Measuring Ideology at the Constitutional Convention[1]

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[T]he politics of the Convention resemble that of any legislative body, and its votes become grist for the fine-milling techniques of roll-call analysis that are commonly used to explain decision-making in Congress . . . . The key to understanding the "great compromise" may thus be found, one political scientist has suggested, through two- or five-factor solutions with the varimax rotation.—Jack Rakove, Original Meanings, 1997, p. 15.

Interpreting the Convention

That the constitutional convention was—and remains—important is not open to serious disagreement. Whether during a crisis, or simply amidst normal politics, Americans and their elected officials turn to the constitution's passage and ratification debates for enlightenment, guidance, and authority. Specifically, they are looking for authority conferred by those proceedings to enact policies today. First-year political science students—indeed anyone who has read much about the constitution—knows that those debates are open to many different interpretations: the importance of economic class (Beard 1913; McDonald 1958); pluralist interpretations (Roche 1961); regional interpretations (Wood 1969; Elazar 1972); cultural interpretations (Hartz 1955; Bailyn 1967; Wood 1991) and ideational interpretations (Rakove 1997). Lacking a definitive interpretation of the constitution, politics is often about multiple, competing interpretations of the document—and of what took place in Philadelphia's hot 1787 summer.

Because that event was not merely seminal—but revolutionary and founding—the interpretation of the document and the debates takes on an added importance: which interpretations will guide our current public policy debates? What clauses are simply arcane? Does arcaneness imply that the clause is outmoded, and therefore ignorable? What exactly were they trying to accomplish? And, perhaps most elusively, what where the motivations behind the document (Rakove 1990)?

The constitutional convention—like most political settings—was filled with disagreement. The civics text picture of the "founding fathers" sometimes glosses over the deep conflict at the convention and in the period. One state (Rhode Island) never sent a delegation, completely distrusting the deliberations. Some individual delegates actively opposed adoption of the constitution (among them Luther Martin of Maryland, and—at least for a time—Edmund Randolph of Virginia,

the man who introduced Madisons Virginia Plan). No one who left the constitution was happy about every outcome. For instance, in an October 1787 letter to Jefferson Madison explained, at length, his reasoning for a national negative on the power of state legislatures and governors. He was disappointed that the provision was not included. And Madison was so committed to the idea of proportional representation that he described the Senate's equal representation of states as an "embarrassment." But Madison, like many others who attended, swallowed his disappointment with various clauses and supported the eventual document—perhaps out of a sense that change was necessary, even when it was insufficient.

This traditional reason for eventual support for ratification—the apparent need for a stronger national government—was something agreed to by most of the delegates Rakove (1997). But the very fact that most delegates left the convention and went out to stump for ratification (in an 18th century fashion) helps shroud the debate: they left the convention with an agreement against disseminating knowledge of the debates. Thus only with the release (decades later) of the notes on the convention came knowledge of the actual proceedings.

This leaves modern students of the constitution with two difficult hurdles. First, our own perceptions of those founders as demigods is likely to cloud our vision of what was accomplished at those debates.[1] Second, our lack of hard knowledge of the proceedings has enabled the debate over competing interpretations of the convention.

At the outset we quoted Jack Rakove's (obviously skeptical) perspective on roll call analysis, citing Jillson (1988). Rakove's skepticism has some merit. Finding a "solution" to such difficult historical questions as motive, interpretation, and ultimately meaning is probably beyond statistical techniques. But this is not to say that such models shed no light on the key historical questions.

The contribution of roll call analysis is to better measure and define the terms of the debate. Stacking up speeches, classifying interest groups, and arguing about class motives are all important scholarly pursuits, but obviously rest upon the inherent subjectivity of the analysis. To take one crucial example, was James Madison in favor of proportional representation because it was more fair (by any standard it is), or because it would benefit the citizens of Virginia (it clearly did). Without making a claim to be able to resolve that kind of question, roll call analysis does allow us

[1] Although the opposite danger is not ignorable: some authors like to envision this moment as an unremarkable episode in the history of politics. We try to subscribe to neither bias.

to map the debate, and it is to that task that we now turn.

Statistical methods that recover the observed ideological positions of individuals based on the votes that they cast on policy proposals is fundamental to the study of Congress. These methods are also applicable in other settings in which most action occurs formally through a series of votes. In particular, roll call analysis can be applied to the Constitutional Convention. Although not formally a legislature, the Constitution evolved in a psuedo-legislative setting, with the substance of the proposed Constitution evolving over a series of 569 roll call votes (Farrand 1966). Using these methods, we provide a description of the general issues facing the delegates at the Constitutional Convention. We attempt to discern the proper dimensionality of the issue space, and to identify the most salient issues facing the Framers, reflected in the voting behavior on roll calls by the state delegations.

The two previous efforts to map the debate of the constitutional convention come from Jillson (1988) and Londregan (1999).[2] Using a series of factor analysis solutions (covering different time-periods of the convention) to describe the coalitions at the convention, Jillson concludes that five cleavages accurately describe the convention conflict and voting coalitions: republic size, control of the legislature, the scope of the national government, federalism, and control of the executive and Senate (See Figure 10.1 and relevant text in that chapter for a summary). Jillson clearly describes the potential dimensions of the conflict, but his analysis does not lend itself to formally mapping the positions of the individual state delegations

Londregan (1999) extends Jillson's analysis on voting coalitions at the convention by providing an improved approach to estimating the positions of the state delegations. Londregan uses an item response model, similar to the method implemented in this paper, in order to place the states' positions (and even individual delegates) in the issue space. In his model, he also incorporates information about the proposals in order to identify the delegates' positions. One limitation is that Londregan estimates each dimension separately instead of simultaneously. Londregan splits the Convention into two parts, and assumes that the first half concentrates primarily with representation, and the second half is scope and power (actually defined much more broadly than our definition, including slavery, commerce, .etc), based on the conclusions of Jillson. Indeed, the first

[2]Dougherty and Heckelman (2006) also conducts an exploratory analysis using Keith Poole's Optimal Classification program (Poole 2000).

half of the Convention primarily considers issues of representation, and once this the representation in the Senate is resolved, issues concerning the power of the national government dominate. Nevertheless, these issues are considered throughout the Convention, with scope and power votes from the very beginning, and votes reconsidering the representation of the states near the end. Instead, we code the dimension(s) onto which each vote loads. Most votes are allowed to be related to either dimension, with some votes restricted to only relate to representation or scope and power.

