Comparing NOMINATE and IDEAL

Points of difference and Monte Carlo tests

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Abstract

Empirical models of spatial voting allow legislators' locations in an abstract policy or ideological space to be inferred from their roll call votes. Over the past 25 years, these models have provided new insights about the US Congress and legislative behavior more generally (see, for example, Poole and Rosenthal, 1997). There are now a number of alternative models, estimators, and software that researchers can use to recover latent issue or ideological spaces from voting data. While these different estimators usually produce substantively similar estimates, important differences also arise. In this paper, we investigate the sources of observed differences between two leading methods, NOMINATE and IDEAL. Considering data from the 1994 to 1997 Supreme Court and the 109th Senate, we demonstrate that while some observed differences in the estimates produced by each model stem from fundamental differences in their underlying behavioral assumptions, others arise from arbitrary differences in implementation. Using Monte Carlo experiments, we find that neither model has a clear advantage over the other in the recovery of legislator locations or roll call midpoints in either large or small legislatures.

1. Introduction

Over the past twenty-five years, the study of Congress has increasingly involved the analysis of roll call voting data. Empirical models of spatial voting, often referred to as ideal point estimators, allow legislators' locations in an abstract policy or ideological space to be inferred from their roll call votes. These models have provided new insights about the US Congress in particular and legislative behavior more generally (see, for example, Poole and Rosenthal 1997). Recently ideal point models have also been applied to voting in non-legislative venues such as the United Nations (Voeten 2000), elections (for example, Herron and Lewis, 2007), and courts (for example, Martin and Quinn, 2002). There are now a number of alternative models, estimators, and software that researchers can use to recover a latent issue or ideological space from voting data. These approaches are often tailored to particular problems, such as voting in small chambers (Londregan, 2000), measuring dynamics (Martin and Quinn, 2002), or application to very large data sets (Lewis, 2001). The proliferation of estimators raises some general questions. Which (if any) approach is most appropriate in any given research situation? And, what leads to observed differences between methods when applied to the same data?

While there are some casual assertions in the literature and a good deal of folk wisdom among practitioners, there is little systematic research related to the conditions under which the various statistical estimators and the programs that implement them are more or less appropriate in either relative or absolute terms. In this paper, we attempt to shed some light on this question. We focus on two leading models; Poole and Rosenthal's NOMINATE (1985) and Clinton, Jackman, and Rivers' IDEAL (2001). NOMINATE has been the standard in the field since its development in early 1980s. Legislators' NOMINATE scores have been used in hundreds of published papers in political science and economics.

Developed in the late 1990s, IDEAL is a leading implementation of the MCMC-based methods of ideal point estimation that have recently been introduced in the literature (Martin and Quinn, 2002; Quinn, 2004; Bafumi et al., 2005). Other well-known ideal point estimators that we do not consider here include Poole's Optimal Classification (2000) and Heckman–Snyder scores (1997). We choose NOMINATE and IDEAL because NOMINATE continues to be the most widely used and IDEAL has many of the features of the more recent entrants—most notably the assumption of quadratic spatial utility that is common to nearly every approach other than NOMINATE and MCMC estimation.[1]

Although both IDEAL and NOMINATE can and are often used to estimate multidimensional issue spaces, we focus here on one-dimensional issue spaces. Multiple dimensions introduce greater complexity and difficulty in comparing estimates across models. We leave the comparison in higher dimensional spaces for future work.

Our decision to refer to these approaches by the names of the software routines that implement them is more than a choice of convenience. NOMINATE and IDEAL are both based on behavioral models which are used to derive statistical estimators and there are fundamental differences in their formal properties. However, there are also important differences in how the models are implemented and these differences in implementation are, in practice, an important source of differences between the results yielded by each approach. We seek to understand not just the differences that arise from the formal mathematical features of each model, but also those differences that arise from these less fundamental sources.

We begin with a brief history of IDEAL and NOMINATE in Section 2. In Section 3, we present the important potential sources of difference between the models in terms of both formal features and implementation. In Section 4, we take data from the US Supreme Court and US Senate and compare estimates generated by IDEAL, NOMINATE, and an MCMC-based version of NOMINATE. Comparing IDEAL and NOMINATE estimates to estimates generated by the MCMC-based version of NOMINATE allows us to isolate differences between IDEAL and NOMINATE that arise directly from their different spatial utility functions rather than from their different estimation techniques. In Section 5, we present the results of Monte Carlo experiments that assess the practical differences between the two models under a variety of conditions. We conclude with some general observations in Section 6.

2. A brief history of NOMINATE and IDEAL

The original one-dimensional NOMINATE was developed at Carnegie-Mellon University 1982-84 and the multidimensional NOMINATE was developed at the Purdue Supercomputer Center during 1986–87. This initial multidimensional program was written in CDC Vector FORTRAN (D-NOMINATE was based upon this program). W-NOMINATE was initially written by Nolan M. McCarty and Keith T. Poole in 1991 and has essentially been unchanged except for very minor bug fixes since 1997.[2] This version has been implemented in R (Poole et al., 2007; R Development Core Team, 2007).

The first published Monte Carlo analyses are reported in Poole and Rosenthal (1987). These were for the original one-dimensional NOMINATE. Monte Carlo studies of the two-dimensional D-NOMINATE program are reported in Poole and Rosenthal (1991) and Monte Carlo studies of W-NOMINATE are reported in Poole and Rosenthal (1997). All of these studies showed that the various versions of NOMINATE accurately recovered legislator configurations and roll call midpoints. In addition to these direct studies of NOMINATE, other studies have found that the legislator coordinates estimated by W-NOMINATE are highly similar to those obtained through the Heckman-Snyder (1997), KYST,[3] Optimal Classification (Poole, 2000), and Quadratic-Normal (Poole, 2001) methods.

Developed by Joshua Clinton, Simon Jackman, and Douglas Rivers at Stanford in the late 1990s, IDEAL is a Bayesian quadratic-normal procedure (Jackman, 2001; Clinton et al., 2004). IDEAL uses a Markov Chain Monte Carlo (MCMC) algorithm to infer legislator and bill parameters from roll call voting data. The basic framework has been extended to the dynamic ideal point model of Martin and Quinn (Martin and Quinn 2002). Martin and Quinn also provide an alternative computer implementation of the basic IDEAL model in their MCMCpack software (Martin and Quinn 2007). IDEAL and extensions built upon it have been widely used in the discipline. IDEAL was originally developed in the C computer language as a stand-alone program, but has since been repackaged to be called directly from the R statistical environment (Jackman, 2007; R Development Core Team, 2007).

Some comparisons between IDEAL and other estimators are included in Lewis and Poole (2004) and Hagemann (2007). The comparisons generally find few differences between the estimators when the size of the legislature is large but, find more substantial differences in smaller voting bodies (such as the US Supreme Court) (Clinton et al., 2004).

NOMINATE and IDEAL each have practical advantages over the other. NOMINATE can be run reasonably quickly on very large data sets. For example, the DW-NOMINATE scores provided by Keith Poole and Howard Rosenthal for the US Congress are based on over 92 thousand roll calls and 12 thousand legislators (McCarty et al., 1997). Due to the computational intensity of its MCMC algorithm, IDEAL is impractical for such a large problem. However, IDEAL also has all of the advantages of an MCMC estimator, such as the easy calculation of auxiliary quantities of interest and it provides measures of estimation uncertainty for all estimated quantities. However, these sources of practical advantage are waning for both methods. As computers become faster, the MCMC algorithm can be applied to larger and larger datasets. Faster computers also allow the application of the bootstrap to NOMINATE narrowing the gap between IDEAL and NOMINATE with respect to measuring the estimation uncertainty associated with model parameters and auxiliary quantities of interest (Lewis and Poole, 2004).

As practical considerations become less binding, the choice of procedure becomes more difficult. Often the models provide very similar estimates, but which should we prefer when they differ? In order to answer this question, one must first understand the possible sources of those differences.

3. Sources of difference between NOMINATE and IDEAL

While NOMINATE and IDEAL usually produce similar ideal point and bill parameter estimates, the estimates do differ and, in some cases, the differences can be substantively important. For example, the two methods might identify a different median member of the body or they might disagree about how far the leftmost member is from next most extreme member. These differences arise for a number of reasons. The sources of difference range from fundamental differences in the behavioral models (utility functions), to differences in identifying restrictions, to differences in estimation technique (MCMC versus ML), and finally to differences that arise from how the models are implemented in computer code. Understanding where and why NOMINATE and IDEAL differ is central to an informed decision about which, if either, estimator is preferable in a given situation. In this section, we detail these potential sources of difference.

3.1 Both IDEAL and NOMINATE are random utility models

We begin with one point on which there is no difference between IDEAL and NOMINATE; both are random utility models (McFadden, 1973) of Euclidean spatial voting (Enelow and Hinich, 1984; Hinich and Munger, 1994, 1997). In both models, voters are assumed to assign a utility to each of the two alternatives associated with each roll call. We will refer to these two alternatives as the *bill* and the *status quo*.[4] The utility associated with each alternative is determined in part by the distance between the alternative and the legislator's most preferred position and, in part, by an additive random shock. For each roll call (bill–status quo pair), legislators choose the alternative that provides the greater utility. The systematic spatial utility difference between the bill and the status quo arising from the location of the legislator and the locations of the two alternatives is, of course, the main object of substantive interest. The parameters related to this aspect of legislators' utility functions are what NOMINATE and IDEAL are designed to infer. The random shocks link the systematic spatial utility differences to probabilities of voting for each alternative. The random utility shocks in NOMINATE and IDEAL can and have been assumed to be (type I) extreme value distributed (leading to a logit link function) or normally distributed (leading to a probit link function). Aside from arbitrary differences in scale, the choice between these two error processes has little effect on the estimates.[5] For the purposes of this discussion, we consider IDEAL and NOMINATE to have i.i.d. normal utility shocks and i.i.d. extreme value shocks respectively. The normal shocks are assumed to be mean zero and have variances that depend in part on how the issue space is parameterized as will be considered in greater detail below.

