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Identifying the median justice on the Supreme Court through multidimensional scaling: Analysis of "natural courts" 1953–1991 *

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Abstract. Given the fundamental unidimensionality in the data on Supreme Court voting patterns 1951–1993 we observe, we are able to determine the identity of "median" members of each court in a fashion that does not require subjective coding of the extent to which particular cases reflect left-right issues. Also, while the exact numerical values of MDS-obtained locations cannot be compared across different "natural courts", the positions of Supreme Court justices across their careers relative to the courts on which they served can be traced. Our data show overwhelming quantified evidence of a very strong rightward drift (relative to our MDS defined dimensions) in the composition of the court as we move from the Warren Court to the Burger Court, and again as we move from the Burger Court to the Rehnquist Court.

1. Introduction

We offer a dimensional scaling of votes in the U.S. Supreme Court, 1953–1991. Our work is in the Poole and Rosenthal (1984, 1991a, 1991b, 1997) tradition of longitudinal dimensional analysis of Congressional roll-call voting.[1] While there is a parallel body of work in the judicial literature, drawing on the Schubert-Spaeth "attitudinal" tradition,[2] our work differs in two important ways from most earlier work on Supreme Court voting patterns.[3]

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First, we perform our analyses on the entire range of cases considered by the Supreme Court rather than looking separately at cases within some particular more narrow issue domain such as First Amendment freedoms, Fourth Amendment search and seizure cases, judicial power, federalism, etc. (see e.g., Rohde and Spaeth, 1976; Segal, 1984, 1997; Segal and Spaeth, 1993) While there are unquestionable gains in both statistical fit and in subtlety of analysis to be obtained by looking at cases pre-grouped according to the similarity of their issue content, a broad-brush pattern captures a very substantial portion of the variance.

Second, rather than using Guttman scaling or factor analysis, like Poole and Rosenthal (1984, 1991a, 1991b, 1997) we use a form of multidimensional scaling (MDS) to estimate the policy preferences of the justices.[4] When the structure of the data can be thought of in terms of voters who have ideal points in some n-dimensional space and who are choosing among alternatives that can also be represented as points in that same n-dimensional space, MDS is the most appropriate technique to recover voter ideal points and specify the dimensionality of the issue space, i.e., MDS is appropriate for representing data generated by an underlying Coombsian unfolding model (Coombs, 1964) that, in the legislative roll call voting context, can be thought of as giving rise to a spatially embedded "ideological" structure.[5] In particular, when properly used, MDS does not normally create artifactual additional dimensions (e.g., an extremism dimension) the way that factor analysis inevitably does when applied to attitudinal data or to data on voter choices or preferences that has been generated by spatial proximity in unfolding terms.[6]

In political science and economics, while the recent seminal work of Keith Poole and Howard Rosenthal (l984, l991a, 1991b, 1997) on historical patterns of roll-call voting in the U.S. Congress brought MDS ideas to the attention of political scientists and economists, MDS had been relatively little used, at least as compared to factor analysis.[7] MDS techniques have, as far as we are aware, only rarely been applied to multi-judge voting patterns, twice in the form of "smallest-space analysis", used by Schubert (1974) and Spaeth and Peterson (1971) to analyze Supreme Court decision-making, and once in the form of metric factor analysis (Rohde and Spaeth, 1976).

We use MDS techniques to model that aspect of Supreme Court decision-making that is most directly comparable to roll call voting in legislatures. Roll call data may consist of yes/no votes by a set of legislators on some set of bills or amendments, or reverse/affirm votes by members of a multi-judge (appellate) court on some set of cases (on appeal) before it. Drawing on the computerized data base on Supreme Court decisions that has been created by Harold J. Spaeth, we examine the voting patterns of justices from the fifteen of the twenty-three "natural courts" found during the period 1953–1991 in

which a full nine justices served and in which there were a substantial number of full-opinion cases heard by the full court.

First, given the fundamental unidimensionality we find in the data, we wish to identify the median (or swing) voter on each of these natural courts. Here, we find the identity of the median justice is frequently shifting as members come and go on the court, but that Justice White was pivotal for much of his career on the court in both the Burger and Rehnquist eras.

Next, we use our methodology to examine the overall ideological changes caused by judicial turnover by studying the effects of pairwise replacements. Transitions between the 15 nine member courts we examine occur when one justice is replaced by another, e.g., Justice Burger by Justice Scalia in the first Rehnquist Court, Justice Marshall by Justice Thomas in the fifth Rehnquist Court. We find striking evidence of a rightward drift in the composition of the court as we move from the Warren Court to the Burger Court and again as we move from the Burger Court to the Rehnquist Court.

While it is unlikely that readers familiar with the Supreme Court will be much surprised by any of our findings, we believe that they are quite important, nonetheless, in providing quantitative and non-subjective evidence showing how strong the impact of judicial replacement can be, and how consistent the patterns of Court replacements have been (overwhelmingly in a liberal direction in the Warren Court era, overwhelmingly conservative in the Burger and early Rehnquist courts).

2. Data and empirical results

2.1. *Data*

We make use of the invaluable computerized data base on Supreme Court decisions that has been created by Harold Spaeth.[8] For most purposes, we group data for analysis according to "natural courts", i.e., courts with the same set of members. Our analyses cover only those nine member courts with a substantial number of cases heard by all nine justices during the period 1953–1991. Our coding choices restrict us to fifteen of the seventeen nine-member natural courts found during the period 1953–1991. (The methodological appendix to this paper provides more detailed discussion of our coding choices.)

2.2. *Data analyses*

2.2.1. *Estimating the dimensionality of Supreme Court voting: 1953–1991*

The MDS calculations we report here were carried out using SYSTAT 5.0.[9] We report results from both metric and non-metric MDS.[10] We answer the

question of how many dimensions are needed to account for Supreme Court decision-making by looking at total explained variance and at the gain in proportion of variance explained as we increase the number of dimensions used to fit the data.[11] Of course, when we look at only nine justices, then the maximum feasible dimensionality of any solution space is eight.