In this paper we offer a new methodology for mapping the states at the constitutional convention. Our methodology has two key advantages. First, we incorporate information about the agenda. Second, we employ a method for analyzing the "divided" votes (something previous efforts would have had to omit). The resulting pictures of the debates reveal that the nature of the specific votes matters a great deal (confirming Jillson's emphasis on the importance of the temporal nature of the convention).

Data and Methods

The basics of ideal point estimation are discussed in numerous sources, but a reproduction of the basic model here is still useful. In spatial models of voting, the legislator considers two positions, the "Yea" (bill proposal) position ω_j and the "Nay" (status quo) position q_j, for $j = 1, \ldots, m$ roll calls. The utility functions for each position are functions of the ideal points x_i, for $i = 1, \ldots, n$ legislators:

$$U_i(q_j) = \psi(|x_i - q_j|)$$
$$U_i(\omega_j) = \psi(|x_i - \omega_j|),$$

where $\psi(\cdot)$ is a monotonically decreasing function of $|x_i - q_j|$ ($|x_i - \omega_j|$); i.e., utility decreases for alternatives further away from the ideal point. The legislator votes "Yea" if $U_i(\omega_j) > U_i(q_j)$, and"Nay" otherwise. If, without loss of generality, $\omega_j > q_j$, then legislator i votes "Yea" when $x_i > \frac{\omega_j + q_j}{2}$. The quantity $\frac{\omega_j + q_j}{2}$ is the *cutpoint*, the ideal point for a legislator indifferent between the status quo and the proposal. Thus, if the status quo lies to the left of the cutpoint, all legislators with ideal points to the left of the cutpoint would be expected to vote "Nay," while those with

ideal points to the right of the cutpoint would be expected to vote "Yea."

Because the delegations voted by state, there is a complication due to aggregation. While this ideal point model is often applied for such actors[3], the use of this model does require some caution when discussing the "ideal point" of state i. In particular, we will refer to x_i as the "revealed position," since x_i is a reflection of the delegation decision making process, which does not necessarily result in the revelation of the median or mean position of the delegation. An estimate of $\mathbf{x}_i$ with a low score on both representation and scope and power reflects a state delegation with a decision making process that results in actions supporting equal voting among states and limited national government.

Following, Clinton, Jackman, and Rivers (2004) and Martin and Quinn (2002), the utilities include a random component, and $\psi(\cdot)$ is specified as a quadratic loss function:[4]

$$U_i(q_j) = -(x_i - q_j)^2 + \nu_{ij} \tag{1}$$

$$U_i(\omega_j) = -(x_i - \omega_j)^2 + \eta_{ij}. \tag{2}$$

where η_{ij} and ν_{ij} are error terms, usually assumed to be distributed normal (for probit links) or Type-I extreme value (for logit links). For this paper, we assumed the errors followed an extreme value distribution. The difference of these utilities can be represented as

$$\begin{aligned} y^*_{ij} &= U_i(\omega_j) - U_i(q_j) \\ &= -(x_i - \omega_j)^2 + (x_i - q_j)^2 + (\eta_{ij} - \nu_{ij}) \\ &= -x_i^2 + 2\omega_j x_i + \omega_j^2 + x_i^2 - 2q_j x_i + q_j^2 + (\eta_{ij} - \nu_{ij}) \\ &= 2(\omega_j - q_j)x_i - (\omega_j^2 - q_j^2) + (\eta_{ij} - \nu_{ij}) \\ &= \beta_j x_i - \alpha_j + \varepsilon_{ij}. \end{aligned}$$

The probability that legislator i on roll call vote j votes "Yes" is

$$\Pr(y_{ij} = 1) = \Pr(y^*_{ij} > 0) = \Pr(\varepsilon_{ij} > \beta_j x_i - \alpha_j) \tag{3}$$

[3]For an example regarding countries' positions from roll calls in the U.N. General Assembly, see Voeten (2004).
[4]Poole and Rosenthal's `DW-NOMINATE` specify a Gaussian loss function (Poole and Rosenthal 1985, 1991, 1997).

where $\beta_j = 2(\omega_j - q_j)$ and $\alpha_j = \omega_j^2 - q_j^2$. This model is a standard item response model (IRT), used frequently in the evaluation of educational testing (Johnson and Albert 1999). The coefficient β_j is the *discrimination* parameter for roll call j, and α_j is the *difficulty* parameter.

The model extends naturally to multiple dimensions, with utility functions

$$U_i(\mathbf{q}_j) = -\|\mathbf{x}_i - \mathbf{q}_j\|^2 + \nu_{ij} \tag{4}$$

$$U_i(\boldsymbol{\omega}_j) = -\|\mathbf{x}_i - \boldsymbol{\omega}_j\|^2 + \eta_{ij}. \tag{5}$$

with a latent variable model

$$\begin{aligned} y_{ij}^* &= U_i(\boldsymbol{\omega}_j) - U_i(\mathbf{q}_j) \\ &= \mathbf{x}_i\boldsymbol{\beta}_j - \alpha_j + \varepsilon_{ij}. \end{aligned}$$

For the two dimension case, the model is

$$y_{ij}^* = \beta_{j1}x_{i1} + \beta_{j2}x_{i2} - \alpha_j + \varepsilon_{ij}$$

In educational testing, the parameter x_i is the unobserved *ability* of the test-taker. Consequently, the coefficient β_j indicates the extent to which the test question gauges ability. If the coefficient is large and different than zero, the test question "discriminates" between low ability and high ability test takers extremely well. In the context of roll-call voting, if proposal vote j does not concern dimension d, then $\omega_{jd} = q_{jd}$, or $\beta_{jd} = 2(\omega_{jd} - q_{jd}) = 0$.