3.2 The choice of utility function

The most obvious way in which the underlying behavioral model used in IDEAL and NOMINATE differ is in the choice of utility function. While both are Euclidean in the sense that a legislator is always more likely to choose an alternative that is closer to her ideal point than an alternative that is farther away, the shapes of utility functions differ, leading to different choice probabilities for given bill and status quo locations. However, over a wide range of bills and status quos, the two models closely match each other. Indeed, as shown above, IDEAL's quadratic utility function is a first-order power series approximation of NOMINATE's Gaussian utility function.

In IDEAL, legislators' preferences are quadratic. That is, assuming one dimension and letting *X* be the legislator's ideal point and *B* be the location of a proposed bill,

$$U_{IDEAL}(X,B) = -(X - B)^2 + e_B$$

where is the random utility shock associated with the bill. As is well known and easy to work out, quadratic utility implies linear utility differences. Letting *S* be the location of the status quo, under IDEAL the utility difference between the bill and status quo can be written as

$$\Delta(X,S,B) = (S^2 - B^2) + 2(S - B)X + e_B - e_S.$$

If the predicted choice probabilities depend on utility differences, the linear form of these differences is particularly convenient. Because the utility shocks are assumed to be normal and letting $a_0 = (S^2 - B^2)$ and , we can write

$$\Pr_{IDEAL}(Vote = B) = \Phi(a_0 + a_1 X) \qquad (1)$$

where Φ is the cumulative normal distribution function with mean zero and variance $\sigma^2 > 0$. This function is identical to the two-parameter IRT (item-response theory) model used in educational testing and indeed a good deal of IDEAL's estimation and implementation follows from the MCMC IRT models of the early 1990s (Albert and Chib, 1993). This form is amenable to MCMC estimation because a multivariate normal prior over the parameters leads to conjugate posteriors and a simple Gibbs sampling scheme.[6]

In the NOMINATE model, legislator utility functions have a Gaussian or bell-shape. Formally, the utility function is

$$U_{Nom}(X,B) = \beta \exp(-\frac{1}{2}w(X-B)^2) + e_B$$

where β and *w* are positive constants. The utility difference function admits no useful simplification and is

$$\Pr_{NOMINATE}(X,S,B) = \beta \exp(-\frac{1}{2}w(X-B)^2) - \beta \exp(\frac{1}{2}w(X-S)^2) + e_B - e_S$$

Assuming the logistic link function, the probability of voting for the bill over the status quo is

$$\mathbf{Pr}_{NOMINATE}(Vote = B) = \Lambda\left(\beta \exp(-\frac{1}{2}w(X-B)^2) - \beta \exp(-\frac{1}{2}w(X-S)^2)\right) \quad (2)$$

where Λ is the logistic cumulative distribution function. Perhaps not surprisingly, this characterization of the choice probabilities in terms of the locations of the alternatives and the legislator's ideal point offers little in the way of computational convenience. Rather, the choice of the Gaussian form is made on theoretical grounds.

[Figure 1 about here]

Figure 1 plots the corresponding NOMINATE and IDEAL spatial utility functions.[7] The curves are corresponding in the sense that the legislator has the same ideal point in each case and the utility scales are normalized to yield levels that are maximally similar for bill locations in the neighborhood of the legislator's ideal point. The key differences are seen in the tails of plotted curves. In the tails, the marginal loss in utility is decreasing in the NOMINATE formulation. In the tails of the IDEAL utility function, the marginal loss in utility is increasing at an increasing rate. Thus, in IDEAL, holding fixed the distance between the bill and status quo, legislators are increasingly more disposed to support the closer alternative the farther away both the bill and status quo are from their ideal points. On the other hand, in NOMINATE, the utility function is not globally concave, and as the bill and status quo are moved sufficiently far from the legislators' ideal points, the utility differences between the bill and status quo are decreasing. The vertical hashes found at the bottom of each panel in Figure 1 represent 200 randomly selected bill or status quo locations from the 109th Senate estimated using NOMINATE.[8] About 90 percent of these locations fall in the -1.5 to 1.5 interval. Over that interval there is little difference between the NOMINATE and IDEAL utility functions for a legislator whose ideal point is at or close to zero.

[Figure 2 about here]

Typical choice probability functions for the two models are shown in Figure 2. These functions are typical in that they reflect parameter values associated with estimates obtained from the contemporary United States Congress. For each panel, the axes are the location of the bill and the location of the status quo and the contour lines represent sets of the bill-status quo pairs that produce the indicated probabilities of supporting the bill. The ideal point of the legislator is represented in each panel by a solid black circle. Notice that in both IDEAL and NOMINATE the contours of indifference (points where the bill and status quo are supported with equal probability) are 45 degree and minus 45 degree lines that intersect at the legislator's ideal point. Along these lines the alternative and the status quo are equidistant from the legislator and consequently the legislator experiences zero systematic utility difference for those bill-status quo pairs. Notice that the two choice functions are very similar for bills and status quo pairs around the legislator's ideal point. The differences arise in the determination of choices that involve bill-status quo pairs that are both relatively far from the legislator's ideal point. In IDEAL (quadratic preferences), the choice function becomes knife-edged as we move away from the legislator's ideal point along the contours of indifference. On the other hand, in NOMINATE, the equiprobability contour lines do not converge as the bill-status quo pair is moved away from the ideal point. Indeed for bill-status quo pairs very far from the legislator's most preferred position, the equiprobability contours bend back away from one another.

The light colored dots in each panel of Figure 2 represent estimated bill–status quo (yea–nay) pairs from the 109th Senate as estimated by NOMINATE. Relatively few of these pairs fall in regions where IDEAL and NOMINATE assign substantially different choice probabilities. This is the case for legislators located at 0 and at -0.9 (NOMINATE estimated ideal points range from -1 to +1). Nevertheless, there is a significant minority of roll calls for which legislators located at 0 and -0.9 are predicted to be substantially less likely to support the closer alternative under NOMINATE than under IDEAL. The empirical significance of this difference between the models will be considered in detail in Section 4.2 below.

The close correspondence of NOMINATE and IDEAL for alternatives in the neighborhood of the legislator's ideal point is made all the more apparent considering a power series expansion of the NOMINATE utility function:

$$\begin{aligned} U_{Nom}(X;B) &= \beta - \frac{\beta w}{2}(X-B)^2 + \sum_{k=2}^{\beta} (-1)^k \frac{\beta w}{2k!}(X-B)^{2k} \\ &\text{»} \quad \beta - \frac{\beta w}{2}(X-B)^2 \end{aligned}$$

for alternatives (*B*) in the neighborhood of *X*. Apart from the arbitrary scaling constants β and this approximation is exactly IDEAL's utility function.

While NOMINATE and IDEAL use different spatial utility functions, those functions differ in their predictions about voting behavior mainly for votes involving bills and status quos far from the legislator's ideal point. Thus, we should expect differences between IDEAL and NOMINATE resulting from difference in their spatial utility functions to be manifest in the estimated locations of members whose ideal points fall far from the bill and status quos (usually these will be members with extreme ideal points) and also manifest in the estimated locations of bills and status quos that are farthest away from the center of the ideal point distribution.

3.3 Parameterization of the roll calls

NOMINATE and IDEAL both assign choice probabilities to each vote choice as a function of legislators' ideal points and the locations of the alternatives associated with each roll call vote. However, neither directly estimates the bill and status quo locations. Rather for each roll call, NOMINATE estimates $m = \frac{B+S}{2}$ and and IDEAL estimates and as defined above. These are choices of convenience. Parameterizing IDEAL in terms of and yields the probit regression form shown in Equation 1. Multivariate normal priors over and create conjugate posteriors convenient for MCMC estimation. NOMINATE's *m* and *s* parameters are referred to as the *midpoint* and *spread* respectively.

These differences in parameterization are of little substantive importance and the translation between the parameterizations is straightforward: $s = -\frac{\alpha_1}{2}$ and $m = -\frac{\alpha_0}{\alpha_1}$.[9]

3.4 Identifying restrictions

All of the parameters of interest in NOMINATE and IDEAL are latent and, consequently, have no inherent objective scale. In this sense, both models are only identified up to a choice of scale. Differences in the estimated parameters that are returned by each model are, in part, driven by differences in the how each model is identified (fixes the scale of the policy space). For the most part, these difference are arbitrary and can be removed by simple linear transformations in the same way that one temperature scale is converted to another with no loss of information.

However, these arbitrary choices of scale have subtle effects on the uncertainty associated each model's estimates. For example, as typically identified, legislator ideal points as estimated by IDEAL are usually less precise for members located at the ends of the continuum than for members located near the middle (Jackman, 2001; Clinton et al., 2004). On the other hand, NOMINATE often reports greater certainty about the locations of extremists than centrists (Lewis and Poole, 2004). While this might appear to be a fundamental difference between the two models and one might be tempted to conclude that NOMINATE is relatively better at locating extremists and IDEAL is relatively better at locating moderates, such conclusions are incorrect. As we describe below, it is largely differences in the arbitrary choice of identifying restrictions that drives differences in the uncertainty associated with the estimated ideal points (and roll call parameters) reported by each model. Because the choice of scale is arbitrary, so too are the consequences that arise from the choice of scale including those consequences related to how uncertainty is apportioned across parameters.

In NOMINATE, the scale is determined by fixing the end points of the ideal-point continuum.[10] The left-most legislator is fixed at -1 and right-most legislator is fixed at 1. Of course, the polarity of the scale is also arbitrary. The polarity is fixed by constraining (in the US context) the location of a known liberal (or conservative) to the negative (or positive) values. These restrictions alone are sufficient to uniquely identify the space. However, NOMINATE also places additional constraints on the parameters related to the bill and status quo locations. The midpoints (m) are constrained to fall in the $[-1,1]$ interval. Second, the spread parameters (s) are constrained such that both the bill and status quo locations cannot be outside of the $[-1,1]$ interval. This constraint implies that $|\min(m+s,m-s)|\leq 1$. The effects of these two additional constraints can be seen in Figure 2. The two sets of light colored dots falling along the -45 degree lines in the top right and bottom left of each panel reflect estimated bill and status quo locations for which the midpoint constraint was binding. The set of light-colored dots forming notches in the upper left and lower right corners of the panels in Figure 2 represent roll calls on which the spread constraint was binding. The constraints typically bind in cases of perfect or near unanimous voting. As described below, roll calls with perfect and near unanimous voting provide little information about their bill and status quo locations. While not strictly required for identification, these constraints help to pin down the roll call parameters when the data provide relatively little information. For this reason, the application of these constraints has little effect on the estimates of the legislators' ideal points.