Our expectation that solutions of low dimensions would well describe the various natural courts is generally satisfied. On average, over the 15 courts, the mean r^2 values are .86 for a one dimensional metric MDS solution, and .97 for a two dimensional metric MDS solution. The corresponding mean r^2 values are .80 and .95 for the non-metric solutions. For the one-dimensional solution, we have r^2 values above .85 for 5 of the 15 courts, and r^2 values above .80 for 10 of the 15 courts when we consider non-metric MDS solutions; and r^2 values above .85 for 9 of the 15 courts and r^2 values above .80 for 11 of the 15 courts when we consider metric MDS solutions. For metric MDS, for which the fits are generally slightly better, only Warren 1, Warren 3, Warren 9 and Warren 10 show any real evidence of requiring even a two-dimensional solution, and no court requires a solution in more than two dimensions.

Another important result is that the degree of unidimensionality has, generally speaking, been on the increase. For example, the mean r^2 values for the Warren courts are .74 for the one dimensional non-metric MDS solution and .80 for the one dimensional metric MDS solution. The corresponding mean values for the Burger courts are .87 and .88; while the mean values for the Rehnquist courts are .85 and .93. Thus, by the time we get to the Rehnquist courts the finding of strong unidimensionality is indisputable. Clearly a one-dimensional solution is a very good one, but we can, nonetheless, almost perfectly explain the data with two dimensions. The issue is very simple: which should we use? For this paper we have chosen to go with the one-dimensional solution, for ease of interpretation and because it explains so much of the variance in the data.[12] This choice is consistent with Poole and Rosenthal's (1997) approach to measuring roll-call voting using D-Nominate scores. For scholars who wish a more fine-tuned analysis, concern for the second dimension as well would be desirable, but we shall not attempt such analysis here. Rather we would simply emphasize how much of the voting behavior of justices is explained by a single dimension.

2.2.2. *Locating the median justice in each natural Court*

Tables 3 and 4 show the estimated locations generated from one dimensional non-metric MDS and one dimensional metric MDS solutions, respectively.[13] The numbers should be thought of as comparable only within a particular natural court, and the values are unique only up to a linear transformation we

Table 1. Unidimensional non-metric MDS scores for Supreme Court justices on fixteen nine member "natural courts": 1953–1991

JUSTICE	W1	W3	W5	W6	W8	W9	W10	B2	B4	B6	B7	R1	R3	R4	R5
Jackson	0.95														
Minton	0.57	0.60													
Reed	0.82	0.91													
Burton	0.68	0.99	0.89												
Frankfurter	0.24	0.04	0.91	0.91											
Clark	0.35	–0.41	0.87	0.87	0.56	0.47									
Warren	–0.05	–0.86	–1.11	–1.11	–0.49	–0.71	–0.46								
Black	–1.53	–1.08	–1.13	–1.12	–1.07	–0.11	0.05	–0.28							
Douglas	–2.03	–1.64	–1.13	–1.14	–1.44	–1.53	–1.49	–2.06	–1.71						
Harlan		1.44	0.92	0.91	1.87	1.64	2.04	0.61							
Whittaker			0.89	0.90											
Brennan			–1.10	–1.10	–0.37	–0.69	–0.40	–0.83	–1.21	–1.60	–1.44	–1.13	–1.16		
Stewart				0.82	1.13	1.37	1.04	0.76	–0.04	0.76					
Goldberg					–0.48										
White					0.28	0.42	0.47	0.67	0.36	0.10	0.37	0.89	0.83	0.59	0.11
Fortas						–0.85	–0.87								
Marshall							–0.39	–0.83	–1.04	–1.65	–1.45	–1.13	–1.16	–1.44	
Burger								0.97	0.94	0.96	0.98				
Blackmun								0.97	0.75	0.23	–0.42	–1.11	–1.07	–1.34	–1.55
Powell									0.83	0.62	0.66	0.88			
Rehnquist									1.13	1.18	1.22	0.90	0.91	0.78	1.06
Stevens										–0.60	–0.86	–1.10	–1.09	–1.45	–1.58
OConnor											0.94	0.90	0.91	0.70	–0.47
Scalia												0.90	0.91	0.77	1.11
Kennedy													0.91	0.70	–0.04
Souter														0.69	0.14
Thomas															1.23
MEAN	0.00	0.00	0.00	–0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEDIAN	0.35	0.04	0.87	0.82	–0.37	–0.11	–0.39	0.61	0.36	0.23	0.37	0.88	0.83	0.69	0.11

Table 2. Unidimensional metric MDS scores for Supreme Court justices on fixteen nine member "natural courts": 1953–1991

JUSTICE	W1	W3	W5	W6	W8	W9	W10	B2	B4	B6	B7	R1	R3	R4	R5
Jackson	1.20														
Minton	0.64	0.69													
Reed	0.94	0.81													
Burton	0.80	1.32	0.82												
Frankfurter	–0.09	0.07	1.23	1.15											
Clark	0.10	–0.58	0.34	0.38	0.57	0.48									
Warren	–0.29	–1.09	–0.94	–0.94	–0.48	–0.73	–0.54								
Black	–1.52	–1.16	–1.26	–1.12	–1.09	–0.08	0.26	–0.30							
Douglas	–1.79	–1.31	–1.40	–1.50	–1.44	–1.43	–1.41	–1.82	–1.71						
Harlan		1.24	1.21	1.13	1.87	1.67	1.89	0.48							
Whittaker			0.63	1.01											
Brennan			–0.65	–0.71	–0.38	–0.66	–0.54	–1.03	–1.15	–1.59	–1.41	–1.32	–1.38		
Stewart				0.60	1.12	1.35	1.21	0.87	–0.06	0.62					
Goldberg					–0.46										
White					0.28	0.39	0.54	0.69	0.38	–0.09	0.42	0.75	0.57	0.03	0.12
Fortas						–0.99	–0.86								
Marshall							–0.54	–0.96	–1.08	–1.51	–1.46	–1.38	–1.40	–1.47	
Burger								1.08	0.95	0.99	0.93				
Blackmun								0.99	0.70	0.14	–0.46	–0.90	–0.67	–1.04	–1.54
Powell									0.79	0.67	0.72	0.44			
Rehnquist									1.19	1.40	1.23	1.19	1.07	1.01	0.91
Stevens										–0.62	–0.87	–0.71	–0.88	–1.55	–1.59
OConnor											0.92	0.93	0.89	0.64	–0.49
Scalia												1.01	0.97	0.95	1.14
Kennedy													0.82	0.80	–0.07
Souter														0.63	0.22
Thomas															1.29
MEAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEDIAN	0.10	0.07	0.34	0.38	–0.38	–0.08	–0.54	0.48	0.38	0.14	0.42	0.44	0.57	0.63	0.12