One limitation of this model is that the progression of the agenda is ignored. One can scramble the ordering of the votes, yet the `DW-NOMINATE` (and `CJR`) estimates will remain unchanged. Clinton and Meirowitz (2001, 2004) extend this model by incorporating the agenda directly into the estimation. First, for vote j, if proposal $\boldsymbol{\omega}_j$ passes, then the new status quo point equals this proposal: $\mathbf{q}_{j+1} = \boldsymbol{\omega}_j$. If $\boldsymbol{\omega}_j$ fails, then the status quo remains unchanged: $\mathbf{q}_{j+1} = \mathbf{q}_j$. Second, if a proposal does not concern dimension d, even if $\boldsymbol{\omega}_j$ passes, the coordinates of the status quo for irrelevant dimensions will remain unchanged: $q_{j+1,d} = q_{j,d}$. Figure 1 in ClintonMeirowitz illustrate the indexing required of the parameters. Each voting option (whether currently a status quo or

proposal) is represented by the parameter vector $\boldsymbol{\theta}$. The parameters $\mathbf{q}_j$ and $\boldsymbol{\omega}_j$ are mapped into $\boldsymbol{\theta}$, indexed by $y(j)$ and $n(j)$, where $\mathbf{q}_j = \boldsymbol{\theta}_{y(j)}$ and $\boldsymbol{\omega}_j = \boldsymbol{\theta}_{n(j)}$. By fixing some of the proposals to constants, one can directly estimate the structural parameters (status quo points and proposals), instead of the reduced form parameters $\boldsymbol{\beta}_j$ and α_j. The model is now

$$U_i(\mathbf{q}_j) = -\|\mathbf{x}_i - \boldsymbol{\theta}_{n(j)}\|^2 + \nu_{ij} \tag{6}$$

$$U_i(\boldsymbol{\omega}_j) = -\|\mathbf{x}_i - \boldsymbol{\theta}_{y(j)}\|^2 + \eta_{ij}. \tag{7}$$

with

$$y^*_{ij} = \|\mathbf{x}_i - \boldsymbol{\theta}_{n(j)}\|^2 - \|\mathbf{x}_i - \boldsymbol{\theta}_{y(j)}\|^2 + \varepsilon_{ij} \tag{8}$$

Naturally, for modern legislatures, such restrictions are difficult to impose, with single votes changing many policies simultaneously. For Clinton and Meirowitz, the approach works well in the 1st Congress, where the primary issues considered are the location of the capital and the assumption of state debts. Bills propose specific changes to these areas, and irrelevant proposals are easily removed. The Constitutional Convention has a more varied agenda, but the proposals are very specific and the number of substantive subjects is limited. Procedural votes, since they do not affect the status quo if passed, are excluded. All but one unanimous vote is removed as well, along with any votes that are unanimous, except for one divided vote. Some of the unanimous votes could conceivably be used, as long as both the status quo and proposal positions appear in enough non-unanimous votes. In practice though, these votes cause problems for the estimation. A total of 353 votes are used in this analysis; the distribution of Yea, Nay, and divided votes, as well as absences, are presented in table 1.

In the IRT model, much like factor analysis, certain restrictions must be imposed to ensure rotational invariance. Without restrictions, any orthogonal transformation to $\mathbf{x}$ and $\boldsymbol{\beta}$ will provide different parameter estimates but the same predicted probability.[5] One approach sufficient for identification, outlined by Rivers (2003), is the restriction of $D(D+1)$ rows of $\mathbf{X}$ to fixed constants. Alternatively, similar to a confirmatory factor analysis, the model can be identified with appropriate restrictions on the vote parameters. Aguilar and West (2000) specifies a block diagonal structure

[5] I.e., if $\mathbf{R}$ is an orthogonal matrix, $\mathbf{R}'\mathbf{R} = \mathbf{I}$, and $\mathbf{x}_i\boldsymbol{\beta}_j = (\mathbf{x}\mathbf{R})(\boldsymbol{\beta}\mathbf{R}')$.

	Yea	Nay	Divided	Absent
New Hampshire	122	102	9	120
Massachusetts	170	149	11	23
Connecticut	179	167	7	0
New York	34	37	8	274
New Jersey	144	155	1	53
Pennsylvania	186	152	10	5
Delaware	164	172	6	11
Maryland	158	166	24	5
Virginia	201	151	1	0
North Carolina	191	136	10	16
South Carolina	192	158	3	0
Georgia	192	146	8	7

Table 1: Distribution of Votes

on $\boldsymbol{\beta}$, with β_{dj} for one "reference" item on each dimension set equal to 1. We fix the proposals on vote 37 (proportional representation for the House) to be one on the first dimension ($\theta_{20,1} = 1$, with $\theta_{20,2} = \theta_{19,2}$), and vote 163 (national negative on state laws) to be one on the second dimension ($\theta_{97,2} = 1$ and $\theta_{97,1} = \theta_{96,1}$). The initial status quo (possibly the Articles of Confederation) is fixed to be (-1,-1). We also add additional polarity restrictions on the states; Virginia is constrained to be positive on both dimensions, Delaware is restricted to be negative on the first dimension, and Pennsylvania is restricted to be positive on the second dimension.

Another complication with the Constitutional Convention data is the presence of divided votes. Since the states vote by delegation, it is possible for states to become deadlocked on any particular vote. How should these votes be addressed? One cannot feasibly treat each vote as an ordered or unordered indicator, since the number of divided votes are indeed rare. For votes with no divided votes, one could not separately estimate divided vote coefficients (in unordered models) or vote specific thresholds (in ordered models). Consequently, the approach taken in all previous analyses has been to exclude the votes as missing. Of course, this "throws out" some information about the states revealed positions. In addition, the most important vote in the Convention, vote 156 (on the Great Compromise), is partly decided by Massachusetts switching from "Nay" to "Divided." Furthermore, it would be unlikely that these thresholds could be considered identical across state delegations. Some states were more likely to be divided than others. One obvious factor was whether the delegation was small or large, or odd an even. Also, some delegations had several opposing state political factions represented.

We express the stalemate within the delegation as the delegation split evenly between "Yea" and "Nay" positions. The resulting behavior results in a revealed position close to the cutline, the closeness measured by parameter δ. Since some states are more likely to be divided than others, we estimate separate δ_i for each state. Consequently, if two states have the same x_i, the state with the larger δ_i will be more likely to vote "Divided."

Following Sanders (1998, 2001), the model is the same quadratic utility model, but the decision rule is

$$y_{ij} = \begin{cases} \text{"Yea"} & \text{if } U_{ij}(\boldsymbol{\omega}_j) - U_{ij}(\mathbf{q}_j) > \delta_i \\ \text{"Yea"} & \text{if } U_{ij}(\boldsymbol{\omega}_j) - U_{ij}(\mathbf{q}_j) < -\delta_i \\ \text{"Divided"} & \text{if } -\delta_i \leq U_{ij}(\boldsymbol{\omega}_j) - U_{ij}(\mathbf{q}_j) \leq \delta_i \end{cases}$$

This is equivalent to an ordered model, with state specific thresholds that are common across votes, with the restriction that $\tau_1 = -\tau_2$. As long as the state has been divided on a roll call at least once, δ_i is estimable.