Identification of latent quantities in Bayesian models such as IDEAL can be achieved in two ways: through the priors and through constraints similar to those used in NOMINATE. In early versions of IDEAL, identification was established by assuming that the prior distribution of the ideal points was standard normal. Because the data contain no information about the mean and variance of the ideal points (i.e., the scale), the assumed zero mean and unit variance of the prior determine the scale. As described in Lewis and Poole (LewisPoole04), this identification strategy leads to some overstatement of the estimation uncertainty (posterior variances) because the identification via the priors does not completely pin down the choice of scale. Some uncertainty in the (arbitrary) choice of scale is therefore manifest in the posterior distributions of the parameters leading to some overstatement of the actual uncertainty. Intuitively, this occurs because the prior implies that the set of legislators is drawn from a *population* with mean zero and unit variance rather than constraining the observed sample of legislators to have mean zero and unit variance (which would be sufficient to pin down the scale). As the number of legislators increases, this source of excess uncertainty diminishes.

More recently, Clinton, Jackman, and Rivers (2004) have recommended identification of the IDEAL model through parameter constraints. In IDEAL, the locations of any two members can be fixed though the identities of the members to fix is determined *a priori* by the analyst rather than during the estimation (as a result of the constrained legislators' extremity) as in NOMINATE. Identification can also be established in IDEAL by constraining the ideal point distribution to be exactly mean zero with unit variance (Z-scoring).

Differences in how the latent issue space is established lead to differences in how estimation uncertainty is applied to each parameter estimate. Fundamentally, all that is identified in these models are distances between pairs of legislators up to a choice of unit. The fundamental uncertainty is associated with those distances. For example, when a legislator's location is fixed then there is no uncertainty related to her location. All of the uncertainty associated with the distances between the fixed legislator and all unfixed legislators is reflected in the locations of those other legislators. By fixing the location of the most extreme legislators, NOMINATE associates estimation uncertainty with the locations of less extreme members. By restricting the distribution of ideal points to have mean zero and standard deviation one, IDEAL spreads the uncertainty more evenly across the members (as no single member's position is fixed). However, when one considers that only distances between members are truly identified, these apparent differences diminish.[11]

A final parameter in IDEAL is the variance of the random utility shocks, . Because the variance of random shocks cannot be separately identified from the and parameters, this variance is simply set to 1/2. By setting the variance of each shock to 1/2, the difference in shocks has a variance of one and the cumulative normal distribution function, Φ, in Equation 1 is the standard normal CDF. While this normalization is innocuous from the perspective of estimating legislators' ideal points, it is not innocuous with respect to estimating bill and status quo locations. In particular, note that by normalizing the variance of the difference in the shocks to be one, as in standard probit regression, IDEAL is in essence estimating not and for each roll call, but and where σ is the true (but, unobserved) standard deviation of the difference in the bill and status quo shocks. The roll call midpoint can be identified because it is expressed as a ratio of and cancelling out the unidentified σ. However, the distance between the bill and status quo cannot be uniquely determined in IDEAL and is only identified up to the arbitrary choice of σ.

In NOMINATE the scaling parameter β calibrates the relative importance of the random shock versus the spatial utility in the determination of vote choices. The locations of the bill and status quo can be identified from the data (given a choice of scale). However, this identification is weak in the sense that it follows entirely from the nonlinearity of the choice function (Equation 2). Thus in NOMINATE, the midpoints are strongly identified but the spreads are not.

In either IDEAL or NOMINATE, locating the bill and the status quo alternatives requires very strong assumptions. In particular, if the error component is in fact non-homogenous (i.e. the error variances differ across roll calls), those differences will be reflected in the bill and alternative locations. On the other hand, the roll call midpoints are more strongly identified by the data as described above. Any use of either NOMINATE or IDEAL that turns on the estimated bill or status quo locations should be viewed by the reader with suspicion and auxiliary evidence must be brought to bear by the researcher to justify the very strong assumptions required in this case.

Two additional issues related to identification are unbounded parameter estimates and empirical under-identification. In the absence of prior beliefs, the location of the bill and status quo cannot be uniquely identified when a vote is unanimous and therefore the roll call parameters are under-identified in that case. Near unanimous votes are dropped in NOMINATE, but can be included by IDEAL.[12] However, such votes are not informative about ideal points in the absence of strong prior beliefs about the roll call parameters and the roll call parameters associated with (near) unanimous roll calls are themselves only identified by the prior beliefs. In NOMINATE, near unanimous roll calls often have midpoints located at -1 or +1 due to parameter constraints as described below. Similar empirical under-identification also occurs whenever a vote is orthogonal to the spatial dimension. In that case, NOMINATE will conclude that the bill and status quo are identical and IDEAL will conclude that bill and status quo are nearly identical in expectation. However, where the bill and status quo are co-located along the policy dimension cannot be identified in either model. In the case of IDEAL, this location will depend upon on the priors.

Unbounded parameter estimates typically arise in the context of what Poole (2005) and others have referred to as *perfect spatial voting*. That is, roll calls on which every legislator votes for the alternative that is closer to their ideal point.[13] When perfect spatial voting occurs in IDEAL, the associated roll call parameter tends to plus or minus infinity. As can be seen in Figure 2, the choice function becomes increasingly inflected as the location of the bill and status quo are moved away from the voter's ideal point. By moving the bill and status quo unboundedly far from the legislators, while holding fixed the set of legislators who are closer to each alternative, all legislators are estimated to cast their observed votes with probability one. In this case, the mode of the posterior distribution of is only bounded away from infinity by the prior distribution placed upon it. The effect of the prior distributions that IDEAL places on the discrimination parameters is considered in more detail Section 4.1.

Because of the backward bending choice probability contour lines of the NOMINATE choice probability function shown in Figure 2, perfect roll calls do not lead to unbounded estimates of the bill and status quo locations under NOMINATE. While not unbounded, the

NOMINATE spread parameters (s) could become quite large in the presence of perfect voting. It is for these situations that NOMINATE constrains $|\min(m+s, m-s)| \leq 1$ as described above.

Perfect voting also creates minor complications for the estimation of the roll call midpoints. Under IDEAL, when voting is perfect, there is not a unique most likely midpoint. Without loss of generality, suppose a perfect vote such that all legislators to the left of a given point vote nay and all members to the right of that point vote yea. Under IDEAL, any point between the right-most nay-voting member and left-most yea-voting member has the same likelihood of being the bill's midpoint. Therefore, the location of the midpoint is not uniquely determined by the data and the priors on the bill parameters determine the unique posterior mode (or expectation). Under NOMINATE the midpoints associated with perfect votes are uniquely identified by the data because the estimated choice probabilities are not being driven to one as they are under IDEAL and therefore the likelihood is responsive to the location of the midpoint even in the interval between the left-most yea-voting member and the right-most nay-voting member. Despite these complications, the midpoints associated with perfect votes in all but the smallest voting bodies are typically quite precisely estimated by either model.

The NOMINATE procedure also includes an additional constraint designed to address legislators having perfect liberal or conservative voting records. As noted above, IDEAL will attempt to push a perfectly liberal or conservative legislator far away from all non-perfect voting legislators. In that case, exactly where the perfect-voting legislator is located is determined by the prior beliefs. In NOMINATE, perfect voting legislators would not be placed arbitrarily far from their colleagues in the absence of further constraints, however there is often a large discontinuous change in a legislator's estimated location that accompanies perfect voting if no further constraint is imposed. While this has no effect on the rank ordering of legislators, it can distort estimates of their relative locations. The problem is especially serious for small data sets, where perfect voting is more likely to occur by chance. To avoid placing perfect-voting legislators far from their non-perfect voting neighbors, NOMINATE constrains the distance between those legislators located at -1 and 1 (the leftmost and rightmost positions) and their nearest neighbors not located at -1 or 1 to be no more than 0.1 units (or 5 percent of the -1 to 1 scale).[14] In some cases, particularly when the number of legislators is small, this constraint can bind in the absence of perfect voting. In very small legislatures (fewer than 20 members), the constraint is not applied at all (see section 4.1 below).

3.5 Implementation

Detailed descriptions of how IDEAL and NOMINATE are implemented are given by Jackman (2001; 2007) and Poole (2005) and we will not rehash those discussions here. Rather, we focus on a few salient points of difference between the models and on what, if any, effects those differences are expected to produce.

As mentioned above, IDEAL is implemented using MCMC. MCMC has many advantages for assessing model uncertainty and for calculating auxiliary quantities of interest along with their associated uncertainty (standard errors). In general, determining the convergence criteria for MCMC estimators is something of an art, but the IDEAL estimator seems to mix rapidly. Due to the stochastic nature of the optimization, the exact estimates will differ slightly from run to run, but little of the difference between IDEAL and NOMINATE can be attributed to IDEAL's MCMC estimation. As a Bayesian estimator, IDEAL requires that priors be placed on each model parameter. By default these priors are quite diffuse and have little impact on the estimated quantities beyond those described above. However, stronger priors could induce important differences between the two models. In the simulations presented below, we employ the default diffuse (uninformative) priors.

NOMINATE uses an iterative constrained maximum likelihood algorithm. Starting values for the legislator locations are obtained by analyzing a legislator-by-legislator matrix of disagreement scores (fraction of times a given pair of members disagreed across roll calls upon which both members of the pair voted). Conditional on these starting values for the legislator locations and provisional values for the scaling constants w and β, a likelihood formed from the choice probability function shown in Equation 2 is maximized over the roll call parameters. That same likelihood is then maximized over w and β holding fixed the legislator and roll call parameters. Finally, new legislator parameter estimates are obtained conditional on the current values of the roll call parameters and β and w. This cycle is repeated until a convergence criteria is met. While this convergence criteria is a holdover from a time of less powerful computing and is not particularly strict, there is little evidence that failing to iterate until full convergence has important effects on the estimates produced by NOMINATE.

