Estimating Vote-Specific Preferences from Roll-Call Data using Conditional Autoregressive Priors*

Benjamin E. Lauderdale
Associate Professor
Department of Methodology
London School of Economics
b.e.lauderdale@lse.ac.uk

Tom S. Clark
Asa Griggs Candler Professor
Department of Political Science
Emory University
tom.clark@emory.edu

April 24, 2015

ABSTRACT

Ideal point estimation in political science usually seeks to reduce a matrix of voting data to a small number of preference dimensions. We argue that taking a non-parametric perspective, attempting to estimate vote-specific preferences for each individual, can yield measures that are a more useful starting point for some kinds of subsequent analysis. We propose a conditional autoregressive preference measurement model, which we use to generate case-specific preference estimates for US Supreme Court justices from 1946 to 2005, with legal similarity conditioning the correlation of each justice's preferences across cases. Using the resulting estimates, we are able to show that the varying relative legal positions taken by justices across areas of law condition the opinion assignment strategy of the Chief Justice and the decisions of all Justices as to whether to join the majority opinion. Unlike previous analyses that have made similar claims, we are able to hold constant the identities of the justices involved, providing much stronger evidence that justices are strategically responsive to each others' relative positions on a case-by-case basis rather than simply their average relative preferences.

*We thank Andrew Martin and Maya Sen for helpful comments and suggestions. Earlier versions of this paper were presented at the 2013 meetings of the European Political Science Association and the American Political Science Association, the Princeton University Public Law Colloquium, and at Emory University.

1. INTRODUCTION

Ideal point estimation in political science usually seeks to reduce a matrix of voting data to a small number of preference dimensions. This process can be motivated through a theoretical model of spatial voting, but it can also be motivated as a simple exercise in data reduction. The resulting estimates of individual preferences have facilitated a wide range of subsequent analysis, because they translate the original voting data into a form which is comparable and amenable to including in a regression model. There is no questions that having one or two numbers to summarize the behavior of a political actor, relative to others, has many attractive features for subsequent analysis. However, it also makes certain kinds of analysis difficult.

When used to test theories of bargaining in legislatures or courts, such measures require one to rely on weakly-identified temporal variation (Ho and Quinn 2010) or prevent one from holding the composition of the legislature or court constant. Without holding the set of voters constant, it is impossible to adjudicate whether it is actually political preferences or some other stable features of individuals that are the origin of the patterns that are observed. Going from individual votes to summary measures has the consequence of eliminating from the data all within-individual variation. In this paper, we develop the idea that vote-specific measures enables us to look at within-individual variation in behavior across different kinds of votes, where legislators or judges' allies may be different, even as the set of individuals remains the same. If we want to make an argument that the patterns we observe are due to strategic interactions, where actors look at what other actors want in the given instance and respond accordingly, identification is greatly improved if we can exploit variation in relative preferences of the same individuals across different decisions.

This is not merely an argument about statistical identification. The application of the approach we develop in this paper is to the U.S. Supreme Court. Theories of judicial coalition-

building and opinion-writing in a single case implicate the case-specific preferences of justices, not their average preferences across all cases. If the justices do systematically vary in their relative alignment across areas of the law, the outcomes of these bargaining games should vary as a function of these alignments as well. Thus concern with preference variation by substantive issue is not about measuring modest fluctuations around more important general patterns, but rather more precisely identifying the implications of theories with minimum confounding.

To estimate case-specific preferences, we develop a model based on conditional autoregressive models commonly used in spatial statistics (Besag 1974). While we apply this model to the dispositional votes on U.S. Supreme Court cases, it is applicable to any other preference estimation problem where it is possible to produce a suitable similarity matrix for the votes based on metadata about the subject of the votes. This model smooths voting patterns across *substantive* similar cases to estimate relative preferences in individual cases. The resulting estimates of relative positions have significant uncertainty at the case level, however they nonetheless achieve the goal of enabling more credible identification strategies because they measure within-justice variation in preferences that can be used to make within-justice comparisons that have been previously unidentifiable.

To demonstrate how such estimates can be used as the starting point for subsequent analysis, we revisit a central question in the literature on the Supreme Court: how much influence do individual members of the Court exert over the majority opinion? In particular, we consider the assignment of opinion authorship to a member of the majority coalition and the decisions of all the justices in that coalition on whether to join the decision. We find evidence that chief justices strategically assign authorship to associate justices in cases where their preferences are more proximate, within the set of cases where the chief and a given associate justice are both in the majority. We also find evidence that justices who are in the majority are less likely to join the majority opinion in areas of law where their

preferences are further from the author, holding constant the identity of the author, the joining justice and the full set of justices serving on the court. Because these results are true holding justices fixed, as preferences vary by area of law, we interpret this as very strong evidence that the author's preferences influence the content of the opinion, and that chief justices are strategically responsive to this fact in making assignment decisions.

2. AUTOREGRESSIVE SPATIAL PREFERENCE ESTIMATION

Our estimation approach diverges from previous Bayesian ideal point estimators in several respects. We do not motivate our model using a random utility model that describes a choice between binary policy alternatives under spatial preferences (Poole 2005). For our purposes it is enough to assume that our voters (justices) have latent preferences for each side of each case relative to one another, and that these are correlated across cases. To this end, we do not aim to estimate a small (Jackman 2001), or even a large (Lauderdale and Clark 2014) number of dimensions to summarize behavior: we aim to estimate latent preferences on every vote. That is, we want to know which justices were close to the cutpoint in a case, and in what order of preferences they were likely to have been arranged. To learn this, instead of modeling the latent preferences on each vote in terms of a small number of latent dimensions, we estimate them conditional on each other, subject to an assumption that latent preferences are more similar on substantively similar cases than on substantively distant cases. From a more mechanical perspective, we aim to *smooth* the binary observations of justice votes into continuous measures of justice preferences, with the smoothing occurring across substantively similar cases.

To achieve this smoothing, our model for each justice's case specific preferences is a conditional autoregressive (CAR, Besag 1974) prior for the covariance of a justice's preferences across cases. Most often CAR models are used in geographic contexts, where physical adja-

cency determines the covariance structure. Here, we use citation data to construct a measure of legal adjacency between cases (Lauderdale and Clark 2012; Clark and Lauderdale 2012). Citation counts provide a similarity weight that indicates the likely strength of correlation between the latent preferences for each pair of cases. The latent preferences of justice $i \in \{1, 2, \ldots, n\}$ for case $j \in \{1, 2, \ldots, m\}$ have an expected value of the citation count weighted mean of her preferences in all other cases, with a total precision determined by the number of citations and an estimated parameter λ_ψ. The following formulation is based on the notation and Gibbs sampler described by Besag, Green, Higdon and Mengersen (1995).

Let Y be an $n \times m$ matrix of votes, where $y_{ij} = 1$ if justice i is in the majority in case j, $y_{ij} = 0$ if justice i is in the minority in case j, and is missing otherwise. Let ψ_{ij} be the latent preferences for justice i on case j, let α_j be the cutpoint for case j, and let $\beta_j \in \{-1, 1\}$ be the polarity of case j. The observed decision is

$$
\begin{aligned}
y_{ij} &= 1 \quad \text{if} \quad \psi_{ij} \geq \alpha_j \;\&\; \beta_j = 1 \\
y_{ij} &= 0 \quad \text{if} \quad \psi_{ij} < \alpha_j \;\&\; \beta_j = 1 \\
y_{ij} &= 1 \quad \text{if} \quad \psi_{ij} \leq \alpha_j \;\&\; \beta_j = -1 \\
y_{ij} &= 0 \quad \text{if} \quad \psi_{ij} > \alpha_j \;\&\; \beta_j = -1
\end{aligned}
$$

That is, we assume there exists a threshold value for each case that divides the justices into voting coalitions depending on whether their each justice's latent utility is greater or lesser than that threshold. The β parameter captures the polarity of the case majority—if a case majority is voting in a "liberal" direction, then having latent preferences greater than the case location (α_j) implies that a justice did *not* vote with the majority; when the majority is voting in a "conservative" direction, the opposite relationship will exist. Hence, a conservative outcome will be associated with $\beta = 1$, and a liberal outcome will be associated with $\beta = -1$.

