KEITH T. POOLE
Carnegie-Mellon University

Recent Developments In Analytical Models Of Voting in the U.S. Congress

This paper surveys recent developments in analytical models of roll-call voting in the U.S. Congress. Two controversies are analyzed in the paper: the one over the number of evaluative dimensions that underlie congressional voting and the other over the relative importance of the legislator's ideology and the objective economic interests of the constituency. The framework for the analysis is a spatial theory of voting, which embodies Philip Converse's theory of belief systems.

It is a commonplace observation in psychometrics that if a set of data is structured then a variety of techniques—reflecting differing theories about the processes generating the data—will reveal aspects of that structure. This is especially true of roll-call voting in the U.S. Congress. Factor analysis, hierarchical clustering, Guttman scaling, multidimensional scaling, and linear logit models—to name just a few—have been applied to sets of roll-call votes. All have revealed structure, and the literature is dense with examples. The purpose of this essay is not purely bibliographical; I do not intend to list all these examples. Rather, I will deliberately limit myself to discussing two recent lines of research using roll-call votes and how they relate to the MacRae-Clausen "standard position" method of analyzing roll-call voting.[1] The two areas I will focus upon are dimensional studies by political scientists, which by their nature involve large numbers of roll calls, and linear logit models, typically done by economists, which involve small numbers of roll calls. The framework for my analysis will be Converse's (1964) seminal paper on belief systems and the recent spatial theory of voting that, in effect, is a mathematical realization of Converse's model. My aim is to show how this model is consistent with the structure revealed by these various roll-call voting studies.

A Belief System Model of Congressional Voting

Converse defines a belief system "as a configuration of ideas and attitudes in which the elements are bound together by some form of

constraint or functional interdependence" (1964, p. 207). "From the point of view of the actor, the idea organization that lends to constraint permits him to locate and make sense of a wider range of information from a particular domain than he would find possible without such organization" (p. 214). From an observer's point of view, the constraint means that certain issue positions are bundled together, and the knowledge of one or two issue positions makes the remaining positions very predictable. To know that a member of Congress favors an increase in the minimum wage makes it highly likely that the member favors increased spending to aid the homeless. These relationships are typically summarized by the words "liberal" and "conservative," and informed observers of the U.S. political landscape can easily tick off the issue positions normally associated with these words.

However, as Converse noted about the closely related word "ideology," "liberal" and "conservative" have been "thoroughly muddied by diverse uses" (p. 207). Hinich and Pollard (1981) argue that these words do not necessarily mean the presence of some coherent political philosophy. Rather, they are best understood as labels that have become attached to certain consistent patterns of political behavior. It is not necessary that this constituency derive "from anything so strong as ideology. . . . The behavioral labels we observe are more likely derived from *ad hoc* responses to changing conditions and political fortunes" (p. 325). What matters is the predictability of the behavior—that is, the existence of constraint across issues.

For example, a "conservative" member of Congress is likely to oppose government intervention in the economy (raising the minimum wage, OSHA, expanding the food stamp program, etc.), to favor government intervention in the private lives of individuals (banning abortions, care of deformed newborns against the wishes of physicians and parents, allowing prayer in the public schools, etc.), and to favor foreign intervention to contain the spread of communism. It is difficult to argue that a coherent philosophy of government underlies this mix of attitudes; indeed, the point is that such a philosophy need not exist. "Such diversity is testimony to an absence of any strict logical constraints among such idea-elements, if any be needed. What is important is that the elites familiar with the total shapes of these belief systems have *experienced* them as logically constrained clusters of ideas" (Converse, 1964, p. 211).

The absence of an overarching logical (in the deductive sense) philosophy tying various ideas together does not mean that a belief system is complex. In fact, just the opposite may be true. The more constrained a belief system, "the more economically it may be described and

understood" (1964, p. 214). That is, the higher the constraint, the fewer the evaluative/judgmental dimensions needed to organize and simplify the political world.

Party identification simplifies the political world. No one questions that the primary explanatory variable in congressional voting is party. But what sort of variable is party? It clearly is not a nominal variable because we speak of degrees of party support by individual members. What is meant by party support? Surely political parties stand for something; party platforms in presidential election years are quintessentially collections of issue positions with high-sounding rhetoric. Political parties are thus collections of people with similar patterns of constraint over issues. (In this regard, the Democratic party after World War II was really two political parties—northern and southern.) Thus the primary evaluative/judgmental dimensions that underlie congressional voting should be those that most clearly separate the political parties.

A natural model of this process is a spatial theory of voting suggested by Ordeshook (1976) and fully articulated by Hinich and his colleagues (Hinich and Pollard, 1981; Enclow and Hinich, 1984). The mathematical structure of the model is quite simple. In the context of congressional voting, each issue is modeled as an ordered dimension of alternatives, and each member is assumed to have an ideal point on, and single-peaked preferences over, each issue dimension. Constraint has a straightforward geometric interpretation. It means that the issues lie on a low-dimensional hyperplane. Or, stated another way, that the ideal points in the basic space defined by the hyperplane generate all the issue dimensions through simple linear maps.

Let p denote the number of legislators, n the number of issues, and s the number of dimensions in the basic space. The spatial model is summarized by the relationship $XW = Y$; where X is the p by s matrix of individual positions in the basic space, W is an s by n matrix of linear maps, and Y is the p by n matrix of issue positions. To give a concrete example, suppose the basic space is defined by one evaluative dimension. Then every issue dimension is simply a linear transformation of the evaluative dimension. In an errorless world, the correlation between any pair of issues would be one. If there are two or three evaluative dimensions and error is present in the mapping matrix W, then the intercorrelations computed from Y could be far less than unity.

