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Introduction: The Liberal/Conservative Structure

Roll Call Voting and the Liberal/Conservative Continuum

"All politics are local," said Tip O'Neill, Speaker of the House from 1977 to 1987. If only because the Congress of the United States must amalgamate the diverse preferences of constituencies,[1] the task of finding a simple structure to explain how members of Congress vote when the roll is called might well be a hopeless one. Perhaps only detailed accounts of action on particular bills can fully capture the legislative process. But any science of politics must seek to find simple structures that organize this apparent complexity. We have developed a parsimonious model that accounts for the vast majority of the millions of individual roll call decisions during the 200 years of roll call voting in the House of Representatives and the Senate.

Aggregating the local loyalties of members of Congress into legislation is a matter of solving an institutional labyrinth replete with committees, subcommittees, and conference committees.[2] The outcomes reflect not only the preferences of the legislators themselves, but the pressures and appeals of countless staff members, lobbyists, and constituents. Moreover, activity in Congress will be responsive to the veto power of the president. One might expect chaotic rather than orderly behavior.[3]

When, on the other hand, local concerns give way to a disciplined two-party system, day-to-day roll call voting is devoid of interest. A stylized description of Great Britain, for example, would indicate that national elections create a parliamentary majority. Until the next elections, the winning party proposes legislation. The legislation is routinely approved by all members of the majority and opposed by all members of the minority.[4]

Such a model obviously doesn't work on our shores. President Reagan was able to enact his economic program in 1981, including a large tax cut and cuts in domestic spending, in spite of a divided government, with the Democrats being in the majority in the House of Representatives. Defections of "boll weevil" Democrats from the South eroded the majority.

It is tempting to resuscitate a model of pure party conflict by arguing that, at least for the last 50 years, the United States has really had a three-party system, with the Democrats split into northern and southern factions. In the three-party model, majorities would be formed by shifting alliances between two of the three parties. But this model doesn't work cleanly either. When the 1964 Civil Rights Act was passed, northern and southern Democrats took opposite sides. But, the Republican party also

split, with its more conservative members joining the southern Democrats. Similarly, throughout the 1830s and 1840s, slavery roll calls cut across parties, dividing North from South, rather than Whigs from Democrats.

More generally, roll calls typically split one or both of the parties. Why are there splits? Perhaps it is because American legislators are parochial—"all politics are local"—and because they are overwhelmingly responsive to the needs of their constituents and not responsive to national interests.[5] If so, for many issues, we would need an issue-specific economic model that specifies and measures constituency interests.[6] When a roll call involves a strong element of *geographic* distribution of resources, our simple structure may in fact fail to account for voting behavior. More typically, as we shall show in chapter 6, roll call voting is accounted for by the structure, and little is gained by attempting to enrich this accounting by introducing measures of the economic interests of constituencies.

Searching for the impact of specific economic interests may be, more fundamentally, fruitless because the legislative process is dynamic, with a vast set of issues being considered as time progresses. In a dynamic setting, rational actors may find it in their interest to coalesce and logroll (trade votes).

The linkage of commercial issues was nicely captured by Representative Hewitt (D-NY) during the debate on the Interstate Commerce Act in 1884:

> Men of business in New York despair of wise legislation upon these great commercial questions from this House. They have seen this House resist the resumption of specie payments. They have seen this House thrust the silver bill down the reluctant throats of an unwilling community; and now they behold this House and this side of it forcing reactionary measures upon the commerce of the country which will paralyze the business of the port which is the throat of the commerce of this country.[7]

In other words, Hewitt saw railroad-freight regulation as linked to previous votes on the gold standard and on a direct subsidy to the silver interests in Nevada. Each vote can thus reflect coalition behavior, as well as the apparent substance of the vote. "Anticommercial" interests are likely to stick together on a large set of bills. When such coalitions are stable, a parsimonious model that uses a simple structure may encapsulate the coalitions and give a better account of voting patterns than do attempts to deal with the substance of the roll call in isolation. In fact, we find that a model of flexible coalitions is typically far superior to models in the literature that use economic interests.

What simple structure permits flexible coalitions? Briefly, one in which legislators can be described by a continuum of positions. Although the continuum is an abstraction, it is convenient to use the word *ideology* as a shorthand code for these positions. Henceforth in this book, we use *ideology* as a shorthand in the sense intended by Converse (1964) in his seminal essay on belief systems. That is, voting is along ideological lines when positions are predictable across a wide set of issues. Someone who favors higher minimum wages is also likely to favor lower defense spending, affirmative action programs, higher capital-gains taxes, and so on. We can think of the continuum of ideological positions as ranging from the Left to the Right, or from very liberal to moderate to very conservative.

In contemporary America, this continuum is a perceived reality, a part of the common knowledge not only of the players on K Street and the Beltway but also of many

ordinary citizens. Consider these six senators: Edward Kennedy (D-MA), Robert Byrd (D-WV), Sam Nunn (D-GA), Alphonse D'Amato (R-NY), Strom Thurmond (R-SC), and Jesse Helms (R-NC). American politics buffs would generally agree that the order given for these six is their appropriate liberal/conservative ordering. Our method of estimating the continuum allows us to provide interval-level measurements of positions, not only for the contemporary period but also for all Congresses, beginning with the first, which convened in 1789.[8] Moreover, we will show that this structure is a predominant feature of nearly all roll call voting.

