who receive poor representation in gerrymandered districts: minority-party members and independents. Majority partisans, by nature of their majority status, are already well-represented; they have little to gain and perhaps even something to lose by strengthening territorial interests through geographic redistricting principles. This reasoning leads to the final hypothesis:

Hypothesis 3: The effects of compactness and coterminosity on evaluations of responsiveness are conditioned by the party of the respondent. Compactness and coterminosity are more strongly associated with greater responsiveness for electoral losers than they are for electoral winners.

Data

Following previous research on districts and representation (e.g., Niemi et al., 1986; Winburn and Wagner, 2010; Hibbing and Alford, 1990; Frederick, 2007), this project relies on public opinion data to measure the relationship between constituents and House members. The 2008 Cooperative Congressional Election Study (CCES) is uniquely suited for the study of dyadic representation from the perspective of constituents (Ansolabehere, 2008). With over 32,000 respondents in all 50 states and all 435 congressional districts, the survey is large enough to measure district effects. At least twenty respondents from each congressional district are included in the survey, with an average of 75 respondents per district.[7]

The 2008 CCES contains several questions which address the representational relationship.[8] Three questions address perceptions of legislative responsiveness and another three tap communication and information transmission. Eulau and Karps (1977) argue for a broad view of repre-

[6]Such reasoning forms the basis for the recent academic support for non-competitive districts (Buchler, 2005; Brunell, 2008).

[7]Such large samples are made possible by the survey's unique sample methodology: the CCES is an Internet survey which randomly selects names from large population lists and then matches those randomly selected names with respondents who have opted into similar surveys. The matching is based on demographic and geographic variables.

[8]See appendix for exact question wording for all representational relationship measures.

sentation, offering four "components of responsiveness" as a way of viewing the representational task in its entirety. The four components are policy, service, allocation, and symbolic responsiveness. The CCES contains suitable questions to evaluate the first three of these components. Policy responsiveness is the congruence between citizen views and representative actions on matters of public policy. Respondents in the CCES were asked to place themselves and their House members on a 100-point, conservative to liberal scale. The ratings are used in two ways to capture policy responsiveness. First, the mean ideology score for each MC was created by averaging each MC's 100-point placement over all respondents in her district, thus providing an estimate of MC ideology.[9] Each respondent's self-reported ideology score was then subtracted from this MC ideology score, and the absolute value of that difference is the measure of policy divergence. For the second measure, the MC ideology scores are not aggregated; instead the absolute value of the difference between the ideological self-placement of the respondent and the respondent's ideological placement of his or her representative was created. The second measure thus allows individuals to differ in both their own ideology ratings *and* in their MC's rating. In the first measure, the MC ideology score is constant for all respondents in the district. This difference is important as it is possible that MCs do not present themselves in the same way to all constituents. Both measures are continuous with smaller values denoting better policy responsiveness. Service responsiveness is the ability of representatives to provide selective benefits to constituents or to respond to constituent requests for various service. To measure service responsiveness, each respondent in the CCES who reported contacting their House member was asked if they were satisfied with the outcome of the contact on a four-point scale. Finally, allocation responsiveness, or the ability of the representative to secure federal funding for district projects, is tapped through a question on whether the respondent recalls any projects the representative brought to the district.

As measures of the constituent-legislator linkage, respondents were asked whether they had contacted their representative and whether they could recall the party and race of their representative. After matching the recall questions with the MC's actual party and race, three dichotomous variables were created. For each dummy variable, those respondents who reported contacting their MC or correctly identifying the party or race of the MC were coded as 1 with all others coded as 0. If compact and coterminous districts make constituent-legislator communication more effective, then such an influence should be evidenced in the contact and recall questions.

Methodology

To test these expectations, the CCES survey data were merged with the TDP data discussed earlier. These data are generated on two levels: the individual level of survey respondents and the aggregate level of the congressional district. Because of the multilevel nature of the data generating process, random intercept multilevel models are used to account for the nested nature of the data in the

[9]The aggregate perceived MC ideology measure is correlated with Poole and Rosenthal's first dimension DW-Nominate scores at r=.92, suggesting citizen perceptions are picking up real differences in legislative behavior (see Poole and Rosenthal, 2000).

parameter estimates (Gelman and Hill, 2007; Steenbergen and Jones, 2002).[10]

The strength of the representational relationship as measured by Eulau and Karps's (1977) components of responsiveness and the extent of constituent-legislator communication is treated here as a function of three sets of predictor variables: first, district-level factors which provide the context for electoral competition and define the composition of the geographic constituency; second, district-level political factors relating to the incumbent MC; and third, respondent-level factors known to influence citizen evaluations of elected officials and political participation. Together, these variables provide a good baseline set of rival explanatory factors against which to test for the effects of geographic districting.

For district compositional variables, the growth in the number of constituents, the percentage of the district living in an urban area, racial diversity, and median income of the district are controlled for. Population growth, urbanism, and racial diversity are all associated with increased district heterogeneity (Frederick, 2009; Fischer, 1975, 1995; Bailey and Brady, 1998; Gerber and Lewis, 2004), which makes the task of identifying and representing district interests more difficult (Ensley et al., 2009). Wealthier constituents care more about policy responsiveness and less about service or allocation than do poor respondents (Cain et al., 1987); median income of the district should capture aggregate effects of these divergent expectations about legislative behavior. Two political controls are included: the competitiveness of the 2008 House race in the respondent's district (respondents were interviewed one month before the election) and the seniority of the MC. Electoral competition has long been associated with greater interest in elections, greater incentives to vote, higher participation rates, and more elite mobilization (Downs, 1957; Cox and Munger, 1989; Leighley and Nagler, 1992). Competition is also thought to be a crucial link in the representational relationship, ensuring a connection between public opinion and responsiveness in the political system (Mayhew, 2004) and is obviously a function of legislative districts (McDonald, 2006; Swain et al., 1998).[11] Legislators early in their careers in the U.S. House are less electorally secure than are more senior members and tend to spend less time on developing a legislative agenda and more time on constituent service (Cain et al., 1987; Fenno, 1978; Hibbing, 1991).

For individual-level predictors, basic demographic and socio-economic status variables which form the core of most public opinion and political behavior models are included here as well: respondent education, income, age, sex, and race are strong predictors of political participation and various political opinions (e.g. Verba and Nie, 1972; Leighley and Nagler, 1992; Rosenstone and Hansen, 1993). A number of important political variables have been added to this core model.

