Geography, Uncertainty, and Polarization*

NOLAN MCCARTY, JONATHAN RODDEN, BORIS SHOR,
CHRIS TAUSANOVITCH AND CHRISTOPHER WARSHAW

*U*sing new data on roll-call voting of US state legislators and public opinion in their districts, we explain how ideological polarization of voters within districts can lead to legislative polarization. In so-called "moderate" districts that switch hands between parties, legislative behavior is shaped by the fact that voters are often quite heterogeneous: the ideological distance between Democrats and Republicans within these districts is often greater than the distance between liberal cities and conservative rural areas. We root this intuition in a formal model that associates intradistrict ideological heterogeneity with uncertainty about the ideological location of the median voter. We then demonstrate that among districts with similar median voter ideologies, the difference in legislative behavior between Democratic and Republican state legislators is greater in more ideologically heterogeneous districts. Our findings suggest that accounting for the subtleties of political geography can help explain the coexistence of polarized legislators and a mass public that appears to contain many moderates.

One of the central puzzles in the study of American politics is the coexistence of an increasingly polarized Congress with a more centrist electorate (Fiorina and Abrams 2010). Because it has been difficult to find a reliable link between polarization in Congress and the polarization of voter policy preferences, researchers have generally abandoned explanations of congressional polarization that rely on changes in the ideology of the mass public and focus instead on institutional features like primaries, agenda control in the legislature, and redistricting (Fiorina and Abrams 2008; Barber and McCarty 2013).[1]

This paper brings attention back to the distribution of ideology in the mass public with new data and an alternative theoretical approach. Previous explanations for polarization focus, quite naturally,

[1] Scholars have generally recognized that the policy positions of partisan identifiers have diverged over the past several decades, but argue that this is the result of better ideological sorting of voters into partisan camps. Rather than driving elite polarization, such voter sorting may be its consequence (see Levendusky 2009).

on variation across the nation as a whole, or on the average or median traits of citizens in each district (e.g., Jacobson 2004; Clinton 2006; McCarty, Poole and Rosenthal 2006; Levendusky 2009). This work follows from a long literature on representation that builds on Anthony Downs's (1957) argument that two-candidate competition should lead to platforms that converge on the preferences of the median voter. The great majority of scholarship on this question, however, finds that the median voter is an inadequate predictor of candidate or legislator positions (Miller and Stokes 1963; Ansolabehere, Snyder and Stewart 2001; Clinton 2006; Bafumi and Herron 2010). Moreover, polarization in Congress (McCarty, Poole and Rosenthal 2006; McCarty, Poole and Rosenthal 2009) and state legislatures (Shor and McCarty 2011) has been primarily a reflection of increasing differences in the way Republicans and Democrats represent otherwise similar districts. Consequently, it is unlikely that polarization can be explained purely by changes in the distribution of voter ideology across districts.

We take a different approach. We build upon a literature that focuses on the distribution of voter preferences *within* districts rather than the distributions of voter medians or means across districts (e.g., Bailey and Brady 1998; Gerber and Lewis 2004; Levendusky and Pope 2010; Ensley 2012; Harden and Carsey 2012; Stephanopoulos 2012). We show that differences in the roll-call voting behavior of Democratic and Republican legislators are largest in the most ideologically heterogeneous districts. Our main contribution is empirical: this paper is the first to use a large-scale national data set of the votes of about 3000 legislators and the policy views of hundreds of thousands of constituents to test hypotheses about ideological heterogeneity. But first, we motivate these hypotheses with a theoretical model that builds on the work of Calvert (1985) and Wittman (1983), who argue that policy-motivated candidates might adopt divergent positions in the face of uncertainty about voter preferences. When candidates are uncertain about the ideological location of the median voter, they shade their platforms toward their or their party's more extreme ideological preferences. Our extension focuses on mechanisms by which voter heterogeneity produces more uncertainty about the median voter and therefore more polarization.

After presenting the formal model, we turn to an empirical analysis of the roll-call voting behavior of state legislators. Existing research on polarization in the United States focuses primarily on attempting to explain the dramatic growth of polarization in the US Congress (Poole and Rosenthal 1997; McCarty, Poole and Rosenthal 2006). The small empirical literature that examines how the distribution of voters' preferences within districts affects legislators' roll-call behavior has likewise focused on the US Congress (Bailey and Brady 1998; Jones 2003; Bishin, Dow and Adams 2006; Ensley 2012; Harden and Carsey 2012). The notable exception is Gerber and Lewis (2004) who use data from the California Assembly and Senate.

Congressional polarization has moved in tandem with many potential explanatory variables. Thus, the literature's exclusive focus on Congress undermines efforts to test competing hypotheses. Moreover, most of the increase in polarization occurred prior to the years for which reliable estimates of voter ideology can be created at the district level. In this paper, we turn away from an analysis of change over time in the US Congress and focus instead on the considerable cross-sectional and more limited longitudinal variation in state legislative polarization.

Our primary focus is on state legislative upper chambers, or state senates. This is a calculated choice that provides a desirable combination of substantial statistical power (several thousand observations of unique state legislators) and good measures of district heterogeneity (hundreds of individual survey respondents within each state Senate district). Congressional districts provide the latter without the former, while state lower chamber (state house or assembly) districts provide even more power, but substantially poorer measures of heterogeneity, based as they are on only a few dozen observations within each district. Nevertheless, we have run our models for both US House and state lower chambers, and have found substantially identical results. These estimates are detailed in the Supplementary Appendix C and D.

Building on the work of McCarty, Poole and Rosenthal (2009), we match upper chamber districts that are as similar as possible with respect to ideology, showing that (1) as in the US Congress, there is considerable divergence in roll-call voting across otherwise identical districts controlled by Democrats and Republicans, and (2) this inter-district divergence is a function of within-district ideological heterogeneity. Given the panel structure of our data, we also have a set of observations of within-district switches in party control. We find that the change in legislator ideal point associated with such a partisan switch is substantially larger in heterogeneous districts.

We conclude with a discussion of the implications of these findings for the polarization literature. Based on our findings, we find it quite plausible that the rise of polarization in the US Congress has been driven in part by increasing within-district heterogeneity associated with the demographic and residential transformations of recent decades. Moreover, our results offer skepticism about redistricting reforms aimed at creating more ideologically heterogeneous districts as a cure for legislative polarization (McCarty, Poole and Rosenthal 2009; Masket, Winburn and Wright 2012). Finally, the utility of these results for explaining polarization suggests that future research on representation should take seriously the idea that the distribution of preferences within districts may be important for determining the positions of legislators, who must balance competing strategic considerations as well as their own preferences in deciding what policy positions to uphold (Fiorina 1974). The arrival of very large data sets on public opinion and legislative behavior is now making this type of empirical exercise possible.

POLARIZATION IN THE MASS PUBLIC AND STATE LEGISLATURES

We begin by reviewing some of the stylized facts and research findings that motivate the paper. First, we examine the geographic distribution of voter ideology within states. One of the obstacles to previous research on this topic is that scholars have lacked good measures of the mass public's ideology at the individual level in each state. Existing research primarily relies on measures of ideological self-placement on relatively small national surveys (Jones 2003; Bishin, Dow and Adams 2006), economic and demographic characteristics (Bailey and Brady 1998; Stephanopoulos 2012), or state-level survey responses (Harden and Carsey 2012; Kirkland 2014) to measure preference distributions.[2] However, Tausanovitch and Warshaw (2013) demonstrate how to estimate the ideal points of survey respondents from their policy views on several surveys and project them onto a common scale, allowing for vastly larger sample size. They bridge together the ideal points of survey respondents from eight recent large-sample surveys using survey responses on a battery of policy questions. Although these surveys ask different questions, a smaller survey asks questions from all of the other surveys. This "super-survey" facilitates comparisons across all of the other samples. Using a scaling model not unlike factor analysis, they are able to produce a single ideological score for every respondent, which summarizes each respondent's views on the many policy questions they were asked. See Supplementary Appendix A for more details.