We can represent most roll calls as splits along the continuum—everyone to one side of a critical point will vote one way and everyone to the other side will vote the opposite way. Which side wins depends on where the critical point is located. If it is to the left of the median of legislator locations, the conservatives get a majority. Conversely, if it is to the right, the liberals win. As the critical point shifts, coalitions shift. Coalitions are therefore flexible but they must conform to splits along the continuum.

The fact that most roll calls are splits implies that we can represent most votes as mappings of the issues onto the continuum—examples would be the level of the minimum wage; the extent to which assault weapons should be banned; and whether prayer, silent or vocal, should be permitted in schools. Consequently, nearly everything becomes a straight liberal/conservative issue.

Nonetheless, several caveats should be noted:

1. *The simple ideological structure of Congress does not lead to a predictive model for specific issues.* True, in the short term, one can predict votes with accuracy. For example, in Poole and Rosenthal (1991a), we show how the final vote on the confirmation of Robert Bork as a Supreme Court justice could have been forecast from the early announcements of members of the Senate Judiciary Committee. Indeed, divisive voting on Supreme Court nominations, when it occurs, fits very nicely into the structure. But to obtain medium- and long-term forecasts, one would need to model how issues *map* onto the structure. This book will not help one to understand why, sometime before Bork was rejected, a perhaps equally conservative nominee, Antonin Scalia, was confirmed by a 99-to-0 vote. The book's basic message is more limited: If issues do come to a vote, a mapping will tend to occur and make votes consistent with the structure.

2. *Just one continuum of positions may not be enough.* We may need two or more sets of positions to describe roll call voting behavior. Each underlying continuum is termed a dimension. For most of American history, the structure is indeed one-dimensional; at times a second dimension is an essential part of the picture. A second continuum was most important during two periods when the race issue was central to American politics. The first time was during the debate over slavery in the 1830s and 1840s. (By the 1850s the slavery issue had become so intense that at first, roll call voting patterns were chaotic rather than structured; later, patterns were restructured, with the slavery issue becoming the primary dimension.) The second occasion was the civil-rights controversy of the 1940s, 1950s, and 1960s. From the late 1970s onward, roll call voting again became largely a matter of positioning on a single, liberal/conservative dimension.

In addition to the substantive issue of race, party loyalty—ranging from strong loyalty to one party in the two-party system to strong loyalty to the other—could provide a basis for a second continuum of positions. Indeed, legislators might be viewed, on

every vote, as trading off the implementation of their liberal/conservative preferences against the need to be loyal to their party coalition. In 1989, for example, Senate majority leader George Mitchell was able to defeat President Bush's proposed capital-gains tax cut by transforming a vote on an economic issue into a crucial test of party loyalty.

Undoubtedly, party loyalty is involved in our finding that a slightly better accounting of roll call votes is gained by using two dimensions, even in periods when the race issue is largely inactive. One's loyalty to the party, however, is hardly totally independent of one's liberal/conservative position. Indeed, for most of American history, parties have defined clusters on the first dimension—which, at some risk of oversimplification, basically represents conflict over economic redistribution. Nonetheless, the clusters are just clusters rather than permanently jelled voting blocs. Some degree of intraparty diversity has always been tolerated in Congress. In the contemporary Congress, there will be some issues, such as the 1981 tax bill, on which moderate Democrats vote with Republicans; and there will be others, such as the 1991 civil-rights bill, where moderate Republicans vote with Democrats. On those occasions when whips and leaders enforce party discipline, the roll call split will occur at the point on the first dimension that most clearly divides Democrats from Republicans.

3. *Our method for finding the dimensions is blind both to the party affiliation of the legislator and to the substance of the roll call vote.* The simple structure we find is an abstraction. The fact that a simple abstraction accounts for the data suggests that, although there is some flexibility involved in forming coalitions, coalition formation is constrained. Parties are obviously an important constraining influence.[9] We observe not only clustering of legislators by party but also clustering of roll calls by the vote's substance. Although these clusters enable us to interpret the results, the basic finding is that a simple abstract model accounts for the data.

4. *Voting may appear as splits along a continuum even on bills that represent packages dealing with a multitude of policy areas.* On these bills, substantial vote trading or vote buying may have taken place. For example, President Reagan obtained the defection of the "boll weevils" in exchange for subsidies to Louisiana sugar producers that ought to have been anathema to the free-market credo of his administration. Yet when all the deals are done, roll call voting respects the continuum. If votes are in fact bought on an issue, the buyers will seek legislators with a low price. These should be legislators who are indifferent, or nearly indifferent, on the issue—that is, legislators who would be close to the point that would separate Yea voters from Nays if there were no vote buying.[10] So vote buying is more likely to move the separating point than to create a chaotic pattern of voting. Similarly, even on issues in which a specific constituency interest could cause a legislator to deviate from his usual voting patterns, the legislator must be sure that the deviation is correctly perceived by constituents. Otherwise, the legislator's reputation may be better served by voting with people that the legislator usually votes with.