[10]Spatial regression was also considered due to the spatial nature of the key independent variables. Multilevel models are preferred to spatial regression for two reasons. First, while the district boundary measures are spatially correlated since each line defines the districts on either side of the boundary, there is no reason to expect the error term of individual survey responses to be correlated with the error terms in spatially-proximate districts. In other words, the error coming from this correlation should not be a problem for the hypothesis tests utilized here. Second, no standard statistical package currently allows spatial regression to be incorporated within multilevel models, making it very difficult in practice to account for both sources of serial correlation. Since we know well the serious consequences of ignoring clustered data (deflated standard errors), and such error would influence the interpretation of the key independent variables, multilevel modeling is the preferred approach.

[11]Competitiveness is measured as the vote margin (in percentage points) between the top two candidates in the 2008 general election in the respondent's district recoded so that higher values signify greater competition. The data come from the Federal Elections Commission (http://fec.gov/).

First, a variable measuring whether the respondent was represented in the House by a member of his or her political party is included.[12] Several works have found the status as an electoral winner to influence attitude about government and political behavior (Anderson and Guillory, 1997; Anderson and LoTempio, 2002). And second, racial descriptive representation is incorporated through the use of an indicator variable, since previous research shows greater trust and more constituent-legislator communication when respondents are represented by someone of their own race (Gay, 2002). Third, residential mobility is included in the models, since the MC will not have had time to develop a personal source of support among residents new to the district.[13]

Results

Are boundary characteristics related to the quality of representation produced in territorial districts? Table 1 offers the first round of evidence. The dependent variable in the models presented in Table 1 is policy divergence, with the first three columns using the aggregated estimates of MC ideology and the final three columns employing the respondent-reported measure of MC ideology.[14] The table shows mixed support for the first hypothesis. Coterminosity is not associated with greater ideological similarity using either measure of legislator ideology. This is, perhaps, not too surprising, given the expectations in Hyp. 3. Since there is some evidence that respecting subdivisions act as good constraints on gerrymandering (Winburn, 2009), coterminosity may lead to better policy representation of some citizens (out-party and independents), while encouraging legislators to be less responsive to partisan demands. This suggestion is supported by the fact that being of the same part as one's House member is far and away the strongest predictor of ideological similarity. Co-partisans report being nearly 22 points closer (aggregate) and 32 points closer (individual) to their House members than do those who are not represented by a member of their political party.

Insert Table 1 here.

The findings for compactness are stronger. While the Polsby-Popper measure is correctly signed (negative) in both divergence models, it is not statistically significant. The Reock score, on the other hand, is significantly associated with greater policy congruence. Moving from a district with a minimum Reock score (.003) to one at its maximum (.65) is associated with a 2.7 point (aggregate) and a 3.3 point (individual) decrease in the distance between representative and citizen ideology. In addition, it is plausible that examining average effects mutes the true relationship between compactness and policy representation, and that the effect for electoral winners is likely to be much weaker than for electoral losers. To examine this possibility, these models were re-estimated with the inclusion of interaction terms between electoral winner status and compactness

[12] Respondents are coded 1 if they identify with the same party as their member of Congress. All other respondents, both nonpartisans and partisans of the out party, are coded 0.

[13] Residential mobility is measured at the respondent level by a three point ordinal scale, with those who had lived at their current residence for less than one year coded 1, those living at their current residence for longer than one year but less than five years coded 2, and those living at their current residence for five years or longer coded 3.

[14] Since the dependent variables in Table 1 measure ideological disagreement, negative coefficient values mean better policy representation.

and coterminosity. These results are presented in Models 3 and 6 of Table 1. As hypothesized, the effect of compactness and coterminosity varies by electoral winner status. For partisans being represented by a House member of the same party, coterminous and compact districts have little positive benefit. In fact, coterminosity is associate with *increased* policy divergence (significant at .1 level). Reock compactness is still associated with greater congruence, but the relationship is weak. The reverse is true for electoral losers. The coefficients for coterminosity and Reock compactness in Models 3 and 6, due to the inclusion of the interaction term, represent the effect of the district characteristics when the electoral winner variable is set to 0 - in other words, for electoral losers. The results for Reock compactness is particularly notable: for electoral losers, the predicted effect of compactness rivals that of competitiveness and urbanism.[15]

Table 1 also supports the contention that competition is good for representation as predicted by median voter models (e.g., Downs, 1957). Greater competition is associated with less policy divergence. But party effects dominate Table 1. Electoral winner status is by far the most important predictor of ideological divergence, and the coefficients for Republican and Democratic respondents show that out-party partisans report more divergence than do independents.

What about other ways in which legislators represent their constituents? Table 2 presents the results for the service and allocation responsiveness models. For constituent service, measured here as satisfaction with citizen-initiated contact with the House member, broad support is found for geographic TDPs. Both coterminosity (Model 1) and Reock compactness (Model 2) are associated with more positive evaluations of legislative responses to respondent contact, although these are only significant using a 90% confidence level. It appears as though some of relationships between these variables and constituent service may be overlapping, since coterminosity is only significant when compactness is measured using the Polsby-Popper perimeter score. Still, Models 1 and 2 provide more evidence that geographic TDPs improve legislative representation (Hyp. 1). Model 3 adds the interactions between electoral winner status at the district level and the boundary characteristics. As was the case in the policy responsiveness models, the relationship between geographic TDPs and service responsiveness is strongly conditioned by party. Both coterminosity and Reock compactness have significant and large coefficients *among those respondents who are not represented by a member of their own political party*. The overall effect of the district characteristics for electoral winners is still positive but quite small, as the negative coefficients for the interaction terms nearly equal the positive ones for the constituent terms. For service responsiveness, then, the data show support for both Hyp. 1 and 3: coterminosity and compactness are related to increased service responsiveness, but the positive benefits of geographic districting accrue largely to out-partisans and independents.

Insert Table 2 here.

[15] Another way of viewing the effect of compactness and coterminosity on policy responsiveness is to look at the coefficient for electoral winner. In the interaction models, the electoral winner coefficient represents the average change in policy divergence when moving from an electoral loser to an electoral winner in a district with minimum values of compactness and coterminosity, as the minimum values are 0 or nearly 0. The effect of being an electoral winner is much stronger when districts do not follow geographic districting principles, suggesting that in such districts partisanship is more important for representation.