We assume the justices' latent case-specific utilities, ψ_{ij}, have a joint prior distribution that depends on the strength of the relationship between pairs of cases j and j' (including cases that justice i did and did not vote on). While the strength of the relationship between case pairs could depend on many factors, in this paper we model it purely as a function of the citations between case j and j'. Let the $m \times m$ matrix $A = \{a_{jj'}\}$ measure the relationship between all pairs of cases. We assume $a_{jj'}$ is the fraction of citations in case j that are to case j', plus the fraction of citations in case j' that are to case j. Usually there will only be citations in one direction; however, cases that are decided concurrently may cite each other reciprocally. Thus, the A matrix is symmetric, with $a_{jj} \equiv 0$.[1]

The CAR model of the justice's latent preferences across cases is the following:

$$p(\psi_{ij}|\cdot) \quad \propto \quad \lambda_{\psi}^{m/2} exp\left\{-\frac{1}{2}\lambda_{\psi}\sum_{j}\sum_{j'} a_{jj'}\left(\psi_{ij}-\psi_{ij'}\right)^2\right\} \tag{1}$$

This conditionally normal distribution implies that the justices' latent preferences in each case (ψ_{ij}) are, in expectation, a weighted average of their latent preferences across all other cases ($\psi_{ij'}$), weighted by the strength of the relationship to each other case ($a_{jj'}$).

This *intrinsic conditional autoregressive* prior is not a proper multivariate normal distribution: the prior only identifies the latent preferences relative to one another and the mean of the ψ_{ij} is therefore not identified (Besag et al. 1995). Intuitively, if each element of ψ_{ij} has an expected value that is a precision-weighted mean of the other elements $\psi_{ij'}$ (where $j' \neq j$), then the overall mean $\sum_j \psi_{ij}$ must be unidentified as the same relative positions can be achieved around any overall mean. Thus, to identify the scale, we put independent standard normal priors over the case locations/cutpoints α_j—i.e., $\alpha_j \sim \mathcal{N}(0,1)$. By assuming the case cutpoints fall in in a range dictated by a standard normal prior, we guarantee that

[1]There are many ways one could define this matrix in terms of citations and/or other data, and so exploration of alternative specifications here is an important area for further development.

the justices' case-specific latent preferences ψ_{ij} will lie in a similar range. We also standardize the α_j at each iteration of the Gibbs Sampler (see below), with proportionate rescaling of all other parameters.

Cases decided unanimously tell us nothing about relative preferences: the cutpoint α_j is either greater than or less than all of the voting justices' latent preferences. We still include these cases as they are part of the adjacency network and can indirectly strengthen the estimation of the correlation structure of preferences across areas of the law, even though we cannot determine whether a case is unanimous because the cutpoint was to the left or to the right of all the justices. This indeterminacy has implications for the design of the Gibbs sampler described below.

To summarize, the inferential problem we are trying to solve is to estimate continuous latent preferences on cases when we only observe binary votes. Our solution is to infer those continuous preferences by looking to justices' behavior (binary votes) on related cases. We assume that the justices' preferences in any given case are a weighted average of their latent preferences in legally related cases, with weights determined by common citations. The observed votes result from whether the latent preferences of a justice are above or below a cutpoint that is specific to that case, and whether the case has a left majority or a right majority is estimated from the data at the same time. We specify an MCMC simulation of the posterior distribution for model in the Supplemental Information, where we also provide details on chain length and other implementation details for the results reported below.

2.1. *Gibbs Sampler*

We draw a posterior sample from this model by MCMC. This sampler is written in C++ and linked to R using Rcpp (Eddelbuettel and François 2011). MCMC for this model is expensive both in terms of computation and storage. The computational burden arises because where

there are M votes and N voters, each step of the Gibbs sampler involves doing computations comparable to fitting a regression by OLS on M observations, $M \times N$ times. Storing the resulting $M \times N$ latent preferences ψ_{ij} for each iteration of the sample then consumes storage at a high rate. The analyses in this paper are based on a 5000 iteration sample (after 500 iteration burn in), thinned to every fifth iteration, yielding a saved chain of 1000 iterations consuming 3.7GB of storage. Traceplots, multiple runs, and comparison of estimates based on the beginning and ends of the chains all suggest that this length sample is sufficient for convergence.

The MCMC algorithm is a Gibbs sampler with one Metropolis-Hastings step. This step is needed because of the deterministic relationship between latent votes, the cutpoint, and the case polarity. Without a sampling step that proposes to flip several quantities at once, the sampler could never explore both the possibility that the majority is on the left and that the majority is on the right for the same case. Let $a_{j+} = \sum_{j'} a_{jj'}$ be the sum of the bidirectional citation fractions linking case j to all other cases, and let W be an $m \times m$ matrix with diagonal elements $w_{jj} = a_{j+}$ and off-diagonal elements $w_{jj'} = -a_{jj'}$.

- For each case j,
  - Propose flip of case polarity $\beta_j^{\dagger} = -\beta_j^{(t-1)}$ and a reflection $\alpha_j^{\dagger}$ of the current cutpoint $\alpha_j^{(t-1)}$ across the mean of ψ_j, where $\beta_j^{(t-1)}$ and $\alpha_j^{(t-1)}$ are the values selected in the previous iteration of the sampler. Compute the Metropolis-Hastings acceptance ratio:

$$r = \prod_i \frac{\Phi\left(\sqrt{\tau_{ij}} \cdot (\alpha_j^{\dagger} - \mu_{ij}) \cdot (-1)^{\frac{y_{ij}\beta_j^{\dagger}+1}{2}}\right)}{\Phi\left(\sqrt{\tau_{ij}} \cdot (\alpha_j^{(t-1)} - \mu_{ij}) \cdot (-1)^{\frac{y_{ij}\beta_j^{(t-1)}+1}{2}}\right)} \quad (2)$$

$$\tau_{ij} = \lambda_{\psi} a_{j+} \quad (3)$$

$$\mu_{ij} = \frac{\sum_{j'} a_{jj'} \psi_{ij'}}{a_{j+}} \quad (4)$$

With probability $min(r, 1)$, we accept the flipped case polarity $\beta_j^{(t)} = \beta_j^{\dagger} = -\beta_j^{(t-1)}$ and the reflected cutpoint $\alpha_j = \alpha_j^{\dagger}$; otherwise $\beta_j^{(t)} = \beta_j^{(t-1)}$ and $\alpha_j^{\dagger} = \alpha_j^{(t-1)}$.

– For each justice i: draw ψ_{ij} from a singly truncated normal distribution consistent with α_j and β_j:

$$\psi_{ij}^{*\dagger} \sim t\mathcal{N}\left(\mu_{ij}, 1/\tau_{ij}, \alpha_j^{\dagger}, \infty\right) \quad \text{if } y_{ij} \cdot \beta_j^{\dagger} = 1 \tag{5}$$

$$\psi_{ij}^{*\dagger} \sim t\mathcal{N}\left(\mu_{ij}, 1/\tau_{ij}, -\infty, \alpha_j^{\dagger}\right) \quad \text{if } y_{ij} \cdot \beta_j^{\dagger} = -1 \tag{6}$$

– Draw α_j from the singly or doubly truncated normal distribution of values consistent with ψ_{ij} and β_j. For case j, let $\psi_{ij}^{(max,-1)}$ be the maximum value of ψ_{ij} among dissenting justices i ($y_{ij} = -1$), let $\psi_{ij}^{(min,-1)}$ be the minimum value of ψ_{ij} among dissenting justices i, and let $\psi_{ij}^{(max(1))}$ and $\psi_{ij}^{(min,1)}$ be the corresponding quantities for justices in the majority. Let $u_j = 1$ if $y_{ij} = 1 \forall i$, and $u_j = 0$ otherwise.

$$\alpha_j \sim t\mathcal{N}\left(0, 1, \psi_{ij}^{(max,-1)}, \psi_{ij}^{(min,1)}\right) \quad \text{if } \beta_j = 1 \;\&\; u_j = 0 \tag{7}$$

$$\alpha_j \sim t\mathcal{N}\left(0, 1, \psi_{ij}^{(max,1)}, \psi_{ij}^{(min,-1)}\right) \quad \text{if } \beta_j = -1 \;\&\; u_j = 0 \tag{8}$$

$$\alpha_j \sim t\mathcal{N}\left(0, 1, -\infty, \psi_{ij}^{(min,1)}\right) \quad \text{if } \beta_j = 1 \;\&\; u_j = 1 \tag{9}$$

$$\alpha_j \sim t\mathcal{N}\left(0, 1, \psi_{ij}^{(max,1)}, \infty\right) \quad \text{if } \beta_j = -1 \;\&\; u_j = 1 \tag{10}$$

- Draw λ_ψ:

$$\lambda_\psi \sim \mathcal{G}\left(a_\psi + \frac{m \cdot n}{2}, b_\psi + \frac{1}{2}\sum_{i=1}^{n} \psi_i^{\top} W \psi_i\right) \tag{11}$$

Each iteration of the above steps provides a single draw from the posterior distribution of our model. We use an improper prior $a_\psi = b_\psi = 0$, as scale identification is provided by the prior on and renormalization of α_j.