Table 3. Ideological rank order of Supreme Court justices on fifteen nine member "natural courts" 1953–1991 (based on unidimensional non-metric MDS scores)

JUSTICE	W1	W3	W5	W6	W8	W9	W10	B2	B4	B6	B7	R1	R3	R4	R5
Jackson	9														
Minton	6	6													
Reed	8	7													
Burton	7	8	6												
Frankfurter	4	[5]	8	8											
Clark	[5]	4	[5]	6	7	7									
Warren	3	3	3	3	3	3	3								
Black	2	2	1	2	2	[5]	6	4							
Douglas	1	1	1	1	1	1	1	1	1						
Harlan		9	9	8	9	9	9	[5]							
Whittaker			6	7											
Brennan			4	4	[5]	4	4	2	2	2	2	1	1		
Stewart				[5]	8	8	8	7	4	7					
Goldberg					4										
White					6	6	7	6	[5]	4	[5]	6	[5]	4	[5]
Fortas						2	2								
Marshall							[5]	2	3	1	1	1	1	2	
Burger								8	8	8	8				
Blackmun								8	6	[5]	4	3	4	3	2
Powell									7	6	6	[5]			
Rehnquist									9	9	9	7	6	9	7
Stevens										3	3	4	3	1	1
OConnor											7	7	6	6	3
Scalia												7	6	8	8
Kennedy													6	6	4
Souter														[5]	6
Thomas															9

have recoded the data so that negative numbers reflect positions on the left, while positive number reflect positions on the right (relative to members of that court). There is no absolute meaning to location of the zero point; it is merely a centrist position relative to members of that court and has no larger ideological meaning. Note also that the mean values of all justices are normed to sum to zero.

Table 4. Ideological rank order of Supreme Court justices on fifteen nine member "natural courts" 1953–1991 (based on unidimensional metric MDS scores)

JUSTICE	W1	W3	W5	W6	W8	W9	W10	B2	B4	B6	B7	R1	R3	R4	R5
Jackson	9														
Minton	6	6													
Reed	8	7													
Burton	7	9	7												
Frankfurter	4	[5]	9	9											
Clark	[5]	4	[5]	[5]	7	7									
Warren	3	3	3	3	3	3	[3]								
Black	2	2	2	2	2	[5]	6	4							
Douglas	1	1	1	1	1	1	1	1	1						
Harlan		8	8	8	9	9	9	[5]							
Whittaker			6	7											
Brennan			4	4	[5]	4	[3]	2	2	1	2	2	2		
Stewart				6	8	8	8	7	4	6					
Goldberg					4										
White					6	6	7	6	[5]	4	[5]	6	[5]	4	[5]
Fortas						2	2								
Marshall							[3]	3	3	2	1	1	1	2	
Burger								9	8	8	8				
Blackmun								8	6	[5]	4	3	4	3	2
Powell									7	7	6	[5]			
Rehnquist									9	9	9	9	9	9	7
Stevens										3	3	4	3	1	1
OConnor											7	7	7	6	3
Scalia												8	8	8	8
Kennedy													6	7	4
Souter														[5]	6
Thomas															9

Tables 3 and 4 retabulate the numbers in Tables 1 and 2 in ordinal terms. Values range from 1 (most liberal) to 9 (most conservative), with values of 5 those of the median justice. Cells indicating the median justice(s) are outlined in bold. Comparison of Tables 3 and 4 shows that, in all of the courts except Warren 6 (where there is an interchange of the position of the median and a neighboring justice), the median justices identified by metric and non-metric

scaling models are in fact, identical, except for ties (Warren10) . Therefore, to simplify our discussion, we will henceforth refer only to the metric MDS estimates, since these estimates make somewhat finer distinctions among the locations of the justices and also have a marginally higher explained variance.

One strong finding that can be gleaned from Table 4 is that the identity of the median justice is frequently shifting. Eleven of the 27 justices have been the median justice on at least one of the fifteen natural courts – all but two only once.[14] One justice has thrice been median (Justice Clark), and one remarkable justice (Justice White) has been the pivotal justice for a substantial proportion of his career on the court, serving as a median justice on a total of four different courts – two in the Burger era and two under Chief Justice Rehnquist.

Identifying the median justice as we do in Tables 3 and 4 allows us to identify the ideological center of gravity of each of our natural courts. Over time that center of gravity shifts from justices such as Clark and Frankfurter, to Justices Marshall, to Justice White, and then to more recently appointed justices such as Powell, and later Justices O'Connor and Souter. In a relatively polarized court, such as the one we now have, the views of the median justice can be critical in determining outcomes on vital policy issues, as is arguably presently the case for Justice O'Connor re affirmative action (Biskupic, 1997) and voting rights (Grofman, 1997).[15] It does not take much knowledge of the Supreme Court to recognize that a court with Justice Frankfurter as median justice is a very different court from one where Justice Marshall plays that role.[16]

2.2.3. *Has the overall ideology of the Court shifted rightward?*
While we lack a straightforward baseline model to determine if there is statistically significant shift over time in the location of individual justices,[17] we can get a clear sense of overall ideological shift in the Court by looking at the patterns of judicial replacements. This allows us to get a measure of ideological movement "from the data" rather than by subjectively coding particular cases in left-right terms.

Table 5 shows the effects of judicial replacement by identifying the rank (ideological location) of the justice who is being replaced in the last full court on which that justice served and the rank (ideological location) of the replacement justice in the first full court on which that justice served. The difference between these ranks provides us a direct measure of the extent to which replacements move the court in a given ideological direction.