The allocation responsiveness models shown in the second half of Table 2 (Models 4-6) differ slightly from the previous sets of results. Here coterminosity is clearly the more important boundary characteristic. Coterminosity is consistently and positively associated with improved citizen recall of the MC's efforts to bring projects to the district, regardless of the measure of compactness used. This relationship is not conditional: the interaction term in Model 6 fails to reach statistical significance and is *positive*, indicating that if anything, partisans represented by a member of their own party have even stronger effects of coterminosity. It makes sense that coterminosity is more closely associated with allocative responsiveness than service or policy responsiveness, since allocation is nearly always about securing funds for projects already undertaken by local governments. Coterminous boundaries should make these efforts more salient to constituents because their shared interests based on county or city of residence are unified in the district. The relationship between compactness and allocation is somewhat mixed. Again there are different findings depending on the compactness measure used. The Polsby-Popper score is positive and significant in Model 4, while the Reock score does not reach conventional significance levels in Model 5.[16] However, as in the other responsiveness models, Model 6 does provide evidence that Reock compactness matters for allocation responsiveness, the effects are simply limited to electoral losers.[17]

Since the substantive effect of the boundary characteristics are difficult to determine by examining the coefficients in the random intercept logistic and ordered logistic models, population-averaged predicted probabilities were calculated. These are displayed as first-differences, or the effect of moving from a minimum value on the district characteristic to its maximum value, and are shown in Figure 5. The first-differences show the predicted effects from the base models, not the interaction models. Moving from minimum to maximum values on both the Reock compactness score and coterminosity are associated with a 4.5 percentage point increases in the probability of being satisfied with their MC's response to contact. Compactness is associated with a 3.75 point (Polsby-Popper) increase in the probability of recalling a project brought to the district, while a min to max change in coterminosity is associated with a 6.4 point increase in recall. While these effects appear somewhat small, it should be noted that only 14% of respondents reported recalling a project the MC had brought to the district. In this light, a four or six point increase represents a very large effect.

Insert Figure 5 here.

While the results presented so far show an important connection between boundary characteristics and various components of responsiveness (Eulau and Karps, 1977), the strongest and most consistent relationships are found in the information transmission/linkage models presented in Table 3. The findings provide support for the expectation that complex and unrecognizable

[16]The p-value in Model 4 is .097, just under the .1 significance threshold (two-tailed test). However, this finding fails to reach significance when including a dummy variable for at-large congressional district states (AK, DE, MT, ND, SD, VT, and WY) or when dropping respondents from those states. All other relationships between boundary charactersitics and the dependent variables remain unchanged when controlling for at-large states or dropping those respondents, signaling that the findings here are not driven by the uniqueness of at-large states on compactness or coterminosity.

[17]Neither the constituent term nor the interaction term reaches significance when Model 6 is replicated using the Polsby-Popper score.

district boundaries may make it difficult for residents to place themselves within the districting system, reducing citizen-initiated contact with and knowledge about House members. In general, the Polsby-Popper score outperforms the Reock measure in the communication models, with Polsby-Popper first-difference effects estimated at 8 points (contact), 12 points (party recall), and 10 points (race recall). The influence of coterminosity is also large: a min to max change in the proportion of coterminous boundaries is associated with approximately 8 to 9 point increases in contact, party recall and race recall.[18] All told, Table 3 presents robust support for Hyp. 2 and in accordance with the expectations of geographic TDPs. The results for coterminosity are notable because they mirror previous findings on respect for political subdivisions. For example, Niemi et al. (1986) find that community-district overlap, measured as the number of districts a county is split into, is associated with an 8 percentage point increase in incumbent name recall and recognition. Winburn and Wagner (2010) likewise find a 6-12 point increase in name recall of incumbent House members, depending on the exact measure of the dependent variable and the respondent's level of political knowledge. That my measure of respect for subdivisions results in remarkably similar estimates is evidence of the robustness of the underlying relationship. Districts drawn to match pre-existing political communities appear to foster increased knowledge about and communication with elected representatives. It is also noteworthy that, unlike in the responsiveness models, no interaction effects were identified for the linkage models. While electoral winners at the district level are much more likely to contact their MC and recall information about their MC, electoral winner status is not associated with variation in the effects of boundary characteristics.[19]

Insert Table 3 here.

Conclusion

While reformers and scholars alike have suggested compactness and respect for subdivisions have positive representational outcomes, the empirical identification of such effects has been lacking. However, the findings presented here provide strong and unequivocal support for the use of geographic TDPs. Respondents in compact and coterminous districts are more likely to report being ideologically similar to their House member, more satisfied when they contact their representative, more likely to recall the allocative work of the member on behalf of the district, more likely to contact their representative, and tend to remember more basic information about their MC. These relationships, on the whole, show that geographic districting enhances the connection between citizens and their elected representatives. Further, the relationships for responsiveness are strongest among those individuals most disadvantaged in single-member legislative districts: out-party partisans and political independents.

[18]The predicted effects are calculated from Models 1, 3, and 5 in Table 3 (the models with Polsby-Popper compactness as a covariate). Coterminosity has larger coefficients when using the Reock score, so these first-differences are the conservative estimate of the potential influence of coterminous boundaries.

[19]Interaction models show null effects for the interaction terms, meaning any change in slope for the boundary characteristics does not reach statistical significance. Further, these interaction terms are nearly always positive. If anything, the effect of compactness and coterminosity is greater for electoral winners than for independents and out-partisans. Models are available upon request.

This research makes several contributions to our understanding of legislative representation and the role redistricting plays in the representational process. Measuring respect for subdivisions as coterminosity with counties and municipalities offers significant advantages over previous measures of the concept. District-county area comparisons are limited because county-based redistricting is not possible in densely populated metropolitan areas. Measuring the TDP as coterminosity, however, allows municipal boundaries to count in the respect for subdivisions score. Coterminosity holds promise for future studies of redistricting as well, since any number of geographic, political, social, and physical boundaries can be incorporated in the score. Future research should examine what effects (if any) drawing district lines over highways, rivers, mountain ridges, precinct lines, wards, or informal neighborhood boundaries has on elections and representation. Incorporating these additional types of boundaries might shed more light on the causal mechanisms underpinning the TDP.

The results for coterminosity reinforce and extend previous findings showing a connection between the TDP and knowledge about House members (Niemi et al., 1986; Winburn and Wagner, 2010). But coterminosity is also shown to be associated with responsiveness, particularly among items with a strong geographic component. The measure is clearly associated with service and allocative responsiveness, and unlike the findings for compactness, these results are not limited to electoral losers. It may be that using political subdivisions as district building blocks enables the MC to maintain a personal vote through service provision and attention to local interests. Future research should examine this connection; coterminosity could be incentivizing certain types of legislative behavior, like the representation of local interests at the expense of partisan ones, or it could be influencing the effectiveness of credit claiming activities (Grimmer et al., 2012). Likewise, the results for compactness and coterminosity on policy responsiveness are intriguing. In an age of partisan sorting of the population and record polarization in Congress, geographic TDPs appear to be advantaging nonpartisan interests. Those respondents who are not represented by a member of their own party place their MC closer ideologically to their own position when districts are coterminous and compact than when they are not.