Estimation

Given the large number of parameters in the posterior distribution, the non-standard form of the joint distribution, and the difficulty in estimating the parameters jointly using classical methods of maximum likelihood, we work in a Bayesian setting, using Markov chain Monte Carlo methods (standard references include Gelman et al. (1995), Tanner (1996), and Johnson and Albert (1999); Jackman (2000a,b, 2004) provides an survey of these methods and their applicability to political science). The likelihood is

$$L(\boldsymbol{\theta}, \mathbf{x}, \boldsymbol{\delta}|\mathbf{Y}) = \prod_{i=1}^{N}\prod_{j=1}^{M}\prod_{k=1}^{3}\left[\Lambda\left(\tau_{ki} - (U_{ij}(\boldsymbol{\theta}_{y(j)}) - U_{ij}(\boldsymbol{\theta}_{n(j)})\right) - \Lambda\left(\tau_{k-1,i} - (U_{ij}(\boldsymbol{\theta}_{y(j)}) - U_{ij}(\boldsymbol{\theta}_{n(j)})\right)\right]^{I(y_{ij}=k)}$$

where $\Lambda(\cdot)$ is the logistic distribution, $\tau_{1i} = -\delta_i$, $\tau_{2i} = \delta_i$, with $\tau_{0i} = -\infty$ and $\tau_{3i} = +\infty$. The posterior distribution is

$$p(\boldsymbol{\theta}, \mathbf{x}, \boldsymbol{\delta}|\mathbf{Y}) = L(\boldsymbol{\theta}, \mathbf{x}, \boldsymbol{\delta}|\mathbf{Y})p(\boldsymbol{\theta})p(\mathbf{x})p(\boldsymbol{\delta}) \tag{9}$$

The prior densities for the parameters are assumed to be independent. Each unconstrained element of $\boldsymbol{\theta}$ has a $N(0, 4)$ prior distribution. The prior distribution for each unconstrained x_i is $N(0, 1)$,

with the constrained dimensions of Virginia, Pennsylvania, and Delware assumed to have truncated $N(0,1)$ prior distributions. The priors for elements of $\boldsymbol{\delta}$ are diffuse Gamma$(0.1, 0.1)$ distributions. We implement this MCMC scheme `WinBUGS`, using the Metropolis-Hastings sampler with normal proposal density (Lunn et al. 2000).[6]

Analysis

Here we present the results of our model for three periods:

- May through June 16.
- May through July 17.
- A complete model of the convention

We want to see if the estimates for each of the three periods appear idiosyncratic or if there are consistencies across the convention. The results seem to indicate that the representation dimension is quite robust: delegation positions changed very little over the course of the convention. There is some evidence that positions on representation issues changed slightly over the first six weeks of the convention, though most of the differences appear to be due to delegation polarization: each side became more and more entrenched. Despite this consistency on the first dimension the second dimension is clearly quite sensitive to the agenda and the votes included in each model. We begin with a brief description of the results from each model and then turn to a more comprehensive discussion comparing the results.

Model results

Figure 1 displays the results of our model from the beginning of the convention through June 16. Table 2 presents the results of the model in tabular form. The representation dimension appears to be quite clear: small states—or states that voted with this coalition—such as Delaware, Maryland, New York and New Jersey are placed on the left. Though they are clearly not well differentiated from one another they are unified in their opposition to proportional representation favored by

[6]The sampler had a burn-in of 20,000 iterations, with 30,000 samples (thinned by 10).

such states as Pennsylvania, Virginia, Massachusetts, and North and South Carolina. Connecticut is an interesting outlier, grouped (on the representation dimension) in this period with the large states. Under Sherman's leadership Connecticut was pushing for a compromise during this point of the convention and it seems likely that Connecticut voted often enough with the larger states to be classified as more moderate on the representation dimension (Robertson 2005; Dougherty and Heckelman 2006).

The second dimension is problematic (and discussed in more detail below). In this early period it appears that the dimension captures issues that split the small-state coalition: with Maryland and Delaware in opposition to Connecticut (New York and New Jersey in relatively moderate positions). It seems possible that since small-states were willing to vote increased powers to the federal government in this period—see for instance votes 28 and 59 on a national judiciary and national stipends for legislators, where states like Maryland and Delaware were willing to go along with the more stridently nationalist position. It is also possible that there is not quite enough information about the second dimension to get clear measurement of this dimension. But since several small states went along with some of the large-state proposals to expand the powers of government it seems likely that—at least for this period—their behavior appeared to be rather pro-national.

Since the point of running different models is comparison, we turn now to a discussion of a model of the convention from the beginning through July 17 (covering the period through the acceptance of the Great Compromise and some ancillary issues the next day). These models are captured in Figure 2 and Table 3.[7]

The representation dimension is now showing a clear division that corresponds to traditional accounts of the convention. If anything it is obvious that the two groups have drifted further and further apart: the divisions are clear. Connecticut is particularly interesting as it seems to hold a position less sympathetic to proportional representation in this model. Georgia appears to behave in just the opposite fashion: moving to a position much more sympathetic to proportional representation. Other than these changes in positions the model through July 17 is extremely consistent with the model through June 16. At this coarse level of analysis our model is unable to

[7]Note, figure 2 uses vote 163 as the reference vote for the second dimension, and figure 1 uses vote 28. The figure (not shown) for the period through July 17 using vote 28 as the reference vote is almost identical to figure 2, except New York and New Jersey are shifted slightly.