The resulting data set has a measure of the ideological preferences of over 350,000 respondents on a common left-right scale.[3] The ideal point for a given individual signifies the

---

[2] Notable exceptions are Gerber and Lewis (2004), who estimate ideal points using ballot measures in California, and Levendusky and Pope (2010), who calculate congressional district-level heterogeneity estimates from survey responses (albeit with a much smaller sample than ours).

[3] Tausanovitch and Warshaw's (2013) estimates of the mass public's ideal points are based on survey data from the 2000 and 2004 National Annenberg Election Surveys and the 2006–2012 Cooperative Congressional Election Studies.
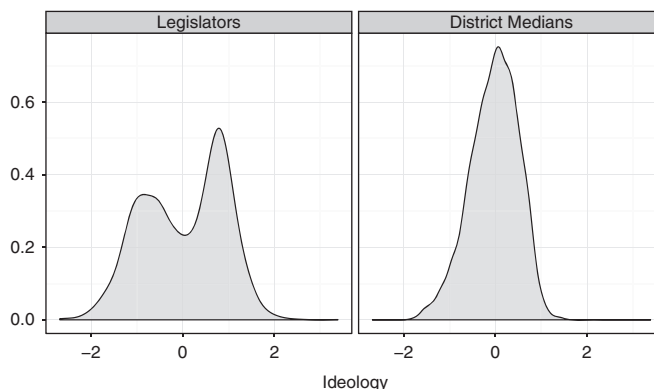
Fig. 1. Distributions of legislator and district median ideal points
Note: This plot shows the distribution of legislators' ideal points and the median citizen's ideal point in each district. It indicates that the distribution of legislators' ideal points is much more polarized than the ideal points of the median citizens.

liberalness or *conservativeness* of that individual. These data on the ideological preferences of hundreds of thousands of Americans enable us to increase dramatically the size of survey samples for small geographic areas, which makes it possible to characterize not only the mean or median position, but also the nature of the overall distribution of citizens' ideological preferences within states and legislative districts.

These data enable a new approach to what has become a classic question in American politics: is the mass public responsible for ideological polarization in legislatures? The current literature answers with a tentative "no," based on time series analysis of the US Congress, where legislative polarization has grown but the ideological distance between Democratic and Republican voters began growing much later and at a slower rate. Addressing the question at the state level requires new data and measures. Using a combination of archival and online data gathering, Shor and McCarty (2011) estimated ideal points of members of state legislatures from a large data set of roll-call votes cast between 1993 and 2015. These estimates once again summarize positions on large numbers of roll-call votes using a simple measurement model. However, no comparisons across different states are possible without some method to account for the fact that agendas are vastly different across states. That "bridging" is facilitated by a survey that asks candidates from different states about their policy positions using the same questions (see Shor and McCarty 2011, 532–3). Individual-level measurements can be then aggregated in a variety of ways to make statements about states as a whole.

Combining the data on ideological distributions of voters and positions of state legislators provides the opportunity to take a first look at the relationship between district heterogeneity and legislative polarization. If legislative polarization is a function of ideological polarization of voters across districts, we would expect to see the familiar bimodal distribution of legislator ideal points mirrored in the distribution of district-level median ideal points of voters. Figure 1 displays kernel densities of both measures across all state upper chambers. There is sharp divergence between the roll-call votes of Democrats and Republicans, but the distribution of median ideology across districts has a single peak. The disjuncture is even more extreme when one examines these distributions separately for each state. Thus Fiorina's (2010) puzzle reappears at the district level: there is a large density of moderate districts, but in many states the middle of the ideological distribution is not well represented in state legislatures (Shor 2014). The same is true for the US Congress (Rodden 2015).

(a)

(b)
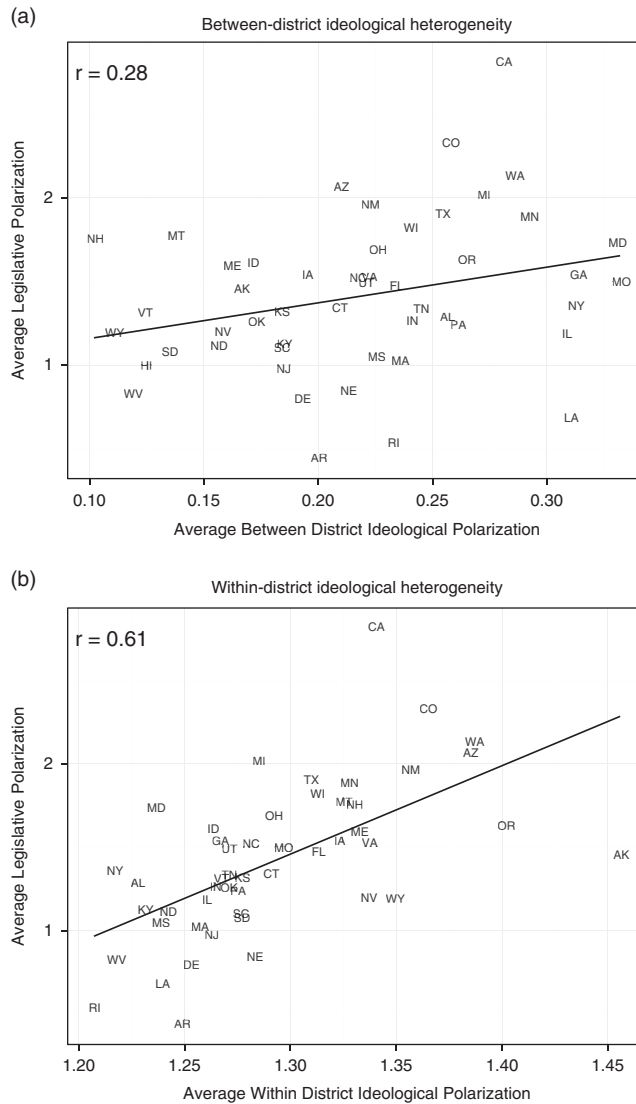
Fig. 2. *Legislative polarization and ideological heterogeneity*
Note: These plots show the correlation between legislative polarization and the between-district (a) and within-district (b) polarization of citizens in each state.

Next, we examine cross-state variation in the polarization of legislatures that we measure as the distance in ideal point estimates between state legislative Democratic and Republican medians (averaged across chambers). A commonly held view is that polarization reflects the way in which voters are allocated *across* districts. If this were the case, we would expect to see that our measure of legislative polarization correlates strongly with the variation of district medians within each state. In the top panel of Figure 2, we examine this hypothesis by plotting the degree of legislative polarization against across-district ideological heterogeneity in the mass public for each state (measured as the standard deviation of the district-level ideology estimates). Indeed, we find a correspondence between across-district heterogeneity and the polarization of the legislature.

Fig. 3. Average district ideology and within-district polarization
Note: This plot shows the relationship between the median citizens' ideological preferences and the heterogeneity of citizens' preferences in each state senate district in the country.