4. Two examples: Voting in The Supreme Court and the 109th Senate

In this section, we compare estimates obtained from IDEAL and NOMINATE when applied to data from the 1994 to 1997 US Supreme Court (Jackman, 2007) and from the 109th Senate (Lewis and Poole, 2008). With only nine members and 213 non-unanimous decisions, the Supreme Court data are about as small as any dataset to which these estimators are likely to be applied. The US Senate dataset has 102 members (including the President) and 520 non-unanimous votes; it is more typical of the data to which IDEAL and NOMINATE are applied. In addition to applying the NOMINATE and IDEAL estimators as described in detail above, we also apply a version of NOMINATE that is estimated via MCMC and which uses the same identifying restrictions as IDEAL (Carroll et al., 2008) and Poole's Quadratic Normal (QN) model (Poole, 2001).[15] As the name suggests, the QN model assumes quadratic utility. It applies parameter constraints similar to those imposed by WNOMINATE and is a (constrained) maximum likelihood estimator. Using these additional estimators, we are able to better isolate differences between NOMINATE and IDEAL estimates that arise from their distinct spatial utility functions and those that arise from differences in identifying restrictions or from differences in implementation.

4.1 United States Supreme Court, 1994–1997

In recent years, ideal point models have been increasingly applied to non-legislative voting bodies and, in particular, to the United States Supreme Court (for example, Martin and Quinn, 2002). Smaller voting bodies such as legislative committees have also been considered in the recent literature (for example, Londregan, 2000; Bailey, 2001; Peress, 2008). In this subsection, we compare NOMINATE and IDEAL estimates of the decision midpoints (m's) and Justice ideal points (X's) obtained when each method is applied to the 213 non-unanimous Supreme Court decisions made between 1994 and 1997.

[Figure 3 about here]

Comparisons of the estimated ideal points are shown in Figure 3. The panels above the main diagonal plot pairs of ideal point estimates against each other. For the purposes of comparison, the dimensions recovered by each of the three methods are normalized such that the ideal points range from -1 to +1. The first thing to note is that all four methods produce quite similar estimates. The IDEAL and NOMINATE estimates correlate at 0.99, IDEAL and the MCMC version of NOMINATE (MCMC NOMINATE) correlate at 0.99, and the two versions of

NOMINATE correlate at over 0.98. All three methods identify Stevens as the left-most justice and Thomas as the right-most justice and agree on the rank order of the remaining seven justices.

As described above, differences in the estimated standard errors across methods largely arise from differences in identifying restrictions. This will be more clearly shown when we consider the 109th Senate, but in the Supreme Court data, we see that NOMINATE estimates imply near certainty that Stevens and Thomas anchor the space (are the most extreme legislators) and, thus, associates no uncertainty with their locations (because the extremes are fixed by construction). For IDEAL and MCMC NOMINATE, there is substantial uncertainty associated with locations of the extreme members. Interestingly, the MCMC NOMINATE-estimated locations of the extreme members are considerably less certain than when estimated by IDEAL. Indeed, IDEAL estimates generate smaller standard errors than MCMC NOMINATE overall. While we need to investigate this further, these lower standard errors may arise from the non-concave tails of the NOMINATE utility function.

[Figure 4 about here]

Figure 4 presents comparisons of the estimated decision midpoints across the three methods. The decisions are split into two types. The first type of decision, shown in the upper row of panels, comprises those 142 decisions for which the underlying spatial dimension is sufficiently predictive that some meaningful information about the location of the midpoint can be recovered. The lower panels show the estimated decision midpoints for those 71 decisions where the underlying dimension was not sufficiently predictive to recover meaningful information about the location of the midpoint. This occurs when the underlying dimension is not predictive. For example, the underlying dimension is not predictive when the five most centrist justices vote in opposition to the remaining four justices. In such cases, the bill and status quo locations are inferred to be quite close together. However, whenever the bill and status quo locations are very close together and holding the distance between them fixed, the choice probabilities are only weakly related to where the bill and status quo are jointly located. Thus, the location of the midpoint is empirically under (or weakly) identified in such cases.[16] Across all 213 decisions, the estimated midpoints correlate at 0.71 between IDEAL and NOMINATE, at 0.83 between NOMINATE and MCMC NOMINATE, and at 0.79 between MCMC NOMINATE and IDEAL. However, if we consider only the 142 decisions for which the midpoints can be reasonably well pinned down, those correlations increase to 0.96, 0.99, and 0.97 respectively. Thus, for those votes on which any sizeable amount of information exists as to the location of the rollcall midpoint, there is substantial agreement between the various methods. Of course, with only, at most, nine members voting on each decision, the uncertainty associated with the estimated midpoints is substantial. As will be shown in our study of voting in the 109th Senate below, the midpoints are, as one would expect, substantially more precisely estimated when number of votes on each roll call is increased ten-fold.

4.2 The 109th Senate

The data from the 109th Senate is more typical of roll call voting matrices to which NOMINATE and IDEAL are applied. Including the announced positions taken by President Bush as votes, there were 102 voters in the 109th Senate and 520 votes on which at least 3 members voted on the losing side (non-unanimous or non-near unanimous votes). Figure 5 presents comparisons of the estimated Senator locations associated with IDEAL, NOMINATE, QN, and MCMC NOMINATE. Because of the larger number of voters and roll calls in the 109th Senate, these comparisons are cleaner than those shown for the US Supreme Court in the previous section. As was the case for the Court, all methods produce similar ideal point estimates. Correlations among estimates generated by the various estimators range from 0.985 to 0.997.

[Figure 5 about here]

Surprisingly, the largest correlation across the estimates is between NOMINATE and QN and the smallest is between IDEAL and QN. Given that QN and IDEAL use the same choice function and differ only by IDEAL's use of prior distribution and QN's roll-call parameter constraints, we expected that QN and IDEAL estimates would be very nearly perfectly correlated. Unlike the Supreme Court data, the number of voters is relatively larger in the Senate; the effect of the roll call parameter priors should be minimal in this context. One possible explanation is that NOMINATE and QN use the same procedure for generating ideal-point starting values and, using default settings, neither estimator is iterated to full convergence. Thus, it is possible that the relatively high correlation between NOMINATE and QN and relatively low correlation between QN and IDEAL may be due to insufficient optimization of the QN and NOMINATE estimates. By default QN and NOMINATE take a small and fixed number of optimization steps rather than iterating until a convergence criteria is met. To check for the possibility that lack of convergence is responsible for the pattern of correlations across methods, we refit the QN and NOMINATE models iterating them to conventional full convergence.[17] We find some evidence that lack of convergence may be an issue. The fully converged QN estimates correlate with IDEAL estimates at 0.9999. The slight change in the estimates when more fully converged is also reflected by the smaller correlation of 0.9926 between the default QN estimates correlate with the fully converged QN estimates. On the other hand, the default NOMINATE estimates are correlated with the fully converged NOMINATE estimates at 0.9994. Thus, while it may be advisable to iterate the QN model beyond the default setting, additional iterations of the NOMINATE model (at least, in this case) had less impact on the recovered senator locations.

The variation in the reported uncertainty of the estimates across methods can be seen more plainly in the case of the Senate than was the case for the Supreme Court. As revealed by the horizontal and vertical lines in the top row of panels in Figure 5, the greatest uncertainty in the IDEAL and MCMC NOMINATE estimates is associated with members whose ideal points fall in the tails of the distribution. NOMINATE loads the estimation uncertainty largely onto the locations of less extreme members (particularly, in this case, on those positioned left of center). The lower row of panels in Figure 5 reveals that estimation uncertainty, while consistently greater for MCMC NOMINATE than for IDEAL, is apportioned relatively similarly across members by those two methods. On the other hand, NOMINATE apportions the uncertainty in the estimated ideal points in a markedly different way. As previously described, these differences and similarities are not fundamental and follow directly from the choice of identifying restrictions.

The point located near the middle of the cloud of Republican senators on the top and right of each panel in the first row of panels in Figure 5 that is associated with an unusually large confidence interval represents President Bush who only took a position on 81 of the 520 rollcall votes considered.

The effects of other constraints imposed by NOMINATE can be seen in Figure 5 as well. The hash marks in the margins of each panel in the upper row show the estimated locations of the 520 roll call midpoints. Notice that NOMINATE midpoints all fall within the -1 to 1 interval (or more precisely the range of the legislator ideal points).

[Figure 6 about here]

Figure 6 presents comparisons of the estimated midpoints across methods. As we did in the Supreme Court example above, we separate out the rollcalls for which the midpoint could be located with any certainty from those rollcalls for which the midpoint could not be pinned down. For those rollcalls for which the midpoints were reasonably estimable, the relative locations of the midpoints are very highly correlated across methods.

[Table 1 about here]

The one notable outlier in the comparison of the legislator ideal points across methods in Figure 6 is Russ Feingold (D WI). This can be seen most clearly in the comparison of IDEAL and MCMC NOMINATE where we find a lone point far below the 45 degree line near -0.5 on the x-axis. This point represents Feingold, who is found to be the most liberal member by the MCMC version of NOMINATE, but is only the fifth most liberal member as estimated by NOMINATE, and only the 22nd most liberal member as estimated by IDEAL. Table 1 shows the rank position of the four members who are among the two leftmost members as estimated by at least one of the four methods considered. While there are small differences in how Boxer, Corzine, and Kennedy are ranked, Feingold is placed quite differently by the methods that assume quadratic utility and those that assume Gaussian utility. The source of this difference relates to the difference in IDEAL (quadratic) and NOMINATE (Gaussian) choice probabilities described in section 3. Under quadratic utility, choice probabilities move quickly to zero or one as the location of the bill and the alternative are moved farther from each other and farther from the location of the legislator's ideal point. Under Gaussian utility the choice probabilities do not fall as rapidly as the alternatives are moved farther apart or farther from the legislator's ideal point. Feingold is an occasional ideological maverick in the sense that on a number of rollcalls he voted with the Republicans and against almost everyone else in his party. These maverick votes by an extreme legislator are particularly unlikely to occur under IDEAL and they account for the more moderate position given to Feingold by that method.