5. *Voting may not appear as splits along the continuum if legislators are behaving strategically with respect to the agenda represented by a sequence of amendments to a bill.* For example, conservatives might act strategically by voting with the liberals and against the moderates. Suppose a bill looked too liberal to be likely to win passage, and that an attempt was made to moderate the bill by introducing a "saving" amendment. If the amendment were passed, it, rather than the original bill, would be voted on against the status quo. Conservatives who would like to see the status quo preserved might cast a strategic vote *against* the amendment, even though they would prefer a more moderate bill to a very liberal one. But, as we explain in the next chapter, as long as legislators know each other's preferences and the agenda, both ends voting against the middle and other deviant voting patterns should not occur. In our example, the reason is that the liberals will not be fooled by the tactics of the conservatives. They, too, will act strategically and vote *for* the amendment, even though they truly prefer the original bill. Thus even when legislators act strategically, the roll call will still engender a split along the continuum.

6. *The structure will not be perfect.* As in almost any social-science endeavor, allowances must be made for errors. We allow for errors via a probabilistic model of voting. Legislators who are very close to the critical point on a roll call are almost as likely to vote Yea as they are to vote Nay, whereas legislators who are very far from the critical point are highly predictable. Thus, on a roll call that was close to a 50–50 vote in the Senate, we would be very surprised if Kennedy voted on the conservative side or Helms on the liberal side. Overall, the structure will be useful only if we can find critical points on each roll call that yield very few errors.

When we seek the critical point on each roll call, however, we do not aim to minimize the number of legislators incorrectly classified—those on the liberal side of the point who vote conservative, and vice versa. Rather, roughly speaking, we pick the point to minimize errors which are weighted by distance from the point. This seems natural; a vote by Ernest Hollings (D-SC) to support the Bork nomination was a less serious error than a Kennedy vote to confirm would have been. When we estimate positions of the legislators and the critical points (or cutting lines if there are two dimensions), we, in fact, find that voting errors are overwhelmingly concentrated among legislators whose positions are close to the point. This pattern of errors would not hold if, in contrast, both ends frequently voted against the middle, because extremists were either voting together for strategic reasons or simply expressing their distaste for the winning motion. This pattern of errors is an important element of support for our model of simple structure.

The Dynamics of the Structure of Roll Call Voting

Finding a liberal/conservative structure of roll call voting at any moment in time would be interesting, but our effort is more ambitious. We study the dynamics of the structure. Exploring dynamics will allow us to examine many interesting questions, including:

- Is the voting continuum stable? In the professional jargon of political science, do major "realignments" occur at critical times in American history—the collapse of Federalism and the advent of Jacksonian democracy; the Civil War; the 1890s; the Great Depression? In contrast to some earlier literature, we find remarkable stability since the Civil War, with the only perturbation being the emergence of the civil-rights continuum in the 1940s.
- Are individual senators and representatives stable in their positions on the continuum? Again, we find remarkable and increasing stability. At least in this cen-

tury, the relative order on the continuum barely changes. Members of Congress come to Washington with a staked-out position on the continuum, and then, largely "die with their ideological boots on." In particular, they do not alter their behavior and "shirk" just before they retire.

- Is the range of political conflict, the length of the continuum, changing? We find a gradual condensing of the continuum in the past century, a diminishing of conflict. During this same period, the amount of *intra*party diversity has remained roughly constant. The shortening of the continuum is due almost entirely to a reduction in the separation of the two parties. Since the mid-1970s, this long-term trend has reversed, and the parties have polarized. Their differences, albeit still slight in comparison to the situation at the turn of the century, have widened dramatically.

A Look at the Rest of the Book

The second chapter of this book presents the details of our dynamic model of the structure of roll call voting and discusses how we estimated the model. The rest of the book is concerned with substantive insights drawn from the estimation results.

In chapter 3, we first discuss the overall fit of the model—we find that a two-dimensional model, with a simple linear time trend in legislator positions, is the best fit to the roll call record. We then turn to a discussion of the issue content of the two dimensions over time. We end the chapter with a discussion of a variety of sets of supporting evidence for our finding of low dimensionality.

This finding of low dimensionality initially generated widespread disbelief. In 1985, our working paper, "The Unidimensional Congress," provoked both our political-science colleagues, many of whom have studied the intricate inner workings of the Hill, and our economics colleagues, many of whom have been struck by the complex web of economic interests that seek to influence legislation. Indeed, Van Doren (1990) has argued that roll call voting is only a small part of the congressional process, and that most issues are screened out without reaching the floor. Snyder (1992b) has formalized this argument in a model of committee gatekeeping. Koford (1989, 1991, 1994) presented a series of methodological arguments against the finding of low dimensionality. Our discussion of low dimensionality in chapter 3 replies to these arguments.[11]