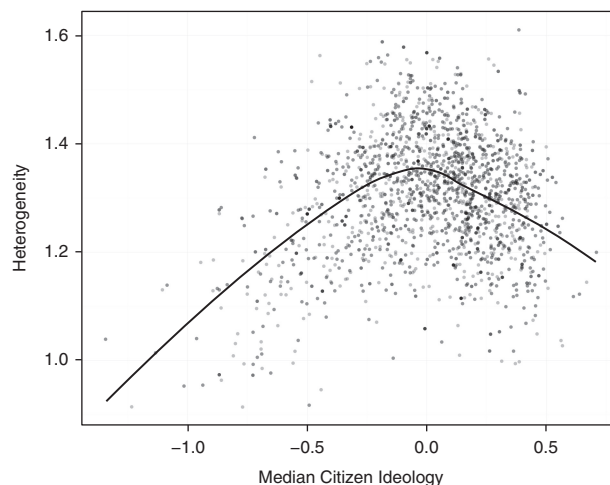This relationship, however, leaves a large part of the variance unexplained. In the bottom panel of Figure 2 we test a different proposition—that heterogeneity *within* districts correlates with legislative polarization. The horizontal axis captures the average within-district standard deviation of our ideological scale for district opinion. Again we find a systematic relationship, stronger indeed than that for between-district heterogeneity. Not only is legislative polarization correlated with across-district ideological heterogeneity, but the states with the highest levels of within-district heterogeneity, such as California, Colorado, and Washington, are also clearly those with the highest levels of legislative polarization.

If district heterogeneity impacts polarization, it is important to understand what sorts of districts have this feature. More specifically, what is the relationship between ideology—how conservative or liberal a district is on average—and that district's heterogeneity? Figure 3 plots our measure of the standard deviation of public ideology for each state senate district on the vertical axis, and our estimate of mean ideology of the district on the horizontal axis. The left side of the inverted u-shape of the lowess plot in Figure 3 shows that the far-left urban enclaves are ideologically relatively homogeneous. The same is true for the conservative exurban and suburban districts on the right side of the plot.[4]

The most internally heterogeneous districts are those in the middle of the ideological spectrum. In other words, the districts with the most moderate ideological means—the so-called "purple" districts where the presidential vote share is most evenly split—tend to be places where the electorate is most heterogeneous. These are the districts that switch back and forth between parties in close elections and determine which party controls the state legislature. Reformers often idealize such moderate districts because it is believed that they are most conducive to the political competition that is supposed to

---

[4] One might be concerned that the inverted u-shape in Figure 3 is driven by the truncation of the ideology scale. For example, a district with an extreme conservative average must have a low variance because it can have no voters with a conservatism score above the maximum. However, the truncation would only affect the standard deviations of districts with averages close to the extremes. But it is clear in Figure 3 that the relationship is not driven by extreme values, and the lowess plot peaks in the middle of the distribution, well beyond the point at which truncation could reasonably have an effect.

produce moderate representation. But as we will show, the fact that such districts are more likely to be heterogeneous mitigates their ability to elect moderate legislators. A takeaway from Figure 3 is that state senate districts come predominately in three flavors: "liberal," "conservative," or "moderate but heterogeneous." Our argument is that *none* of these are conducive to centrist representation.

To better understand why moderate districts are so often heterogeneous, it is useful to take a closer look at an example of the distribution of ideology in Colorado, a highly polarized state. The top portion of Figure 4 zooms in on the pivotal "purple" Denver–Boulder suburban corridor, representing the centroids of precincts with dots.[5] The identification numbers of the districts with the most ideologically moderate means are displayed on the map, and the bottom portion of Figure 4 presents kernel densities capturing the distribution of our ideological scale within each corresponding district.

The kernel densities show that these "moderate" districts are very heterogeneous internally. Several of these are relatively compact formerly white districts in the suburbs that have experienced large inflows of Hispanics in recent years. These districts contain a mix of Democratic, Republican, and evenly divided precincts. Another type of internally polarized district is exemplified by Districts 15 and 16—sprawling, sparsely populated districts that contain rural conservatives and concentrated pockets of progressives.

Throughout the United States, our estimates of within-district ideology tell a similar story. Districts in the urban core of large cities are homogeneous and liberal. Yet many of their surrounding suburban districts are quite ideologically heterogeneous—a phenomenon that is driven in large part by the growing racial, ethnic, and income heterogeneity of American suburbia (Orfield and Luce 2013). As for rural districts, some are overwhelmingly white, sparsely populated, and conservative, but in many cases, they also include countervailing concentrations of progressive voters surrounding colleges, resort communities, mines, 19th century manufacturing outposts, or Native American reservations.

These initial findings motivate the remainder of the paper: in the middle of each states' distribution of districts lies a set of potentially pivotal districts that are ideologically moderate on average, but where voters are often quite heterogeneous and characterized by a lower density of moderates than one might expect. Moreover, this within-district ideological heterogeneity is a good predictor of polarization in state legislatures.

But given the logic of the median voter, why would electoral competition in these pivotal but heterogeneous districts generate such polarized legislative representation? The remainder of the paper develops a simple intuition: relative to a homogeneous district where voters are clustered around the district median, candidates in such heterogeneous districts face weaker incentives for platform convergence due to uncertainty about the ideology of the median voter.

A FORMAL MODEL

In this section, we extend a canonical model of electoral competition to provide some intuition about a possible of linking heterogeneity to polarization. Following Wittman (1983) and Calvert (1985), assume that there are two political parties with preferences over a single policy dimension X. Party L prefers that policies be as low as possible and party R wants policy to be as high as possible.[6] Thus $u_R(x) = x$ and $u_L(x) = -x$.

---

[5] Maps made in ArcMap 10.3.1 using data from the Harvard Election Data Archive (Ansolabehere, Ban and Snyder 2017) and the National Historical Geographic Information System (Manson et al. 2017). See the Online Replication archive for further details.

[6] The assumption that each party has monotonic preferences greatly simplifies the exposition. If each party had an interior ideal point, the basic results would not change.

(a)

(b)
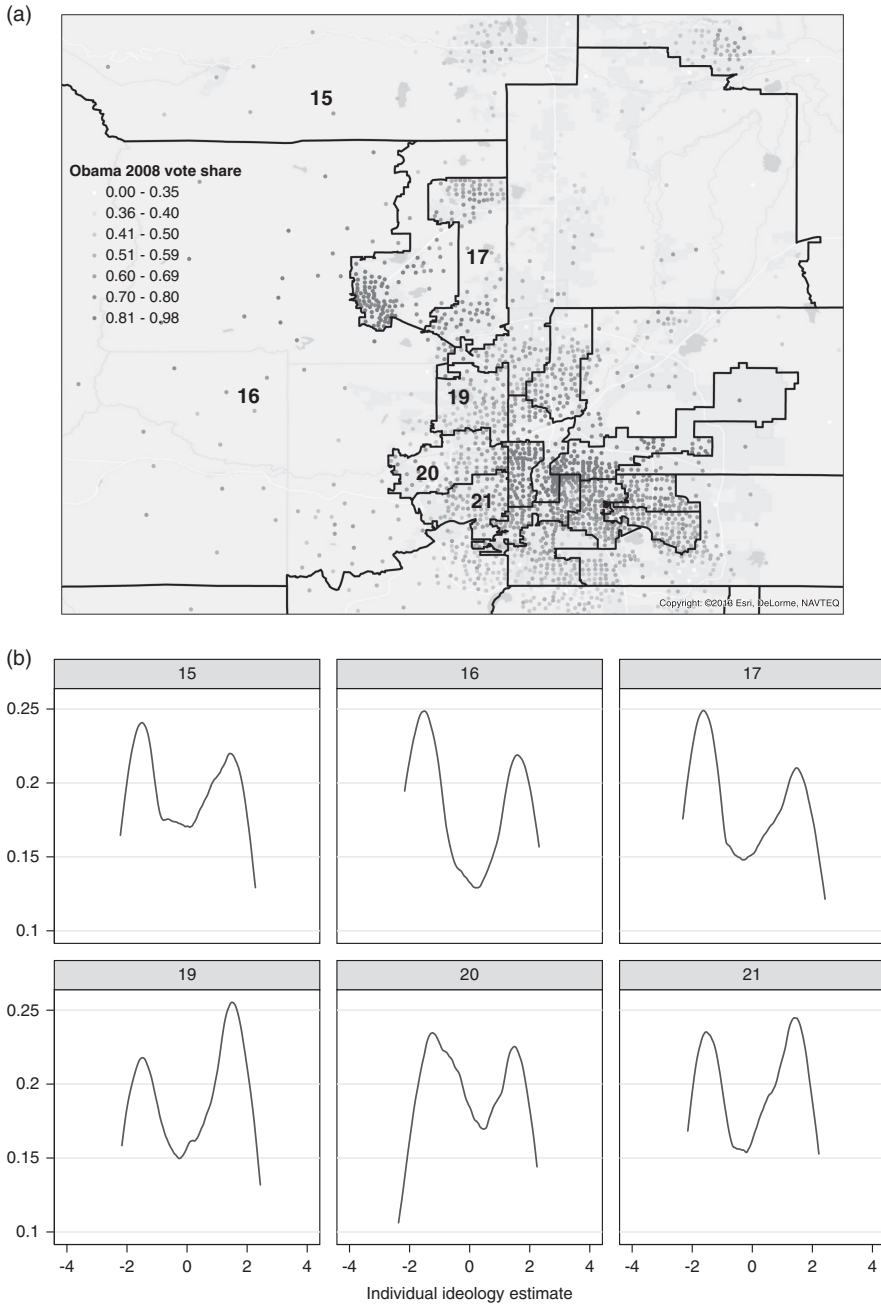
Fig. 4. Within-district distributions of votes and ideology, selected Colorado senate districts
Note: (a) Precinct-level 2008 Obama vote share; (b) within-district distribution of ideology, pivotal districts.