The transformations shown in Table 5 are dramatic. After the first Warren Court we see a steady leftward drift (with the biggest jump occurring when Justices Frankfurter and Clark are replaced by Justices Goldberg and

Table 5. Replacement effects on fifteen nine member "natural courts" 1953–1991 (based on unidimensional metric MDS ranks)

Court	Replacement justice(s)	Position rank on first full Court served	Replaced justice(s)	Position/ rank on last full Court served	Difference
WAR 1	Warren	x	x	x	x
WAR3	Harlan	8	Jackson	9	–1
WAR5	Whittaker	6	Reed	7	–1
	Brennan	4	Minton	6	–2
WAR6	Stewart	6	Burton	7	–1
WAR8	Goldberg	4	Frankfurter	9	–5
	White	6	Whittaker	7	–1
WAR9	Fortas	2	Goldberg	4	–2
WAR10	Marshall	3	Clark	7	–4
BURG2	Burger	9	Warren	3	+5
	Blackmun	8	Fortas	2	+6
BURG4	Rehnquist	7	Black	4	+3
	Powell	7	Harlan	5	+2
BURG6	Stevens	3	Douglas	1	+2
BURG7	O'Connor	7	Stewart	6	+1
RENQ1	Scalia	8	Burger	8	0
RENQ3	Kennedy	6	Powell	5	+1
RENQ4	Souter	5	Brennan	2	+3
RENQ5	Thomas	9	Marshall	2	+7

Marshall, respectively). *Every* change during the Warren era after Warren 3 is either a change in the direction of *liberal* ideas or neutral! But then comes the first full Burger Court (Burger 2), reflecting a sharp right turn. That right turn continues. *Every* change during the Burger Court is a change in a *conservative* direction! Similarly, with the exception of the more or less even swap of Justice Scalia for Justice Burger, *every* change in the Rehnquist era is a change in a *conservative* direction, with the most dramatic effects occurring with the replacements of Justice Brennan by Justice Souter and, of

course, most dramatically, with the replacement of Justice Marshall by Justice Thomas! It does not take advanced statistics to see that these results are both substantively and statistically significant.[18]

2.3. *Comparisons with results of previous work*

2.3.1. *Locations of justices: Comparisons with Schubert (1974)*

Because the data analyzed by Schubert (1974) from 1946–1969 overlaps in part with the time period of our study, and because he uses a version of MDS for some of his analyses, we will provide direct comparisons for the natural courts found in both data sets.[19] For Warren 1, our metric rank ordering from left to right is Douglas, Black, Warren, Frankfurter, Clark, Minton, Burton, Reed, Jackson; while for Schubert (1974: 135) it is Douglas, Black, Warren, Clark, Frankfurter, Jackson, Burton, Minton, Reed. All the differences, with the exception of the switch between Jackson and Reed, occur as locational switches between proximate justices. For Warren 3 our ordering is identical with his. For Warren 5, Schubert gets an ordering of Black, Douglas, Warren, Brennan, Frankfurter, Clark, Harlan, Whittaker, and Burton; while we get Douglas, Black, Warren, Brennan, Clark, Whittaker, Burton, Harlan, and Frankfurter. Here there are important differences in the results of the two methods, especially with respect to the location of Frankfurter. For Warren 6, Schubert's smallest space analysis yields a near-degenerate solution, with five justices at virtually identical locations at the rightmost pole and four at the leftmost pole (1974: 135); while our method yields a much clearer separation among the positions of the justices (as does the non-metric analysis), but one which is otherwise identical to that given by Schubert in rankings. For Warren 8 the two methods again get identical results. For Warren 9, the two methods give identical rankings except for two inversions between proximate justices: between Clark and White and between Warren and Fortas. For Warren 10 we get Douglas, Fortas, a tie between Marshall, Warren, and Brennan, Black, White, Stewart, and Harlan; while Schubert (1974: 135) finds Douglas, Fortas, Marshall, a tie between Warren and Brennan, Stewart, Harlan, White, and Black. Clearly, for this court, we are agreeing on who is to the right and who to the left, but not necessarily fully agreeing on relative location (at least on the right). In four of the seven courts for which we can directly compare our work and that of Schubert (1974), we identify the same median justice. In one instance (Warren 1 and Warren 5) we get an inversion between two proximate justices, and only in Warren 10 do our results differ significantly, but even there the reason for the difference is simply that smallest space analysis places four justices very very close to one another but not in the same order as in our MDS analysis. The computer program Schubert (1974) uses reflects an earlier generation of technology and has a tendency to come up with solutions

in which not all justices have unique positions. This problem arises in a major way in 20% of his one-dimensional solutions. Thus, in general, we regard our results as "cleaner".

2.3.2. *Replacement effects on the Court*

When we look at replacement effects using Schubert's one-dimensional smallest space results, we again find a dramatic shift leftward in the Warren Court, with seven of the eight shifts in a leftward direction.[20] Moreover, Schubert's data, which go back further than ours, allows us to see what the effect was of replacing Justice Vinson with Justice Warren, namely a whopping - 6 (leftward) shift in ideological ranks. This would suggest that, in the modern era, only the replacement of Justice Marshall by Justice Thomas had a greater impact on the ideological makeup of the Supreme Court.

The other work on replacement effects we have found tends to look only a specific set of cases. But results are generally highly consistent with our own. For example, looking only at search and seizure cases, Segal (1985) finds evidence of a clear rightward shift during the Burger Court.

Baum (1992) offers one of the most sophisticated attempts to identify the importance of replacement effects, especially as compared to changes in case content and changes in issue attitudes of continuing justices. His data is limited to civil liberties cases but he looks at a longer time period than we have. He finds (1992: 11–12) that "the decline in civil liberties support between the early and late Vinson courts resulted entirely from membership change – a spectacular drop in support as the very liberal Frank Murphy and Wiley Rutledge were succeeded by Tom Clark and Sherman Minton. . . . Similarly, the growth in civil liberties support in the 1956 and 1957 terms can be attributed entirely to the arrival of two new justices, the more important by far being William Brennan (Charles Whittaker was the other). . . .The growth in civil liberties support that created the later the Warren Court in the 1962–1964 period apparently derived overwhelmingly from the appointments of Byron White and Arthur Goldberg in 1962".

While Baum (1992:13) finds changes between other natural courts arising partly from replacement and party from other effects, his overall conclusion is that "changes in the Court's membership seems to account for a majority of the voting change".[21] Moreover, when we compare the data in our Table 5 with that in his Table 3 (1992: 13), we find that his conclusions about the directionality of change with respect to civil liberties over the period 1953–1985 are virtually identical to our findings for the entire set of cases before each natural court over the same period. In particular, judged by his data on voting on civil liberties cases, from 1953 to 1964 all replacement effects are

in a liberal direction, and from 1969–1985 all replacement effects are in a conservative direction.