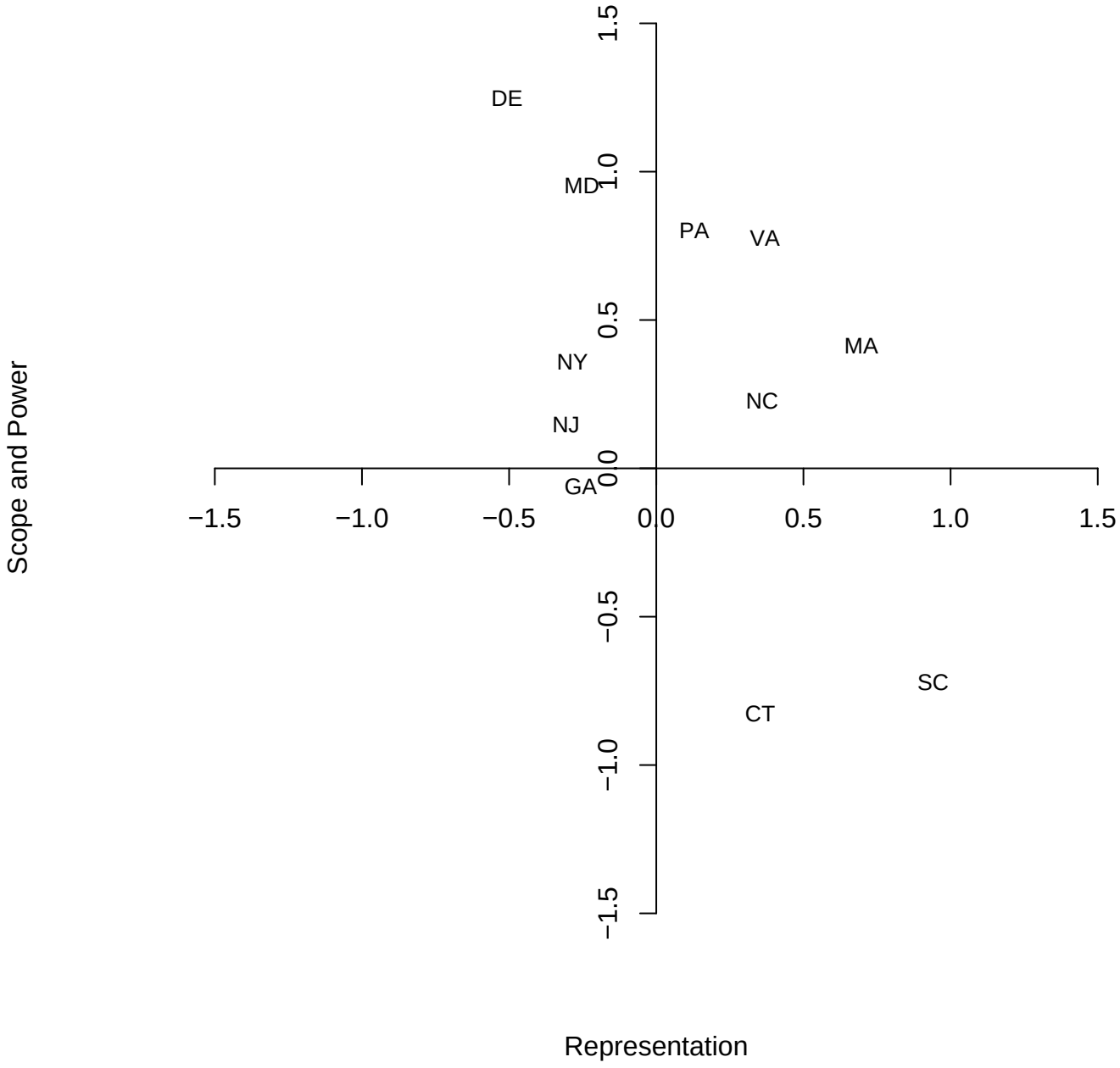

Figure 1: Model of state delegation ideal points through June 16.

State	Representation	Scope and Power
New Hampshire	NA	NA
Massachusetts	0.697 (-0.353, 1.897)	0.413 (-0.282, 1.135)
Connecticut	0.353 (-0.864, 1.429)	-0.826 (-2.056, 0.313)
New York	-0.285 (-1.280, 0.650)	0.361 (-0.256, 1.026)
New Jersey	-0.306 (-1.434, 0.833)	0.361 (-0.256, 1.026)
Pennsylvania	0.125 (-0.754, 1.143)	0.803 (0.013, 1.559)
Delaware	-0.507 (-1.404, -0.000)	1.248 (0.303, 2.232)
Maryland	-0.253 (-1.330, 0.853)	0.955 (0.091, 1.959)
Virginia	0.366 (0.001, 0.972)	0.778 (0.009, 1.501)
North Carolina	0.360 (-0.565, 1.380)	0.228 (-0.489, 0.912)
South Carolina	0.941 (-0.442, 2.316)	-0.719 (-1.851, 0.308)
Georgia	-0.256 (-2.008, 1.614)	-0.061 (-1.875, 1.678)

Table 2: Estimated positions of the states through June 16. Entries in parentheses indicate the highest probability density interval (HPD's are an analogue to frequentist confidence intervals).