The MacRae-Clausen "Standard Position" for Roll-Call Analyses

Duncan MacRae (1958, 1970) pioneered the "dimension method" of analyzing roll-call voting. As Collie (1985) notes, MacRae's

generation of scholars were heavily influenced by the "responsible" party paradigm (APSA, 1950), and MacRae was careful to distinguish party from "ideological" influences in his work. "Throughout my research in this area I tried to emphasize the contrast between ideological dimensions . . . and strictly partisan dimensions, reflecting loyalty to the legislative party, which may not be so visible but which can be relevant to a legislator's career" (personal communication). For the analysis of issues, MacRae recommends the use of hierarchical clustering and Guttman scaling; for the analysis of partisanship, he recommends factor analysis of Yule's Q matrices (1970, p. 286-287).

Clausen (1973) explicitly rejects a belief-system model of the type I outlined above. However, his rejection appears to be aimed specifically at a unidimensional liberal/conservative model that is assumed to structure all of roll-call voting. Clausen regards the "ideologist theory" as "too gross a simplification of the decision-making apparatus of the typical congressman, so proud of his pragmatism and so scornful of ideological straitjackets" (p. 31). Instead, Clausen proposed a policy dimension theory of voting, in which alignments could vary from policy area to policy area. The method that flows from the theory proceeds by coding all nonunanimous roll calls according to their policy content, computing Yule's Q matrices for each policy area, and then applying hierarchical clustering to isolate roll calls that form a policy dimension. His basic finding is that voting alignments on these prespecified policy dimensions are stable over time.

Neither MacRae's nor Clausen's approach is inconsistent with the simple belief-system model. MacRae would estimate the columns of Y associated with partisanship separately from the columns of Y associated with issues. In contrast, Clausen's method isolates some (perhaps all) of the columns of Y. The major difference between the two approaches is that MacRae is more disposed to let the dimensions emerge from the data, while Clausen prespecifies them. In this regard, MacRae is closer to the standard approach taken in psychometrics, in which the overall dimensionality of the data is determined and then the content of the recovered dimensions is studies (Coombs, 1964; Kruskal, 1964).

The Dimensionality Controversy

MacRae and Clausen—by the very character of their approaches to roll-call analysis—are in fundamental agreement that congressional voting is multidimensional. In recent years a series of studies have appeared that cast doubt on this point of view. Jerrold Schneider (1979) claims that a single liberal/conservative dimension structured congres-

sional voting during the 1971-1976 period. He found high rank-order correlations between the liberal/conservative orderings of legislators over several policy areas. Examining interest group ratings computed from roll calls, Kritzer (1978)—using factor analysis—and I (Poole, 1981, 1984, 1986; Poole and Daniels, 1985)—using metric unfolding—found that, at most, two dimensions account for the variance in the ratings during the 1959-1982 period. Hoadley (1980) applied nonmetric multidimensional scaling to the legislator-by-legislator agreement score matrices for the 1971-1978 Senates and found two dimensions underlying voting. Smith (1981), using the Clausen dimensions, found that over the 1957-1976 period, Senate voting patterns exhibited an "overall trend toward greater alignment consistency [which appears] to be related to an underlying trend in the ideological patterns in the alignments" (p. 792). He attributes the difference in the results of Schneider and Clausen to the different time periods analyzed. William Schneider (1982, 1983, 1984, 1985, 1986; see also Cohen, 1982; and Cohen and Schneider, 1987) employed a principal components analysis of key votes in three general policy areas—economic, social, and foreign policy—and found a high degree of alignment similarity. "Most members of Congress had relatively consistent voting patterns on economic, foreign policy, and social issues" (Cohen, 1982, p. 810). Finally, Rosenthal and I have developed a method of scaling which we have dubbed NOMINATE (for *nominal t*hree-step *e*stimation); this method estimates a simple one-dimensional spatial model—an ideal point for each legislator and two policy locations, yea and nay, for each roll call—directly from the roll calls (Poole and Rosenthal, 1985a). We found that a single dimension correctly classified about 82% of all voting in the 1919-1985 period in both the House and Senate (Poole and Rosenthal, 1986).

What are we to make of this cacophony of methods and findings? Is there any objective way of determining the dimensionality of roll-call voting? The answer is a qualified yes, if roll-call voting is in accord with the belief-system model I outlined above or if Clausen's model is correct. Technically, if voting along the underlying dimensions is in accord with a dominance model (i.e., a Guttman scale) or a two-stimulus proximity model (legislators vote for the closest stimulus and have single-peaked utility functions), then a principal components analysis of the Yule's Q matrix will reveal the dimensionality underlying the voting (Weisberg, 1968). If there are a large number of roll calls that pit a moderate group against two extreme groups so that there are in effect three policy choices (Weisberg [1968, p. 89] gives the example of the moderates versus the abolitionists and southerners during voting on the compromise of 1850), then this approach will not reveal the correct dimensionality. With this caveat in mind, let us look at the data.