[Figure 7 about here]

Figure 7 shows one such vote and how the likelihood of Feingold's choice on that vote would have varied had he been located at any other point on the ideological dimension. This vote, the 227th taken in the 109th Senate was on an amendment to The Science, State, Justice, Commerce, and Related Agencies Appropriations Act of 2006 (HR 2953).[18] The amendment, offered by Senator Stabenow (D MI) and Senator Corzine (D NJ), earmarked $5 billion out of the Department of Homeland Security's budget for the funding of inter-operable communications equipment grants to states and localities.[19] Feingold joined moderate Democratic Senators Carper (DE), Conrad (ND) and Nelson (FL) in voting with 54 Republican Senators to defeat the amendment. No Republicans supported the amendment. The upper panel in Figure 7 shows the yeas and nays on this vote as a function of Senators' NOMINATE scores and reveals Feingold's vote as a notable outlier in a roll call that otherwise fits the spatial model nearly perfectly. The lower two panels show how moving Feingold's position along the spatial dimension would affect the estimated log-likelihood of the vote that he cast. On the lower left panel, we see that if Feingold was moved from his estimated IDEAL location, represented by the solid circle, to the IDEAL position of the fifth ranked Senator (Feingold's NOMINATE rank), represented by the solid square, the log-likelihood of his nay vote would fall by 6.7. Put another way the probability of Feingold casting this nay vote would be 780 times less likely if he was moved left to the location of the senator that IDEAL ranked fifth most liberal. On the other hand, as shown in the lower right panel of Figure 7, under NOMINATE moving Feingold from his fifth ranked position to the location of the 22nd ranked Senator (Feingold's IDEAL rank) would increase the log-likelihood of his vote by 1.3 or, put another way, such a shift in position would make his nay vote 3.8 times more likely. The median log-likelihood of Feingold's votes across 512 votes is -0.01 under NOMINATE and -0.02 under IDEAL. Large log-likelihoods are relatively insensitive to small changes in location (as seen in the right tails of the curves displayed in the lower panels of Figure 7. Thus, it is not surprising that both methods are sensitive to outlying votes such as the one considered here. However, because IDEAL is more sensitive to these outlying votes, "mavericks" such as Feingold are shifted further towards the middle of the ideological spectrum by IDEAL than they are by NOMINATE.[20]

5. Monte Carlo Experiments

In this section, we summarize the results of a large number of Monte Carlo experiments comparing NOMINATE and IDEAL. The focus of these experiments is to establish conditions under which one or the other might produce more reliable estimates and characterize the conditions under which differences between the procedures can be expected to arise. The conditions that we vary are the size of the legislature, the number of roll calls taken, and whether the simulated data are generated from NOMINATE's choice function or IDEAL's choice function. Other important features such as the level of voting error (importance of random utility component), the distribution of legislator ideal points, and the distribution of roll call parameters are held fixed.

[Figure 8 about here]

We consider three legislature sizes, N: 9, 100, and 435. Similarly, we consider seven different numbers of roll call votes, K: 50, 75, 100, 150, 200, 350, and 500. The distribution of ideal points is held fixed across experiments with the same number of legislators. We ran 50 simulations for each of the 21 $N \times K$ value combinations. The distribution of ideal points for the

435 member legislature is shown in Figure 8. Smaller legislatures were generated by sampling without replacement from the distribution shown in Figure 8. A complete description of how the simulated data were generated and computer code to replicate these simulations are available upon request.

[Figure 9 about here]

Figure 9 shows the average mean square error of the estimated ideal points across all legislators and trials for a given legislature size and number of roll calls. The mean square errors are net of arbitrary scale differences between the estimates and the true ideal points. The curves are obtained by LOESS regression of the mean square errors on the number of votes for each legislature size. The left-hand panel of Figure 9 shows the mean square errors for IDEAL estimates. These estimates are based on simulations that follow IDEAL's assumed data generating process. Similarly, the right-hand panel shows the average mean square errors associated with NOMINATE estimates for given numbers of legislators and roll call votes. The NOMINATE estimates are based on simulations which follow NOMINATE's data generating process. The plots reveal somewhat smaller mean square error for the NOMINATE estimates across the board and particularly when the number of votes taken is small. Given that the data generating process is not the same in both cases and our attempt to make the data as comparable as possible by equalizing the number of misclassified votes (instances in which a legislator chooses the alternative that was farther from her ideal point) across the two data generating processes is somewhat crude, little should be inferred from Figure 9 about which method produces the larger mean square error. Instead, we focus on the similarities. In particular, for both methods the ideal point estimates are highly volatile when the number of voters is small and while the number of legislators has an impact on the precision of the ideal point estimates, these differences are modest if the number of legislators is greater than 100. From the standpoint of recovering ideal points, these initial experiments reveal no clear advantage of one over the other for any particular legislature size or number of votes taken.

[Figure 10 about here]

Figure 10 presents results from our Monte Carlo experiment related to estimating roll call midpoints. The top two panels show the average estimated mean square errors of the roll call midpoints as estimated by each of the two methods. As expected, the quality of these estimates increases dramatically as the size of the chamber is increased, However, these estimates are little improved by increasing the number of votes taken beyond 50 (the minimum number of roll calls considered in the experiments). While the estimated NOMINATE midpoints appear to be considerably more accurately estimated, two caveats must be kept in mind. As noted above, the data generating processes used to create the samples applied to NOMINATE and IDEAL in our experiments cannot be exactly matched with respect to the amount of information they contain. Thus, some of the apparent disadvantage of IDEAL may be due to incomparability in the data used. Another difference arises from the constraints that NOMINATE places on the location of the alternatives associated with a given roll call vote. As described in Section 3, under NOMINATE the midpoint is constrained to lie within the range of the legislators' ideal points. The data in our experiment are consistent with this constraint. IDEAL imposes no such constraint. Thus, the upper bound on the error in midpoint placement that NOMINATE can make is less than that of IDEAL. In this sense, some of NOMINATE's advantage in estimating midpoints arises simply from its willingness to assume more about the data generating process than does IDEAL.

In practice, interest in roll call midpoints is largely related to where the midpoints fall within the distribution of ideal points. The bottom two panels of Figure 10 present the accuracy of the midpoint estimates in terms of where they fall within the estimated ideal point distribution. The vertical axis in these two panels is the average absolute difference between the estimated percentile of the ideal point distribution at which each midpoint falls and the corresponding true percentile. The reliability of these ordinal midpoint locations improve as more votes are taken because the ideal point estimates improve as more votes are considered. Interestingly, the estimates of the midpoints' ordinal locations do not improve as legislators are added. In this case, adding legislators has offsetting effects: the interval-level estimates of the midpoints improve and the likelihood that any given estimation error will affect the estimated percentile location of the associated midpoint increases. In these data, it is the second of these offsetting effects that wins out. Overall, when a large number of votes are taken, estimates of where the rollcall midpoints fall in the distribution of ideal points are generally quite accurate — within 3 or 4 percentiles of the true values. NOMINATE also appears to be more accurate in recovering these ordinal midpoint locations than is IDEAL. The reason for this greater average accuracy is unlikely to be related to the additional constraints on the midpoint location that are imposed by NOMINATE because while the midpoint estimates that fall far outside the range of the legislators' ideal points can have a large effect on the mean square error of IDEAL's midpoint estimates, such estimates have limited effects on the ordinal location of such midpoints—once the midpoint estimate is beyond range of legislators' positions, it is at the 0th or 100th percentile regardless of how far outside that range it falls. Rather, these difference between NOMINATE and IDEAL may relate to the greater sensitivity of the IDEAL estimates to outlying votes. In the previous section, we saw how Senator Feingold's location under IDEAL was influenced by a small number of unexpected "conservative" votes. Similarly, we expect that the estimated roll call midpoints will be pulled toward the ideal point of an unexpected vote.[21] While more detailed study is required to pin down the relative importance of the various sources of difference, our experiments suggest that roll call midpoints can be well estimated in reasonably large chambers and that it is important to consider both the uncertainty in the ideal points and the uncertainty in the midpoints when estimating where in the distribution of ideal points that a particular midpoint falls.

[Figure 11 about here]

When considering real-world data, one does not know if it is generated by the process assumed by IDEAL, the one assumed by NOMINATE, some combination of the two, or some other process altogether. It is possible that one of the methods is more robust in the presence of the data generating process assumed by the other. That is, when the data are consistent with the other estimators' data generating process, the more robust estimator produces results that are more similar to the estimates that would have obtained if the other estimator had been applied. If one method was shown to be more robust in this sense than the other, that robustness would be a good basis on which to prefer that method to the other. Figure 11 considers this possibility by comparing the correlations between NOMINATE and IDEAL estimates when applied to the same datasets. In the left panel, these datasets are produced by IDEAL's assumed data generating process. In the right panel, the datasets follow NOMINATE's data generating process. Neither estimator appears to be markedly more robust than that the other.

Overall, these simulations are consistent with the results developed in the two empirical examples presented above. Neither method presents a clear advantage over the other for any particular legislature size or number of votes taken. Both methods produce quite accurate estimates when the number of legislators and votes is reasonably large and noisier estimates when those two quantities are small. Similarly, there is no evidence that one method is particularly more robust in the presence of the data generating process of the other.

6. Conclusion

We have compared the properties and performance of the two leading models for inferring legislators' positions in one-dimensional issue spaces from their roll call votes; NOMINATE and IDEAL. The two models differ both in their formal properties and in their software implementations, and although NOMINATE and IDEAL consistently produce very similar estimates, the differences arising both from these formal and procedural properties are significant in some cases.

Some differences stem from the fundamental distinction between the normal utility function assumed by NOMINATE and the quadratic utility function assumed by IDEAL. Others derive from the parameter constraints and identifying restrictions not fundamental to the methods. These less fundamental differences can lead to the appearance of relative advantages of one method over the other—for example, an apparent greater relative certainly of the estimated ideal points for moderate legislators as estimated by IDEAL and for extreme legislators as estimated by NOMINATE. These differences are artifacts of arbitrary identifying assumptions. Further differences between IDEAL and NOMINATE are attributable to the choice of priors within IDEAL, particularly in the case of small voting bodies such as the US Supreme Court. No major differences, however, appear to be attributable solely to the MCMC implementation of IDEAL or the ML implementation of NOMINATE.

Using data from two voting bodies, the US Supreme Court and the 109th US Senate, we compared the performance of NOMINATE and IDEAL. In order to isolate the source of observed differences between the results produced by each method, we also considered an

MCMC implementation of NOMINATE and an ML implementation of IDEAL, the QN model. In general, we find a high correlation across methods between estimated ideal points and midpoints. While the same rank order is reliably obtained across all four methods for the US Supreme Court, significant differences arise in the interval-level locations estimated by IDEAL and NOMINATE.