The difference between the findings for Polsby-Popper and Reock measures of compactness also deserve additional attention. The Polsby-Popper score, which punishes districts for border complexity, is more strongly associated with the communication and linkage items, while the Reock score, which measures dispersion around a central point, is more closely connected with evaluations of responsiveness. The success of the Polsby-Popper score for the linkage items supports Grofman's (1985; 1993; 1995) concept of recognizability: districts with contorted shapes (usually) make communication difficult because constituents have a hard time understanding the districting system and correctly placing themselves within it. Alternatively, the Reock score's connection with the responsiveness measures, especially for electoral losers, suggests that the representational benefit of compactness works through the unification of geographically-structured shared interests (Morrill, 1982; Butler and Cain, 1992).

Redistricting authorities are faced with a daunting task: designing legislative districts to meet numerous, conflicting goals in a districting plan. Using large-scale survey data combined with a new measure of respect for subdivisions and measures of geographical compactness, I find strong evidence that geographic TDPs matter for citizen assessments of congressional representation and

the linkage between MCs and their constituents. Violating TDPs to advance other goals in redistricting thus comes with a clear representational cost.

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Table 1: Boundary Characteristics and Policy Divergence, 2008 CCES

	Divergence from Mean MC Rating						Divergence from Respondent's MC Rating					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Coterminosity	-.362	(1.315)	-1.029	(1.240)	-1.936	(1.336)	-.276	(1.466)	-.888	(1.372)	-3.711*	(1.592)
Winner * Coterminosity					1.730+	(.959)					5.498**	(1.581)
Compactness												
Polsby-Popper	-3.169	(2.063)					-2.856	(2.242)				
Reock			-4.141*	(1.895)	-5.046*	(2.054)			-5.049*	(2.060)	-7.900**	(2.440)
Winner * Reock					1.885	(1.628)					5.848*	(2.658)
Δ in Constituency Size	-.003	(.004)	-.003	(.004)	-.003	(.004)	-.005	(.004)	-.004	(.004)	-.004	(.004)
Seniority	-.026	(.031)	-.026	(.031)	-.025	(.030)	-.058+	(.033)	-.058+	(.033)	-.055+	(.033)
District Competitiveness	-4.337**	(.979)	-4.338**	(.976)	-4.360**	(.974)	-3.512**	(1.083)	-3.494**	(1.077)	-3.545**	(1.075)
Urbanism	5.055**	(1.716)	4.459**	(1.702)	4.486**	(1.699)	7.291**	(1.879)	6.672**	(1.859)	6.807**	(1.855)
Racial Diversity	-.282	(1.662)	-.154	(1.644)	-.150	(1.640)	-1.272	(1.832)	-1.238	(1.810)	-1.246	(1.806)
Median Income	-.010	(.025)	-.007	(.025)	-.008	(.025)	-.038	(.028)	-.036	(.027)	-.039	(.027)
Republican	15.38**	(.341)	15.38**	(.341)	15.35**	(.341)	19.49**	(.572)	19.50**	(.572)	19.43**	(.572)
Democrat	13.36**	(.337)	13.36**	(.337)	13.39**	(.337)	17.70**	(.572)	17.71**	(.572)	17.82**	(.573)
Electoral Winner	-21.66**	(.204)	-21.66**	(.204)	-23.56**	(.868)	-31.93**	(.332)	-31.94**	(.332)	-38.01**	(1.444)
Descriptive Representation	.553*	(.281)	.548+	(.281)	.573*	(.282)	-1.546**	(.461)	-1.565**	(.461)	-1.496**	(.461)
Union Member	.681**	(.212)	.680**	(.212)	.677**	(.212)	.413	(.344)	.412	(.344)	.393	(.344)
Residential Mobility	.137	(.142)	.137	(.142)	.137	(.142)	.049	(.244)	.045	(.244)	.045	(.244)
Intercept	25.72**	(1.92)	27.23**	(2.07)	28.24**	(2.12)	29.39**	(2.271)	31.34**	(2.419)	34.47**	(2.520)
Random effects												
Intercept	1.403**	(.042)	1.400**	(.042)	1.397**	(.042)	1.323**	(.057)	1.314**	(.057)	1.311**	(.057)
Residual	2.710**	(.004)	2.710**	(.004)	2.710**	(.004)	3.072**	(.005)	3.072**	(.005)	3.072**	(.005)
Observations	27957		27957		27957		21476		21476		21476	
AIC	231667		231665		231663		193348		193343		193329	

Note: All models are random intercept multilevel linear regressions. Intercepts vary by congressional district. The dependent variable is the absolute value of the difference between estimates of MC and survey respondent ideology scores. In the first three models, MC ideology is estimated by the mean incumbent ideology rating by survey respondents in the MC's district; in Models 4-6, MC ideology is the placement of the representative by the survey respondent on a 0 - 100 liberal-conservative scale. Models also controlled for gender, age, education, income, and race of the respondent. AIC is the Akaike Information Criterion. + $p < .1$, * $p < .05$, ** $p < .01$, two-tailed test.

Table 2: Boundary Characteristics, Constituent Service, and Allocation, 2008 CCES

	Service Responsiveness						Allocation Responsiveness					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Coterminosity	.282+	(.168)	.222	(.157)	.345+	(.188)	.544**	(.161)	.632**	(.152)	.597**	(.183)
Winner * Coterminosity					-.244	(.205)					.063	(.178)
Compactness												
Polsby-Popper	-.243	(.251)					.406+	(.245)				
Reock			.438+	(.234)	.752**	(.281)			.252	(.228)	.532+	(.277)
Winner * Reock					-.683*	(.335)					-.517+	(.291)
Δ in Constituency Size	-.001+	(.000)	-.001+	(.000)	-.001+	(.000)	-.002**	(.000)	-.002**	(.000)	-.002**	(.000)
Seniority	.011**	(.004)	.012**	(.004)	.011**	(.004)	.025**	(.004)	.025**	(.004)	.025**	(.004)
District Competitiveness	.334**	(.124)	.321**	(.124)	.319**	(.124)	.273*	(.119)	.280*	(.119)	.276*	(.119)
Urbanism	-.551*	(.214)	-.542*	(.212)	-.547**	(.212)	-.223	(.205)	-.164	(.205)	-.165	(.205)
Racial Diversity	-.121	(.207)	-.071	(.205)	-.072	(.205)	-.186	(.202)	-.216	(.201)	-.216	(.201)
Median Income	.002	(.003)	.002	(.003)	.002	(.003)	-.016**	(.003)	-.017**	(.003)	-.017**	(.003)
Republican	-.449**	(.071)	-.450**	(.071)	-.446**	(.071)	.055	(.064)	.054	(.064)	.054	(.064)
Democrat	-.711**	(.071)	-.712**	(.071)	-.719**	(.071)	.021	(.064)	.021	(.064)	.018	(.064)
Electoral Winner	1.890**	(.046)	1.891**	(.045)	2.314**	(.187)	.450**	(.037)	.451**	(.037)	.589**	(.163)
Descriptive Representation	.080	(.061)	.082	(.061)	.078	(.061)	.141**	(.052)	.142**	(.052)	.142**	(.053)
Union Member	.006	(.043)	.006	(.043)	.007	(.043)	.194**	(.037)	.194**	(.037)	.194**	(.037)
Residential Mobility	.036	(.033)	.037	(.033)	.039	(.033)	.216**	(.028)	.216**	(.028)	.216**	(.028)
Intercept							-5.038**	(.250)	-5.119**	(.268)	-5.190**	(.283)
Cut 1	-1.450**	(.267)	-1.258**	(.283)	-1.054**	(.297)						
Cut 2	-.307	(.266)	-.114	(.282)	.091	(.296)						
Cut 3	1.116**	(.267)	1.308**	(.282)	1.514**	(.297)						
Random effects												
Intercept	.380**	(.028)	.376**	(.028)	.375**	(.028)	.410**	(.025)	.412**	(.025)	.412**	(.025)
Observations	10262		10262		10262		29263		29263		29263	
AIC	24529		24527		24525		24686		24688		24689	