In chapter 4, we discuss the stability of our estimated coordinates. We find that after the Civil War, legislators are very stable in their estimated coordinates. Spatial movement in our dynamic model was never extensive in relation to the span of the space, and it declined steadily after the Civil War, except for some slight upturns during the realignment of the 1890s and during the late 1930s. We find that changes in congressional voting patterns occur almost entirely through the process of replacement of retiring or defeated legislators. During the New Deal, these replacements among the northern Democrats had the effect of moving the Democratic party sharply to the Left. In effect, legislators elected during the early stages of the New Deal were willing to have the federal government become much more active in managing the economy. This was also true, to some extent, of Republicans who became more liberal from roughly the onset of the Depression until the middle of the Nixon presidency. The liberal trend among Republicans was countered, beginning with the second New Deal, by a conservative trend among southern Democrats. The result was a reduction in the polarization of the two parties. In the past two decades, however, new Republican cohorts have been increasingly conservative and southern Democrats increasingly liberal, leading to an increase in polarization.

In chapter 5, we cover political realignment by examining two episodes, both in the antebellum era, when the model breaks down entirely; and two other episodes, both involving race, when a second continuum must be brought into play. These episodes all center on major changes in the party system: the collapse of the Federalists; the collapse of the Whigs; and the split, in the mid-twentieth century, between northern and southern Democrats. We also indicate why we do not regard 1896 and 1932, two dates that are commonly thought of as denoting realignments, as dates that correspond to realignments in the structure of roll call voting.

Our discussion of issues continues in chapter 6. We argue that the presence of spatial voting is not inconsistent with voting on the basis of economic interests. Economic interests, although difficult to measure, arguably have an important influence. Even so, we show, through several case studies, that members of Congress often express these interests strategically by logrolling—that is, trading votes across issues. This logrolling can be implicit or explicit, but the essential point is that various interests are packaged. This packaging tends to produce only a few dimensions of voting. We examine five issues in detail: the interstate-commerce legislation of the 1870s and 1880s; the minimum wage; food stamps; occupational safety; and strip mining.

We also show in chapter 6 that economic interests cannot be viewed as those of a representative, or pivotal, voter in each constituency. Our simple analysis demonstrates that, even if economic interests were perfectly measured, pivotal-voter models would fail as models of congressional voting.

Although chapter 6 argues that simple models of voting on economic interests are poor alternatives to the spatial model of voting, the chapter indicates that economic interests can enter into the process that maps issues into a low-dimensional spatial model. As a result, the mapping between quantitative issues and the space can shift in time. We illustrate this point by examining minimum-wage legislation, and legislation on inspection of firms by the Occupational Safety and Health Administration (OSHA).

In chapter 7, we study amendment voting and agendas. We examine the rare episodes of strategic voting that have been noted in the literature and study the performance of our model in these cases.

Chapter 8 ties our analysis of roll call voting to the ratings of members of Congress that are published by interest groups such as the Americans for Democratic Action (ADA), the Chamber of Commerce of the United States (CCUS), and the National Farmers Organization (NFO). We treat the interest groups as voters and use their "votes" to place the House and Senate in a common framework. The results confirm our earlier analysis. But the analysis also reveals a substantive message: The interest groups turn out to be more polarized than the legislators. Liberal and conservative groups are pulling at both ends, contributing to the polarization of politicians.

In chapter 9, we explore the representativeness of congressional committees. Our major finding is that, particularly before 1947, committees are seen as representative of the full chamber. Few committees are dominated by extreme conservatives or extreme liberals. But the evidence also shows that committees are likely to be informa-

tion specialists in their oversight areas and to have common interests in these areas. Committee members vote together more often than would be expected from their party positions and liberal/conservative positions.

Chapter 10 looks at turnout. In recent years, abstention, particularly after paired and announced votes are considered, is not an important aspect of voting in Congress. Historically, however, participation rates were far lower. The global increase in turnout rates reflects better transportation and better health. At all times, abstention has also reflected preferences and strategy. Indifferent voters near the critical dividing points on roll calls tend to abstain. In the modern House, voters on the majority side of a roll call tend to be more silent than those on the minority side.

Finding a simple structure that accounts for roll call voting is, from a scientific viewpoint, merely a beginning. Future research will need to ask what produces a stable structure and how specific issues map into the structure. We conclude, therefore, in chapter 11, with a summary directed at focusing future research on roll call voting and tying the analysis of roll call voting to the study of the larger legislative process. This final chapter also contains an epilogue which brings our analysis up-to-date.

2
The Spatial Model and Congressional Voting

The Constraint Hypothesis

Congress both considers a wide variety of substantive issues and represents the diverse constituencies of 435 congressional districts and 50 states. If we succeed in accounting for individual roll call decisions with a parsimonious model, it follows that considerable constraint operates across issues.[1]

The presence of constraint is evident in the everyday language used to discuss politics. Expressions such as "liberal," "moderate," and "conservative" are part of the common language used to denote the political orientation of a member of Congress; such labels are useful because they furnish a rough guide to the positions a politician is likely to take on a wide variety of issues. A contemporary liberal, for example, is likely to support an increase in the minimum wage; oppose a reduction in the capital-gains tax; oppose the use of military force abroad; oppose further funds for Star Wars; support mandatory affirmative action programs; and support federal funding of health care and day care programs. Indeed, just knowing that a politician opposes increasing the minimum wage is enough information to predict, with a fair degree of reliability, the politician's views on many seemingly unrelated issues.