In our comparison using the 109th Senate, correlations among estimates generated by the various methods are even higher. Some of the practically negligible differences are accounted for by the lax default convergence criteria employed by QN and NOMINATE. In terms of estimation uncertainty, we found that the identifying restrictions of each estimator result in greater certainty for the more extreme estimates under NOMINATE; estimation uncertainty is distributed more evenly for the MCMC methods. In perhaps the most striking difference arising from a fundamental difference between the two models, we find that the extreme variation in the estimated location of Senator Feingold, the leftmost senator under one method and twenty-second most liberal member under another, can be traced back to Feingold occasionally spurning his party and voting with the Republicans on near party-line votes despite maintaining a generally quite liberal voting record. Large differences in the likelihood that IDEAL and NOMINATE assign to these occasional “maverick” votes account for the substantial variation in Feingold’s estimated location across methods.

Finally, using Monte Carlo experiments varying the numbers of legislators and roll call votes we show more generally that for both methods the ideal point estimates are highly volatile when the number of voters is small. Our simulations reveal no clear advantage of one method over the other in producing estimates for any particular legislature size or number of votes taken. Further, neither estimator appears to more robust than the other in obtaining estimates from the data generating process assumed by the other method.

With the growing demand among legislative scholars for empirical estimates of ideological differences, we must better understand the properties of widely-used ideal point estimation methods. In our tests, we find no reason to expect a general advantage for either of the two most popular ideal point estimation procedures, IDEAL and NOMINATE, nor do we find support for a general rule that one estimation procedure is always superior in a certain type of voting body. Nevertheless, the findings we outline above highlight several differences in both the assumptions and the implementation of each method that can be easily overlooked, yet may have substantial effects in practice, particularly in smaller legislatures. Consumers of these methods must therefore be careful when interpreting their data to consider the factors potentially driving ideal point estimation results in general and the associated interval information in particular.

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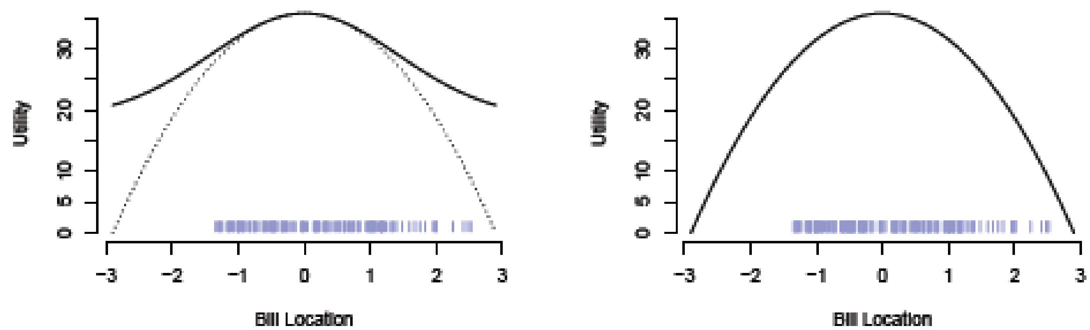


NOMINATE IDEAL

Figure 1: Nominate and IDEAL utility functions. Vertical hashes at the bottom of each panel show 200 randomly selected bill or status quo locations from the 109th Senate as estimated by NOMINATE. The dotted line in the left-hand panel shows the quadratic approximation to the NOMINATE utility curve.

(Figures shown here correspond to utility1.pdf and utility2.pdf)

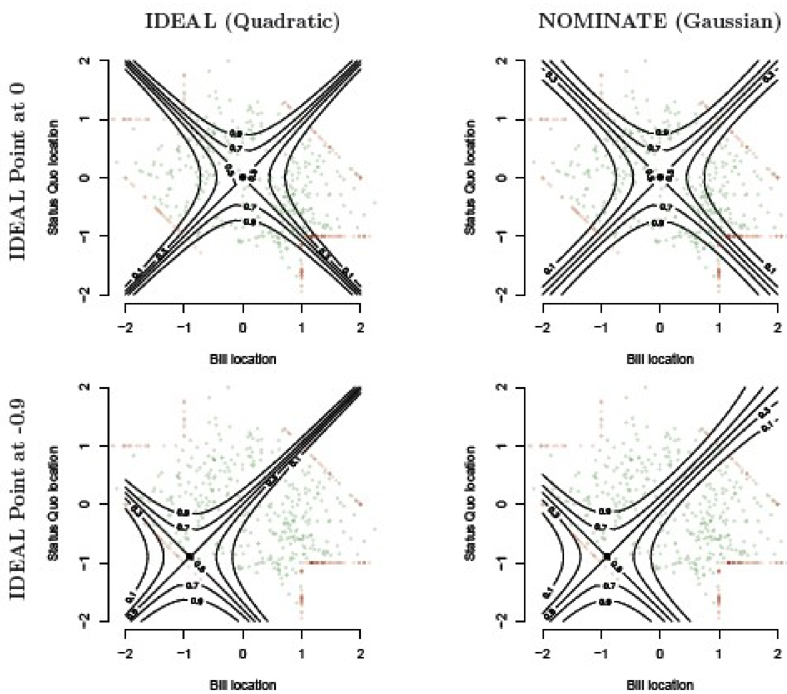


Figure 2: Choice probability functions for NOMINATE and IDEAL. Each contour line shows the set of bill–status quo pairs that result in the indicated probability of supporting the bill. The left two panels show choice probabilities associated with IDEAL. The right two panels show probabilities associated with NOMINATE. The top two panels set the legislator's ideal point to 0. The bottom two panels set the legislator's ideal point to -0.9. These contours are based on parameter values typically found when analyzing US Congressional roll call data. The light colored dots are NOMINATE-estimated bill and status quo (more precisely, yea and nay) locations from the 109th Senate.

(Figures shown here correspond to voteprobcontour1.pdf, voteprobcontour2.pdf, voteprobcontour3.pdf, voteprobcontour4.pdf)

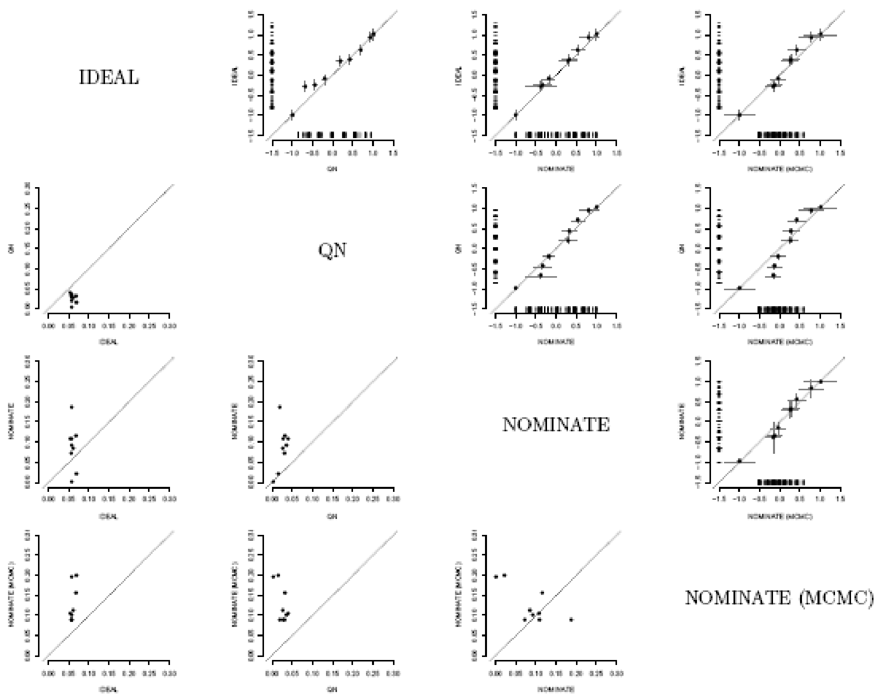


Figure 3: Estimated Supreme Court Justice Locations, 1993–97. Each panel plots justice locations or associated standard errors as estimated by two of four estimators. Panels above the main diagonal show point estimates and 95 percent intervals. The hashes in the margins show the locations of estimated cut points for each of the given estimation methods. The panels below the main diagonal plot the standard errors associated with each method against those from each other method.

Figures shown here correspond to (by row):

SCplot01.pdf, SCplot02.pdf, SCplot03.pdf
SCplot07.pdf, SCplot04.pdf, SCplot05.pdf
SCplot08.pdf, SCplot09.pdf, SCplot06.pdf
SCplot10.pdf, SCplot11.pdf, SCplot12.pdf

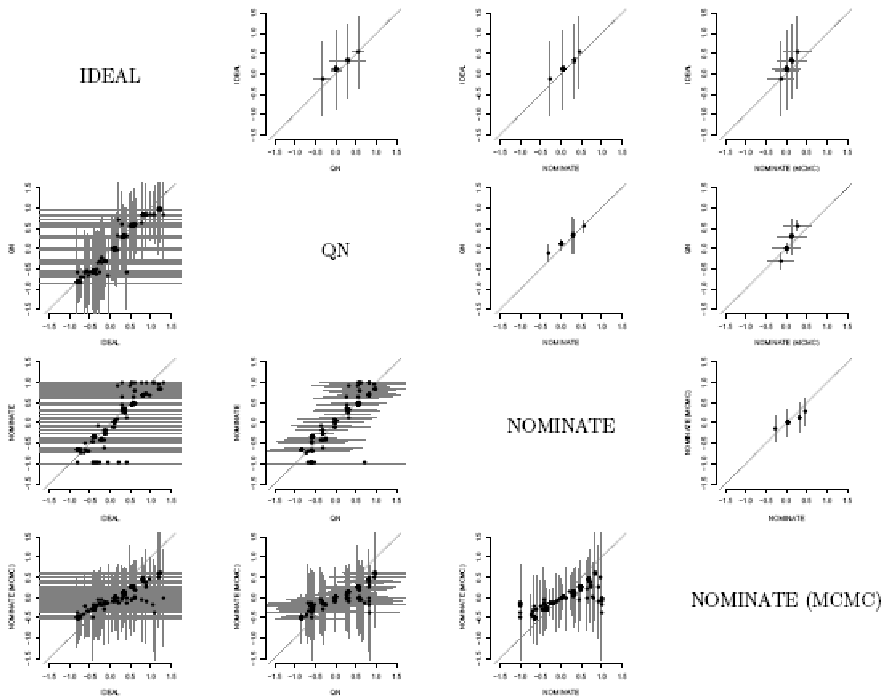


Figure 4: Estimated Supreme Court Decision Midpoints, 1993–97. Each panel plots estimated decision midpoints and 95 percent confidence intervals as estimated by two of four estimators. Panels above the main diagonal show estimates for the 142 well identified decision midpoints. The panels below the main diagonal plot estimates for the 72 weakly-identified decision midpoints. Confidence intervals for NOMINATE-estimated midpoints are not available.