2.4. *Other issues*

In this paper we have focused on a relatively limited set of judicial behavior questions such as the dimensionality of Supreme Court decision-coalitions and the importance of judicial replacements. In doing so, we have only made use of voting data, not the content of opinions and not other information about internal processes of the Court. While we make no claim that multidimensional scaling of court decisions is the only way, or even the most informative way, to make sense of the decision processes of multi-judge courts, it is still a natural question to consider in what ways our analyses might be misleading

First, while ideology is the natural way to explain the dimensional patterns we find in legislative roll-call data, some readers may have objected to our repeated use of the term "ideology" to characterize the attitudinal underpinnings of judicial decision-making in the discussion above. If there exists a consistent patterning of judicial choices that is remarkably similar across cases, it might be the case that these similarities in voting alignments are due to similarities in "jurisprudential philosophies", rather than due to similarities in something like what is commonly thought of as "ideology". Dimensional scaling, *per se*, cannot allow us to choose between these two interpretations, and discussion of theories of jurisprudence and case-specific analyses would take us well beyond the scope of the present paper.[22] However, if the reader finds herself uncomfortable with the use of the term "ideology" to refer to the underpinnings of Supreme Court decision-making, s/he may simply substitute the phrase, "data that fits a Coombsian unfolding model".[23]

Second, it might be argued that since justices might engage in strategic behavior – including the decisions to engage in separate (or joint) concurring and dissenting opinions – that YES-NO roll-call votes can be limited or even misleading indicators of justices' true attitudes. However, we do not regard this claim as creating a major problem in interpreting our results. In our view, the limitations of using roll call voting data as an indicator of judicial values are essentially no greater for courts than they are for legislators.[24] For congress, evidence for strategic voting on the floor is very hard to come by. Similarly, Segal (1997; 1998: 923) finds, "consistent with the attitudinal model, that the justices overwhelmingly engaged in rationally sincere behavior". For congress, analyses of roll-call voting patterns and coalitional patterns continue to be central in the study of topics such as the degree of party polarization (See e.g. Collie, 1988) and the representativeness of congressional committees (Krehbiel, 1990, 1991; Hall and Grofman, 1990).[25] In like manner, considering the immense amount of effort that legal scholars

have put into analysis of the wellsprings of judicial decision-making, especially that of the Supreme Court, it seems to us quite remarkable how far we get merely by thinking of justices as points along a line, with ideological proximity the best predictor (and a very good one!) of which coalitional alliances will form.

Finally, we would note that no single study can do everything. By tracking changes over time in the location of the median justice, we have identified changes in the attitudinal "center of gravity" of the court, and we have shown how pairwise replacement effects have either taken the court strongly in a liberal direction (during the Warren era) or strongly in a conservative direction (during both the Burger and Rehnquist eras, through 1991).[26] Our results, based on a different methodology, strongly support Baum's (1992: 22) finding that "presidential appointments appear to be the primary force that reshapes the decisions of the Supreme Court".[27] In sum, we see our work as establishing a basic schematic overview of nearly 40 years of court history to serve as a springboard to more detailed analyses of judicial philosophy and judicial choices and the changing dynamics of the Court that may come with the appointment of new members, especially a new Chief Justice, and with the introduction of new issues. Our work is based on a careful analysis of a multidimensional scaling results for justices in nine member courts over a nearly 40 year period. We have provided results disaggregated to natural courts as well as evidence from pooled data. Unlike most other work in this area, we have not restricted our analyses to subsets of the data selected because they deal with some relatively narrowly defined type of policy question. Moreover, what we learn from MDS analyses of the Supreme Court has paralleled what scholars such as Poole and Rosenthal (1997) have told us about the U.S. Congress.

Methodological appendix

Data

Using Spaeth's (1993) codebook accompanying the ICPSR Supreme Court dataset, the set of cases we analyze was initially screened by selecting dataset "cases" where his level of analysis variable ANALU = " " and his decision type variable DEC_TYPE = 1. We focus on "natural courts" with a substantial number of cases hears, since Courts with too few cases reduce the reliability of the MDS spatial estimates.

There were 23 natural courts during the period 1953–1991. Of these, seventeen were nine member courts. We report as the first number below the number of cases actually used for analyses of that natural court after we have

performed our screening; the second number is total number of cases in the data set for that court before screening. Warren Court 1 (N = 48/65), consists of Justices Black, Burton, Clark, Douglas, Frankfurter, Jackson, Minton, Reed, and Warren. In Warren Court 2 (N = 36/39, omitted), Justice Jackson leaves the court but is not yet replaced (this court has only eight members). In Warren Court 3 (N = 75/121), Justice Jackson is replaced with Justice Harlan. In Warren Court 4 (N = 26/43, omitted), Justice Minton is replaced with Justice Brennan. In Warren Court 5 (N = 116/161), Justice Reed is replaced with Justice Whittaker. In Warren Court 6 (N = 291/342), Justice Burton is replaced with Justice Stewart. In Warren Court 7 (N = 0/49, omitted), Justice Whittaker is replaced with Justice White, but Frankfurter fails to serve on any of the decisions in our reduced data set. In Warren Court 8 (N = 270/312), Justice Frankfurter is replaced with Justice Goldberg. In Warren Court 9 (N = 161/197), Justice Goldberg is replaced with Justice Fortas. In Warren Court 10 (N = 98/175), Justice Clark is replaced with Justice Marshall. In Warren Court 11 (N = 29/34, omitted), Justice Fortas steps down but is not yet replaced (this court has only eight members). In Burger Court 1 (N = 56/70, omitted), Justice Warren is replaced with Justice Burger (this court has only eight members). In Burger Court 2 (N = 95/128), Justice Fortas is replaced with Justice Blackmun. In Burger Court 3 (N = 18/18, omitted), Justices Black and Harlan leave but are not yet replaced. In Burger Court 4 (N = 394/514), Justice Black and Harlan are replaced with Justices Rehnquist and Powell . In Burger Court 5 (N = 6/6, omitted), Justice Douglas leaves the court but is not yet replaced (this court has only eight members). In Burger Court 6 (N = 569/772), Justice Douglas is replaced with Justice Stevens. In Burger Court 7 (N = 624/728), Justice Stewart is replaced with Justice O'Connor. In Rehnquist Court 1 (N = 132/145), Justice Burger is replaced with Justice Scalia. In Rehnquist Court 2 (N = 21/22, omitted), Justice Powell departs but is not yet replaced. In Rehnquist Court 3 (N = 303/378), Justice Powell is replaced with Justice Kennedy. In Rehnquist Court 4 (N = 100/112), Justice Brennan is replaced with Justice Souter. In Rehnquist Court 5 (N = 87/106), Justice Marshall is replaced with Justice Thomas.