We assume that the parties are uncertain about the distribution of preferences among voters who will turnout in a general election. The parties share common beliefs that the ideal point of the median (and decisive) voter m is given by probability function F. We assume that the median voter has preferences that are single-peaked and symmetric around m.

Prior to the election, parties L and R commit to platforms x_L and x_R.[7] Voter m votes for the party with the closest platform. Therefore, party L wins if and only if $m \leq \frac{x_L + x_R}{2}$. Therefore, we may write the payoffs for the parties as follows:

$$U_L(x_L, x_R) = F\left(\frac{x_L + x_R}{2}\right) u_L(x_L) + \left[1 - F\left(\frac{x_L + x_R}{2}\right)\right] u_L(x_R), \qquad (1)$$

and

$$U_R(x_L, x_R) = F\left(\frac{x_L + x_R}{2}\right) u_R(x_L) + \left[1 - F\left(\frac{x_L + x_R}{2}\right)\right] u_R(x_R). \qquad (2)$$

The first-order conditions for optimal platforms are[8]

$$-F\left(\frac{x_L + x_R}{2}\right) + \frac{1}{2}\left[F'\left(\frac{x_L + x_R}{2}\right)\right](x_R - x_L) = 0, \qquad (3)$$

$$\left[1 - F\left(\frac{x_L + x_R}{2}\right)\right] - \frac{1}{2}\left[F'\left(\frac{x_L + x_R}{2}\right)\right](x_R - x_L) = 0. \qquad (4)$$

It is straightforward to establish that convergence is not an equilibrium. Suppose $x_L = x_R = x$, then the first-order conditions become $F(x) = 1 - F(x) = 0$ which obviously cannot hold. Thus, the only candidate equilibrium is one where $x_L^* < x_R^*$. Thus, when there is uncertainty about the median voter, the candidates diverge in equilibrium. Conversely, if the median voter is known with certainty, then candidates converge as predicted by Downs.

Now, we can establish the direct relationship between uncertainty and polarization by re-writing the first-order conditions as:

$$\frac{F'(\tilde{x})}{F(\tilde{x})} = \frac{F'(\tilde{x})}{1 - F(\tilde{x})} = \frac{2}{x_R - x_L}, \qquad (5)$$

where $\tilde{x} \equiv \frac{x_L + x_R}{2}$. Equation 5 implies that $1 - F(\tilde{x}) = F(\tilde{x})$ which implies that $\tilde{x}$ equals the median of F, $\overline{m}$. Moreover, $x_R - x_L = \frac{1}{F'(\overline{m})}$.

This result is summarized in Proposition 1.

PROPOSITION 1: Let F be a distribution function with median $\overline{m}$, then

  (a) there exists a pure strategy Nash equilibrium such that $x_L^* = \overline{m} - \frac{1}{2F'(\overline{m})}$ and $x_R^* = \overline{m} + \frac{1}{2F'(\overline{m})}$,
  (b) the level of divergence is $x_R^* - x_L^* = \frac{1}{F'(\overline{m})}$.

The upshot of the proposition is that the divergence between candidates is proportional to the inverse of the density at the median of the distribution of median voters. When there is a lot of mass around the median of the distribution, electoral competition drives the parties toward convergence. When there is less mass around the median and more in the tails, policy-seeking parties will choose more divergent candidates.

To generate an observable comparative static on the distribution of median voters, we assume somewhat more structure for F. Let F be a member of the symmetric, scalable family of distributions so that $F(m) = \overline{F}(\frac{m - \overline{m}}{\sigma})$ where $\overline{F}$ is a symmetric distribution with mean and median of $\overline{m}$. Since $\overline{F}$ is symmetric, the scale parameter σ induces mean- and median-preserving spreads, and

---

[7] In equilibrium, it must be the case that $x_L \leq x_R$ otherwise each party would prefer to lose to the other.
[8] The second-order conditions will be met so long as F is neither too concave nor convex.

is thus directly related to the variance of m. With these additional assumptions, the equilibrium candidate divergence is $x_R^* - x_L^* = \frac{\sigma}{F'(0)}$. Thus, divergence is directly proportional to σ and is consequently increasing in the variance of m. This result is stated in the following corollary.

COROLLARY 1: If F is symmetric, scalable distribution, in the symmetric Nash equilibrium described in Proposition 1, the equilibrium level of divergence is increasing in the variance of m.

To illustrate the proposition and corollary, consider a couple of examples. First, assume that m is distributed normally with mean 0 and standard deviation s. In this case, $x_R^* - x_L^* = s\sqrt{2\pi}$. Therefore, the equilibrium level of divergence is increasing in s. Similarly assume that m is distributed $u[-a, a]$, $x_R^* - x_L^* = 2a$. Therefore divergence is increasing in a and hence the variance of m.[9]

Our results establish that uncertainty about the median voter can contribute to candidate divergence. The next step is to connect uncertainty about the median voter to the underlying preference heterogeneity of the district. To motivate this connection, we assume that beliefs about the distribution of the district median are formed by public pre-election polls of the district.

To keep things simple, assume that parties do not know the distribution of the median voter, have diffuse priors, and rely on a poll with sample size N to generate posterior beliefs about the distribution of m. Let $G(x)$ be the distribution function for voter ideal points. Let μ be the median ideal point and σ^2 be the variance of ideal points—our measure of heterogeneity.

A standard result from sampling theory suggests that the sample median from a poll of N voters is asymptotically distributed normally with mean μ and $s^2 = \frac{1}{4(N+1)(G'(\mu))^2}$. Therefore, the variance in the estimate of the median ideal point is a decreasing function of the density of median voter in the district. In turn this implies that the equilibrium level of divergence following a public poll would be

$$x_R^* - x_L^* = \sqrt{\frac{\pi}{2(N+1)G'(\mu)^2}}.$$

Thus, given enough data to precisely estimate the density of the median of each district, we could use those estimates as predictors of the level of divergence between the candidates in the district. Unfortunately, while we have a relatively large number of observations per district, precise estimation of the densities $G'(\mu)$ remains formidable. But we can, however, use the variance of the distribution in each district as a proxy. For example, if the distribution of voter ideal points is normal, we can directly relate the variance of the estimated median to the variance of the overall median so that $s^2 = \frac{\sigma^2 \pi}{2(N+1)}$.[10] Thus, the equilibrium divergence is $x_R^* - x_L^* = \frac{\sigma\pi}{\sqrt{N+1}}$.