Figures 1 and 2 show three measures of dimensionality. First, the top parts of the figures show the percentage of variation[2] explained by the first three eigenvalues of the Yule's Q matrix computed for every congress (the 1st through the first session of the 99th) for the House and Senate respectively. Second, the middle part of the figures show the stress formula 1 values from KYST (Kruskal, Young, and Seery, 1973) for one, two, and three dimensional nonmetric scalings of the legislator-by-legislator agreement score matrix computed for each congress. Finally, the lower part of the figures shows the Pearson r-squares for a one, two, and three dimensional metric scaling (Poole, 1984) of the same legislator agreement score matrices analyzed by KYST. All roll calls with at least 10% in the minority were utilized.[3] I used the Cray XMP/48 at the Pitt/CMU national supercomputer center to perform the decompositions and scalings.

The dimensionality pattern for all three measures is basically the same within each house of Congress. The Pearson correlations between the three measures are all on the order of .90.[4] The periods of party realignment show up clearly in the figures (see Burnham, 1970; Sundquist, 1973; Ginsberg, 1972, 1976; Sinclair, 1977, 1981; Brady, 1979, 1982). Overall, the House is more tightly structured than the Senate.

Although the similarity of the patterns is apparent to the eye, how many dimensions are present in any given time period is not so easily determined. For example, in the House, the 55th through the 61st (1897-1910) Congresses were unquestionably one dimensional.[5] In contrast, the dimensionality of Senate voting during the past 25 years is less clear. The stress values and r-squares suggest a two-dimensional structure, while the Yule's Q eigenvalue pattern indicates that only one dimension is present.