Of the 17 nine-member courts, we omitted Warren Court 4, with only 26 cases after data reduction, and Warren Court 7, with no cases after data reduction. We should note that Warren 7, though technically a nine-member court, was not a nine member court in practice, since Frankfurter, although formally still on the court, only participated in 8 of the 93 decisions. The minimum number of cases in any of the natural courts we analyze is 48, in Warren 1.

Including cases with less than a full court might reduce the dimensionality of our solution; thus the decision to exclude them is a conservative choice in

making a solution with low dimensionality less likely.[28] We also analyze only those cases from this data set uniquely identified by case citation number, in which the Court heard oral argument and gave a formally decided full opinion.[29] Where it is used below, the term "case" refers to just these types of cases. Note that all cases involving certiorari or cases with only memorandum opinions are excluded by the coding decisions we have made.[30]

Because we are focusing on affirmance or denial of the lower court decision, we do not require that cases have a majority opinion, as long as the directionality of a decision is clear. Spaeth's categorizations of justice's voting behavior were binarized by recoding "voted with majority", "regular concurrence", "special concurrence", and "judgment of the court" as concurrences and "dissent" as dissent. Cases where one or more Justice's votes were categorized as "jurisdictional dissent", "dissent from a denial or dismissal of cert"., and "non-participation", (namely those for which full roll call data is not available) were also deleted from the data set. Spaeth identified some decisions that he viewed as not being codeable in left-right terms.[31] However, although our interest is in ideological scaling, we have not eliminated those decisions from the data set. Including cases that Spaeth did not see as codeable in left-right terms is another conservative choice because it makes it less likely that a unidimensional model will satisfactorily fit the data.

In our fifteen-court data set we have 4256 cases before data reduction and 3363 cases after data reduction. Because we have deliberately restricted the set of decisions we would analyze in a number of ways, it is natural to ask how much of the data set has been excluded and would our results have been different if we had chosen a more inclusive strategy.[32] First, we would emphasize that, even though we only look at 15 of the 23 natural courts, those courts include 93.8% (4256/4537) of the cases before reduction and 94.6% (3363/3555) of the cases after reduction during the time period under study. Second, a more inclusive strategy would not have significantly altered our results. For example, comparisons between the one-dimensional MDS scalings reported below and additional analyses where both cases with less than full participation and cases involving certiorari decisions were included show almost no difference in average fit.[33] Moreover, our choice of which types of cases to include and which to exclude has minimal consequences for analysis of the identity of the median justice.[34]

We would expect the fit of the MDS model to be greater on average for the disaggregated than for pooled data. One likely source of multidimensionality in the pooled data is the introduction of new issues confronting the court such that the issue positions of justices with respect to these issues are not the same as for the issues that had been previously been central. By focusing on single natural courts, we minimize this problem. Another likely source of

error (and thus potential imputed higher dimensions) is changes over time in the issue locations of justices, i.e., even if the issues don't change, the views of particular justices might. *Ceteris paribus*, the longer the time period over which we examine decisions of a sitting justice, the more likely is it that there will be some ideological drift in that justice's position. For comparison purposes we pooled together the 15 data sets (yielding 3363 cases), computed simple matching coefficients between each pair of the 27 justices that served over this time period, and analyzed the resulting matrix as before with metric and non-metric MDS. The results were as expected. The r^2 value was .79 for the one-dimensional metric MDS solution, and .79 for the non-metric solution as well. For the two-dimensional solutions we found r^2 values of .91 for metric MDS and .90 for non-metric MDS. This is a drop of .05 to .06 in total $r^2$from the average values for the individual natural courts of one dimensional and two-dimensional fit.

Finally, we examined what might be considered the "worst case" scenario, where the pooled data set subject to MDS was expanded in ways that might be expected to introduce still further sources of error. We selected the formally decided full opinion cases uniquely identified by case citation number (as before), but now included cases from all 23 courts (including the eight member courts), and left in those cases where there were less than nine justices participating. (These are the cases where Spaeth coded the Justice's vote as 5 (non-participation), 7 (dissent from a denial or dismissal of certiorari or dissent from summary affirmation), or 8 (jurisdictional dissent).) This left an aggregated dataset of 4537 cases, which we then analyzed as above. Here the fit is slightly worse, but not remarkably so. The r^2 value was .75 for the one-dimensional metric MDS solution, and .75 for the non-metric solution as well. For the two-dimensional solutions we recovered r^2 values of .88 for metric MDS and .87 for non-metric MDS.

Even though the MDS fit for the pooled data is not that bad, our interest in tracking justices over time lead us to prefer dealing with analyses of each of the 15 natural courts, separately; moreover, the estimates of individual locations are not as precise when we use the pooled data set.

2.5. *Methods*

We make no effort in this paper to provide a general mathematical descriptions of MDS techniques since these are available elsewhere (e.g., Kruskal and Wish, 1991), and MDS algorithms are now being included in most advanced statistics program. MDS is closely related to the idea of Coombsian unfolding (Coombs, 1964). The unfolding model has been independently discovered by scholars in different disciplines who often write in ignorance of each other's work. Coombs (1964) distinguished between I scales and J

scales. Coombsian J scales posit that we can locate both individuals and stimuli in the same metric space. An I scale is an individual's preference ordering of the stimuli and may be thought of as the J scale unfolded on the ideal point of the individual, with only the rank order of the stimuli given in increasing distance from the ideal point (Coombs, 1964). In one dimension, the set of Coombsian I scales that are consistent with a given Coombsian J scale gives a form of what economists (Black, 1958; Arrow, 1961) call a "single-peaked" ordering. However, there may be some single-peaked orderings that do not coincide with any Coombsian J scale because, although the ordinality conditions required for a set of individual orderings to be single-peaked are satisfied, any proposed metric on the alternatives gives rise to logical inconsistencies.