---

[9] Below we justify the restriction to symmetric distributions of m, but it is worth noting that the linkage between divergence and the variance of m holds for a wide variety of non-symmetric distributions. These include the exponential, Weibull, log-normal, logisitic, and log-logistic distributions.

[10] One concern is the assumption that N is exogenous to the heterogeneity in the district. Perhaps, large-sample sizes will be used in heterogeneous districts so as to produce as precise estimates of the median as in homogeneous districts. It is worth noting, however, that the parties have no incentive to contribute to a *public* poll. Doing so would reduce divergence without changing the electoral probabilities. Since the parties are policy-motivated, both would be worse off. Suppose, however, that the polls were conducted by the news media with the goal of reducing divergence. Suppose the media perceives a linear loss in divergence, but must pay ε per polling respondent. In the case of normally distributed voter ideal points, the optimal sample size is $N^* = \left(\frac{\sigma\pi}{2\varepsilon}\right)^{\frac{2}{3}} - 1$. Therefore, the equilibrium divergence is $(2\sigma^2\pi^2\varepsilon)^{\frac{1}{3}}$ which is still an increasing function of σ. So while the press does poll more in heterogeneous electorates, uncertainty about the median voter continues to be related to the variance of voter ideal points.

For other distributions, the relationship between $G'(\mu)$ and σ^2 is less direct. But there is a large class of parametric distributions for which the density at the median is lower when the variance is larger. Any symmetric distribution such as the *t*-distribution, uniform, and others symmetric beta family must have this property. Non-symmetric distributions with this property include the log-normal, exponential, and Weibull.

The arguments above show a direct relationship between the variance of the voter ideal points and the level of uncertainty about the location of the median voter for a wide variety of ideal point distributions. Other plausible features of elections also work to strengthen the relationship between heterogeneity and the residual uncertainty following the public poll. One empirically plausible feature is that voters with more extreme ideal points are more likely to turnout on election day. This, of course, has the effect of overweighting the voters with extreme preferences. Consequently, turnout would be generated by a weighted distribution where the weights are highest for extreme voters and lead to more uncertainty about the median following any poll.[11]

Another source of electoral uncertainty are partisan and ideological tides which may lead turnout to be higher or lower in different parts of the ideological spectrum from election to election. The effect of such tides are likely to be magnified in heterogeneous districts.[12]

One might also ask why we rely on measures of heterogeneity rather than directly measure F, the probability distribution of the median voter. The simplest answer is that estimates of F are infeasible. Only recently have district-level data on voter preferences become available. However, even if we could estimate median voters for a set of longitudinal data on each district, this empirical distribution may not closely match the F that is observed by the parties in a specific election. Rational political actors must forecast conditions for each race based on possibly unique features of down-ballot and up-ballot races on the ideological composition of the electorates. A researcher who wishes to estimate F is in the unenviable position of modeling the *ex ante expected* turnout effects of many different candidates in many different races. Such a modeling exercise, even if feasible, is beyond the scope of this paper.

While the variance of the distribution of preferences is an imperfect predictor of electoral uncertainty, we have shown that the variance of voter ideal points will be associated with electoral uncertainty in a broad class of distributions and assumptions. We recognize that there are many theoretical possibilities that could motivate the link between heterogeneous preferences and legislative polarization. Our intention is to demonstrate one such possibility as a starting point. We would encourage other researchers to examine competing theoretically motivated explanations.

RESEARCH DESIGN

Our formal model suggests the following empirical strategy. We would like to estimate the model:

$$divergence_i = \beta V(m_i) + \gamma z_i + \epsilon_i, \tag{6}$$

where $divergence_i$ is the distance between the two-candidates in district i, $V(m_i)$ the variance of the median voter in district i, and z_i a set of control variables. The theoretical model suggests that $\beta > 0$. Unfortunately, we only observe the winning candidates of the elections. Therefore,

---

[11] See the working paper version for a formalization of this argument where we also prove for the case of symmetric distributions, distributions of ideal points with larger variances produce more electoral uncertainty when turnout is correlated with extreme preferences. Again polling estimates of the median "likely voter" will contain more uncertainty when the variance of ideal points in larger. Thus, heterogeneous districts will generate more electoral uncertainty even when turnout is correlated with extreme preferences.

[12] The working paper version of this article uses a simple model of tides to show that variation in electoral tides increases the post-polling uncertainty of the median voter to a larger degree in heterogeneous districts.

we follow the approach of McCarty, Poole and Rosenthal (2009), who decompose partisan polarization into roughly two components. The first part, which they term *intradistrict divergence* is simply the difference between how Democratic and Republican legislators would represent the same district. The remainder, which they term *sorting*, is the result of the propensity for Democrats to represent liberal districts and for Republicans to represent conservative ones.[13]

To formalize the distinction between divergence and sorting, we can write the difference in party mean ideal points as

$$E(x|R) - E(x|D) = \int \left[E(x|R,z) \frac{p(z)}{\overline{p}} - E(x|D,z) \frac{1 - p(z)}{1 - \overline{p}} \right] f(z) dz,$$

where x is an ideal point, R and D are indicators for the party of the representative, and z a vector of district characteristics. We assume that z is distributed according to density function f and that $p(z)$ is the probability that a district with characteristics z elects a Republican. The term $\overline{p}$ is the average probability of electing a Republican. The average difference between a Republican and Democrat representing a district with characteristics z, $E(x|R,z) - E(x|D,z)$, captures the intradistrict divergence, while variation in $p(z)$ captures the sorting effect.

Estimating the average intradistrict divergence (AIDD) is analogous to estimating the average treatment effect of the non-random assignment of party affiliations to representatives. There is a large literature discussing alternative methods of estimation for this type of analysis. For now we assume that the assignment of party affiliations is based on observables in the vector z. If we assume linearity for the conditional mean functions, that is, $E(x|R, z) = \beta_1 + \beta_2 R + \beta_3 z$, we can estimate the AIDD as the ordinary least squares (OLS) estimate of β_2.

Our claim is that the AIDD is a function of uncertainty over the location of the median voter within districts which we have proxied by the variance of the voter's ideal points. We use two empirical strategies to examine whether the AIDD is greater in more heterogeneous districts. First, we use OLS-based regression models of the form:

$$x_i = \alpha + \beta_1 V(m_i) + \beta_2 Party_i + \beta_3 V(m_i) x Party_i + \gamma z_i + \delta_{j[i]} + \epsilon_i, \tag{7}$$

where x_i is the ideological position of the incumbent in district i, $Party_i$ an indicator that equals 1 if the incumbent is a Republican and -1 if she is a Democrat, γ a vector of district-level covariates, and δ a random effect for each census division or state. If $V(m)$ has a polarizing effect, $\beta_3 > 0$ as it moves Republicans to the right and Democrats to the left.

One complication is that there may be unobserved factors that lead to across-state variation in polarization (i.e., the distance between parties within each state). For instance, variation in primary type or other institutions could affect polarization. As a result, we subset the data and estimate the model separately for each party. This allows us to use census division and state-level random coefficients to account for anytime invariant, unobserved factors lead to across-state variation in polarization within parties. Thus, our regression models show the relationship between legislators' ideal points and the amount of district-level heterogeneity *within each census division or state*, depending on the model. This specification also allows β and other coefficients to vary across parties.