2.2. *Quantities of Interest and Interpretation*

The model generates several quantities of interest. First, the posterior distributions of the ψ_{ij} provide our beliefs about the relative positions of justices on a given case. These allow us to construct probabilistic estimates of which justices were likely to have been pivotal in a given case, and they can also be compared to the estimate of the cutpoint α_j for that case, in order to yield a visual representation of preferences in that case. Second, we can define the conditionally expected decision of each justice as $\mu_{ij} = \sum_{j'} a_{jj'}\psi_{ij'}$. This weighted average of preferences in related cases is our expectation for the justice's position on a given case, conditional on all his or her other decisions. Compared across justices, this is a useful summary of how the justices are aligned at a given "location" in the law, as opposed to on a given case. Third, we can define a justice's mean preferences $\theta_i = \left(\sum_j \psi_{ij}\right)/m$, which capture the justice's average position and which are functionally very similar to unidimensional ideal point estimates of judicial preferences.

Traditional scaling models in political science project a complex high-dimensional space onto a low dimensional space (Poole and Rosenthal 1985; Jackman 2001; Martin and Quinn 2002). As noted earlier, the utility of such scaling is to summarize a great deal of information in a way that captures the systematic patterns underlying the information. Implicitly these models are also models for case/vote-specific preferences, and those preferences can be derived from the estimates of the model as they depend linearly on the estimated preference dimensions and case/vote parameters. Our approach directly estimates these case-specific preferences, dispensing with the intermediate step of constructing a small number of general preference dimensions. This enables more flexible estimation of the case-specific preferences that are implicated by the bargaining theories that we wish to test.

With our approach, one might object that the preference space onto which we project the data is just as complex as the original data. One response to this objection is to observe

that the data we summarize are not just N justice votes for each of M cases but *also* a M by M matrix of legal similarity among all pairs of cases. However the better response is to simply acknowledge that our estimates are better thought of as a transformation of the dispositional voting data than as a reduction of that data. Data reduction occurs later through the applications that the transformation enables. Binary judicial votes plus citation counts jointly contain information about justices' expressed preferences regarding case disposition and how those preferences vary across areas of the law, but they do not contain this information in an immediately accessible way. To be useful for theory testing, these raw data sources must be transformed, and this is the role of the model we describe above. These model-based transformations of the raw data are useful for secondary analyses of judicial behavior, in particular for empirically testing theories about the processes of bargaining over opinion assignment and content.

3. PREFERENCE ESTIMATES

3.1. *Median Justices*

Past research on the U.S. Supreme Court has shown that there is variation in who serves as the critical median justice (e.g., Lauderdale and Clark 2012; Lauderdale and Clark 2014) Our approach here allows us to estimate, similarly, who is the median justice in any given case, with the additional benefit of being able to characterize uncertainty about these estimates. We compute the probability of any justice being the median or pivotal justice in every case that the justice heard, by identifying the median justice at each iteration of the MCMC simulation for every case, and then computing a mean across iterations to compute the posterior probabilities of being pivotal, for each justice in each case. In Figure 1, we average these estimates by term, generating estimates of the fraction of cases in each term for which

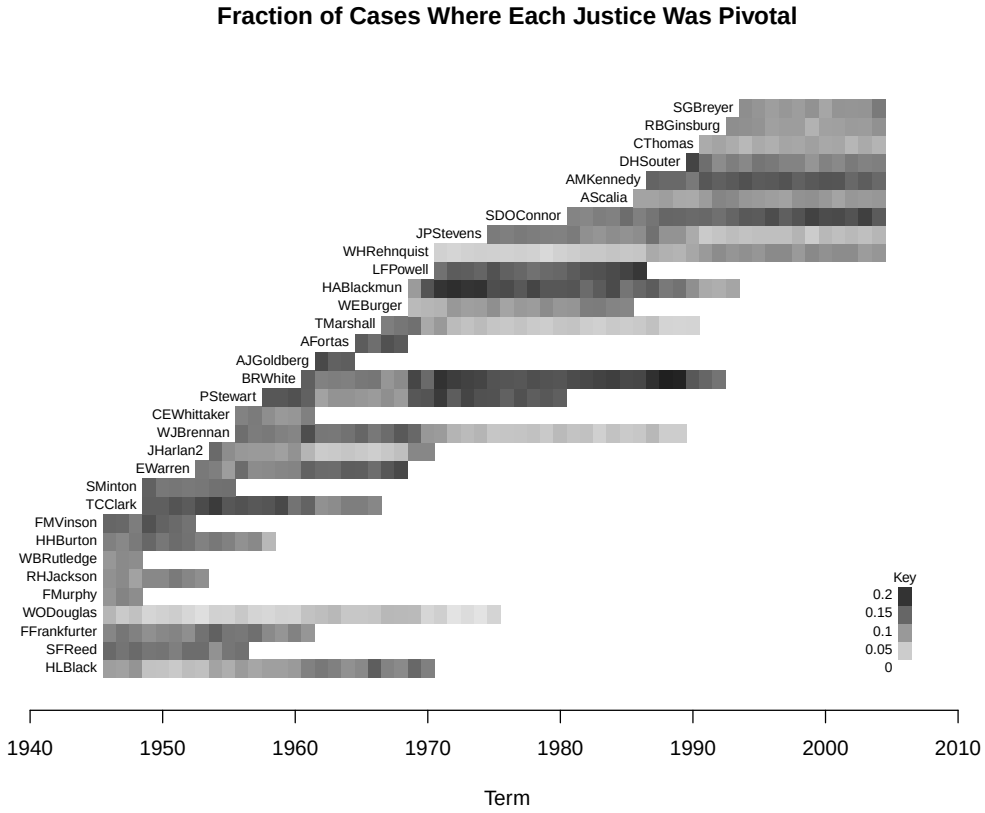

Figure 1: Estimated fraction of cases in which each justice was the pivotal justice, for each term.

each justice was the pivotal justice.

As Lauderdale and Clark (2012) show, the relative degree to which the role of median is concentrated on particular justices varies over time. During the 1970s, the pivotal role was played disproportionately by Justices Stewart, White, Blackmun and Powell. By contrast, throughout the late-1990s and early-2000s, the pivotal role was shared disproportionately by two justices—O'Connor and Kennedy. However, the central lesson we can draw from Figure 1 is that no single justice is ever pivotal in all, or even most, of the cases heard by the Court. Compared to common public perceptions of a Court dominated by a small number of pivotal justices, these estimates reveal that the variation in the rate at which justices are

pivotal is not nearly as unequal as some presume. In terms of the average rate over their careers, the least frequently pivotal justice in the data set is Douglas, the most frequently pivotal is White, but they only differ by about a factor of four in the fraction of cases where we estimate them to have been pivotal. In some sense this should not be a surprise. There are dispositional voting coalitions that cannot be rationalized by a constant unidimensional ordering of justices, and these occur in a substantial number of cases. This indicates that there must be substantial case-to-case variation in the relative preferences of justices, and that the pivotal justices in such cases may be individuals who one thinks of as inhabiting the extremes of the Court more generally. Put differently, knowing who is pivotal depends on knowing something about the substantive nature of what the Court is deciding.

Figure 1 also demonstrates a second pattern. Probability of being pivotal is not something that often shifts sharply and dramatically. Rather, we often see a justice's pivotality waxing or waning over the course of his or her career. Justice White, for example, became increasingly pivotal during the late-1960s and early-1970s. Justice Blackmun, initially a frequent pivotal voter, became less so over the course of his career. Occasionally, though, we see sharp shifts involving many justices. In a short period of time during the late 1960s and early-1970s, Justices Black, Warren, Harlan and Fortas left the Court, while Burger, Blackmun, Powell and Rehnquist joined the Court. This had the consequence of making Justices Marshall and Brennan much less frequently pivotal, as justices who were often to their left were replaced by justices who were rarely to their left. However, the relatively smooth pattern of transitions, accompanied by an even smoother evolution in the issues and questions the Court addresses, leads to a picture of the influence of individual justices that is gradually evolving and which does not change sharply in response to single justice replacements.

3.2. *Case-specific Preferences*

Figure 2 shows the relative positions of the justices voting on four high profile cases. These plots show preferences relative to the cutpoint, and so they slightly overstate the uncertainty of justices' positions relative to one another. The top two cases show *Roe v. Wade* and *Planned Parenthood v. Casey*. The alignments of justices within the voting coalitions in these cases are roughly as we would expect them to be. In the 7-2 decision in *Roe*, the justice most tenuously in the majority is Burger, who rarely voted for the pro-choice side of subsequent abortion cases. While the majority opinion author Blackmun was fourth from the left, near the middle of the Court in *Roe*, our estimates in *Casey* place him farthest to the pro-choice end of any justice. Blackmun's concurrence/dissent in the complicated disposition of *Casey* was notably apocalyptic in reference to the four justices who voted to strike down *Roe*, reinforcing the idea that Blackmun was likely furthest of any justice on the left of Casey from voting the other way.