To get a handle on the question of dimensionality, I conducted a monte-carlo study to determine what stresses, r-squares, and eigenvalues would be produced by an abstract legislature voting in accord with the spatial theory I outlined above.[6] In particular, I used the coordinates in one, two, and three dimensions generated by KYST for the 99th Senate and then randomly produced roll calls in such a way as to reproduce the actual distribution of vote margins observed in the Senate over the past 50 years. I ran 200 simulations each with 300 roll calls at a variety of levels of noise and dimensional weighting. I found that the Yule's Q eigenvalue pattern was indeed a good indicator of the number of dimensions but was a very poor measure of the relative weighting of the dimensions. For example, if the dimensions are equally weighted, then the equivalent number of large positive eigenvalues of approximately the same magnitude will be recovered, corresponding to the dimensionality
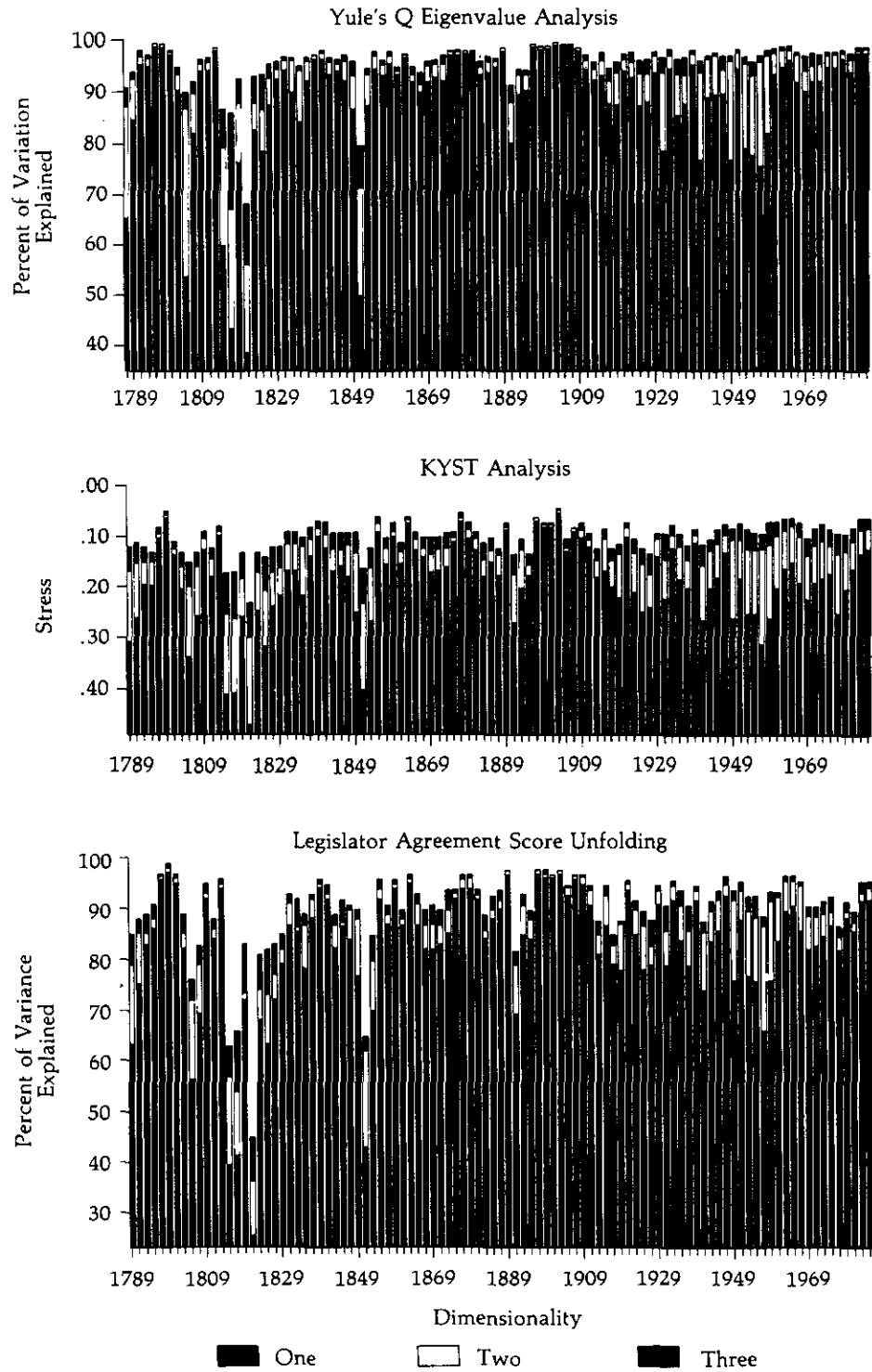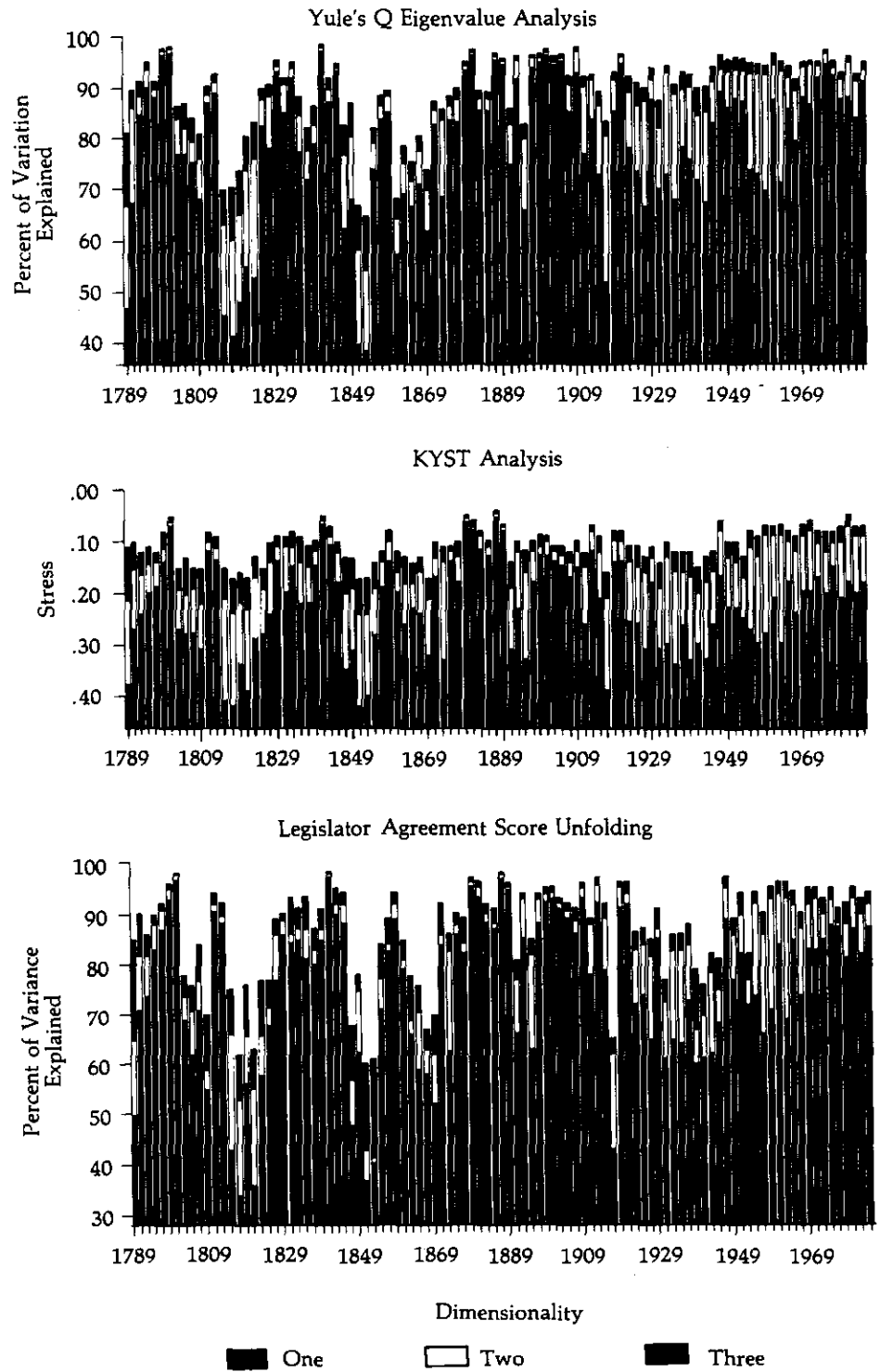
FIGURE 1
U.S. House Roll Calls, 1789-1985

Yule's Q Eigenvalue Analysis

KYST Analysis

Legislator Agreement Score Unfolding

Dimensionality

■ One   ☐ Two   ■ Three

FIGURE 2
U.S. Senate Roll Calls, 1789-1985

Yule's Q Eigenvalue Analysis

KYST Analysis

Legislator Agreement Score Unfolding

Dimensionality

■ One   □ Two   ■ Three

of the legislature. Depending upon the noise level, the remaining eigen-values are smaller and many are negative. If the dimensions are weighted unequally, the eigenvalues are quite distorted. For example, if there are two dimensions with one dimension twice as important as the first (2:1), then the recovered eigenvalues have a ratio of approximately 5.5:1. In contrast, KYST recovers the ratio almost exactly. This is no surprise. KYST has been extensively tested and is known to be highly reliable (Kruskal and Wish, 1978; Pruzansky, Tversky, and Carroll, 1982). The results of the metric scaling are almost as good as those of KYST.[7]

The monte-carlo results indicate that a two-dimensional model with a weight ratio of 2:1 to 3:1 and a 20 to 25% voting error level will reproduce the results of Figures 1 and 2 for the 1913-1985 period. To reproduce the results of the early 1850s, four or more equally salient dimensions are required.