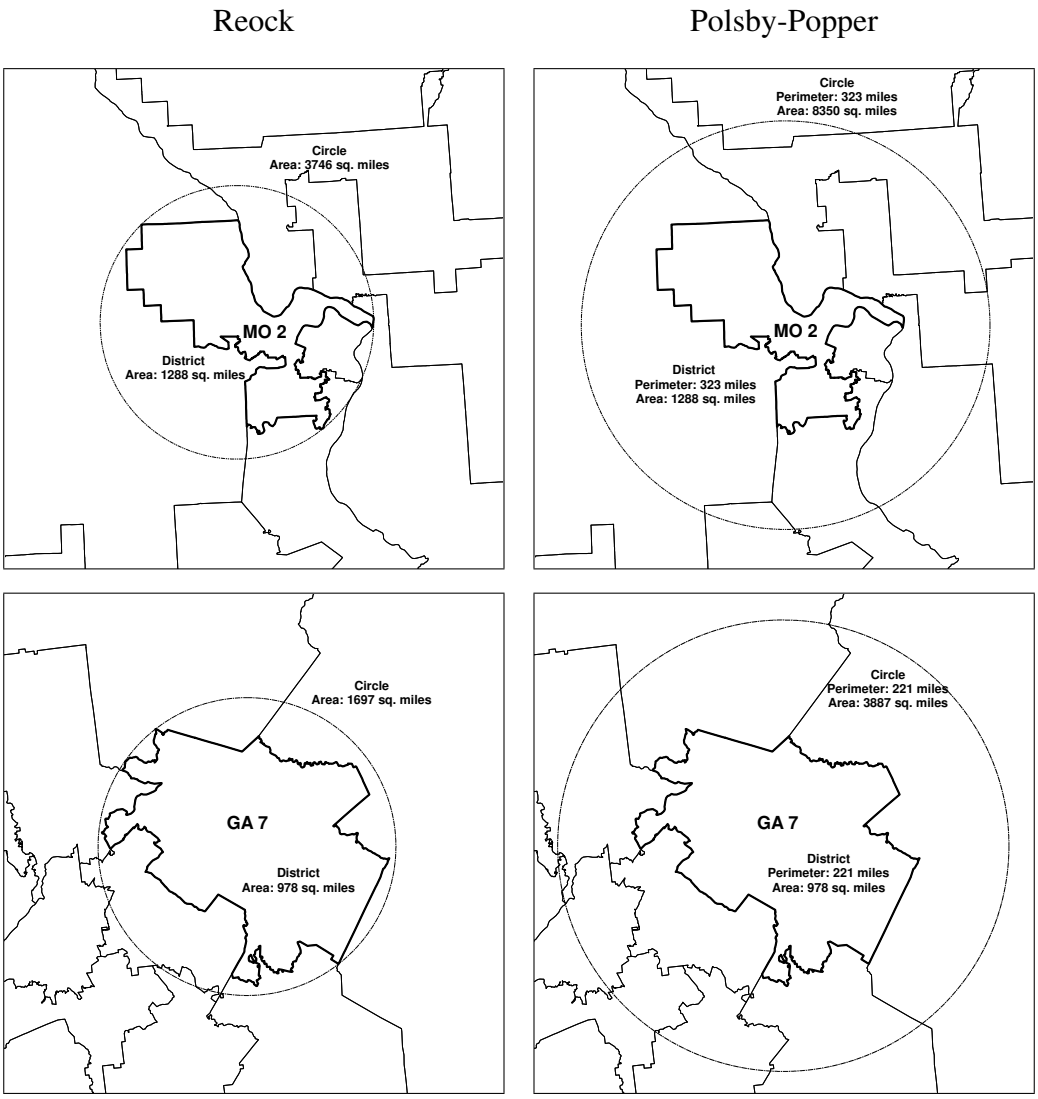
Note: Models 1-3 are random intercept multilevel ordered logistic regressions. Models 4-6 are random intercept multilevel logistic regressions. Intercepts vary by congressional district. Models also controlled for gender, age, education, income, and race of the respondent. AIC is the Akaike Information Criterion. + $p < .1$, * $p < .05$, ** $p < .01$, two-tailed test.

Table 3: Boundary Characteristics and Citizen-Legislator Linkage, 2008 CCES

	Contact				Recall of MC's Party				Recall of MC's Race			
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Coterminosity	.400**	(.116)	.505**	(.109)	.377*	(.165)	.521**	(.156)	.531*	(.218)	.715**	(.206)
Compactness												
Polsby-Popper	.483**	(.176)			.686**	(.259)			.890*	(.349)		
Reock			.390*	(.163)			.658**	(.238)			1.020**	(.317)
Δ in Constituency Size	-.001*	(.000)	-.001*	(.000)	-.002**	(.000)	-.002**	(.000)	-.004**	(.001)	-.004**	(.001)
Seniority	.025**	(.003)	.025**	(.003)	.009*	(.004)	.008*	(.004)	.011*	(.005)	.011*	(.005)
District Competitiveness	.144+	(.086)	.150+	(.086)	.387**	(.123)	.392**	(.123)	.623**	(.164)	.630**	(.163)
Urbanism	-.073	(.148)	.002	(.148)	.803**	(.215)	.918**	(.214)	.318	(.290)	.485+	(.288)
Racial Diversity	-.014	(.145)	-.045	(.144)	-.076	(.209)	-.117	(.208)	-.929**	(.279)	-.978**	(.276)
Median Income	-.002	(.002)	-.003	(.002)	-.014**	(.003)	-.014**	(.003)	-.010*	(.004)	-.011**	(.004)
Republican	.186**	(.048)	.184**	(.048)	.764**	(.051)	.763**	(.051)	.527**	(.060)	.525**	(.060)
Democrat	.025	(.048)	.025	(.048)	.524**	(.049)	.523**	(.049)	.446**	(.058)	.446**	(.058)
Electoral Winner	.238**	(.029)	.239**	(.029)	.284**	(.034)	.285**	(.034)	.134**	(.041)	.135**	(.041)
Descriptive Representation	.130**	(.042)	.132**	(.042)	.374**	(.045)	.375**	(.045)	.998**	(.049)	1.000**	(.049)
Union Member	.159**	(.030)	.159**	(.030)	.072*	(.035)	.072*	(.035)	-.015	(.041)	-.014	(.041)
Residential Mobility	.285**	(.021)	.285**	(.021)	.372**	(.022)	.372**	(.022)	.430**	(.025)	.430**	(.025)
Intercept	-4.513**	(.182)	-4.647**	(.195)	-5.363**	(.251)	-5.590**	(.270)	-3.095**	(.325)	-3.462**	(.351)
Random effects												
Intercept	.268**	(.019)	.270**	(.019)	.467**	(.024)	.466**	(.024)	.647**	(.031)	.644**	(.031)
Observations	29282		29282		29221		29221		29304		29304	
AIC	34767		34769		29106		29105		21968		21965	