In *Miranda*, we see the expected result that the more ardent civil libertarians Brennan and Douglas were to the left of the remaining justices in the majority: Black, Fortas and Warren. Black, while typically on the left of the Court during his career, shifted right late in his career and particularly so in criminal justice cases. *Kyllo*, the final panel, is an interesting case because it involves the unusual alliances of justices discussed at the beginning of this paper. It also is a good case for demonstrating the fact that our model is not always confident of the polarity of the decision. Unlike the other cases plotted in Figure 2, in *Kyllo* the 95% intervals of some justices cover the estimated cut point. This happens because our model estimates the probability that the majority is on the left (i.e., $\beta_j = -1$) to be 68%, in contrast to estimates of very nearly 0% or 100% for the other cases shown in the figure.[2] Substantively,

[2]Kyllo also provides good evidence that the MCMC algorithm is mixing well: in the 1000 saved iterations, there are 436 switches between left and right polarity for this case, and the serial correlation in the polarities

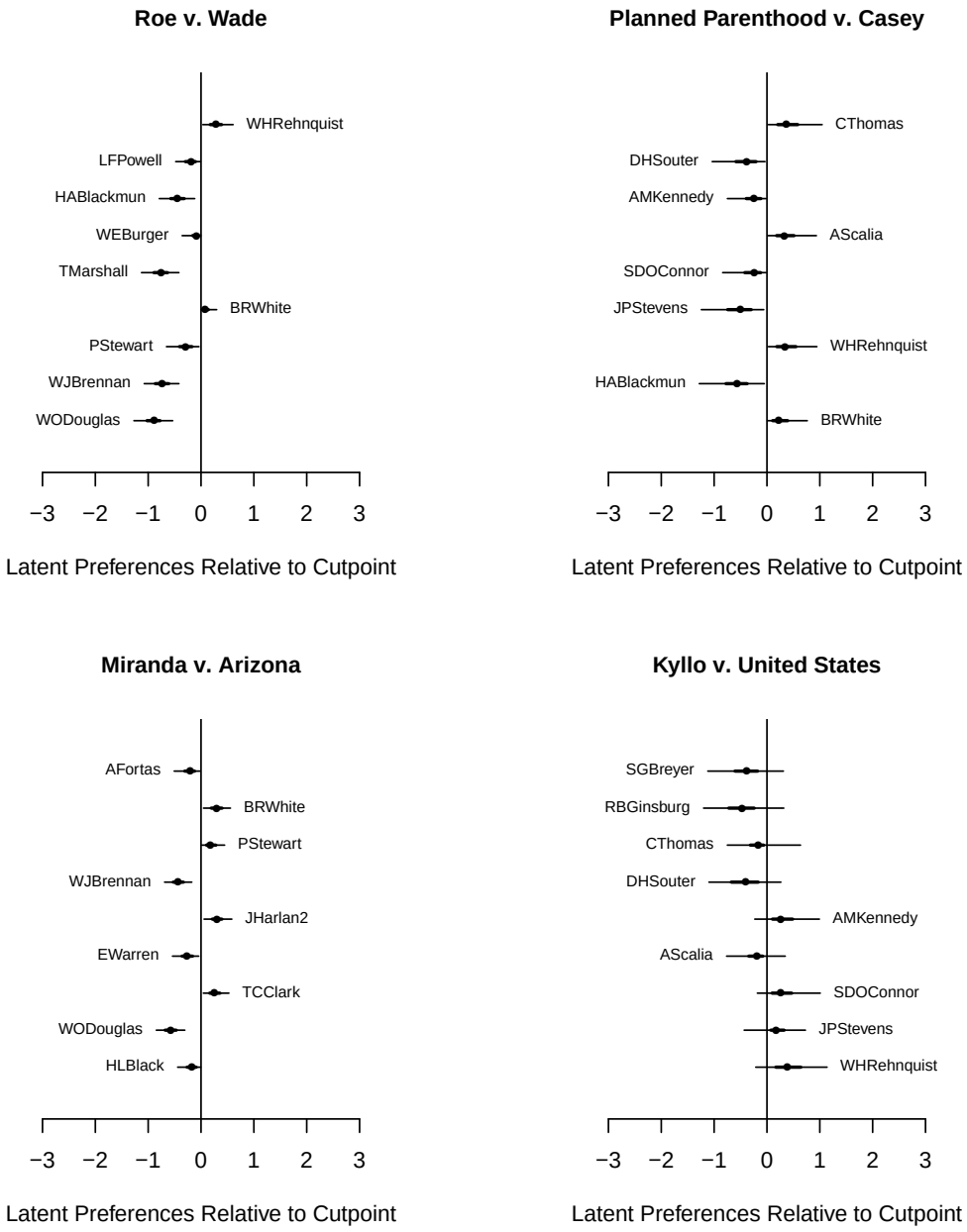

Figure 2: Estimated latent ideal points for justices in selected cases.

the expansive definition of what constitutes a 4th Amendment search is usually considered to be a left position, and so placing Thomas and Scalia to the left of Stevens, O'Connor, Kennedy and Rehnquist is probably the correct alignment, as opposed to placing Ginsburg, Souter and Breyer to their right. However, given only the voting and citation data, there is some remaining ambiguity in this case, precisely because the alignment of the justices is unusual.

As we can see from these plots, our estimates of justices' relative locations are not precise for any particular case, but do reflect meaningful variation in justices' relative preferences across different areas of the law. Our ability to pin down the relative locations of justices varies by case, as a function of the number of total citations from that case to other cases. For example, *Roe* is a case connected to many other cases, with a large number of subsequent cases elaborating the Court's doctrine on abortion rights and related issues, often with varying cutpoints as the case facts varied. As a result, we can infer a great deal about the relative positions of the various justices on this case. In contrast, for a case like *Kyllo*, there are fewer related cases with more heterogenous rulings, and so our uncertainty about the relative positions of justices is greater.

4. APPLICATION: STRATEGIC DYNAMICS IN OPINION ASSIGNMENT AND WRITING

The US Supreme Court makes decisions on many important policy questions, deciding by a simple majority who wins or loses a dispute arising under the law. Critically, though, the Court does much more than decide which litigant wins or loses (the disposition)—the Court is primarily responsible for developing principles of law that control all future cases posing similar legal questions. Those principles of law are not the outcome of a simple vote

is indistinguishable from 0.

but instead a complex process of opinion writing and bargaining among those justices in the dispositional majority. It is for this reason that scholars of the Supreme Court have devoted considerable attention to understanding the politics and process of opinion writing and negotiation among the justices. In particular, the process of selecting an author for the Court's majority opinion and the decision by individual justices to "join" a majority opinion have been the subject of considerable interest (e.g., Murphy 1964; Brenner 1982; Epstein and Knight 1998; Maltzman, Spriggs and Wahlbeck 2000; Lax and Cameron 2007).

When the Supreme Court decides a case, the Chief Justice, if he is in the majority, has the power to select the majority opinion writer. If the Chief is not in the majority, the most senior member of the majority has the power. Next, the majority opinion writer drafts an opinion and has an incentive to attain the assent of at least four other justices, because only an opinion signed by a majority of justices has the weight of binding precedent. These two stages of Supreme Court decision-making have given rise to several theoretical questions. Can a Chief Justice strategically shape the non-dispositional outcome of cases with his power to assign majority opinions? Who controls the content of the opinion, given the complexities of unstructured bargaining among a group of justices?

4.1. *Modeling Opinion Assignment*

Opinion assignment on the Supreme Court is one of the longest-studied phenomena in the literature on judicial behavior (e.g., Murphy 1964; Ulmer 1970; Rohde and Spaeth 1976; Brenner and Spaeth 1988; Segal and Spaeth 2002; Maltzman, Spriggs and Wahlbeck 2000; Lax and Cameron 2007). Among other findings and claims, scholars have argued that the opinion assigner, usually the chief justice, has an incentive to assign opinions to his ideological allies and experts in the particular area of the law at hand, and that the importance of a given case can condition those incentives. These studies almost always rely on simple, parsimonious

measures of judicial preferences to measure ideological alignment among the justices—such as issue-specific agreement rates (Maltzman, Spriggs and Wahlbeck 2000) or Martin and Quinn (2002) estimates of latent ideology (Carrubba, Friedman, Martin and Vanberg 2012). These approaches, while grounded in validated measures of judicial preferences, limit the ability to statistically identify variation in ideological alignment among justices. The former method only allows for variation in agreement between pairs of justices across the 12 substantive areas of the law studied. As a consequence, justices cannot vary in their agreement over time or in substantively more nuanced ways. The latter approach only allows for variation in alignment between justices over time, precluding differential alignment across substantive questions presented in cases.