Generally, MDS techniques seek to optimize some objective function of goodness (or badness) of fit between the observed proximities and the distances between the points in the geometric configuration. The most commonly used objective functions, STRESS 1 and STRESS 2 (Kruskal 1964a, 1964b) are actually badness of fit measures, as is Young's S-STRESS. While the results we report were done using SYSTAT 5.0, a program which minimizes the value of Kruskal's STRESS 1, as an added precaution, the results were replicated using SPSS for Windows, which minimizes Young's S-STRESS. Ordinal results from the two programs were virtually identical, with only a few pairwise reversals of the location of proximate justices in some of the natural courts. Moreover, differences found in ordinal rankings invariably involved justices whose metric locations were virtually indistinguishable from one another. The correlations between the one-dimensional solutions of the two programs were .99 for both the metric and the non-metric solutions, and the same was true for the two dimensional solutions. Because the results of the two methods were so close, we have only reported results from the SYSTAT runs.

Largely following Poole and Rosenthal (1997), we focus on explained variance. The explained variance is the square of correlation between the raw data (i.e., for each pair of justices on a given natural court, the proportion of cases in which those two justices vote the same) and the MDS-recovered inter-justice (paired) distances. In the MDS literature, so-called "Shepard diagrams " are commonly used to display the scattergram between the raw data and the MDS distance estimates (Kruskal and Wish, 1991). We are reporting the square of the correlation that would be found for the data in such scattergrams. This value is, we believe, directly comparable to the explained variance reported in the work of Poole and Rosenthal (1991a, b). We have not reported values for the various stress measures common in the MDS literature

(see e.g. Kruskal and Wish, 1991 and discussion above) because the explained variance measures are more readily interpretable.[35]

Notes

1. The classic early works on congressional roll-call voting analysis are Turner (1951) and MacRae (1958). The methodological underpinnings of this early behavioral work are laid out in MacRae (1970). Similar methods have been applied to legislatures outside the U.S. (see e.g., MacRae, 1967). What is unquestionably the most important recent scholarship in this area has been by Keith Poole and Howard Rosenthal (see Poole and Daniels, 1985; Poole and Rosenthal, 1984, 1991a, 1991b, 1997). The Poole and Rosenthal work reflects major technical advances over the work of the 60s and 70s on roll-call voting.
2. While "legal realism" got its start among lawyers (see e.g., Frank, 1949), it has largely been political scientists such as Glendon Schubert (1959, 1964, 1965, 1974), and Harold Spaeth (1963a, 1963b, 1979), and their students and successors (e.g., Spaeth and Peterson, 1971; Rohde and Spaeth, 1976; Spaeth and Brenner, 1990; Hagle and Spaeth, 1992; Segal and Spaeth, 1993), who, beginning in the late 1950s, have provided the empirical evidence to buttress a claim that the policy attitudes of Supreme Court justices serves as the principal determinant of their voting behavior. The locus classicus for the modern empirical study of the Supreme Court, however, is Pritchett (1948) which viewed the Court as a political institution, looked at the social values of justices, and introduced bloc analysis as a tool for analysis of court decisions. Other important early work was done by Ulmer (1960, 1970, 1973a, 1973b, 1974)– some of it arguing for the importance of judge's social background.
3. The literature on Supreme Court decision-making is too voluminous to review in capsule form, but numerous articles and books focusing on the Supreme Court are cited in the text below and a useful, although now dated, review is found in Ryan and Tate (1980); important general treatments of judicial behavior and public law include Murphy and Tanenhaus (1972), Gibson (1983), Shapiro (1993), and Baum (1997). Reviews of the judicial behavior literature on trial and lower appellate courts, respectively, are found in Jacob (1991) and Gibson (1991).
4. Multidimensional scaling (hereafter MDS) is a class of techniques designed to reduce a matrix of proximities to a geometrical configuration of points lying in some number of dimensions in such a way that the distances d_{ij} between the points are related in some fashion to the proximities δ_{ij}. MDS is based on capturing underlying dimensions in terms of what is called Coombsian unfolding (Coombs, 1964). There are both metric and non-metric versions of MDS (see e.g., Torgerson, 1958; Shepherd, 1962a, l962b; Kruskal, 1964a, l964b; Shepherd, Romney and Nerlove, 1973a; Kruskal and Wish, 1991). The latter may be used where proximity between stimuli is not specified in metric terms and only ordinal information about relative closeness is known.
5. Cf. Feld and Grofman (l988).
6. See van Schuur and Kiers (1994) and Brazill and Grofman (2000).
7. In contrast, there is a long tradition of MDS use in disciplines such as mathematical anthropology and mathematical psychology (see e.g., Shepherd, Romney and Nerlove, 1972b; Carroll and Wish, 1974; Kruskal and Wish, 1991).
8. This data set, "United States Supreme Court Judicial Database: 1953–1991 Terms", was made available to us through ICPSR (ICPSR 9422 4th Release, May 1993).