I conclude that, in the aggregate, congressional voting between realigning periods is simply structured; there are at most three dimensions, with one dimension being at least twice, and more often three times, as salient as the remaining dimensions. I emphasize that these are aggregate results. The classification percentages of empirical spatial models are on the order of 80 to 85% (Poole and Daniels, 1985; Poole and Rosenthal, 1986), so that there is ample room for the presence of fine structure.

In my opinion, the MacRae-Clausen approach recovers a combination of the aggregate structure and the fine structure, and the relative salience of the dimensions is accordingly obscured. As I explained above, I do not believe that the MacRae-Clausen approach is inconsistent with the simple belief-system model that, in one form or another, is implicit in aggregate scaling methods like KYST, which assume single-peaked preferences. To show the connection requires the development of a method that would estimate X, W, and Y directly from the roll calls. This task remains to be done. Until it is, the dimensionality controversy will remain unsettled.

Linear Logit Models of Roll-Call Voting

All scaling methods are ways of decomposing data into simple structure. So, given that we have scaled members of Congress on one or more dimensions using the roll calls, what does the structure we have uncovered mean? For the sake of argument, suppose we find that three dimensions account for most roll-call voting in a given congress. Suppose further that these three dimensions then predict voting in the succeeding congress very accurately. The dimensions predict, but what explains them—that is, what is the causal agent?

The simplest answer is personal beliefs. Members of Congress have well-developed belief systems. In a voting situation, they vote for the policy that best reflects their personal beliefs. This answer is simple and attractive, but unsatisfactory. Members of Congress do not represent just themselves; they represent constituencies — the people who voted for them, campaign contributors, organized groups, and so on. Therefore, voting decisions must be a combination of these interests and a member's personal beliefs. The real question is how important these interests are relative to the member's personal beliefs and, if they do differ, whether it is possible to disentangle them.

Economists of the "Chicago School" take the extreme position that ideology or personal beliefs play no role. If the economic interests can be properly defined and measured, then they will explain the voting decisions. Peltzman (1984) argues that measures such as the ADA rating are simply "proxies for something more fundamental: liberals and conservatives tend to appeal to voters with systematically different incomes, education, and occupations, and to draw contributions from different interest groups." Variables that measure these characteristics are "capable of rationalizing voting patterns without much need for relying on explanations that involve shirking" (p. 210). In a later paper, however, Peltzman appears to recognize, if not endorse, the role of ideology in congressional voting (Peltzman, 1985).

In any case, the generic linear model is

$$\text{Voting Decision} = \alpha + C\beta + \epsilon$$

The dependent variable is either a specific roll-call vote or an index constructed from several roll calls. C is a matrix of economic variables. If the dependent variable is discrete, ϵ is usually assumed to have a logistic distribution, and α and β are easily estimated through standard maximum likelihood methods. In relation to the belief system model, $C\beta$ in effect plays the role of X. That is, this model assumes that individuals are automata; belief systems are entirely a function of economic variables.

This specification has a number of problems. As Fiorina (1974) points out, it is incorrect to use geographic constituency measures of economic self-interest. Rather, the correct procedure is to measure the economic self-interest of the reelection constituency. In fact, the same geographic constituency can support different reelection constituencies (Fenno, 1978). Peltzman (1984) builds this distinction into his models. The remaining papers cited below do not address the issue.

Another major problem with the above specification is that, in practice, a different α and β are estimated for each roll call. This is

equivalent to estimating a separate dimension for every roll call; Y has as many columns as there are roll calls. This is so because α, the intercept, plays the role of a cutting point between the yeas and the nays in a unidimensional spatial model, with $C\beta$ playing the role of the individual unidimensional ideal points (Poole and Rosenthal, 1985b). The correct model is to allow α to vary from roll call to roll call, with β fixed across roll calls (Ladha, 1986). If β is not held constant, different legislator coordinates are being estimated for every roll call.

Except for the claims made by Peltzman (1984), the economic interests model has not proven to be very successful. Rather, a series of papers has appeared, each with a similar conclusion: after controlling for economic interests, ideology is important (Kau and Rubin, 1979; Kau, Keenan, and Rubin, 1982; Kalt and Zupan, 1984).

Kau and Rubin (1979) disentangled ideology from economic interests by regressing ADA ratings on a set of economic variables. The residuals from this regression were used as a measure of "pure" personal ideology. The economic variables and the constructed ideology variable were then utilized in various logit equations to explain a variety of specific roll-call votes. Kalt and Zupan (1984) perform a similar analysis on an index constructed from roll calls on strip mining.[8]

The problem with the residuals approach is that it is very likely that the economic interests of the constituency and the personal ideology of the legislator are highly correlated. There is strong evidence that members of Congress vote consistently over time on issues and are very sensitive to their voting history (Clausen, 1973; Fiorina, 1974; Asher and Weisberg, 1978; Stone, 1980; Bullock, 1981). It seems unlikely in the extreme that a member of Congress could remain so consistent over a career but not be in basic agreement with the reelection constituency.[9] Because of this collinearity, it is very misleading to define the unexplained residuals as "personal" ideology.