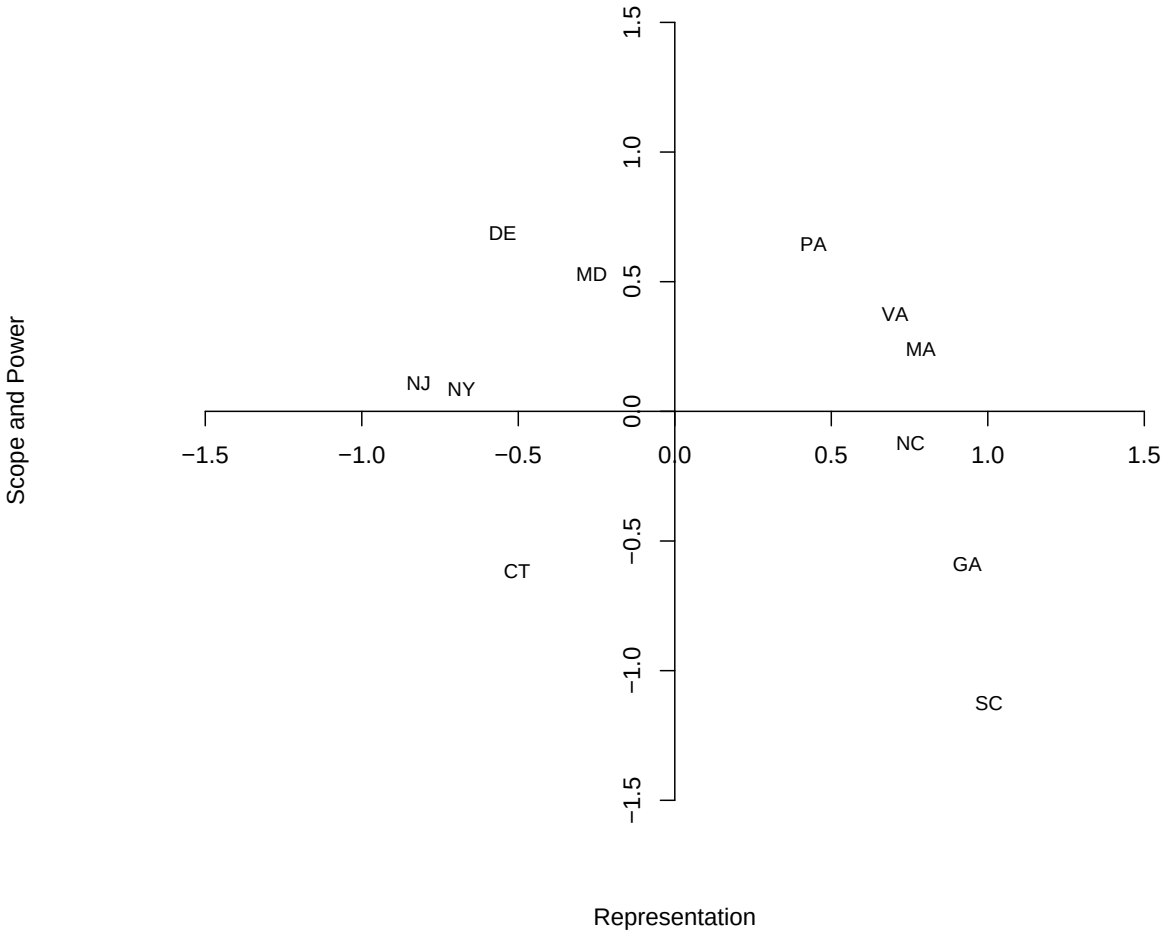

Figure 2: Model of state delegation ideal points through July 17.

State	Representation	Scope and Power
New Hampshire	NA	NA
Massachusetts	0.786 (0.215, 1.372)	0.241 (-0.155, 0.704)
Connecticut	-0.504 (-1.157, -0.057)	-0.617 (-1.216, 0.022)
New York	-0.682 (-1.365, -0.012)	0.088 (-0.380, 0.570)
New Jersey	-0.818 (-1.628, -0.089)	0.108 (-0.470, 0.637)
Pennsylvania	0.439 (-0.067, 1.023)	0.644 (0.083, 1.128)
Delaware	-0.550 (-1.117, -0.001)	0.687 (0.165, 1.203)
Maryland	-0.265 (-0.528, 0.004)	0.531 (0.056, 1.046)
Virginia	0.701 (0.145, 1.228)	0.376 (0.001, 0.784)
North Carolina	0.753 (0.229, 1.268)	-0.120 (-0.531, 0.323)
South Carolina	1.004 (0.349, 1.703)	-1.124 (-1.964, -0.297)
Georgia	0.935 (0.351, 1.555)	-0.590 (-1.117, -0.117)

Table 3: Estimated positions of the states through July 17. Entries in parentheses indicate the highest probability density interval (HPD's are an analogue to frequentist confidence intervals).

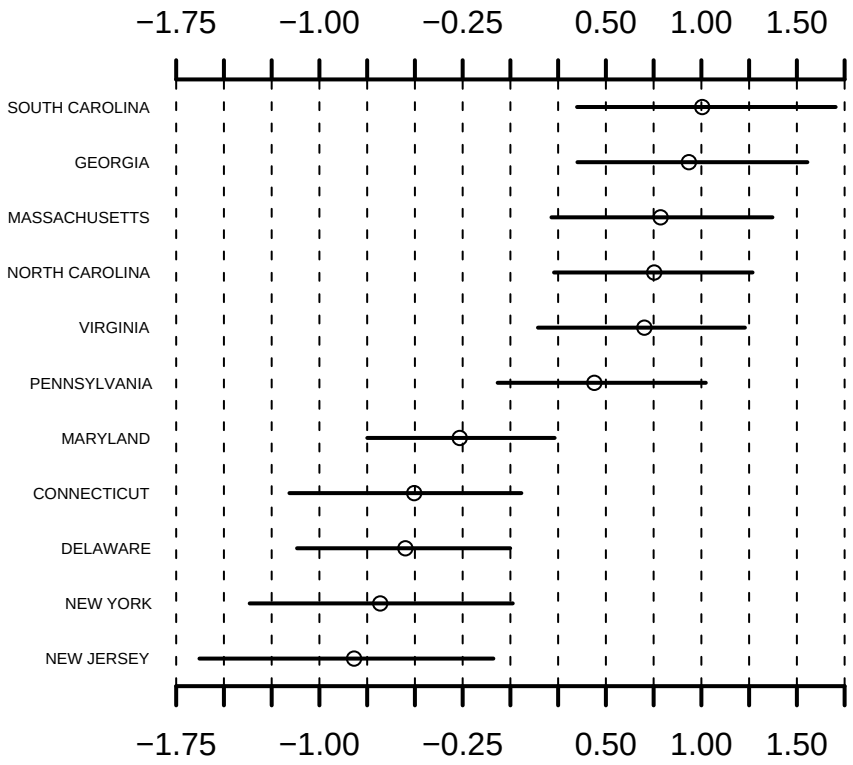

Figure 3: Representation estimates (through July 16). Bars indicate HPD intervals.

establish any effect of deliberation (more about this below) between June 16 and July 17.

Figure 3 graphically diplays the representation dimension estimates by state delegation. The bars indicate the HPD interval for each state. The divisions immediately become clear: South Carolina, Georgia, Massachusetts, North Carolina, Virginia and Pennsylvania oppose Maryland, Connecticut, Delaware, New York and New Jersey. States with overlapping HPD intervals cannot be easily distinguished from one another, but with some moderate exceptions (such as Pennsylvania) there are two fairly clear coalitions (even Pennsylvania is easy to identify with the nationalist grouping). On the second dimension the picture remains relatively static across the first two models suggesting a consistency in this first period of debate.

Our final model of the convention covers the entire period and is displayed in figure 4 and

table 4. In some respects this picture is still quite similar: most large states remain in relatively similar places on the representation dimension. But it is clear that the second dimension has been scrambled. Some states which were previously in favor of adding powers to the central government have moved in the opposite direction: Maryland and Delware. While others like Connecticut, South Carolina and Georgia are painted as more favorable to the expansion of the government's responsibilities.

The model that covers the entire period may reflect the fact that southern states were more comfortable with expanded government powers as guarantees for slavery were added to the constitution. It also seems possible that some mid-Atlantic states like Delaware and Maryland were unhappy with the compromises made in mid-July and voted against additional powers to the national government. But we will need more work on the second dimension to understand it. For now, we turn to a comparison of these three models.