Second, because the functional forms used in our OLS models are somewhat restrictive, we also use matching estimators to check the robustness of our main results (Ho et al. 2007). Intuitively, these estimators match observations from a control and treatment group that share similar characteristics z and then compute the average difference in roll-call voting behavior

---

[13] This concept is closely related to what we refer to above as between-district polarization.

for the matched set. We use the bias-corrected estimator developed by Abadie and Imbens (2006) and implemented in R using the Matching package (Sekhon 2011).[14] Following McCarty, Poole and Rosenthal (2009) and Shor and McCarty (2011), we use matching techniques to estimate the *average district divergence* for districts with different levels of $V(m_i)$. Specifically, we use matching to estimate the AIDD for districts with "high" and "low" levels of heterogeneity. We define districts with "high" levels of heterogeneity as those that are above the national median, and those with "low" levels of heterogeneity as those that are below the national median.

We estimate the position of the median voter in each district using the approach described in Tausanovitch and Warshaw (2013). Specifically, we combine our super-survey of 350,000 citizens' policy preferences with a multilevel regression with post-stratification (MRP) model. Previous work has shown that MRP-based models yield accurate estimates of the public's preferences at the level of states (Park, Gelman and Bafumi 2004; Lax and Phillips 2009) as well as congressional and state legislative districts (Warshaw and Rodden 2012; Tausanovitch and Warshaw 2013). As a robustness check, we also run all of our models using presidential vote share in each district as a proxy for the position of the median voter.

Finally, we estimate the variance of the median voter in district i based on the standard deviation of the electorate's preferences in each district in the large data set of citizens' ideal points from Tausanovitch and Warshaw (2013) (Gerber and Lewis 2004; Levendusky and Pope 2010; Ensley 2012; Harden and Carsey 2012). In Supplementary Appendix B, we also use an alternative measure of the heterogeneity of preferences in each district that eliminates the possibility that the measure is influenced by sample size. Our results are substantively similar using both definitions of the variance of the median voter in each district.

RESULTS

In this section, we present our main results on the link between the variance of the median voter in each senate district and polarization in legislators' roll-call behavior.[15] Before reporting on the multilevel and matching models, we first present some graphical evidence for our argument. Figure 5 shows how legislator ideology changes with district opinion. The three panels represent terciles of district heterogeneity, with the leftmost (or "first") the least heterogeneous, and the rightmost ("third") the most heterogeneous. Each point represents a unique legislator serving sometime between 2003 and 2012, with Republicans represented with triangles and Democrats with circles. Both parties are responsive to district opinion, with more conservative districts being represented by more conservative legislators. Nevertheless, a distinct separation between the parties is quite evident. More central to our point, that divergence is largest for the most heterogeneous districts.

We now turn to our multilevel analyses which are presented in Table 1. The unit of analysis is the unique legislator in Shor and McCarty's (2011) data that served at some point between 2003 and 2012. The two columns show results of a simple multilevel model with varying intercepts for census divisions.[16] The results indicate that both Democratic and Republican state legislators take substantially more extreme positions in more ideologically heterogeneous districts. AIDD is clearly a function of ideological heterogeneity in the district. Controlling for mean district ideology, the difference between the roll-call voting behavior of Democrats and Republicans within states is

---

[14] We match on the position of the median voter in each district.

[15] In Supplementary Appendices C and D, we show substantively similar findings in both state houses and the US House.

[16] In Supplementary Appendix B, we show that we obtain similar results using varying intercepts for each state.
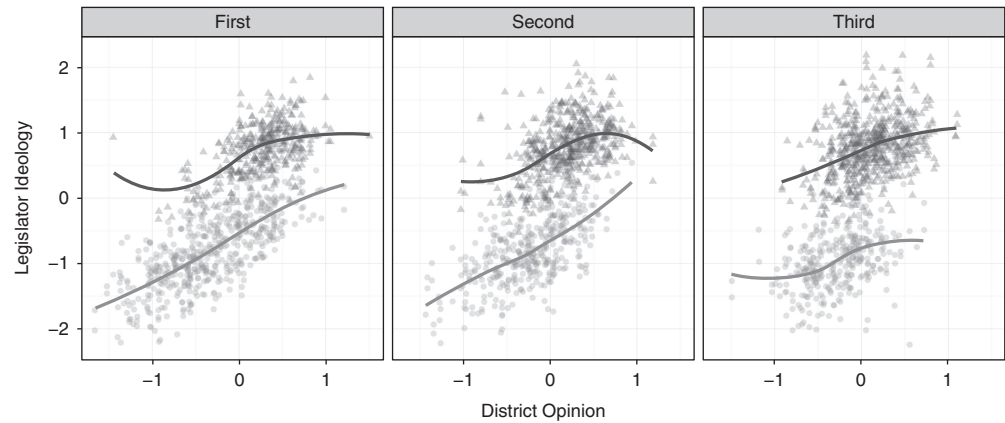
Fig. 5. Scatterplot of legislator ideology and state senate district opinion, by heterogeneity tercile
Note: Republicans are represented with triangles and Democrats with circles.

TABLE 1   *Heterogeneity: Upper Chamber Score Models (Multilevel)*

	Dependent Variables	
	Legislator Score	
	R	D
	(1)	(2)
Heterogeneity	0.44***	−0.32***
	(0.10)	(0.10)
Citizen ideology	0.84***	0.85***
	(0.06)	(0.04)
Constant	0.05	−0.30**
	(0.15)	(0.15)
Observations	1501	1322
Log likelihood	−607.87	−510.19
Akaike information criterion	1225.74	1030.38
Bayesian information criterion	1252.31	1056.31

Note: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

largest in districts that are most heterogeneous, and smallest in the most homogeneous districts.[17] Suggestively, the effect for Republicans appears somewhat higher than that for Democrats (though the difference is not significant at conventional levels). We also find substantively similar results using an alternate measure of ideological heterogeneity which adjusts for sample size at a cost to overall statistical power.[18]

To get a better idea of the size of the effect, consider the first two columns of Table 1. A shift from one-half of a standard deviation below the mean in our heterogeneity measure to one-half of a standard deviation above the mean (from 1.25 to 1.36), while keeping district opinion

---

[17] While the theoretical model suggests that we should control for the expected median, we instead use estimates of the mean voter position that we obtain from MRP estimates. Using presidential vote by district returns the same results.

[18] The details of our analysis using this alternative measure are discussed in Supplementary Appendix B.
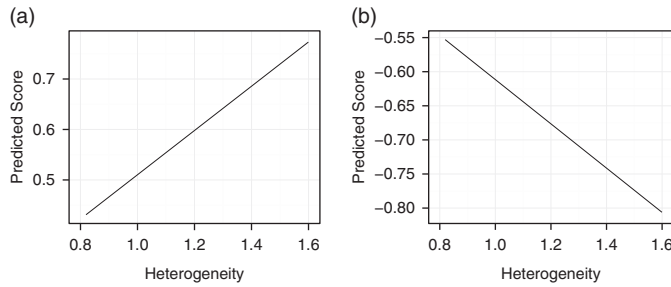
Fig. 6. Predicted values of Republican (a) and Democratic (b) ideal points as a function of district heterogeneity

constant at its mean, is predicted to make Republican legislator ideal points 0.05 units more conservative and Democratic ideal points 0.04 units more liberal. This total 0.09 point shift in AIDD due to an increase of 1 SD of heterogeneity is ~24.2 percent of the mean standard deviation of state legislator ideology by state.[19] Figure 6 shows these effects more vividly. A district with heterogeneity less than 1.0 can expect to be represented by a moderate, regardless of party. In contrast, districts with heterogeneity of 1.4 or more can expect to be represented by a legislator who is from the extremes of their party.

Finally, as discussed above, we use matching estimators to check the robustness of our main results. The matching approach tells a similar story to the OLS models. AIDD is substantially greater among matched districts that are more heterogeneous than in those that contain more homogeneous electorates. Table 2 shows that the AIDD in heterogeneous districts is 25 percent greater than in the more homogeneous districts.