The traditional approach of treating justices' relative preferences as stable across areas of the law provides a great deal of analytic leverage and has the great benefit of parsimony (see, for example, the myriad applications of Martin and Quinn 2002). However, in recent years, scholars have increasingly asked how judges' preferences might vary across legal dimensions and questions (e.g., Kornhauser 1992; Lax 2007; Bailey and Maltzman 2011; Lauderdale and Clark 2012; Lauderdale and Clark 2014). These observations have particular import in the context of opinion assignment and writing, because there exists a strong norm on the US Supreme Court that opinions be assigned in equal numbers across the justices, though deviations have been observed (e.g., Maltzman and Wahlbeck 1996*a*; Benesh, Sheehan and Spaeth 1999). As a consequence, if Chief Justices work to ensure equity in opinion assignments, varying ideological alignments from case-to-case may present a strategy opportunity for the Chief Justice to influence opinion-writing and content. The Chief Justice can distribute cases to justices with generally divergent preferences when they are relatively proximate in a specific case, reducing his average distance to the author across all cases while maintaining the norm of equal assignment.

A class of formal and informal models of opinion-writing predicts that who writes the

opinion could matter greatly for the content of the opinion (Lax and Cameron 2007; Bonneau, Hammond, Maltzman and Wahlbeck 2007; Cameron and Clark Forthcoming; Maltzman, Spriggs and Wahlbeck 2000). We refer to these models of bargaining and opinion assignment as "author influence models" models and contrast them with "monopoly models," which predict that opinion authorship does not matter. The key distinction between these two classes of models is that the former predicts a set of strategic incentives for opinion assignment, whereas the latter predicts no strategic incentives concerning opinion assignment.

The empirical literature has examined opinion assignment, in part to help adjudicate among these competing models of bargaining. Some of this evidence suggests that the power to assign the majority opinion is used strategically to influence case outcomes (Lax and Rader N.d.; Maltzman, Spriggs and Wahlbeck 2000; Cameron and Clark Forthcoming). One of the most powerful research designs in the literature leverages "vote fluidity" to evaluate strategic opinion assignment. Vote fluidity refers to the idea that justices who are "marginal", in the sense that they are ideologically proximate to the minority coalition, have the potential to "defect" and switch their votes from the majority coalition to the minority coalition. Past empirical studies have argued that justices who are closest to being on the fence between the two coalitions are assigned the majority opinion at a disproportionately high rate (Brenner 1982; Brenner and Spaeth 1988). Lax and Rader (N.d.) push this research design further by connecting it to four specific models of opinion-writing: two monopoly models and two author influence models. They find evidence consistent with the claim that the Chief Justice uses opinion assignment to strategically maintain coalitions and induce opinions that are aligned with his preferences.

However, it has also been widely documented that there exists a norm by which opinion assignments are distributed evenly among the justices (e.g., Brenner and Palmer 1988; Maltzman and Wahlbeck 1996*b*; Maltzman, Spriggs and Wahlbeck 2000). Assuming this norm is binding, if the justices' relative preferences do not vary from case-to-case, then it is not

possible for the Chief Justice to assign cases disproportionately to his ideological allies.[3] But if relative preferences do vary case-to-case, then the Chief could use that variation to strategically assign cases to justices *when* they are most aligned with him, relaxing the constraint imposed by the norm of balanced workloads. Relying on measures of preferences that do not allow for case-to-case variation in preferences has prevented previous analyses from comparing two competing accounts of strategic opinion assignment. According to the vote fluidity logic, the Chief Justice assigns opinions to marginal justices in order to hold coalitions together. According to author influence models, the Chief Justice has an incentive to assign opinions to justices that share his views on a given case, particularly when they do not do so more generally.

Because we estimate case-by-case preferences, we can exploit potentially consequential variation in which justices are closest to the chief, or to other key positions in the distribution of justices, across different areas of law. To this end, we specify an empirical model in which opinion assignment is estimated as a function of either a justice's ideological distance to the Chief Justice or ideological distance to the case-specific voting threshold (the point of indifference between the two coalitions). An alternative possible operationalization of the vote fluidity model is that distance to the median, rather than the coalition division, is what really matters. Thus, we also consider each justice's distance to the Court median. Finally, we consider each justice's distance to the coalition median, which, though not predicted by the median of the majority coalition model, potentially captures the influence of the center of the majority coalition. In order to test these varying predictions about authorship assignment, we construct case-specific measures of the median justice, the ideal point of the majority coalition median, the voting cut-point, and the Chief Justice. We then calculate the absolute distance for each justice to each of these points, for each case.

[3]However, if cases vary in importance, the Chief could assign the relatively important cases to his ideological allies.

We specify a hierarchical conditional logit model, which we customize for these data. The general form of the model using all four distance measures described above is as follows; however we also fit the model using one distance measure at a time by fixing other coefficients to zero. Let $Y_{ij} = 1$ if justice i is in the majority in case j. Where $S_{ij} \in \{0, 1\}$ indicates whether justice j was the author in case i, we fit a conditional logit model as a function of the position of that justice relative to the four positions. X_{1ij} is the estimated distance from justice i to the cutpoint in case j; X_{2ij} is the estimated distance to the median of the court; X_{3ij} is the estimated distance to the median of the majority coalition; X_{4ij} is the estimated distance to the chief justice. We limit our attention to the cases where the chief justice is in the majority and is therefore assigning the author of the opinion. Where $t \in \{1, 2, \ldots, 27\}$ is the natural court for case j, and $r \in \{1, 2, 3, 4\}$ is the chief justice for case j, our model has the following form:

$$S^*_{ij} = \gamma^{court}_{it} + \sum_{k=1}^{4} \delta^{court}_{kt} X_{kij} \text{ if } Y_{ij} = 1 \quad (12)$$

$$S^*_{ij} = -\infty \text{ if } Y_{ij} \neq 1 \quad (13)$$

$$p(S_{ij} = 1) = \frac{exp(S^*_{ij})}{\sum_{i=1}^{n} exp(S^*_{ij})} \quad (14)$$

Notice that we assume in our specification that if a justice is not on the court or not in the majority, her probability of authoring is zero ($S^*_{ij} = -\infty$). Among those who are on the court and in the majority (including the chief justice), the probability of authoring is generated by a conditional logistic model where the latent utility of authorship for each justice is based on a justice by natural court specific intercept γ_{it}, plus the effects of the distance measures k, which depend on natural court specific coefficients δ_{kt}. We generally expect the δ_{kt} to be zero or negative for most of the distance measures we consider, as the theories of authorship assignment we consider yield predictions where authorship probability declines as a justice's position gets further from the cut point, the court median, the majority

median and/or the chief justice.

The slope and intercepts from this model are indexed by the natural court; however we specify the model as a hierarchical model, in which natural courts are nested within Chief Justice regimes. Such a specification allows us to make statements about the average relationships among all courts, among natural courts during a particular Chief Justice's tenure, etc. Thus, we include the following parameters and prior distribution assumptions in our model: $\gamma_{it}^{court} \sim \mathcal{N}\left(\gamma_{ir}^{chief}, \sigma^2_{\gamma^{chief}}\right)$, $\gamma_{ir}^{chief} \sim \mathcal{N}\left(\gamma_i, \sigma^2_{\gamma}\right)$, $\delta_{kt}^{court} \sim \mathcal{N}\left(\delta_{kr}^{chief}, \sigma^2_{\delta^{chief}}\right)$, $\delta_{kr}^{chief} \sim \mathcal{N}\left(\delta_k, \sigma^2_{\delta}\right)$, and $\sigma^2_{\gamma}, \sigma^2_{\delta}, \sigma^2_{\gamma^{chief}}, \sigma^2_{\delta^{chief}} \sim \mathcal{E}(1)$.

The hierarchical model for γ and δ reflects the fact that baseline authorship probabilities for a given justice will depend on the other justices on the court, and particularly on the Chief Justice. For example, if we set the $\beta_{kt} = 0$, we would be assuming that the relative positions of justices on a given case versus other cases do not matter, but the γ_{it} would still allow for the possibility that some justices are more likely to author than others, given that they are both in the majority. These natural court-specific intercepts mean that the composition of the court as well as the average distance to a given chief justice is accounted for in the baseline probability of each justice authoring an opinion, conditional on being in the majority. As a result, any effects associated with the distance measures must come from within natural court variation across areas of law.

We program and simulate this model in JAGS (Plummer 2008) via R (R Development Core Team 2008), with reported results based on two parallel chains of 5000 iterations, thinned by 5, recorded after a burn-in of 500 iterations. We summarize the core findings in Figure 3, which shows the posterior estimates of the δ_{kt} coefficients for each natural court (posterior means and central 95% credible intervals). The top row of results shows slope estimates for four distinct models in which we include only a single distance measure as a covariate, reflecting the distinct theoretical predictions from each model. The bottom row shows δ_{kt} estimates from a model that nests all the distance measures together in a single

empirical specification assuming additive effects on the logit scale.