Comparing the models

Which states seemed most consistent across each of the periods studied? New York and New Jersey are generally placed in roughly the same place across all specifications. Virginia, Massachusetts and Pennsylvania are similarly consistent. But other states appear to hold very different positions depending upon the model. Through June 16, Connecticut is classed with the large states on the representation dimension. But in the latter two models Connecticut is more clearly identified on the opposite side of that dimension. Additionally Connecticut's early position on the scope and power of the government appears to moderate throughout the convention. When including all votes in the model Connecticut is indistinguishable from Virginia or Pennsylvania (among other states). Maryland and Delaware tend to be consistent on the representation dimension, but their early enthusiasm for increased government powers appears to wane significantly as the convention proceeded. South Carolina, Georgia and North Carolina appear to fit exactly the opposite pattern: early hesitation to augment the power of the government followed by a willingness to do so.

This instability in the second dimension suggests to us that the second dimension of conflict is probably more complicated than our current modeling strategy permits. Augmenting government powers could come along multiple dimensions: taking power from the states and awarding it to the central government; distributing power between the executive or the legislative branches; or even

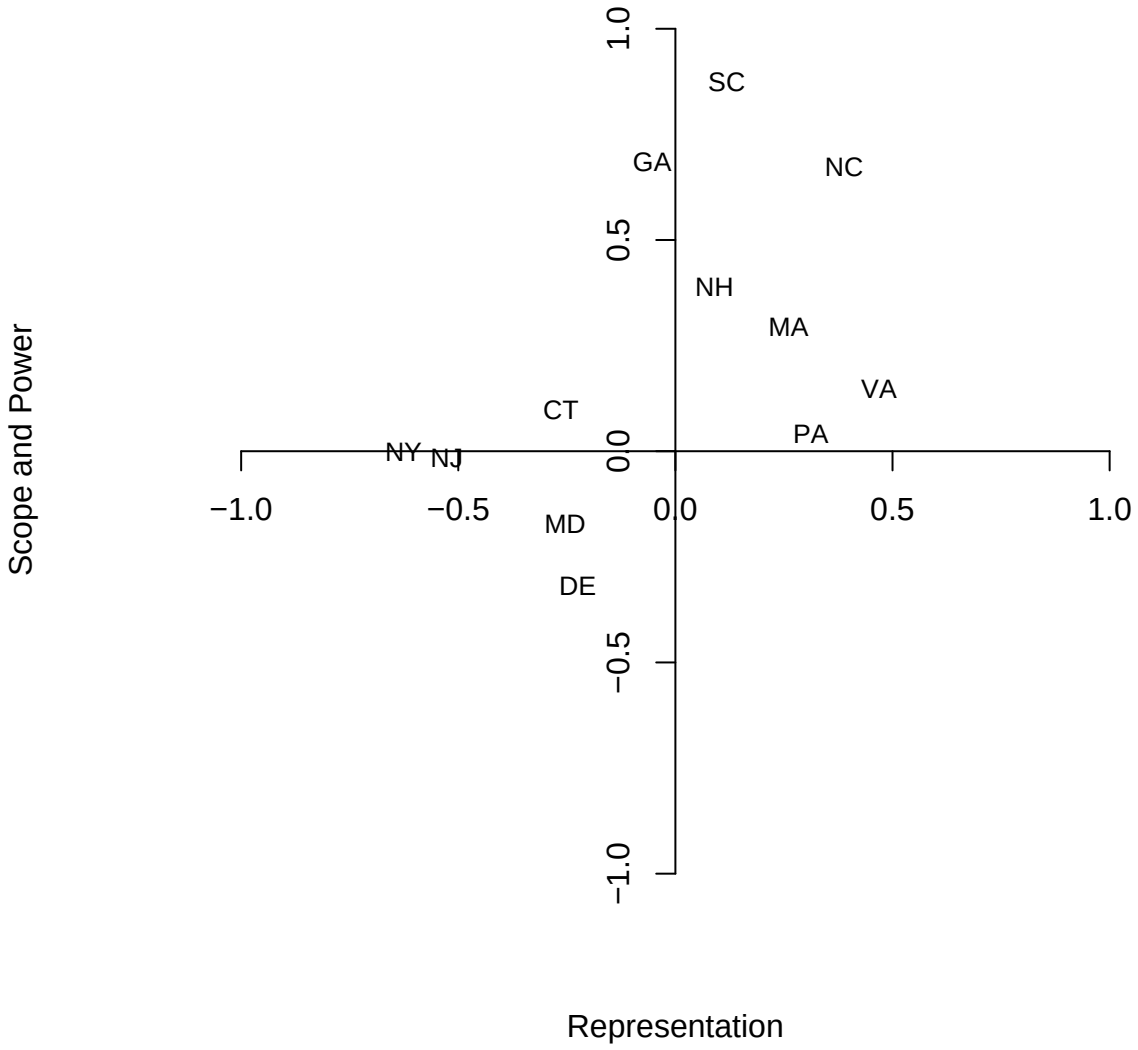

Figure 4: Model of state delegation ideal points including all convention dates.

State	Representation	Scope and Power
New Hampshire	0.090	0.390
	(-0.162, 0.363)	(0.152, 0.650)
Massachusetts	0.261	0.297
	(0.002, 0.519)	(0.088, 0.522)
Connecticut	-0.264	0.098
	(-0.514, -0.018)	(-0.155, 0.373)
New York	-0.626	-0.001
	(-1.227, -0.150)	(-0.497, 0.464)
New Jersey	-0.526	-0.015
	(-0.860, -0.201)	(-0.406, 0.329)
Pennsylvania	0.308	0.041
	(0.044, 0.565)	(0.000, 0.118)
Delaware	-0.225	-0.317
	(-0.480, -0.001)	(-0.606, 0.008)
Maryland	-0.254	-0.172
	(-0.528, 0.004)	(-0.450, 0.115)
Virginia	0.466	0.149
	(0.209, 0.725)	(0.000, 0.328)
North Carolina	0.388	0.674
	(0.088, 0.693)	(0.431, 0.896)
South Carolina	0.118	0.876
	(-0.218, 0.464)	(0.622, 1.165)
Georgia	-0.053	0.686
	(-0.330, 0.245)	(0.445, 0.945)

Table 4: Estimated positions of the states over the entire period. Entries in parentheses indicate the highest probability density interval (HPD's are an analogue to frequentist confidence intervals).

simple disagreement over the description of specific powers granted to the government. In future work we expect that we may need to include additional dimensions making the model less easy to explicate graphically, but potentially adding significant explanatory power.