To illustrate how constraint relates to roll call voting, consider some well-known members of the 101st Senate. Practitioners and observers of American politics will readily agree that John Kerry (D-MA) is an extreme liberal; Albert Gore (D-TN) is a liberal near the center of his party; Sam Nunn (D-GA) is a moderate; Robert Dole (R-KS) is a conservative near the center of his party; and Jesse Helms (R-NC) is an extreme conservative. In other words, we can line up these gentlemen, from left to right, as below.

Liberal Kerry Gore Nunn Dole Helms **Conservative**

If roll call voting is constrained to satisfy a single liberal/conservative dimension, we ought to observe only the following voting patterns:

Unanimous agreement
Kerry against everyone else
Kerry and Gore against Nunn, Dole, and Helms
Kerry, Gore, and Nunn against Dole and Helms
Helms against everyone else

Other possible patterns are ruled out. For example, Kerry and Helms cannot combine against the middle. No one in Washington expects to see this happen, except in very unusual circumstances. The cartoon reproduced as figure 2.1 is amusing because it depicts a rare agreement. To see if roll call voting fits the expected pattern, we can look at every roll call to see if one of the allowable voting patterns holds. For example, of the five senators cited above, only Kerry supported the Leahy amendment on September 26, 1989, which would have cut funding for the B-2 bomber; only Kerry and Gore opposed the Robb amendment, on July 20, 1989, giving the president authority to pursue funding for non-Communist forces in Cambodia; only Dole and Helms voted to confirm John Tower as secretary of defense on March 9, 1989; and everyone else rejected Helms's May 2, 1989, amendment to remove funding for the commission established for Martin Luther King, Jr., day. Of course, all five voted together on noncontroversial measures, such as confirming James Baker as secretary of state. Omitting the uninteresting unanimous vote, we can then simultaneously order these roll calls and the senators as follows:

Kerry *B-2 bomber* Gore *Cambodia* Nunn *Tower* Dole *MLK, Jr.* Helms

The basic implication of the constraint hypothesis is that all issues tend to be mapped onto a fixed ordering, or placement, of legislators.[2] This fixed ordering can be thought of as the underlying, "basic" or "predictive," dimension.[3]

In this book, we represent the positions of legislators not just by a simple ordering but by an interval scale, like the Fahrenheit temperature scale. Thus each legislator has a position that can be described by a number. The number represents the legislator's ideal point—his preferred level of conservatism that he would like to see in any issue that is voted on. Moreover, the legislator's preferences along the dimension are (for methodological reasons that we discuss in appendix A) assumed to be single-peaked and symmetric, as illustrated by figure 2.2. *Single-peaked* means

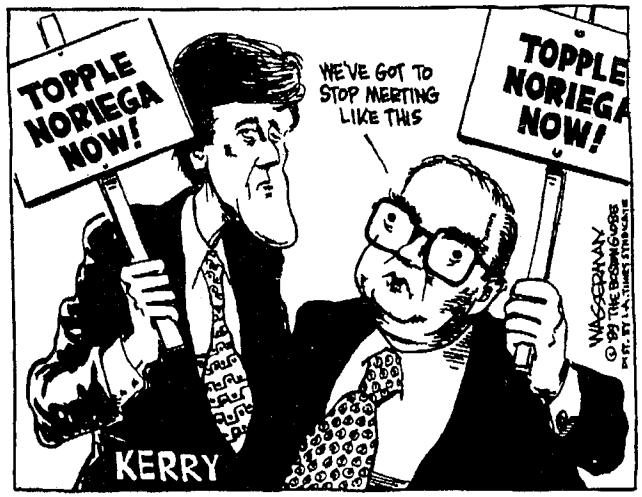

Figure 2.1. An extreme liberal, John Kerry (D-MA), and an extreme conservative, Jesse Helms (R-NC), have a rare agreement. Copyright 1989, Boston Globe; distributed by Los Angeles Times Syndicate. Reprinted by permission.

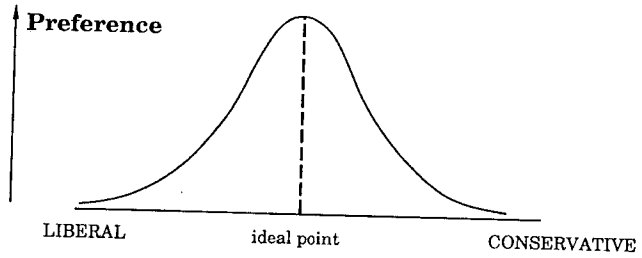

Figure 2.2. Single-peaked preference on the underlying dimension. The ideal point represents the point of highest preference. Positions more liberal or more conservative than the ideal point are less preferred.

that as the policy moves further away from the ideal point in either direction—either more liberal or more conservative—the legislator is worse off. *Symmetric* means that the legislator is indifferent between two policies that are equidistant from the ideal point.