A number of findings stand out. There are weak and inconsistent associations between the probability of being assigned the majority opinion and a justice's distance to the (1) case-specific cut-point, (2) the case-specific Court median, and (3) the median of the majority coalition. All have substantial posterior density on both sides of zero in nearly every natural court. We estimate a much larger and more consistent relationship between authorship and distance from the Chief Justice under every Chief except Vinson. Thus, by far the strongest association, both in magnitude and statistical evidence, is that increasing distance to the Chief is associated with declining probability of receiving authorship assignment.

To help interpret these results, it is worth recalling the derivation of our distance measures. The model shows us that Chief Justices are more likely to assign authorship to an associate justice when the associate justice's voting in similar cases is closer to the Chief's voting in those similar cases. This evidence points to an insight that could only be recovered by contemplating case-specific preferences. Due to an empirical focus on static (Segal and Cover 1989) preferences, or preferences that can only vary term-by-term (Martin and Quinn 2002), scholars have missed a potential implication of the norm of proportionate assignment of opinions among the justices. Rather than simply being required to assign opinions to all justices and therefore strategically selecting "marginal" justices when there is a risk that a coalition will fall apart, it may instead be that the Chief Justice follows the norm of proportionate assignment by leveraging case-by-case variation to assign opinions to justices when they are most closely aligned. The Chief Justice is able to utilize *variation in which justices most strongly share his views* to help sustain a pattern of relatively equal assignment across cases. The fact that being close to the median of the Court or the majority has a much smaller effect, if any at all, indicates that justices are (at most) rarely able to leverage their relative positions on individual cases to gain the right to author opinions.

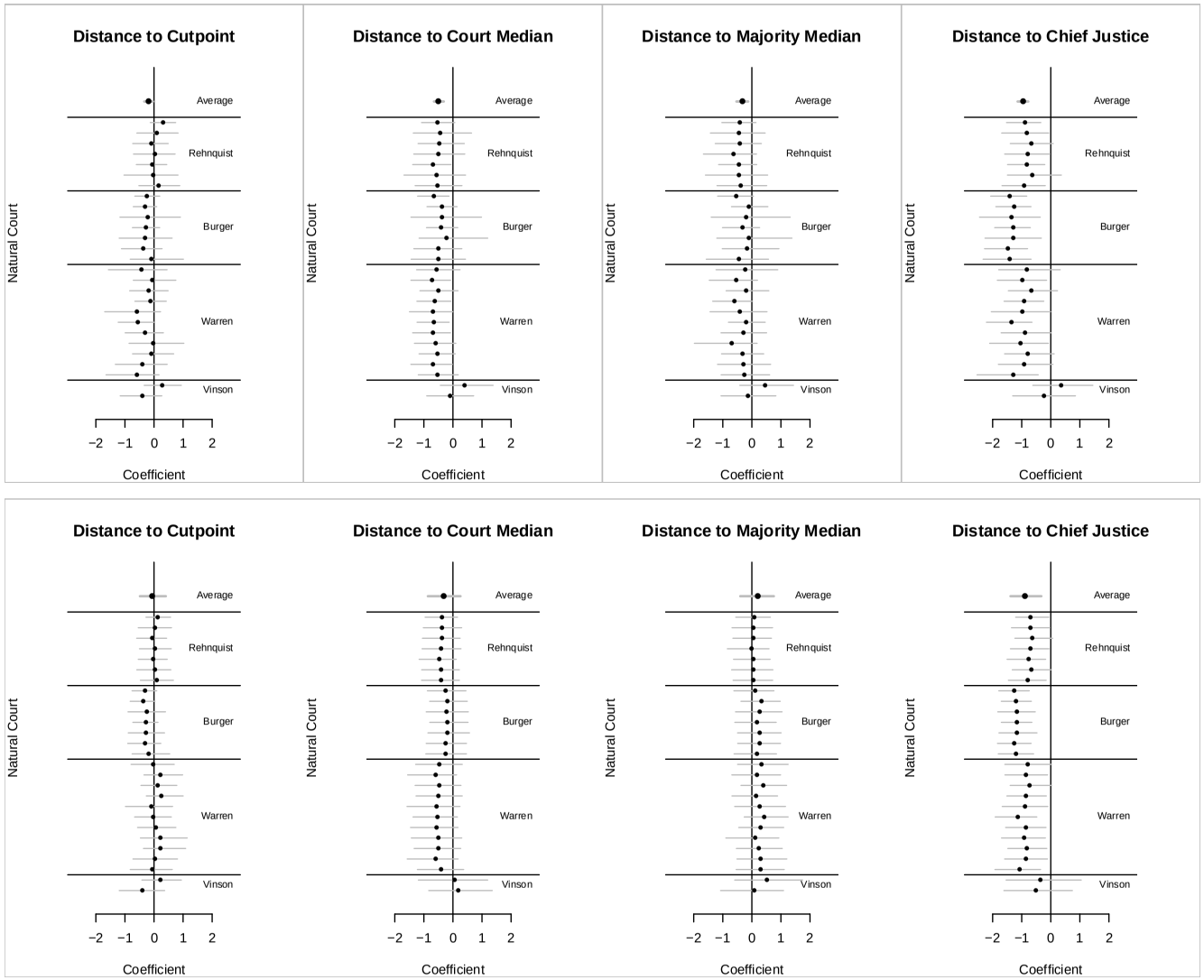

Figure 3: *Coefficients of hierarchical conditional logit model for authorship, for each natural court in chronological order, with central 95% posterior intervals.* The top row shows estimates from four models including only the single distance as a predictor. The bottom row shows estimates from four models including each of the distances together.

4.2. *Modeling the Decision to Join an Opinion*

Part of the motivation behind the studies seeking to understand the choice of opinion author is an interest in the influence individual members of the Court have over the content of the Supreme Court's opinions. Various theories and empirical tests have appeared in the literature (for a review, see Clark and Lauderdale 2010). The key issue at hand concerns how the Court's institutional arrangements shape the way in which the collective views of up to nine justices will be aggregated into a single statement of law in the form of the Court's opinion. Among the many competing theories are claims that the median justice will control the Court's opinion (this argument is a direct application of Black 1948). Bonneau et al. (2007) argue that if the Supreme Court were to operate as a closed-rule institution, then the logic of Romer and Rosenthal (1978) would apply, and the opinion author would have some degree of control over the opinion. Other arguments are more oriented around the Court's actual institutional rules and constraints and make arguments about author influence (e.g., Lax and Cameron 2007) or the difference in bargaining leverage between members of the majority coalition and members of the minority coalition (Carrubba et al. 2012; Cameron and Kornhauser N.d.). Related arguments contend that justices likely to "switch" sides and are therefore more marginal members of the majority coalition have special influence (e.g., Lax and Rader N.d.).

These (sometimes) competing theories yield a set of predictions for which our estimates provide new empirical leverage. Justices who are more proximate to the opinion should be more likely to join the opinion. Therefore, we can evaluate whether the distance from a justice to any theoretically-predicted point is predictive of her decision to join the majority opinion. From the existing literature, we identify five such points: (1) the cut point dividing justices into voting coalitions (more marginal justices have influence); (2) the Court median; (3) the Chief Justice (assignment power); (4) the majority coalition median; and (5) the

opinion author.

We model the decision to join a majority opinion by each member i in the majority voting coalition of case j. Let $O_{ij} = 1$ if justice i joins the majority opinion in case j and $O_{ij} = 0$ if she does not join the majority opinion. We specify the decision as a function of each justice's distance to each of the theoretically-implicated points in the voting space. For this model, we also add in dummy variables Z_{lj} for the total number of judges l in the majority coalition on the decision in case j, to capture the fact that the incentives to join change with the number of justices in the majority, not just their relative positions. Coefficients for each of these variables are estimated for each natural court, hierarchically modeled within Chief Justices, hierarchically modeled within the entire period.

$$O^*_{ij} = \gamma^{court}_{iat} + \sum_{k=1}^{5} \delta^{court}_{kt} X_{kij} + \sum_{l=1}^{9} \nu_{lt} Z_{lj} \quad (15)$$

$$p(O_{ij} = 1) = \frac{\exp(O^*_{ij})}{1 + \exp(O^*_{ij})} \quad (16)$$

In the model for authorship, the slope and intercepts from this model were indexed by the natural courts, which we estimated as nested within Chief Justice regimes. Here, we use a similar nested structure for the slope coefficients δ^{court}_{kt} and the coefficients on the dummy variables for coalition size ν_{lt}. However, we use a different nested structure for the intercepts, reflecting the goal of holding constant the joining justice, the authoring justice, and the overall composition of the court (natural court). We estimate separate intercept for each combination of these three, with the variation in these across natural courts varying around mean joining justice by authoring justice effects. Simulation details are also as in the previous application. The estimates for the coefficients on each of the five distance variables are reported by natural court in Figure 4. As before, we report in the top row models that include only each of the distance measures individually and in the bottom row slope estimates from an empirical model that nests the theories into a single specification.