The pitfalls of this collinearity can be seen clearly in Peltzman's (1984) attempt to explain away personal ideology in favor of measures of constituent economic interests. Following Kau and Rubin, he also regresses ADA (and COPE) ratings on a battery of economic variables, including a dummy variable for political party. He concludes that "an initially large role for party is eliminated and overshadowed by finer specification of interests" (1984, p. 197). However, an examination of his Tables 1 and 2 shows that the most significant variable by far is the labor share of total interest group contributions. In addition, the party dummy is the most significant variable in the equations, that use just average constituency characteristics. Party is less significant when variables are added to measure the reelection constituency, but it still has

considerable punch. The problem is that party, the ADA and COPE ratings, and labor union PAC contributions are very highly intercorrelated. The Pearson correlations of the ADA and COPE ratings with one-dimensional legislator coordinates estimated by a metric unfolding of 37 interest group ratings (Poole, 1984) are .97 and .90 respectively. The same coordinates were used by Poole and Romer (1985) in a simple one-dimensional spatial model of PAC contributions, and they accounted for nearly all labor union PAC contributions. In short, all these variables can be viewed as generated by a simple underlying belief system model.

Kau, Keenan, and Rubin (1982) take a different approach in measuring ideology. They construct a model of legislators, constituents, and campaign contributors and test it using a simultaneous equations logit model. They finesse the whole issue of personal ideology by trying to explain roll-call voting by purely constituency measures of ideology and economic interests. As a measure of ideology, they use the 1976 vote for Ford in each representative's district. Their strongest result was that their ideology measure was significant in all the vote equations. "Ideology is significant in explaining voting by Congress, even after adjusting for economic characteristics of constituents" (p. 287).

All these efforts share a fundamental flaw. None studies how much is explained by economic characteristics once ideology (variously measured) is controlled for. In fact, it is quite likely that a measure such as the ADA rating will explain most voting on the issues considered by these papers, and the addition of a battery of economic variables will add little explanatory power.[10] I think that this is so because the personal beliefs of members of Congress correspond with these of their reelection constituencies. The correlation between the aggregate economic variables and a measure like the ADA rating reflects a very noisily measured correlation between Y and X.

Conclusion

I began this essay with the observation that, if a set of data is structured, then a variety of techniques will reveal aspects of that structure. Roll-call data from the U.S. Congress is a textbook example of this. The data are highly structured, but there is also enough noise in the data so that there is room for considerable debate over the nature of the structure. This debate will undoubtedly become more lively because the advent of large-scale computing resources has made more complex estimations possible.

I believe that the aspects of structure revealed by the various ap-

proaches I surveyed in this essay are consistent with the belief-system spatial model. The model combines two disparate fields of study: theoretical work by economists, statisticians, and political scientists (Hotelling, 1929; Smithies, 1941; Downs, 1957; Davis, Hinich, and Ordeshook, 1970) and the survey research work by the Michigan group that led to Converse's theory of belief systems (Campbell, Converse, Miller, and Stokes, 1960). Furthermore, the model embodies a policy interpretation of political parties as collections of individuals with similar patterns of constraint over issues. A consequence of the model is the primacy of dimensions that most clearly separate the political parties. In this regard, political parties per se are not the primary variable; rather, the fundamental dimensions of belief that give rise to the parties are the primary variables.

When the belief-system model is placed within the context of the work of Fiorina (1974) and Fenno (1978) it is clear that the effort to separate personal beliefs from constituency is futile and misdirected. A geographic constituency is a smorgasbord of discrete groups that the entrepreneurial politician can select from to form support constituencies that are in accord with their personal beliefs. If these support constituencies are large and powerful enough, the politician wins. And if the politician wins, once in Congress, he/she essentially never changes his/her personal beliefs. It is at the formation stage of the support coalition that personal beliefs may be adjusted by the politician to insure success. This is when it is meaningful to try to separate personal beliefs from constituency characteristics. But it is precisely at this stage, before the politician has a voting record, that the data on personal beliefs are scarce. In any case, models that do not incorporate a politician's personal beliefs (however arrived at) simply will not work well. The spatial theory of party competition is an excellent example of this. Recent theoretical work that assumes policy preferences on the part of candidates has finally produced nonconvergent equilibriums that match the results of empirical studies (Wittman, 1983; Calvert, 1985; Alesina, 1987).

How entrepreneurial politicians form support constituencies is an important empirical question with equally important implications for political theory. In a political system with low voter turnout and with geographic constituencies that seem to be able to support different reelection constituencies, just who is being represented and how? Although roll-call voting may be only a small part of congressional decision making, analytical models of the voting process can tell us much about the larger issues of representation.

Keith T. Poole is Associate Professor of Political Economy, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213.

NOTES

1. My essay should be read as a supplement to Melissa Collie's (1985) excellent bibliographical essay. Her essay covers legislatures generally in a comparative perspective.

2. I use percentage of variation rather than variance because the sum of the squared eigenvalues of a symmetric matrix is equal the sum of the squared elements of the matrix.

3. Because of core limitations entailed by the program I used on the Cray to generate the results of Figures 1 and 2, the size of the Yule's Q matrices had to be limited to a maximum of 1000 by 1000. This maximum was reached only in the 94th Senate, where 1027 roll calls met the 10% minority criteria; I used the first 1000 roll calls in the analysis. All roll calls, and senators and representatives who voted at least 25 times, were used in the agreement score analysis.