To order an issue along the underlying dimension as well, we need a mapping between policy outcomes and the underlying dimension. To take an example drawn from the actual roll call votes that we analyze in chapter 6, consider legislation specifying which firms will be subject to inspection by the Occupational Safety and Health Administration (OSHA). Firms with more than a legislated number of employees will be subject to inspection; smaller firms will be exempt. Presumably, the liberal pole (here defined as maximum government intervention in the market, with all firms being inspected) of the mapping is anchored by zero employees—all firms are inspected—whereas the conservative end (no inspections) is anchored by firms with an unlimited number of employees. Figure 2.3 shows a mapping and the hypothetical preferences of the five senators cited.

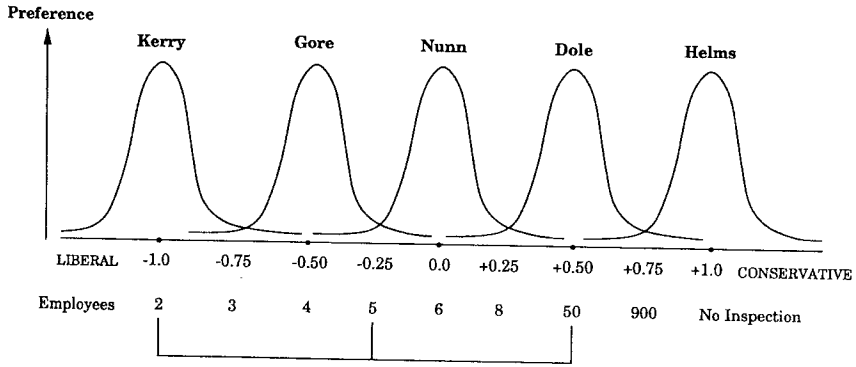

Figure 2.3. Five senators and the mapping of the OSHA inspection issue. All five have single-peaked preferences. The more conservative senators desire higher firm-size limits on inspection. The midpoint between the mapped position of two policies determines voting behavior. Senators with ideal points to the left of the midpoint vote for the lower inspection level; those to the right vote for the higher level.

We have created figure 2.3 so that the legislators are evenly placed on the underlying dimension. Kerry, the most liberal, is at −1; Gore is at −0.5; Nunn at 0; Dole at +0.5; and Helms at +1. The hypothetical mapping used in the figure shows that the most preferred firm-size levels of inspection for the five senators are Kerry, 2 employees; Gore, 4; Nunn, 6; Dole, 50; and Helms, no inspections. For inspection levels higher than his ideal point, each senator is worse off as the inspection level is increased. Similarly, a senator is worse off as an inspection level is decreased below his ideal point. Note that the mapping need not be linear. In our hypothetical mapping, the firm-size difference between 2 and 4 employees is just as important as the difference between 6 and 50.

In this book, we assume that for every roll call vote, legislators vote as if they were voting *sincerely* on a mapping of the Yea and Nay outcomes. That is, a legislator votes for the alternative that is closer to his ideal point.[4] There is a simple rule for deciding which is closer. Just average the mapped positions of the Yea and Nay outcomes. The average is the roll call midpoint. The midpoint represents the critical point discussed previously. If the Yea outcome is to the left of the midpoint, the Yea voters are all the legislators with ideal points to the left of the midpoint. The other legislators vote Nay.

To illustrate, suppose a committee reported a bill that permitted inspection of firms with at least 50 employees, Dole's ideal point; and suppose Kerry proposed his ideal point, 2 employees, as an amendment. The mapped position of the bill is 0.5; of the amendment, −1. The midpoint is $(0.5 + (-1))/2 = -0.25$, so only Kerry and Gore support the amendment. (See figure 2.3.)

If the status quo were no inspection, Helms would be expected to oppose any departure from the status quo, but all the other senators might support some form of an inspection program. If the inspection bill were voted on with an "open" rule (where all amendments are freely entertained), the outcome would be expected to be Nunn's ideal point of 6; 6 will beat any other level in a pairwise vote.[5]

If, on the other hand, someone could force a take it-or-leave-it, "closed" vote on a proposal against the status quo, an inspection level lower than a firm size of 6 could be passed.[6] From figure 2.3, we see that, since Nunn prefers Gore's ideal point of 4 employees to no inspection, if Gore could force a take-it-or-leave-it vote, an inspection level of 4 employees would win by a 3–2 vote, with Kerry, Gore, and Nunn prevailing over Dole and Helms. The mapping midpoint of 4 versus no inspection is +0.25.