Clearly, the use of random effects and matching cannot eliminate all concerns about omitted variable bias. To better account for this possibility, we also examine the subset of districts that have been represented by both parties. We do this in two ways. First, we isolate those districts that have elected members from both parties at some point in this decade. Then we measure within-district party divergence as the difference in the average ideal point score of these Democrats and Republicans. Our second approach cuts an even finer distinction. Here, we look at districts that have elected members from both parties *within the same year*. This would be the case for multi-member districts,[20] or in the context of a within-year transition from one party to the other due to a special election or appointment because of resignation or death. Figure 7 plots divergence as a function of district opinion heterogeneity in either set of districts. The results are striking; district heterogeneity and legislator partisan divergence are quite strongly related.[21]

One final objection to the conclusions above is that our results may be capturing the effects of primary elections or other nominating contests. We address this in Supplementary Appendix E

---

[19] The interquartile range is associated with an increase in divergence of 0.11, or 30.4 percent of the mean standard deviation of state legislator ideology by state, while comparing the 95th percentile heterogeneity district to a 5th percentile district is predicted to increase divergence by 0.28, or 77.6 percent of this benchmark.

[20] This is analogous to comparing two US Senators from the two parties, taking advantage of the fact of their common constituency.

[21] The obvious remaining concern is that the districts that have switched party control are not a random sample of all districts. But such districts represent exactly those properties that we expect of moderate districts—high levels of party competition and legislative turnover. So the fact that we find a strong association of divergence and heterogeneity in such districts bolsters our broader point.

TABLE 2   *Matching Estimates of the Average Intradistrict Divergence (AIDD) (Average Treatment Effect) in the Upper Chamber*

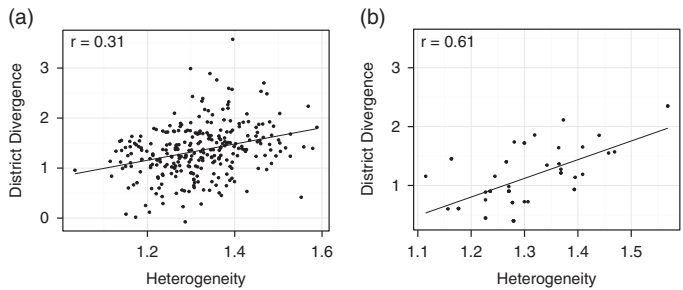|	No. of Observations	No. of Representatives	AIDD	SE
Overall	3396	1784	1.27	0.02
High heterogeneity	1409	864	1.45	0.04
Low heterogeneity	1414	637	1.15	0.04

Fig. 7. Scatterplot of district heterogeneity and partisan divergence
Note: (a) Within-district: compares the difference between the average ideology of Republicans and Democrats representing a single district anytime from 2003 to 2013. (b) Within-district, within-year: compares the differences between the two parties for districts with multiple representatives for a given year, due either to multi-member districts or mid-year replacement.

using analysis that pits our theory against a theory based on primaries. The results are more consistent with a theory based on uncertainty over the median voter.

DISCUSSION AND CONCLUSION

Our key findings can be summarized as follows. Partisan polarization within state legislatures emerges in large part from the fact that Democrats and Republicans represent districts with similar mean characteristics very differently. We have discovered that these differences are especially large in districts that are most internally heterogeneous. Further, we have discovered that these internally diverse districts are especially prevalent in the ideologically "centrist" places that most frequently change partisan hands in the course of electoral competition.

In other words, moderates are often not efficiently clustered in districts where they can dominate. We have identified a class of districts that are moderate on average without containing large densities of moderates. When candidates compete in these internally polarized districts in heterogeneous suburbs and spatially diverse non-metropolitan areas, they face weak incentives to adopt moderate platforms and build up moderate roll-call voting records. Rather, they can cater to primary constituents, donors, activists, or other forces that pull the parties away from the ideological center. We have motivated this intuition with a theoretical model focusing on the candidates' uncertainty about the ideology of the median voter on election day when the district does not contain a large density of moderates. Aggregating up to the level of states, we have shown that the states with the highest levels of within-district ideological polarization are also those with the highest levels of partisan polarization in the legislature.

Our analysis suggests several avenues for further research. First of all, as larger district-level public opinion samples become available with a longitudinal element, future research might
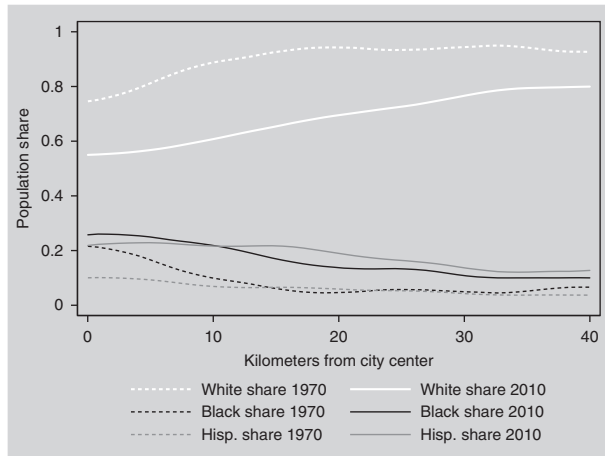
Fig. 8. Race, ethnicity, and distance from city center

focus more explicitly on the relationship between fluctuations in turnout and the identity of the median voter in different types of districts. Second, it would be useful to develop and test hypotheses about the potential role of primaries and campaign finance in generating divergence of voting behavior in heterogeneous districts.

Third, it would be useful to examine whether within-district heterogeneity has risen over time, and whether this can be connected to the rise of polarization in the US House, senate, and state legislatures. We have noted above that many of the ideologically heterogeneous districts are in suburbs that have experienced rapid population change. To visualize this trend, we have collected census tract-level data on race, and measured the distance of the centroid of each tract from the city center in each of the 100 largest metro areas in the United States. Using all of the tracts across 100 cities, Figure 8 displays population shares of African Americans, Latinos, and whites against the distance from the relevant city center, first in 1970 and then in 2010.

Figure 8 illuminates a major demographic transformation. If we define suburbia as beginning around 8 km from the city center, we see that inner suburbs were around 85 percent white in 1970, but on average they are barely over 50 percent white today. While falling with distance from the city center, racial heterogeneity extends well out into the middle and more distant suburbs as well. Latinos and especially African Americans were once clustered in city centers, but they are now spread throughout the suburban periphery.

The geography of income has also transformed during the same period. Figure 9 displays box plots of average inflation-adjusted tract-level household income by distance from the city center, first in 1970 and then in 2010. It shows that the heterogeneity of income has grown dramatically throughout metro areas, especially in the suburbs. When legislative districts are drawn in the suburbs, they are likely to encompass an increasingly heterogeneous group of voters with respect not only to race, but also income.

Finally, our analysis has implications for debates about legislative districting reform. A common claim is that polarization emerges because districts have become too homogeneous, as like-minded Americans have moved into similar communities and politicians have drawn incumbent-protecting gerrymanders. Some reformers advocate the creation of more hetero-geneous districts, like California's sprawling and diverse state senate districts, in order to
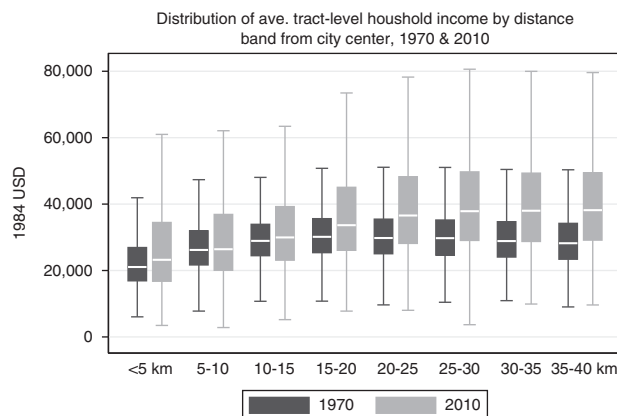
Fig. 9. Income and distance from city center

enhance political competition and encourage the emergence of moderate candidates. This paper turns this conventional wisdom on its head. When control of the legislature hinges on fierce competition within internally polarized winner-take-all districts, candidates, and parties do not necessarily face incentives for policy moderation.