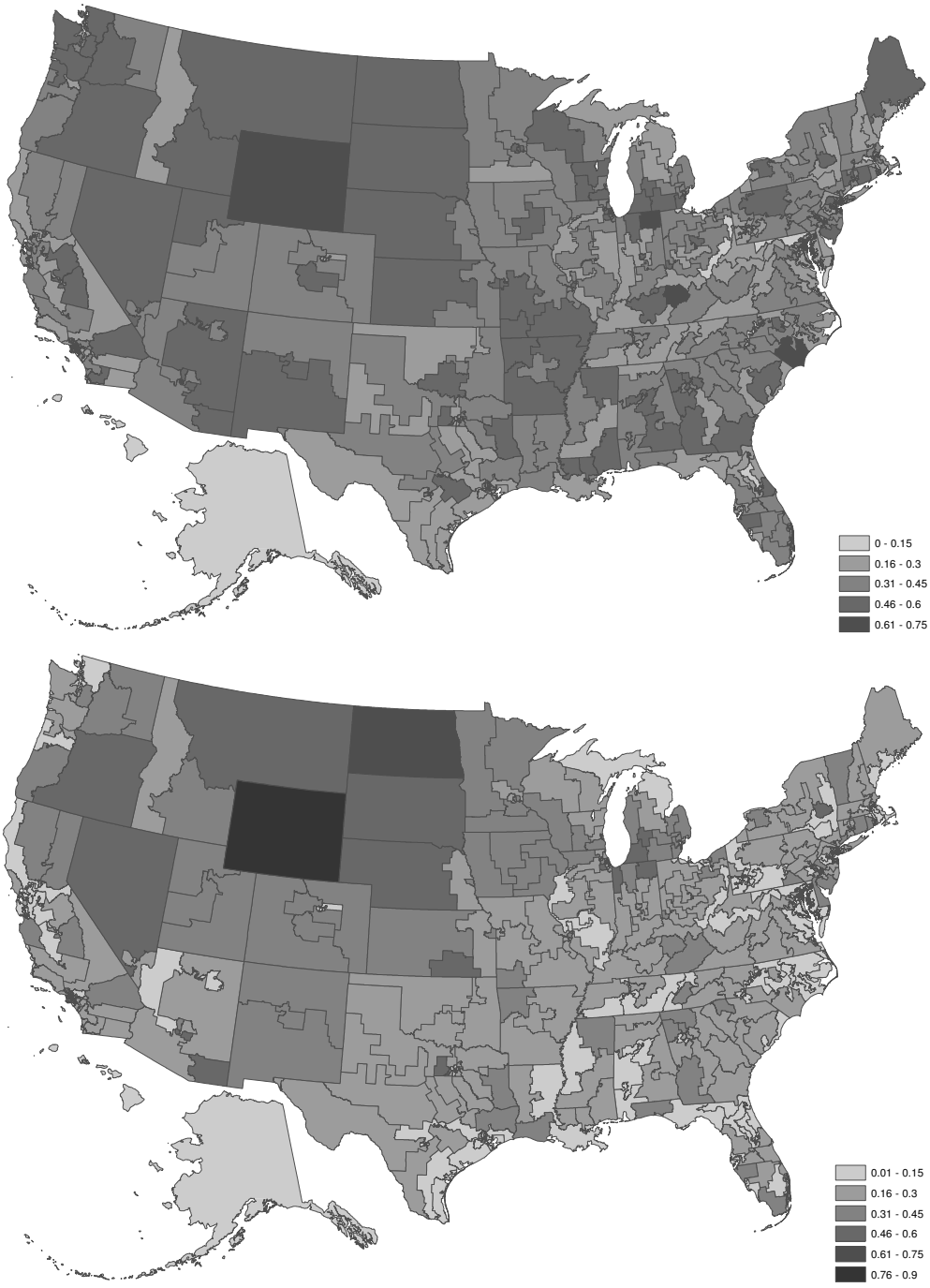
Note: All models are random intercept multilevel logistic regressions. Intercepts vary by congressional district. Models also controlled for gender, age, education, income, and race of the respondent. AIC is the Akaike Information Criterion. + $p < .1$, * $p < .05$, ** $p < .01$, two-tailed test.