Figures shown here correspond to (by row):

SCplot13.pdf, SCplot14.pdf, SCplot15.pdf
SCplot19.pdf, SCplot16.pdf, SCplot17.pdf
SCplot20.pdf, SCplot21.pdf, SCplot18.pdf
SCplot22.pdf, SCplot23.pdf, SCplot24.pdf

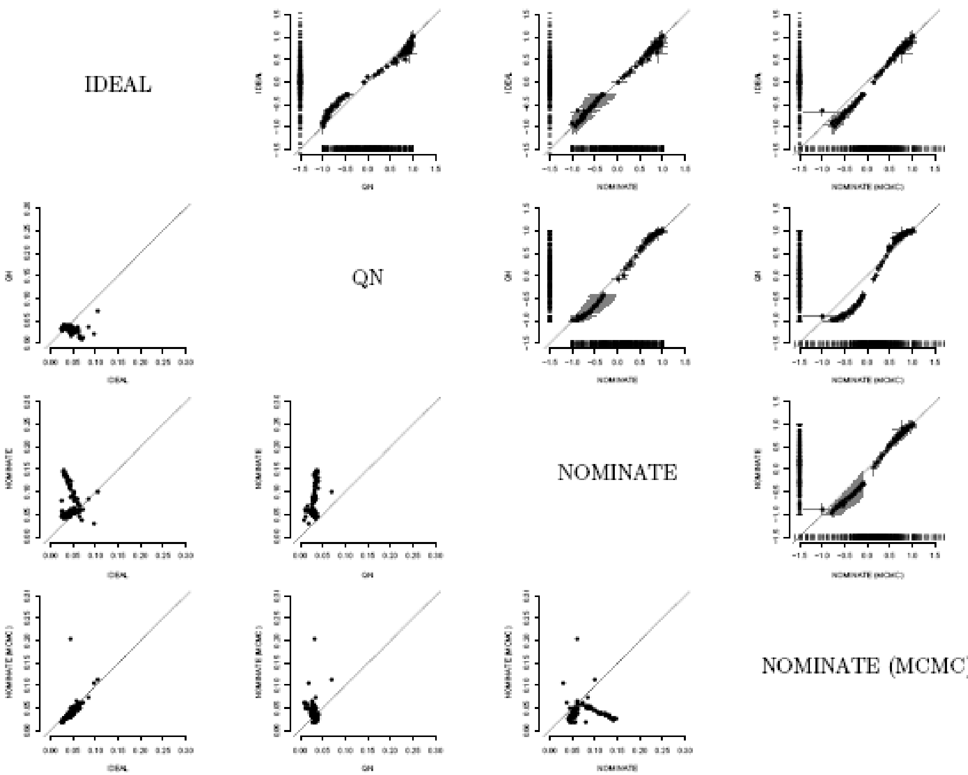


Figure 5: Estimated Senator Locations, 109th Congress. Each panel plots senator locations or associated standard errors as estimated by two of four estimators. Panels above the main diagonal show point estimates and 95 percent intervals. The hashes in the margins show the locations of estimated cut points for each of the given estimation methods. The panels below the main diagonal plot the standard errors associated with each method against those from each other method.

Figures shown here correspond to (by row):

s109plot01.pdf, s109plot02.pdf, s109plot03.pdf
s109plot07.pdf, s109plot04.pdf, s109plot05.pdf
s109plot08.pdf, s109plot09.pdf, s109plot06.pdf
s109plot10.pdf, s109plot11.pdf, s109plot12.pdf

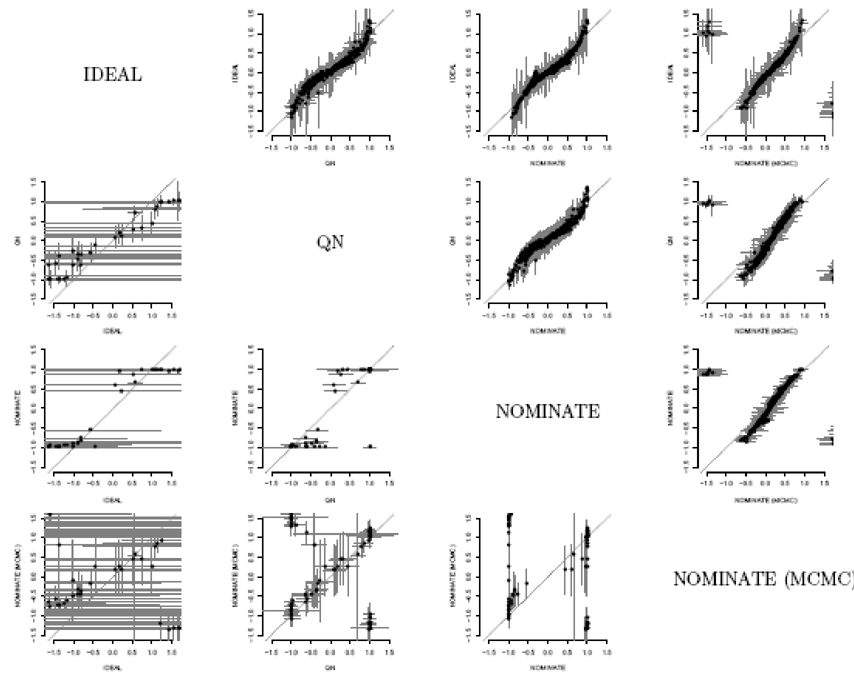


Figure 6: Estimated US Senate Rollcall Midpoints, 109th Congress. Each panel plots estimated decision midpoints and 95 percent confidence intervals as estimated by two of four estimators. Panels above the main diagonal show estimates for the well-identified roll call midpoints. The panels below the main diagonal plot estimates for the weakly-identified roll call midpoints. Confidence intervals for NOMINATE-estimated midpoints are not available.

Figures shown here correspond to (by row):

s109plot13.pdf, s109plot14.pdf, s109plot15.pdf
s109plot19.pdf, s109plot16.pdf, s109plot17.pdf
s109plot20.pdf, s109plot21.pdf, s109plot18.pdf
s109plot22.pdf, s109plot23.pdf, s109plot24.pdf

Member	IDEAL	NOMINATE	QN	MCMC NOMINATE
Boxer (D CA)	2	2	2	3
Corzine (D NJ)	5	1	1	2
Feingold (D WI)	22	5	17	1
Kennedy (D MA)	1	3	4	5

Table 1: Shows the rank positions of the four Senators in the 109th Senate who are estimated to be among the two left-most legislators by at least one of the four ideal-point estimators considered.

(Table shown here corresponds to table1.pdf)

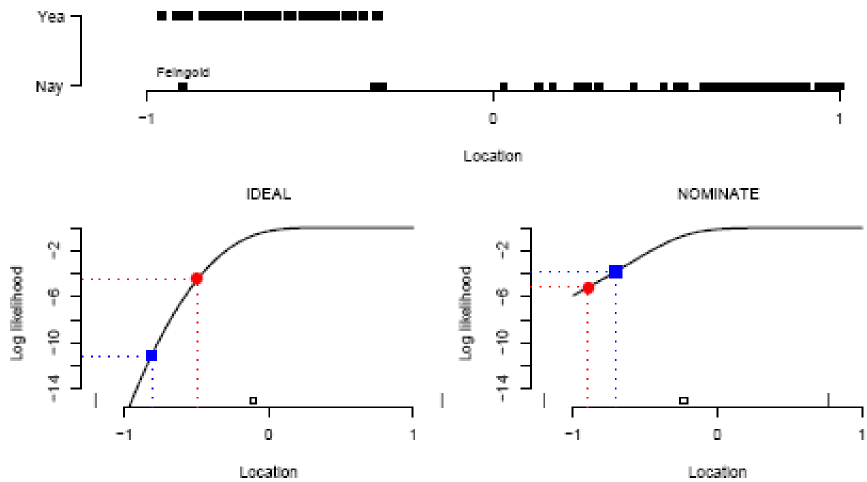
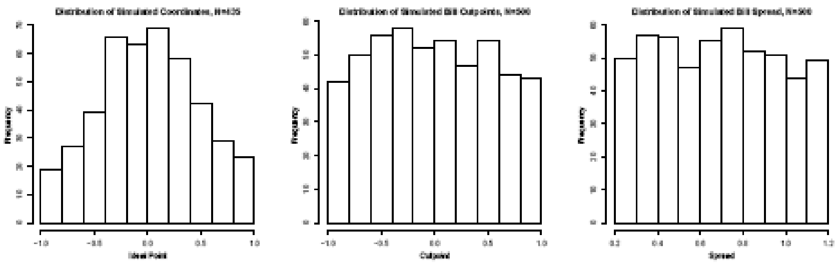


Figure 7: Senator Feingold's vote on 109th Senate's 227th roll call. The top panel shows the yea and nay choices by ideological position of each Senator as estimated by NOMINATE. The bottom panels show the log-likelihood associated with a nay vote as function of the ideological position for the IDEAL (left panel) and NOMINATE (right panel) estimators. The solid square symbols on the lower panel show the estimated location and log-likelihood associated with Senator Feingold for each method. The solid circles show the position and log-likelihood that would have obtained if Feingold had been located at the same rank position estimated by the opposite estimation method. The open square and vertical hash marks show the estimated vote midpoints and yea and nay locations respectively.

Figure saved as feingold.pdf.



(a) Ideal points (b) Midpoints (c) Spreads

Figure 8: Distribution of voter ideal points and rollcall midpoints and spreads in the Monte Carlo Experiments.