4. For the House, the Pearson correlation between the Yule's Q and the KYST measures was .89, between Yule's Q and the metric scaling .94, and for KYST and the metric scaling .96. The corresponding figures for the Senate were .87, .92, and .95 respectively. These figures are for one dimension.

5. A simple Guttman scaling of the congresses in this period correctly classifies an average of 93.3% of the voting with an average coefficient of scalability (proportional reduction of error over the marginals) of 80%.

6. A detailed explanation of the monte-carlo study is available on request.

7. The metric scaling was not as accurate as KYST in recovering the relative weighting of the dimensions because the minimum agreement score in the monte-carlo simulations tended to be about 25. Because the data are transformed into Euclidean distances in a metric scaling, there are limits on the maximum possible distance between any pair of points. The recovered configuration becomes slightly distorted in compensation.

8. Although they do not analyze specific roll-call votes, Carson and Oppenheimer (1984) also advocate the residuals approach to define personal ideology.

9. Another piece of evidence for this constituency is Table 4 in Poole and Daniels (1985). It shows that representatives who are elected to the Senate rarely change their spatial position as measured by a one-dimensional interest group unfolding analysis.

10. Poole and Romer (1983) perform this experiment with the Kalt and Zupan (1984) data. As a measure of ideology, we used the one-dimensional Senate coordinates from Poole (1981). Using the ANTISTRIP dependent variable (Kalt and Zupan, 1984, p. 285), we found that the r-square of the regression using only the ideology variable was .689. The r-square of the regression using the economic variables was .364 and the r-square of the regression with both the economic variables and the ideology variable was .720.

REFERENCES

Alesina, Alberto. 1987. Macroeconomic Policy in Two Party System as a Repeated Game. *Quarterly Journal of Economics,* 102:651-678.

American Political Science Association, Committee on Political Parties. 1950. *Toward a More Responsible Two-Party System.* New York: Holt, Rinehart.

Asher, Herbert B., and Herbert F. Weisberg. 1978. Voting Change in Congress: Some Dynamic Perspectives on an Evolutionary Process. *American Journal of Political Science,* 22:391-425.

Brady, David W. 1979. Critical Elections, Congressional Parties and Clusters of Policy Changes. *British Journal of Political Science,* 8:79-99.

_____. 1982. Congressional Party Realignment and Transformations of Public Policy in Three Realignment Eras. *American Journal of Political Science,* 26:333-360.

Bullock, Charles S. III 1981. Congressional Voting and the 1982 Congressional Elections. *Journal of Politics,* 45:767-770.

Burnham, Walter D. 1970. *Critical Elections and the Mainsprings of American Politics.* New York: Norton.

Calvert, Randall. 1985. Robustness of the Multi-dimensional Voting Model: Candidate Motivations, Uncertainty and Convergence. *American Journal of Political Science,* 29:69-95.

Campbell, Angus, Philip E. Converse, Warren E. Miller, and Donald E. Stokes. 1960. *The American Voter.* New York: Wiley.

Carson, Richard, and Joe Oppenheimer. 1984. A Method of Estimating the Personal Ideology of Political Representatives. *American Political Science Review,* 78:163-178.

Clausen, Aage. 1973. *How Congressmen Decide: A Policy Focus.* New York: St. Martin's Press.

Cohen, Richard E. 1982. Rating Congress—A Guide to Separating the Liberals From the Conservatives. *National Journal,* May 8, pp. 800-810.

Cohen, Richard E., and William Schneider. 1987. Moving to the Center. *National Journal,* March 21, pp. 672-701.

Collie, Melissa P. 1985. Voting Behavior in Legislatures. In Gerhard Loewenberg, Samuel Patterson, and Malcom Jewell, eds., *Handbook of Legislative Research.* Cambridge, MA: Harvard University Press.

Converse, Philip E. 1964. The Nature of Belief Systems in Mass Publics. In David E. Apter, ed., *Ideology and Discontent.* New York: Free Press.

Coombs, Clyde H. 1964. *A Theory of Data.* New York: Wiley.

Davis, Otto A., Melvin J. Hinich, and Peter C. Ordeshook. 1970. An Expository Development of a Mathematical Model of the Electoral Process. *American Political Science Review,* 65:426-448.

Downs, Anthony. 1957. *An Economic Theory of Democracy.* New York: Harper & Row.

Enelow, James, and Melvin J. Hinich. 1984. *The Spatial Theory of Voting.* New York: Cambridge University Press.

Fenno, Richard F. 1978. *Home Style: House Members in Their Districts.* Boston: Little, Brown.

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

Ginsberg, Benjamin. 1972. Critical Elections and the Substance of Party Conflict: 1844-1968. *Midwest Journal of Political Science,* 16:603-625.

_____. 1976. Elections and Public Policy. *American Political Science Review,* 70:41-49.

Hinich, Melvin J., and Walker Pollard. 1981. A New Approach to the Spatial Theory of Electoral Competition. *American Journal of Political Science,* 25:323-341.

Hoadley, John. 1980. The Dimensions of Congressional Voting, 1971-1978: Some Preliminary Considerations. Presented at the annual meeting of the Midwest Political Science Association, Chicago, IL.

Hotelling, Harold. 1929. Stability in Competition. *The Economics Journal,* 39:41-57.

Kalt, Joseph P., and Mark A. Zupan. 1984. Capture and Ideology in the Economic Theory of Politics. *The American Economic Review,* 74:279-300.