Figure 1: Illustration of Compactness Scores



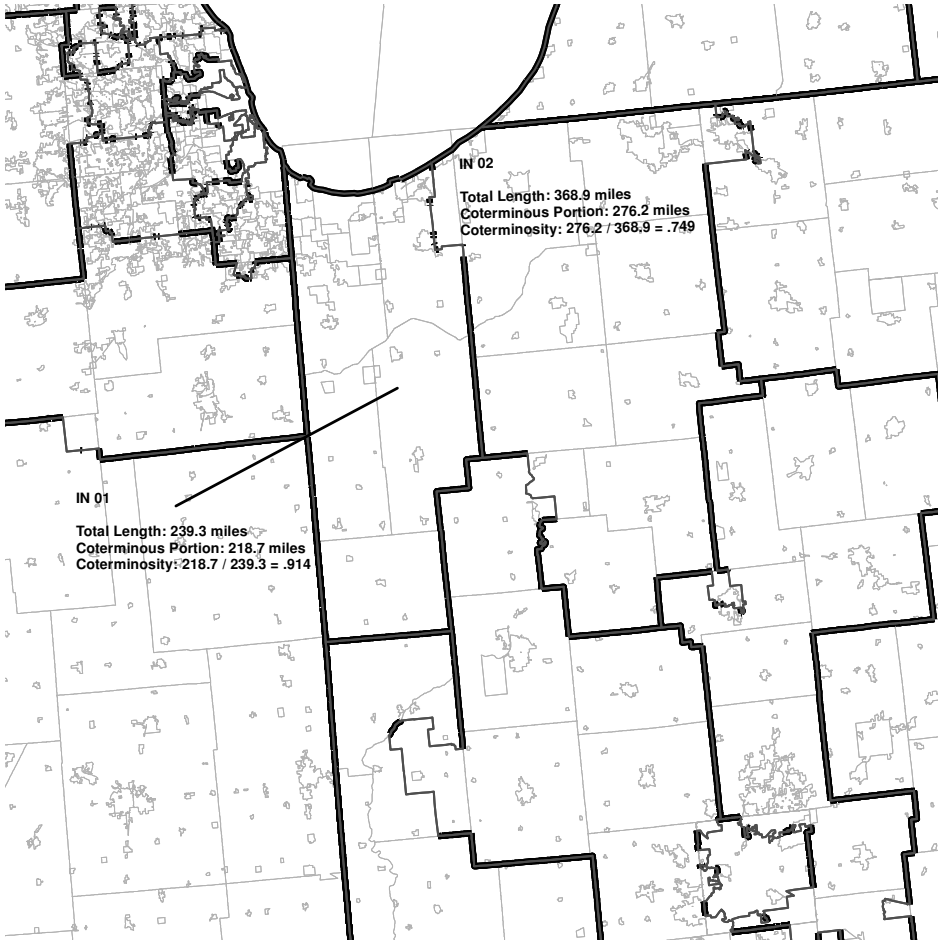
Note: Districts with bold outlines are Missouri's 2nd congressional district (2002-2012) and Georga's 7th district (2007-2012). The Reock compactness score is the ratio of a district's area to that of its minimum circumscribing circle. The Polsby-Popper compactness score is the ratio of district area to the area of a circle whose circumference equals the district perimeter.

Figure 2: Reock (top) and Polsby-Popper (bottom) Compactness Scores in the U.S. House (110th Congress)



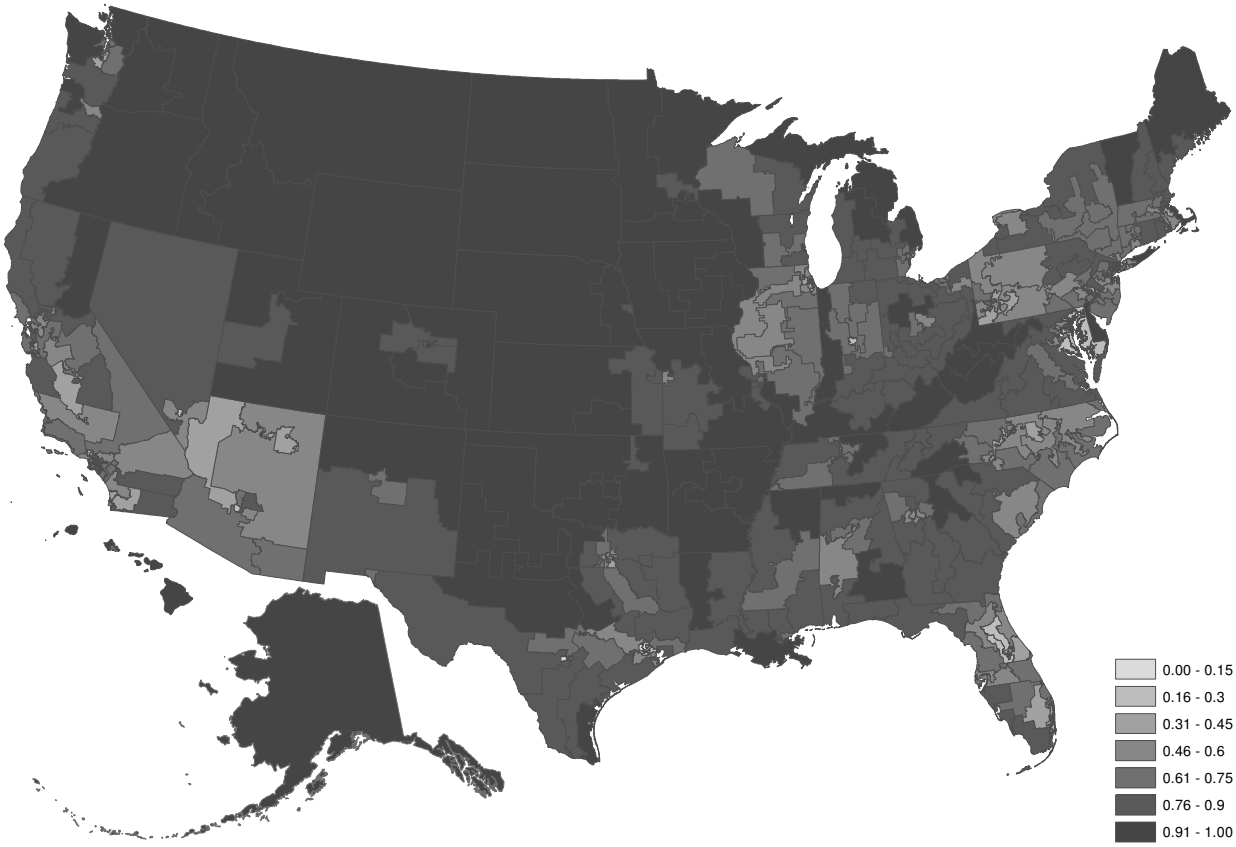
Note: Reock and Polsby-Popper compactness scores calculated by the author using the Census Bureau's Tiger/Line Shapefiles, cartographic boundary files, and ESRI's ArcInfo software.

Figure 3: Example of Coterminous and Non-Coterminous Congressional District Boundaries