For the constraint hypothesis to hold, one must be able to map most issues onto the underlying dimension. Thus, if we consider the minimum-wage rate, the capital-gains tax rate, and OSHA as issues, the mapped ideal points might be similar to the following diagram:

		Kerry	Gore	Nunn	Dole	Helms
Mapped Ideal Points	OSHA	2	4	6	50	No inspection
	Minimum wage	$8	$6	$5	$4	$0
	Capital-gains tax	60%	33%	20%	10%	0%

Of course, not all issues are as readily quantified as OSHA inspections, the minimum wage, and the capital-gains tax. For example, the Cambodia funding issue from 1989 might involve a combination of policies. Which of the contending factions

should receive support? Should they receive just humanitarian aid or military aid as well? What types of weapons should be delivered? Indeed, our quantitative examples must be similarly qualified. Minimum-wage bills, for example, also specify which occupations are covered, whether teenagers are covered, and so on. Even for issues with complex alternatives, however, we maintain the constraint hypothesis: The roll call alternatives map onto the underlying dimension.

Why Constraint May Operate in the Presence of Strategic Behavior

It would be naive, however, to expect that members of Congress will always vote sincerely. One possibility is that they logroll; that is, members trade votes over issues. Even if preferences all mapped onto a single dimension, vote trading might result in voting patterns that contradicted a unidimensional model.

If we voted on the minimum wage and a capital-gains tax, for example, sincere voting, with an open agenda, would lead to Nunn's ideal point of a $5 minimum wage and a 20 percent tax rate. But what if Helms cared a great deal about the capital-gains tax and very little about the minimum wage, whereas Kerry cared a great deal about the minimum wage and little about taxes? Then Helms might agree to support a $6 minimum wage in return for Kerry's supporting a 10% capital-gains tax. The minimum-wage bill would be passed with the votes of Kerry, Gore, and Helms, and the tax bill would pass with the votes of Kerry, Dole, and Helms.[7] Although a Kerry-Helms trade is possible, such a trade would be highly unexpected and therefore highly publicized. Even if the trade were beneficial to constituents, the constituents might not process the relatively complex information correctly. If constituents are mainly sensitive to consistent voting patterns along the predictive dimension, Kerry and Helms may find such trades ill-advised.

More likely trades simply involve changing the mapping. What if the Democratic leadership promised Nunn that a committee would act favorably on another matter of interest to Nunn, if he would oppose any lowering of the capital-gains tax from a status quo rate of 28 percent? Then Nunn would vote with Kerry and Gore on the issue (rather than with Dole and Helms), but this strategic vote would still be consistent with a unidimensional voting pattern.

Moreover, if legislators, perhaps as a result of being concerned about establishing a reputation for consistency, seek to sustain a pattern of unidimensional voting, vote trading may allow observations of roll call votes to appear as if they were preferences mapped onto an underlying dimension even when true preferences have a far more complex pattern. Consider the following hypothetical scrambling of the original preferences:

Issue with Ideal Points	Kerry	Gore	Nunn	Dole	Helms
OSHA	6	4	2	50	No inspection
Minimum wage	$4	$6	$8	$0	$5
Capital-gains tax	0%	33%	20%	10%	60%

Say the status quo on OSHA was firms with 50 employees. Then with an open agenda, 6 employees would prevail. Kerry, Gore, and Nunn would prevail over Helms

and Dole under sincere voting. If $3.35 were the status quo on the minimum wage, $5 would prevail, with only Dole and Kerry being opposed. If the capital-gains tax were 28 percent, 20 percent would prevail, with Gore and Helms in the minority.

Say, too, that Helms cared nearly exclusively about capital gains, Nunn about the minimum wage, and Dole about OSHA inspections. The three senators make a trade: They agree to enact, for each issue, the ideal point of the senator who cares. Kerry and Gore continue to vote sincerely. So the outcomes are 50 employees on OSHA, an $8 minimum wage, and a 60 percent capital-gains tax. The parties to the deal—Nunn, Dole, and Helms—would oppose any attempts by Kerry or Gore to have tighter OSHA enforcement. Only Kerry would vote against a proposal to move the minimum wage from $3.35 to $8, and only Kerry and Gore would oppose the attempt to raise the capital-gains tax. So any votes would still be consistent with a mapping onto an underlying dimension in which the ordering of legislators was Kerry-Gore-Nunn-Dole-Helms. In sum, logrolling does not necessarily render the notion of constraint inoperative and may in fact contribute to a strengthening of the operation of constraint. Logrolling is one form of *strategic* voting. In seeking to further their own interests or those of their constituents, strategic voters may not vote for the closer of the two alternatives on a roll call. Strategic behavior may also occur when voting on a bill is preceded by voting on one or more amendments. Strategic voting on amendments, however, does not necessarily invalidate the model's hypothesis that all votes can be treated as sincere votes. We illustrate this point with House action on the Common Situs Picketing Bill in 1977.[8]

Common Situs was a pro-labor bill which would allow a single union to shut down an entire construction site or other business operation. As it appeared likely that the strongly pro-labor bill reported out of committee would fail, Representative Ronald Sarasin introduced a "saving" amendment. The Sarasin amendment was designed to temper provisions of the bill, making it more appealing to moderates. That is, denoting the mapped location of the bill as B, the amendment as A, and the status quo as Q, the true liberal-conservative ordering of the outcomes was B-A-Q. Since A is closer than B to Q, A might succeed even if B were to fail.