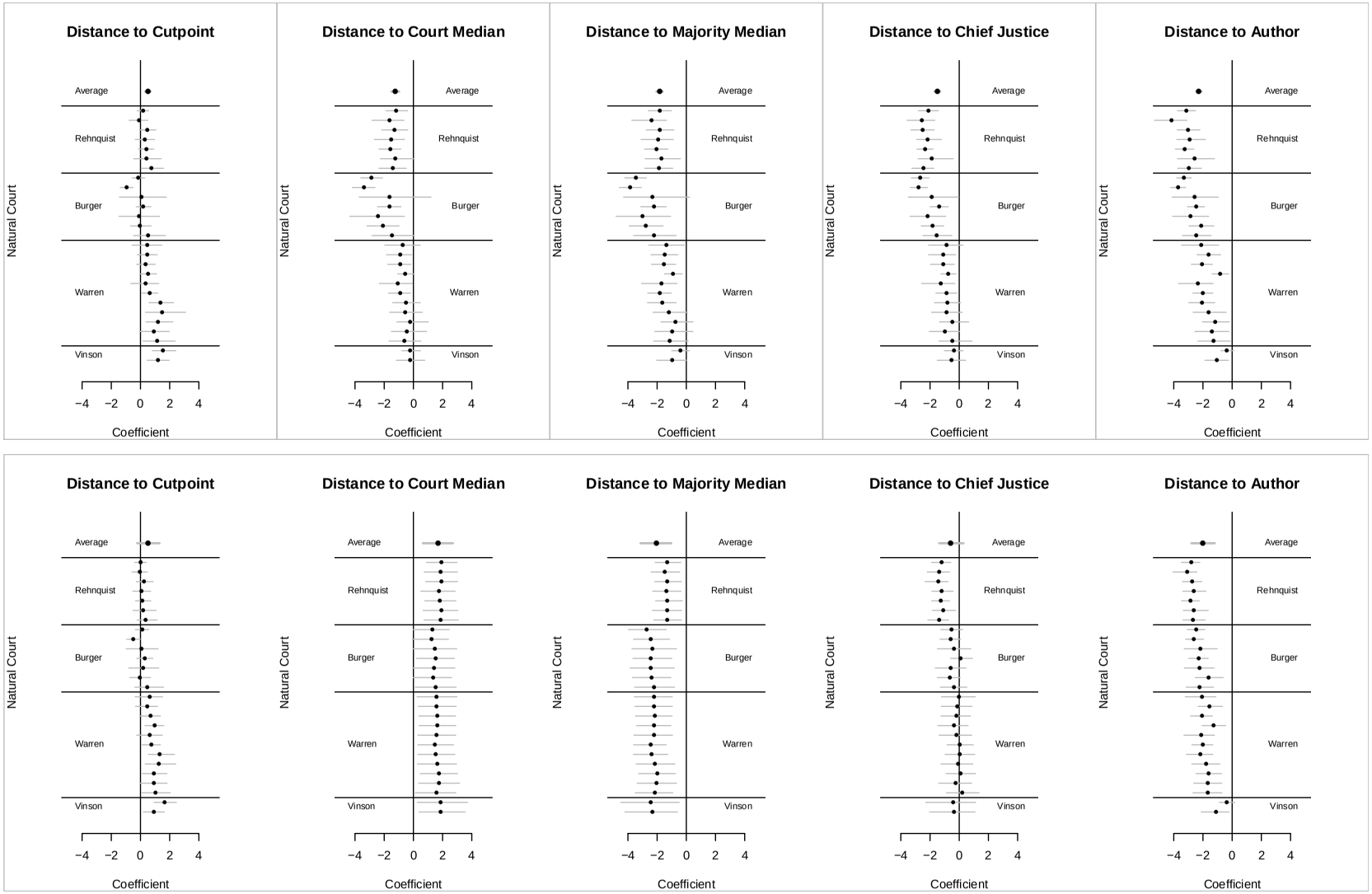

Figure 4: Coefficients of hierarchical logit model for joining the majority opinion, for each natural court in chronological order, with central 95% posterior intervals.

The relationships between the distance measures and the patterns of joining opinions are more complex than we found under the authorship model, where there were weak relationships for all variables other than distance to the Chief Justice. Starting with the left column of Figure 4, and moving through the columns in order, we see that at least since the end of the Warren Court, there is little association between distance to the cutpoint and joining the majority opinion, conditional on the other distance measures. Before that, there was a small positive association, where justices further from the cut point were more likely to join an opinion, other distance measures equal. In the second column, we see a negative relationship between distance to the median justice and joining the majority opinion when that is the only variable in the model, but a positive relationship when controlling for the other distance measures. In the third column, and consistent with Carrubba et al. (2012), the further a justice is from the median of the majority coalition, the less likely she is to join the majority opinion. There is some evidence that distance to the Chief Justice matters where justices farther from the Chief were less likely to join, but this is a relatively weak effect when holding the other distances equal. Finally, the most powerful relationship in the data, and one that seems to have grown more powerful over time, is the negative association between joining the majority opinion and distance from the opinion author. There is some suggestion that this trend may have reversed in the first two years of the Roberts Court, however there are relatively few cases under Roberts before our data set ends with the 2006 term. All of these relationships reflect variation as a function of case-specific estimated position, holding fixed the joining justice, the authoring justice, and the natural court.

If we synthesize these findings, focusing on the most robust and consistent relationships, we find a suggestion that the opinion itself is influenced by the coalition median as well as the author of the opinion (see also Cameron and Kornhauser N.d.). At the same time, we find evidence that the further a justice is from the median justice, the more likely she is to join the majority opinion. In order to interpret this finding, it is important to recognize what it

means to hold all the other measures constant. To imagine what it means to hold constant distance to the author and distance to the majority median, while increasing distance to the median, it is helpful to contemplate the most extreme justice on the Court, who is part of a majority and where the author is in the block of three justices between the extreme justice and the median. The further those three justices and the extreme justice get from the median, the more likely the extreme justice is to join the opinion. In some sense, these are increasingly precarious coalitions with the median, and given the location of the author within the increasingly extreme group of four justices, it makes sense that the extreme justice would be more inclined to support the opinion in order to secure a binding precedent.

The major implication of these results is that distance to the opinion author is the most powerful predictor of the decision to join a majority opinion, and this has become more true over time. The simultaneous predictive power of the opinion author and the majority median is consistent with existing formal models of majority median influence (e.g., Carrubba et al. 2012; Cameron and Kornhauser N.d.). Connecting these results back to those in the previous application, and recognizing that the Chief can only select the author, not the majority coalition, there is a strong suggestion that a strategic Chief Justice can use his assignment power to select opinion authors who share his own views in any given case, just as we saw in the previous analysis. Taken together, these two analyses suggest a strategic dynamic by which the Chief Justice knows that, given a particular majority coalition, the opinion author can influence the opinion content and therefore strategically selects different opinion authors as they vary form case-to-case in the extent to which they are ideologically aligned with the Chief.

4.3. *Threats to Inference*

As with all studies of the history of the Supreme Court, the data we examine are observational and it is necessary to be cautious in the interpretation we draw from the associations we find. The first stage of our analysis, generating case-specific preference estimates using dispositional voting and citation data, is fundamentally descriptive rather than causal. We understand our measures of preference as estimates of the relative positions of justices on a case, based on their behavior in legally similar cases. Where our analysis does implicate causal questions is when we move to the analysis of models relating these preference measures to opinion assignment and joining behavior.

We have argued that the association between distance to the Chief Justice and opinion authorship, holding fixed court composition and the identity of the Chief, suggests strategic assignment on the part of the Chief. This could also reflect strategic and successful lobbying for assignment by the associate justices, or some spurious association between the issue areas that particular justices specialize in authoring opinions within, and the preferences of those justices and the Chief. Since our identification strategy utilizes relative preference variation of justices across areas of law, we cannot effectively control for areas of law in the models for assignment and joining behavior.

Another set of alternative explanations for our results arise to the extent that the measure of legal adjacency that we use (i.e., citation) is endogenous to whether particular justices voted together, although we do not believe this is a major concern given the inferences that we draw. For it to matter that the specific cases cited are chosen after these outcomes that we consider, it would need to be the case that opinion authors cater to the Chief Justice by preferentially citing the past cases where they agreed on the disposition. To yield a similar spurious finding in our analysis of joins, the author would have to do this selectively for only the other justices in the majority who ultimately join the opinion. While we cannot

entirely rule out these possibilities, we can note that our results replicated using Westlaw Key Numbers to generate measures of legal similarity, which are not produced directly by the judges.