Figures shown here correspond to histcoord.pdf, histcutpoint.pdf, histspread.pdf.

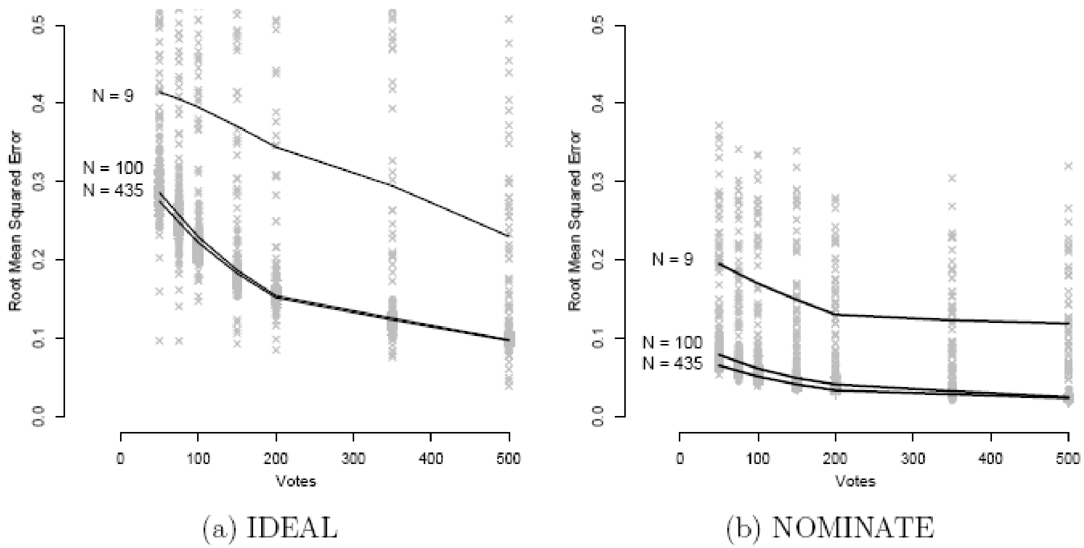
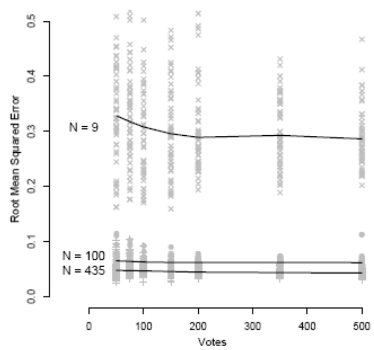
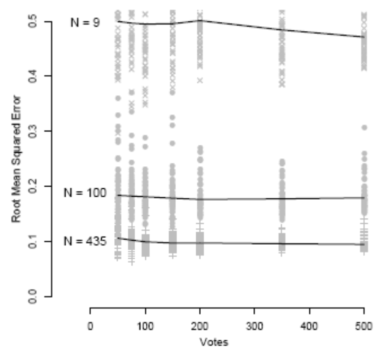


Figure 9: Correlations between "True" ideal points and estimates as a function of the number of voters and the number of rollcalls. Curves shown are from LOESS regressions.

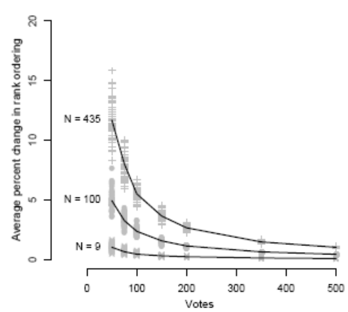
Figures shown here correspond to idealvstrue.pdf, wnomvstrue.pdf:



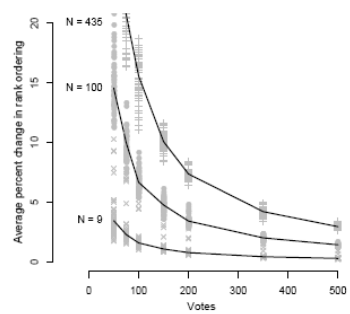
(a) Nominate Midpoints



(b) Ideal Midpoints



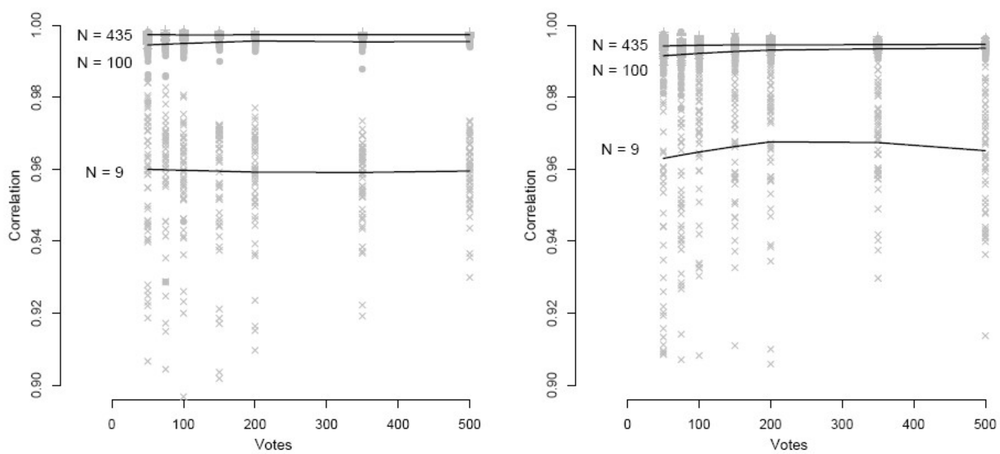
(c) Nominate Ordinal Midpoints



(d) Ideal Ordinal Midpoints

Figure 10: Average errors in the estimates of roll call midpoints. The top two panels plot the mean square errors associated with roll call midpoints estimates by NOMINATE and IDEAL respectively in our Monte Carlo experiments. The second two rows show the average absolute deviation of the estimated roll call midpoints in terms of where in the distribution of estimated member locations that each midpoint falls.

Figures shown here correspond to wnomMPmse.pdf, idealMPmse.pdf, NomMP_ranks.pdf, IdealMP_ranks.pdf.



(a) IDEAL (b) NOMINATE

Figure 11: Correlations between "True" ideal points and estimates as a function of the number of voters and the number of rollcalls. Curves shown are best fit $K^{0.5}$ lines where K is the number of rollcalls taken.

Figures shown here correspond to bothMPidealdat.pdf, bothMPwnomdat.pdf.

[1]Poole's optimal classification, which uses a non-parametric loss function, is the only other widely-used method of ideal point estimation from roll call data that does not assume quadratic spatial preferences.
[2]The current stand-alone program is available from *http://voteview.ucsd.edu*.
[3]KYST stands for Kruskal, Young, Shepard, and Torgerson (Kruskal et al., 1973).
[4]We use the labels bill and status quo loosely and simply to refer to the outcomes associated with voting yea or voting nay respectively on a particular roll call.
[5]For MCMC modelling assuming normal shocks is often computationally convenient, because the normal distribution offers greater opportunities to exploit conjugacy in the estimation.
[6]The dynamic ideal point models of Martin and Quinn also rely on the linear utility differences plus normal error (probit link) set up to facilitate the application of a simple dynamic linear model (DLM) of member locations over time. Random walk models of ideal point evolution without linear utility differences and normal shocks require substantially more complex estimation approaches (such as the particle bootstrap).
[7]The random utility component is held fixed in Figure 1.
[8]As mentioned below, substantive interpretation of the estimated bill and status quo locations is a dangerous business and turns on much stronger and (in some cases) arbitrary assumptions than does the substantive interpretation of the ideal points or roll call midpoints. However, the use of estimated bill and status quo quantities in Figures 1 and 2 is not problematic because the utility and choice-probability contour curves are conditional on the same assumptions as the bill and status quo locations. The hash marks are not centered about zero largely because "bills" (yea alternatives) in the Republican-controlled 109th Senate were largely on the conservative end of the dimension.
[9]Indeed, the midpoint–spread parameterization is sometimes used along with the assumption of quadratic utility as in, for example, Bafumi et al. (2005).
[10]In multiple dimensions identification is established by bounding legislators' ideal points to the unit hypersphere.
[11]See Lewis and Poole 2004 for a detailed description of this result.
[12]By default, NOMINATE drops votes with majority sizes greater than 97.5 percent of votes cast.
[13]Unbounded parameter estimates can also arise if a legislator always votes for the left alternative or always votes for the right alternative.
[14]This constraint is used in W-NOMINATE, but is not used in D-NOMINATE and DW-NOMINATE where legislator ideal points are typically estimated from legislators' career voting records and perfect voting is generally not encountered. A full discussion of the sag problem can be found in Poole's (2005) discussion of Senator Paul Wellstone's (D MN) voting record in the 107th Senate.
[15]Because the NOMINATE choice model (likelihood) has no convenient conjugate distribution, our implementation of the MCMC version of NOMINATE uses slice sampling within a Gibbs sampler to simulate draws from the posterior distribution of the parameters. Also, note that while Poole's (2005) original QN allows for heteroscedastic errors across members, the version that we employ here does not and is therefore similar to IDEAL in this respect.
[16]The weakly identified midpoints are those for which the estimated standard error is estimated to be greater than 0.5 by either IDEAL or MCMC NOMINATE.
[17]Full convergence can be ascertained by comparing the log-likelihoods from the two previous iterations of updates for each estimator, which should be nearly identical. In the case of QN, the 109th Senate produces a log-likelihood of -12133.15330 and a GMP of 0.78785 in iterations 99 and 100 – hence we believe that QN results have converged to at least the 5th decimal place in log–likelihood and GMP. Similarly, the 49th and 50th iterations of NOMINATE produced GMPs of 0.78480 and 0.78477, suggesting that GMPs have converged to the 4th decimal place.
[18]The vote took place on September 15, 2005.
[19]Senate Amendment 1687.

[20]Poole's OC method, which weighs all votes for the more distant alternative equally in its loss function, is expected to be even less sensitive to the occasional maverick votes of an otherwise consistently liberal members such as Feingold.

[21]The sensitivity of estimates from the quadratic normal (IDEAL) model to outlying votes is discussed in Bafumi et al. (2005).