Kau, James B., and Paul H. Rubin. 1979. Self-Interest, Ideology, and Logrolling in Congressional Voting. *The Journal of Law and Economics,* 21:365-384.

Kau, James B., Donald Keenan, and Paul H. Rubin. 1982. A General Equilibrium Model of Congressional Voting. *Quarterly Journal of Economics,* 93:271-293.

Kritzer, Herbert M. 1978. Ideology and American Political Elites. *Public Opinion Quarterly,* 42:484-502.

Kruskal, Joseph B. 1964. Multidimensional Scaling by Optimizing Goodness of Fit to a Nonmetric Hypothesis. *Psychometrika,* 29:1-27.

Kruskal, Joseph B., Forrest W. Young, and Judith B. Seery. 1973. How to Use KYST-2A, a Very Flexible Program to do Multidimensional Scaling and Unfolding. Bell Telephone Laboratories.

Kruskal, Jospeh B., and Myron Wish. 1978. *Multidimensional Scaling.* Beverly Hills, CA: Sage Publications.

Ladha, Krishna K. 1986. Decision Making in the United States Congress. Ph.D. Dissertation, Carnegie-Mellon University.

MacRae, Duncan, Jr. 1958. *Dimensions of Congressional Voting.* Berkeley: University of California Press.

_____. 1970. *Issues and Parties in Legislative Voting.* New York: Harper & Row.

Ordeshook, Peter C. 1976. The Spatial Theory of Elections: A Review and a Critique. In Ian Budge, Ivor Crewe, and Dennis Farlie, eds., *Party Identification and Beyond.* New York: Wiley.

Peltzman, Sam. 1984. Constituent Interest and Congressional Voting. *Journal of Law and Economics,* 27:181-210.

_____. 1985. An Economic Interpretation of the History of Congressional Voting in the Twentieth Century. *American Economic Review,* 75:656-675.

Poole, Keith T. 1981. Dimensions of Interest Group Evaluation of the U.S. Senate, 1969-1978. *American Journal of Political Science,* 25:49-67.

_____. 1984. Least Squares Metric, Unidimensional Unfolding. *Psychometrika,* 49:311-323.

_____. 1986. Least Square Metric, Time-Series Unidimensional Unfolding. G.S.I.A. Working Paper #14-86-87, Carnegie-Mellon University.

Poole, Keith T., and R. Steven Daniels. 1985. Ideology, Party, and Voting in the U.S. Congress, 1959-1980. *American Political Science Review,* 79:373-399.

Poole, Keith T., and Thomas Romer. 1983. Economic Versus Ideological Factors in Congressional Voting. G.S.I.A. Working Paper #XX-82-83, Carnegie-Mellon University.

_____. 1985. Patterns of Political Action Committee Contributions to the 1980 Campaigns for the United States House of Representatives. *Public Choice,* 47:63-111.

Poole, Keith T., and Howard Rosenthal. 1985a. A Spatial Model for Legislative Roll Call Analysis. *American Journal of Political Science,* 29:357-384.

_____. 1985b. The Political Economy of Roll Call Voting in the 'Multi-Party' Congress of the United States. *European Journal of Political Economy,* 1:45-58.

_____. 1986. The Unidimensional Congress. G.S.I.A. Working Paper #44-84-85, Revised, Carnegie-Mellon University.

Pruzansky, Sandra, Amos Tversky, and J. Douglas Carroll. 1982. Spatial Versus Tree Representations of Proximity Data. *Psychometrika,* 47:3-24.

Schneider, Jerrold. 1979. *Ideological Coalitions in Congress.* Westport, CT: Greenwood Press.

Schneider, William. 1982. Borrowing From 10 Congressional Rating Organizations to Develop a New Way of Looking at Voting Records. *National Journal,* May 8, pp. 806-807.

_____. 1983. Party Unity of Tax, Spending Issues—Less in House, More in Senate in 1982. *National Journal,* May 7, pp. 936-952.

_____. 1984. Republicans Move Further Apart on Most Issues in 1983 Session. *National Journal,* May 12, pp. 904-920.

_____. 1985. Politics of the '80s Widens the Gap Between the Two Parties in Congress. *National Journal,* June 1, pp. 1268-1282.

_____. 1986. A Year of Continuity. *National Journal,* May 17, pp. 1162-1191.

Sinclair, Barbara. 1977. Party Realignment and the Transformation of the Political Agenda: The House of Representatives, 1925-1938. *American Political Science Review,* 71:940-953.

_____. 1981. Agenda and Alignment Change: The House of Representatives, 1925-1978. In Lawrence C. Dodd and Bruce I. Oppenheimer, eds., *Congress Reconsidered,* 2nd ed. Washington: CQ Press.

Smith, Steven S. 1981. The Constituency and Ideological Structure of U.S. Senate Voting Alignments, 1957-1976. *American Journal of Political Science,* 25:780-795.

Smithies, Arthur. 1941. Optimum Location in Spatial Competition. *The Journal of Political Economy,* 49:423-439.

Stone, Walter J. 1980. The Dynamics of Constituency: Electoral Control in the House. *American Politics Quarterly,* 8:399-424.

Sundquist, James L. 1973. *Dynamics of the Party System.* Washington, DC: The Brookings Institution.

Weisberg, Herbert F. 1968. Dimensional Analysis of Legislative Roll Calls. Ph.D. Dissertation, The University of Michigan.

Wittman, Donald. 1983. Candidate Motivation: A Synthesis of Alternative Theories. *American Political Science Review,* 77:142-157.