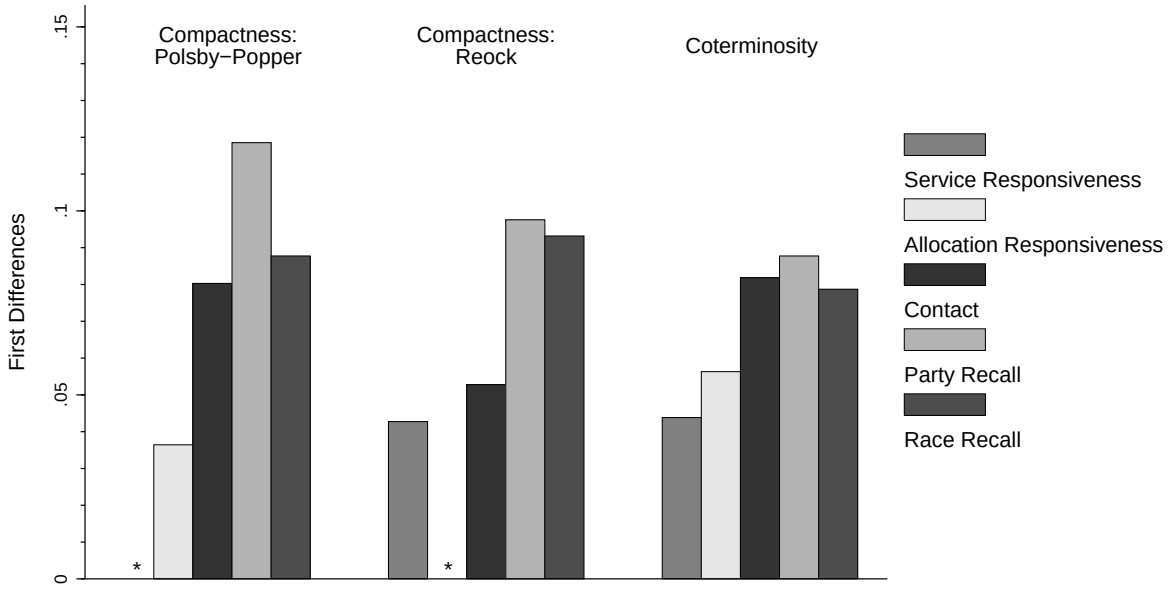
Note: Illinois, Indiana and Michigan congressional districts shown. All county, town, city, and state boundaries are represented by light gray lines in the figure. Dark gray lines outlined in black are portions of congressional districts coterminous with a subdivision boundary. Dark gray lines without black outlines show non-coterminous portions of districts.

Figure 4: Geographic Distribution of Coterminosity



Note: Coterminosity scores were calculated by the author using the Census Bureau's Tiger/Line Shapefiles of all county and place boundaries in the United States, cartographic boundary files of congressional districts, and ESRI's ArcInfo software.

Figure 5: Predicted Effects of District Characteristics



Note: Figure shows population-averaged differences in predicted probabilities as each district characteristic is moved from its minimum value to its maximum value. Only first differences from significant relationships in Tables 2 and 3 are presented. The service responsiveness bars display changes in the probability of a hypothetical respondent giving a positive evaluation on a 4-point scale ($Pr(y > 2)$); the other bars show changes in the occurrence of the dependent variable ($Pr(y = 1)$). All results are from the models in Tables 2 and 3 without interaction terms, and the coterminosity results come from models including the Polsby-Popper compactness scores rather than the Reock scores (Table 2, Models 1 and 3; Table 3, Models 1, 3, and 5).

Appendix

Question Wording and Coding

Responsiveness

The service responsiveness item comes from a question asking respondents to rate their satisfaction with an interaction with their representative. All respondents who reported contacting their House members were asked "How satisfied were you with the response to that contact?" and were given the options of very satisfied, somewhat satisfied, not very satisfied, and not at all satisfied. This item was recoded to create a 4-point scale ranging from not at all satisfied (coded 1) to very satisfied (coded 4).

Policy responsiveness items were created from a series of questions asking the respondent to place himself or herself and several elected officials on 100-point liberal to conservative scale. A divergence score was created by subtracting the respondent's self-placement from the respondent's placement of his or her representative's ideology score or the mean MC ideology placement by respondents in the district. Respondents were asked:

> One way that people talk about politics in the United States is in terms of left, right, and center, or liberal, conservative, and moderate. We would like to know how you view the parties and candidates using these terms. The scales below represent the ideological spectrum from very liberal (0) to very conservative (100). The most centrist American is exactly at the middle (50),

followed by specific questions about their own ideology: "Where would you place yourself? If you are not sure, or don't know, please check 'Not Sure"' and their representative's ideology "Where would you place [name of House Candidate 1]? If you are not sure, or don't know, please check 'Not Sure"'.

Allocation responsiveness is measured from a question asking respondents to recall their House member's allocative work on behalf of the district. Respondents were asked: "Can you recall any specific projects that your members of Congress brought back to your area?" Those respondents recalling such a project were coded 1 and those who did not were coded 0.

Contact and Recall

Contact was measured by the following question: "Have you (or anyone in your family living here) ever contacted Representative [House member name] or anyone in [House member gender] office?" Respondents who had reported contacting their representative were coded 1; those who did not were coded 0.

The party recall question in the CCES was presented in a battery of questions testing political knowledge. Respondents were instructed: "Please indicate whether you've heard of this person and if so which party he or she is affiliated with" for their governor, senators, and House member. The answer to the representative question was combined with actual partisanship of House members. Those respondents correctly reporting the party of their representative were coded 1, and those

unaware of their House member or incorrectly recording his or her party were coded 0. A similar process was used for race recall. The exact question wording for the recall item is "What is the race or ethnicity of your member of the U.S. House of Representatives?", and respondents were given the choices of white, black, Hispanic, other, or not sure.

Table A.1. Descriptive Statistics

Variable	N	Mean	Median	SD	Min	Max
Dependent Variables						
Responsiveness						
Policy Divergence with Mean MC Score	30713	26	22	18	0	99
Policy Divergence with Ind. MC Score	23459	30	23	26	0	100
Satisfaction with Contact (Service)	11297	3	3	1.1	1	4
Project Recall (Allocation)	32560	.14	0	.35	0	1
Linkage & Communication						
Contact	32596	.29	0	.45	0	1
Recall of Party	32523	.61	1	.49	0	1
Recall of Race	32620	.78	1	.42	0	1
Independent Variables - Aggregate Level						
Δ in Constituency Size	435	46	32	59	-207	322
Coterminosity	435	.7	.74	.22	0	1
Polsby-Popper Compactness	435	.22	.21	.12	.0068	.77
Reock Compactness	435	.35	.34	.12	.003	.65
Seniority	435	9	7	7.2	0	39
District Competitiveness	435	.63	.69	.26	0	1
Urbanism	435	.79	.84	.2	.21	1
Racial Diversity	435	.39	.39	.18	.056	.84
Median Income	435	43	41	11	19	80
Independent Variables - Individual Level						
Male	32800	.48	0	.5	0	1
Age	32800	46	47	16	18	100
Education	32800	2.8	3	1	1	5
Income	30600	7.6	7	3.5	1	14
Black	32800	.12	0	.32	0	1
Hispanic	32800	.098	0	.3	0	1
Asian	32800	.017	0	.13	0	1
Union Member	32624	.25	0	.44	0	1
Residential Mobility	32743	2.4	3	.74	1	3
Republican	31753	.36	0	.48	0	1
Democrat	31753	.5	1	.5	0	1
Electoral Winner	32800	.43	0	.49	0	1
Descriptive Representation	32800	.72	1	.45	0	1