REFERENCES

Abadie, Alberto, and Guido W. Imbens. 2006. 'Large Sample Properties of Matching Estimators for Average Treatment Effects'. *Econometrica* 74(1):235–67.

Ansolabehere, Stephen, James M. Snyder, Jr., and Charles Stewart, III. 2001. 'Candidate Positioning in U.S. House Elections'. *American Journal of Political Science* 45(1):136–59.

Ansolabehere, Stephen, Pamela Ban, and James M. Snyder, Jr. 2017. 'Harvard Election Data Archive'. Available at https://dataverse.harvard.edu/dataverse/eda, accessed 25 August 2011.

Bafumi, Joseph, and Michael C. Herron. 2010. 'Leapfrog Representation and Extremism: A Study of American Voters and their Members in Congress'. *American Political Science Review* 104(3): 519–42.

Bailey, Michael, and David W Brady. 1998. 'Heterogeneity and Representation: The Senate and Free Trade'. *American Journal of Political Science* 42(2):524–44.

Barber, Michael J., and Nolan McCarty. 2013. 'Causes and Consequences of Polarization'. In Jane Mansbridge and Cathie Jo Martin (eds), *Negotiating Agreement in Politics*, 19–53. Washington, DC: American Political Science Association.

Bishin, Benjamin G., Jay K. Dow, and James Adams. 2006. 'Does Democracy "Suffer" from Diversity? Issue Representation and Diversity in Senate Elections'. *Public Choice* 129(1–2):201–15.

Calvert, Randall L. 1985. 'Robustness of the Multidimensional Voting Model: Candidate Motivations, Uncertainty, and Convergence'. *American Journal of Political Science* 29(1):69–95.

Clinton, Joshua D. 2006. 'Representation in Congress: Constituents and Roll Calls in the 106th House'. *Journal of Politics* 68(2):397–409.

Downs, Anthony. 1957. *An Economic Theory of Democracy*. New York: Columbia University Press.

Ensley, Michael J. 2012. 'Incumbent Positioning, Ideological Heterogeneity and Mobilization in US House Elections'. *Public Choice* 151(1–2):43–61.

Fiorina, Morris P. 1974. *Representatives, Roll Calls, and Constituencies*. Lexington, MA: Lexington Books.

Fiorina, Morris P., and Samuel J. Abrams. 2008. 'Political Polarization in the American Public'. *Annual Review of Political Science* 11:563–88.

Fiorina, Morris P., and Samuel A. Abrams. 2010. 'Where's the polarization?' In Richard G. Niemi, Herbert F. Weisberg and David C. Kimball (eds), *Controversies in Voting Behavior*, 309–318. Washington, DC: CQ Press.

Gerber, Elisabeth R., and Jeffrey B. Lewis. 2004. 'Beyond the Median: Voter Preferences, District Heterogeneity, and Political Representation'. *Journal of Political Economy* 112(6): 1364–1383.

Harden, Jeffrey J., and Thomas M. Carsey. 2012. 'Balancing Constituency Representation and Party Responsiveness in the US Senate: The Conditioning Effect of State Ideological Heterogeneity'. *Public Choice* 150(1–2):137–54.

Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth A. Stuart. 2007. 'Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference'. *Political Analysis* 15(3):199–236.

Jacobson, Gary. 2004. 'Explaining the Ideological Polarization of the Congressional Parties since the 1970s'. Paper presented at the Annual Meeting of the Midwest Political Science Association, Palmer House Hilton, Chicago, IL, 15 April. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1157024, accessed 1 February 2014.

Jones, David R. 2003. 'Position Taking and Position Avoidance in the US Senate'. *Journal of Politics* 65(3):851–63.

Kirkland, Justin H. 2014. 'Ideological Heterogeneity and Legislative Polarization in the United States'. *Political Research Quarterly* 67(3):533–46.

Lax, Jeffrey R., and Justin H. Phillips. 2009. 'How Should we Estimate Public Opinion in the States?'. *American Journal of Political Science* 53(1):107–21.

Levendusky, Matthew. 2009. *The Partisan Sort: How Liberals Became Democrats and Conservatives Became Republicans*. Chicago: University of Chicago Press.

Levendusky, Matthew S., and Jeremy C. Pope. 2010. 'Measuring Aggregate-Level Ideological Heterogeneity'. *Legislative Studies Quarterly* 35(2):259–82.

Manson, Steven, Jonathan Schroeder, David Van Riper, and Steven Ruggles. 2017. 'PUMS National Historical Geographic Information System: Version 12.0 [Database]'. Available at http://doi.org/10.18128/D050.V12.0, accessed 18 December 2014.

Masket, Seth E., Jonathan Winburn, and Gerald C. Wright. 2012. 'The Gerrymanderers are Coming! Legislative Redistricting Won't Affect Competition or Polarization Much, No Matter Who Does It'. *PS: Political Science & Politics* 45(1):39–43.

McCarty, Nolan, Keith T. Poole, and Howard Rosenthal. 2006. *Polarized America: The Dance of Ideology and Unequal Riches*. Boston: MIT Press.

McCarty, Nolan, Keith T. Poole, and Howard Rosenthal. 2009. 'Does Gerrymandering Cause Polarization?'. *American Journal of Political Science* 53(3):666–80.

Miller, Warren E., and Donald E. Stokes. 1963. 'Constituency Influence in Congress'. *American Political Science Review* 57(1):45–56.

Orfield, Myron, and Thomas Luce. 2013. 'America's Racially Diverse Suburbs: Opportunities and Challenges'. *Housing Policy Debate*, 23(2):395–430.

Park, David K., Andrew Gelman, and Joseph Bafumi. 2004. 'Bayesian Multilevel Estimation with Poststratification: State-Level Estimates from National Polls'. *Political Analysis* 12:375–85.

Poole, Keith T., and Howard Rosenthal. 1997. *Congress: A Political-Economic History of Roll Call Voting*. New York: Oxford University Press.

Rodden, Jonathan. 2015. 'Geography and Gridlock in the United States'. In Nathaniel Persily (ed.), *Solutions to Political Polarization in America*, 104–20. Cambridge: Cambridge University Press.

Sekhon, Jasjeet S. 2011. 'Multivariate and Propensity Score Matching Software with Automated Balance Optimization: The Matching package for R'. *Journal of Statistical Software* 42(7):1–52.

Shor, Boris. 2014. 'Congruence, Responsiveness, and Representation in American State Legislatures'. Paper presented at 2014 Annual Meeting of the American Political Science Association, Washington, DC, 30 July. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1697352, accessed 1 November 2014.

Shor, Boris, and Nolan McCarty. 2011. 'The Ideological Mapping of American Legislatures'. *American Political Science Review* 105(3):530–51.

Stephanopoulos, Nicholas. 2012. 'Spatial Diversity'. *Harvard Law Review* 125(1):1903–2010.

Tausanovitch, Chris, and Christopher Warshaw. 2013. 'Measuring Constituent Policy Preferences in Congress, State Legislatures, and Cities'. *Journal of Politics* 75(2):330–42.

Warshaw, Christopher, and Jonathan Rodden. 2012. 'How Should we Measure District-Level Public Opinion on Individual Issues?'. *Journal of Politics* 74(1):203–19.

Wittman, Donald. 1983. 'Candidate Motivation: A Synthesis of Alternative Theories'. *The American Political Science Review* 77(1):142–57.