However, it is not too early to consider the possible causes for the apparent changes in positions exhibited in these graphs. Three explanations seem most likely: deliberation leading to delegation opinion change; agenda effects that alter votes; and delegation attendance patterns.

Given that the constitutional convention aimed at deliberation it is at least plausible that some delegation positions changed with the changing opinions of delegates (a form of "conversion"). Though these results definitely do not rule out that possibility a comparison of the first and second figures suggests that "conversions" are unlikely. Georgia and Connecticut appear to be the only candidates for a significant "conversion" with respect to representation. The final model—which includes the entire convention—similarly does not indicate that states made significant changes on the representation dimension—though it is important to note that the second half of the convention contains markedly fewer issues related to representation. Regarding the second dimension we would need more certainty about its measurement before drawing firm conclusions about the possibility of any conversions on that dimension.

Some opinion change may be due to agenda effects. As the agenda progresses through the convention some votes may seem to be on similar issues when they are really not. As the agenda changes the status quo it may be that votes that appear similar are really about quite different proposals. As we are able to obtain more stable estimates of the proposals we may be able to better understand how the agenda affected convention voting. One important possibile proposal to examine is the grand committee's report (which clearly affected multiple dimensions) and solidified the "Great Compromise."

Finally, some opinion change is likely due to instability of the delegation. Delegates came and went throughout the convention. Some delegations were more unified than others. Our model allows us to measure the stability of the delegation, and can be extended to incorporate varying delegate attendance.

In sum, upon first glance (we reserve the right to change our opinion as more modeling deepens our understanding) there does not appear to be major evidence of deliberation effects at the convention on the representation issue: states came with positions on representation that

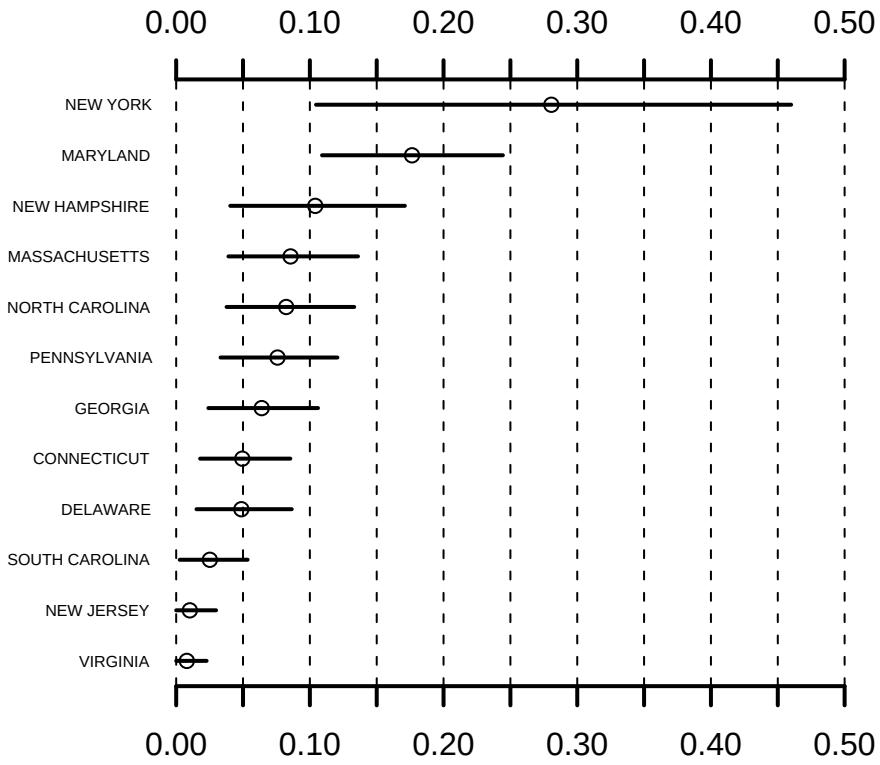

Figure 5: "Indifference zone" for each state.

appear to remain largely static—only Connecticut and Georgia appear to me significant exceptions to this general rule. This is not to imply that deliberation had *no* effect at the convention, merely that our model finds no such evidence.

Divided votes

As discussed above one of the strengths of our approach is adding a method to deal with divided votes. Though we have found that in practice the positions of the states are generally not sensitive to including this in the model we have found clear differences across the states in terms of the region of "indifference" described above. Figure 5 illustrates this region for each of the states.

It is clear that there are differences across the states. Assume that New York and Virginia

had similar ideological positions in the model. These results suggest that there are several votes where New York would be divided that would not divide Virginia (and given the prevalance of the divided votes for the New York delegation this increases our confidence that the model is correctly capturing this aspect of state behavior). As we said, adding this feature to the model does not dramatically change any of the estimated positions of the states. But once we are more confident about the estimation of the proposals at the convention it may help us explain certain key "divided" votes.

Discussion and future work

This paper demonstrates three things. First, we can produce estimates of the states' positions on readily identifiable issue dimensions—though we still need additional work to settle on dimensions beyond the obvious "representation" dimension widely employed in the past (Jillson 1988; Londregan 1999; Dougherty and Heckelman 2006). Second this model permits us to incorporate information about the agenda. Third, our model demonstrates that divided votes can be incorporated into the analysis in ways previously never considered.

In future work we aim to use this model to work on additional historical questions, particularly those related to the unfolding of the agenda at the convention. We believe this will help us better explain features of the convention such as the major compromises, the way the agenda affected those compromises and how delegation attendance contributed to the political outcomes. Eventually, we would like to utilize various sources of partial information to estimate individual delegate ideal points and model the decision-making process of the states. Using individual positions for the delegates from proposals (such as in Londregan (1999)), as well as for seconded motions and stated positions in speeches. Information from attendance records and divided votes can provide a basis for identifying the most likely combinations of voting within delegates.

Before we can settle either of those questions we will need to be confident about the dimensions employed and our ability to model the placement of agenda items, which is very sensitive to the determination of the initial status quo, the dimension of the space, and which votes are restricted to which dimension. But we are are confident that the innovations in this method of analysis can reveal important new insights about the convention.

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