9. See Appendix for methodological details.
10. The choice of metric scaling instead of non-metric scaling has only limited effect on the general configuration of points in most cases. As we shall see, the differences between metric and non-metric MDS results proved unimportant for our analyses of Supreme Court data. For more detailed discussion of differences between metric and non-metric MDS see Kruskal and Wish (1991).
11. See methodological appendix for further details (cf. Poole and Rosenthal, 1991a, b; 1997).
12. We would emphasize that we would never expect to get a perfect scale pattern. As Poole and Rosenthal (1997:7) observe for congressional roll-voting analyses: "Allowance must be made for errors". We can make such an allowance via "a probabilistic model of voting. " Errors, however, should not be randomly distributed. In particular, errors should be most common among legislators who are located near the "cut-point" between any proposal and the status quo reversion point that obtains if that proposal fails to pass. MDS finds the dimensional structure that best fits the data, and allows for mistakes.
13. The results we get when we report ordinates on the first dimension of the two-dimensional MDS solutions are so similar to those for the unidimensional solutions that we do not bother to present them. Using SYSTAT, the correlations between the first dimension of the two dimensional solution and the one dimensional solution are .98 for non-metric MDS and .99 for metric MDS.
14. Recall that there is one tie for median.
15. For a much more general perspective on Justice O'Connor's influence on the Court see Maveety (1996).
16. However, we would repeat the caution of Blasecki (1990) not to confuse a centrist location with (pivotal) influence on the Court. Some justices may be influential even though far from centrist, and some centrist justices may have little persuasive influence on their fellows and, if there are several justices who are generally centrist, there is no guarantee that the justice who is most often median is also the one with the greatest bargaining power/influence on the final shape of the opinion.
17. Our evidence for a genuine ideological shift on the part of Justice Blackmun relies on the "inter-ocular" test as it applies to Table 4 and not on any explicit statistical model. We hope in future work to explore the possibility of developing such a baseline statistical model.
18. Indeed, the probability that we could get a sequence of eight values less than or equal to zero (change in the liberal direction) being followed by ten values greater than or equal to zero (change in the conservative direction) by chance alone is effectively zilch!
19. For reasons discussed below, we will only deal with the analyses done by Schubert (1974) using "smallest space analysis", which is a form of MDS. Also, to maximize comparability, we will only look at the one-dimensional solutions he found. We will not try to compare our scaling of justices' locations with those in the other detailed analysis of Supreme Court data using smallest scale analysis, Spaeth and Peterson (1971), because that work focuses on comparisons of voting patterns in eleven different subsets of the civil liberties cases before the Warren Court in 1960–64 (Warren 8).
20. Only the replacement of Jackson by Harlan would not be scored as a leftward shift if we used the results of Schubert's one dimensional smallest space analysis.
21. Later in the article, however, after reviewing data on the behavior of individual justices over time, Baum (1992: 19) does modify this conclusion somewhat, by placing more equal emphasis on change in the attitudes of continuing justices as a source of change for the Court as a whole. On balance, Baum (1992) aims for a nuanced portrait of the various influences that create voting differences on the Court over time.

22. Perhaps the most sophisticated attempt to develop an empirically testable comparison of competing theories of jurisprudence is Spaeth and Segal (1999), which focuses on *stare decisis*, and offers analysis of both voting patterns and the legal content of opinions.

23. But, if we find a pervasive unidimensionality that cuts across all cases, and if other scholars who have examined the substance of particular rulings find that justices whom our scaling would classify as conservative at some point in time are, for example, willing to overturn or emasculate policies favored by liberals of that time period (e.g., affirmative action), while sustaining policies generally favored by conservatives of that time period (e.g., anti-sodomy laws), then characterizing justices' attitudes in the same way that we might characterize the attitudes of legislators does not seem unreasonable. (Cf. "If it looks like a duck and quacks like a duck, maybe it is a duck".) For more on this debate from a political science point of view see e.g., Spaeth and Teger, 1982; Adamany , 1991; Brisbin, 1996; Songer and Lindquist, 1996, and the references cited therein.

24. Certainly, any student of congress would find it completely uncontroversial to say that we cannot fully understand congress without a study of its internal structure (consider, for example the classic work of Shepsle, 1979 on committee structure, or the recent work of Hall, 1996 on committee and subcommittee influence), or without understanding the interplay between congress and the president. It is equally uncontroversial to observe that a focus on who opposes and who supports a bill may lead us to neglect the actual policy content of bills (as well as details of impact that may be "lost in the fine print".) Similarly, dating back at least as far as Riker (1958) congressional scholars have been sensitized to the potential for strategic calculations by members of congress. None of these concerns is incompatible with a view, which sees legislator ideology as a major determinant of legislative voting. (cf. Gillman and Clayton, 1999)

25. Similarly, while a focus on roll-call voting leaves out some of the most important aspects of judicial decision-making, namely the actual legal precedents and reasoning of the various opinions, legislative roll-call voting data analyses tell us nothing about the crucial question of what the bills that pass (or fail) actually contain.

26. We should also note, however, that, for both legislators and justices the specific policy content of what is liberal and what is conservative may change over time (see e.g., Poole and Rosenthal, 1997).

27. Similarly, Poole and Rosenthal (1991a: 228) conclude that changes in congressional voting patterns have "occurred almost entirely through the process of replacement of retiring or defeated legislators with new members".

28. Also, we did not wish to artificially inflate the similarity between those justices who may have simply failed to participate in some number of particular cases.

29. It should be noted that cases decided "on the merits" are rare, and cases with full signed written opinions are rarer, still In the 1994–95 term, the Court had 2526 cases on its dockets [excluding the 5,574 *in forma pauperis* petitions from indigents seeking reversals of their convictions] and disposed of the vast bulk of them. But of the many cases handled by the Court, "it decided only 160 on the merits, with full signed, written opinions handed down in 91 cases.... the remainder being disposed of either *per curiam*, or by memorandum orders (e.g., "affirmed", "reversed", "dismissed", or "vacated".)" (Abraham, 1998: 197). However, the relatively small set of cases decided on the merits with signed written opinions are the precedent setting cases which are the lifeblood of jurisprudential analysis.

30. It might be argued that the decision coalitions in such cases might differ in substantially significant ways from other cases before the Court.

31. In the fifteen-court data set there are 3,363 cases (after reduction) , but of these there were only a relatively small number (28) that Spaeth viewed as not being codeable in left-right terms.
32. Several of our decisions as to which cases to exclude (e.g., the decision to exclude cases involving certiorari and the decision to exclude multiple decisions arising from a single case) were based in large part on suggestions of an anonymous referee of another (related) paper by the present authors. However, we take full responsibility for the coding choices we have made.
33. The average absolute difference between fit scores (squared multiple r) for the unidimensional solution to the larger as compared to the reduced data set was .045 (standard deviation = .053) for non-metric MDS and .031 (standard deviation = .041) for the metric MDS scalings. Neither data set fit significantly better than the other. The average difference between fit scores (squared multiple r) for the unidimensional solution to the larger as compared to the reduced data set was a minuscule .004 (standard deviation = .07) for non-metric MDS and .006 (standard deviation = .052) for the metric MDS scalings.
34. In none of the comparisons with alternative data sets we performed, did the identity of more than one of the fifteen median justices change, although in some instances we also got additional ties.
35. A heuristic often employed is to examine the scree plot, a graph of the mean variance explained level for solutions of various dimensionalities (m = 1,2,3,...). In theory, there should be an elbow in the plot marking the "true" underlying dimensionality. That is, variance explained should increase rapidly until the appropriate dimensionality is reached and then the plot should gradually flatten out, as the "additional" dimensions reflect mainly noise. (Sometimes "stress reduction" rather than "variance explained" is used as the basis for a decision about dimensionality.) We have not bothered to present such a graph here.

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