5. DISCUSSION AND CONCLUSION

In this paper, we have described an approach to estimating case-specific (or vote-specific) preferences, using roll-call data in combination with data describing the substantive similarity of cases to one another. The underlying statistical logic of our approach is that of smoothing. Case votes are binary, and we aim to give a smooth, continuous summary of the preferences that generate those votes. To generate this, we take account of how individuals voted in similar cases, as well as the varying polarity and cutpoints of individual cases. The model we present in this paper is not the only way to generate such measures, but it is a particularly simple way of doing so. Citations are an especially attractive basis for generating case-specific preferences because they closely track the degree to which shared points of law are raised across cases.

As we note, the estimates of justice preferences at the individual case level are not particularly precise. Thus the goal of the exercise is not so much to estimate relative preferences of particular judges in particular cases, but instead to generate measures that can be used in subsequent analysis of the set of cases as a whole. Our application is to the context of the Supreme Court, where we have made an argument for the utility of employing *case-specific* preferences in studying the arguments that have been previously made about the role of strategic bargaining in the process of generating majority opinions.

Armed with our estimates of preferences, an analysis of opinion authoring and joining reveals new evidence of the strategic incentives facing the justices. For example, while scholars have frequently observed the constraining effect of the norm of equal assignment of

opinion-writing responsibilities across the justices and proposed norm-based justifications for this practice, our analysis suggests a norm of balanced workloads may be supported by the Chief Justice's strategic assignment of opinions to justices who are closest to him *in a given case* (cf. Lax and Cameron 2007). At the same time, we find evidence in support of a recently-developed class of models in which the center of the majority exercises a gravitational force on the content of the opinion (as distinguished from the center of the Court as a whole), while the author still has substantial discretion as well (e.g., Lax and Cameron 2007; Carrubba et al. 2012; Cameron and Kornhauser N.d.). Taken together, these findings suggest a complex interaction among assignment power and bargaining among the justices that could not be documented as convincingly in the absence of case-specific estimates of judicial preferences. While our analysis is far from the final word in the study of Supreme Court bargaining, we hope that the estimation strategy and empirical applications reported here will open the door to future empirical investigations of additional theoretical predictions from the literature.

We conclude by reiterating that our estimation approach could be applied to other contexts, including to legislative voting. The measures of similarity between votes could be a text-based distance measure between legislative texts or debates, it could be a network-based function of connections to common underlying statutes, or something else.[4] Of course more typical ideal point estimates remain attractive for many applications. The approach we present in this paper is valuable primarily for incorporation into subsequent analyses that aim to leverage variation in preferences across different kinds of votes to assess whether observed legislative processes depend on relative preferences, or whether existing ideal point estimates proxy for other constant attributes of individuals.

[4]One could also use a similar approach to estimate a dynamic preference model where the strength of connections depending on chronological distance.

REFERENCES

Bailey, Michael A. and Forrest Maltzman. 2011. *The Constrained Court: Law, Politics, and the Decisions Justices Make*. Princeton University Press.

Benesh, Sara C., Reginald S. Sheehan and Harold J. Spaeth. 1999. "Equity in Supreme Court Opinion Assignment." *Jurimetrics* 39:377.

Besag, Julian. 1974. "Spatial Interaction and the Statistical Analysis of Lattice Systems." *Journal of the Royal Statistical Society (Series B)* 36(2):192–236.

Besag, Julian, Peter Green, David Higdon and Kerrie Mengersen. 1995. "Bayesian Computation and Stochastic Systems." *Statistical Science* 10(1):3–41.

Black, Duncan. 1948. "On the Rationale of Group Decision-making." *Journal of Political Economy* 50(1):23–34.

Bonneau, Chris W., Thomas H. Hammond, Forrest Maltzman and Paul J. Wahlbeck. 2007. "Agenda Control, the Median Justice, and the Majority Opinion on the U.S. Supreme Court." *American Journal of Political Science* 51(4):890–905. Forthcoming.

Brenner, Saul. 1982. "Strategic Choice and Opinion Assignment on the U.S. Supreme Court: A Reexamination." *Western Political Quarterly* 35(2):204–211.

Brenner, Saul and Harold J. Spaeth. 1988. "Majority Opinion Assignments and the Maintenance of the Original Coalition on the Warren Court." *American Journal of Political Science* 32(1):72–81.

Brenner, Saul and Jan Palmer. 1988. "The Time Taken to Write Opinions as a Determinant of Opinion Assignments." *Judicature* 72:179–84.

Cameron, Charles M. and Lewis A. Kornhauser. N.d. "Bargaining on Appellate Courts." Princeton University working paper.

Cameron, Charles M. and Tom S. Clark. Forthcoming. The Chief Justice and Procedural Power. In *The Chief Justice: Appointment and Influence*. University of Michigan Press.

Carrubba, Clifford J., Barry Friedman, Andrew D. Martin and Georg Vanberg. 2012. "Who Controls the Content of Supreme Court Opinions?" *American Journal of Political Science* 56(2):400–412.

Clark, Tom S. and Benjamin Lauderdale. 2010. "Locating Supreme Court Opinions in Doctrine Space." *American Journal of Political Science* 54(4):871–890.

Clark, Tom S. and Benjamin Lauderdale. 2012. "The Genealogy of Law." *Political Analysis* 20(3):329–350.

Eddelbuettel, Dirk and Romain François. 2011. "Rcpp: Seamless R and C++ Integration." *Journal of Statistical Software* 40(8):1–18.

Epstein, Lee and Jack Knight. 1998. *The Choices Justices Make*. Washington, D.C.: C.Q. Press.

Ho, Daniel E. and Kevin M. Quinn. 2010. "How Not to Lie with Judicial Votes: Misconceptions, Measurement, and Models." *California Law Review* 98(3):813–876.

Jackman, Simon. 2001. "Multidimensional Analysis of Roll Call Data via Bayesian Simulation: Identification, Estimation, Inference and Model Checking." *Political Analysis* 9(3):227–241.

Kornhauser, Lewis A. 1992. "Modeling Collegial Courts *II*: Legal Doctrine." *Journal of Law Economics & Organization* 8:441–70.

Lauderdale, Benjamin E. and Tom S. Clark. 2012. "The Supreme Court's Many Median Justices." *American Political Science Review* 106(4):847–866.

Lauderdale, Benjamin E. and Tom S. Clark. 2014. "Scaling Politically Meaningful Dimensions Using Texts and Votes." *American Journal of Political Science* 58(3):754–771.

Lax, Jeffrey R. 2007. "Constructing Legal Rules on Appellate Courts." *American Political Science Review.* 101(3):591–604.

Lax, Jeffrey R. and Charles M. Cameron. 2007. "Bargaining and Opinion Assignment on the U.S. Supreme Court." *Journal of Law, Economics, and Organization* 23(2):276–302.

Lax, Jeffrey R. and Kelly T. Rader. N.d. "Bargaining Power in the Supreme Court." Columbia University working paper.

Maltzman, Forrest, James F. Spriggs, II and Paul J. Wahlbeck. 2000. *Crafting Law on the Supreme Court: the Collegial Game.* Cambridge University Press.

Maltzman, Forrest and Paul J. Wahlbeck. 1996*a*. "May It Please the Chief? Assignments in the Rehnquist Court." *American Journal of Political Science* 40(2):421–443.

Maltzman, Forrest and Paul J. Wahlbeck. 1996*b*. "Strategic Policy Considerations and Voting Fluidity on the Burger Court." *American Political Science Review* 90-3 (Sept.):581–92.

Martin, Andrew D. and Kevin M. Quinn. 2002. "Dynamic Ideal Point Estimation via Markov Chain Monte Carlo for the U.S. Supreme Court, 1953-1999." *Political Analysis* 10:134–153.

Murphy, Walter F. 1964. *Elements of Judicial Strategy.* University of Chicago Press.

Plummer, Martyn. 2008. *Just Another Gibbs Sampler.* http://www-ice.iarc.fr/ martyn/software/jags/: .

Poole, Keith T. 2005. *Spatial Models of Parliamentary Voting*. Cambridge University Press.

Poole, Keith T. and Howard Rosenthal. 1985. "A Spatial Model for Legislative Roll Call Analysis." *American Journal of Political Science* 29(2):357–384.

R Development Core Team. 2008. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.

Rohde, David W and Harold J Spaeth. 1976. *Supreme Court decision making*. Vol. 4 WH Freeman San Francisco.

Romer, Thomas and Howard Rosenthal. 1978. "Political Resource Allocation, Controlled Agendas, and the Status Quo." *Public Choice* 33:27–43.

Segal, Jeffrey A. and Albert D. Cover. 1989. "Ideological Values and the Votes of U.S. Supreme Court Justices." *American Political Science Review* 83(3):557–565.

Segal, Jeffrey A. and Harold J. Spaeth. 2002. *The Supreme Court and the Attitudinal Model Revisited*. Cambridge University Press.

Ulmer, S Sidney. 1970. "Use of Power in the Supreme Court: The Opinion Assignments of Earl Warren, 1953-1960, The." *Journal of Public Law* 19:49.