House rules forced, first, a vote to determine a winner between the committee bill and the amendment. The winner of that vote would face the status quo in a final vote. *Suppose sincere voting were to result in the amendment being passed in the initial vote.* Then liberal voters to the left of (B +A)/2, the A-versus-B midpoint, would have voted first against the amendment and then for the amended bill; those more moderate voters between (B +A)/2 and (A +Q)/2 would have voted for the amendment and for the amended bill; and the most conservative voters, those to the right of (A +Q)/2, would have voted for the amendment but against the amended bill.

With such an agenda, however, sincere voting clearly doesn't make sense. Suppose on the final vote, A would defeat Q but B would lose to Q; then if A wins the initial vote, the final outcome is A, whereas if B wins, the final outcome is Q. Consequently, strategic (sophisticated) voters view the initial vote as one involving A and Q. Conservative voters, then, should vote against the amendment, because the status quo would be more likely to prevail if the final vote pitted it against the more extreme committee bill. So they should vote Nay on the initial vote and Nay on the final vote. Similarly, liberals should support the amendment if they believe the committee bill is doomed to failure; so they should vote Yea on both votes. Moderates can be of two types. The more liberal type likes the amended bill best, the committee bill second best, and the status quo least. People of this bent clearly should vote Yea on both votes. The less liberal type also likes the amended bill best but places the status quo second. This type should vote Yea on the initial vote on the amendment (A) versus the committee bill (B), and Yea on a final vote between the amended bill and the status quo. On the vote between the bill and the amendment, then, we should expect to see liberals and all moderates—that is, all legislators to the left of (A + Q)/2—voting Yea and all legislators to their right voting Nay. On the final vote, between the amended bill and the status quo, we should also expect to see sincere voting with a midpoint of (A + Q)/2.

Whether voters are sincere or strategic, we thus expect to see both votes split perfectly on the underlying dimension. The difference is that on the initial vote, with sincere voting, the bill appears in its true location as the liberal outcome (B), whereas with strategic voting, the bill appears as its strategic equivalent, the conservative outcome (Q). (The amendment [A] exhibits, in either sincere or strategic voting, its true location on both votes; the status quo [Q] exhibits its true location on the final vote.)

The actual roll call voting patterns on the Common Situs Picketing Bill will, even when voting is strategic, provide useful information about the legislator locations because we will observe liberal/conservative splits. A strategic vote means only that we have to do some reinterpretation of alternatives. On the initial vote, the legislators, instead of voting sincerely on A versus B, are voting strategically. But voting strategically means acting as if one is voting sincerely on A versus Q. This insight allows us to learn the true location of A.[9] If the amendment passes, both the initial and the final vote would be votes of A versus Q; so we would expect an identical vote in support of A on both votes.

Consequently, neither logrolling nor strategic voting on agendas necessarily invalidates our use of the simple spatial model. We consider logrolling in chapter 6, and amendment voting, including the Common Situs Bill votes, in chapter 7.

Multidimensionality

Our examples of roll call voting, whether sincere, logrolled, or strategic votes over agendas, have all assumed a single underlying dimension. Political discourse often distinguishes between economic and social conservatives. An economic conservative is generally thought of as believing that government should not intervene in private economic transactions with redistributive taxation; in-kind transfer programs; and regulation of wages, working conditions, and externalities such as air and water pollution. On the other hand, social conservatives believe that government should intervene to regulate personal behavior in matters of freedom of speech and association; sexual and reproductive behavior; gambling; consumption of drugs and alcohol; and (in earlier times) enslavement or segregation of nonwhites.

Of course, economic and social conservatism might be highly correlated. True libertarians, those who want to minimize all forms of government regulation, may be hard to find outside the Economics Department of the University of Chicago. On the other hand, economic liberals who are social conservatives, such as some blue-collar

Roman Catholics, may be more numerous. Thus, more than one underlying dimension may be required to describe voting behavior.

When there are in fact two dimensions, we still model individual legislator preferences as declining with distance from an ideal point. Because preferences in the model are a function of (Euclidean) distance, political scientists refer to our analysis as a *spatial model.* The unidimensional concept of symmetric preference is generalized to include the concept of circular indifference contours. For any circle centered on his ideal point, the legislator is indifferent concerning policies whose mappings are points on the circle. The larger the circle, the greater the distance from the ideal point, and so the less desirable is any policy that is mapped onto the circle.

A set of indifference contours is illustrated, for our hypothetical five-person Senate, in figure 2.4. Abstractly, the space can be thought of as having a horizontal dimension and a vertical dimension. In the figure, the OSHA firm-inspection level is assumed to be a horizontal-dimension issue. Its earlier mapping is preserved. Appropriating funds for enforcement of the Voting Rights Act is mapped as an issue on the vertical dimension.[10] Other issues may be neither strictly horizontal nor strictly vertical. We illustrate this in the figure by having penalties for nonregistrants for the military draft mapped as an issue at an angle of 45° to the horizontal axis.

The concept of the midpoint in one dimension generalizes to a cutting line in two dimensions. The cutting line is the perpendicular bisector of the line joining the two alternatives, and separates the Yea and Nay voters. Figure 2.5 shows a cutting line for a vote between punishments of 6 months and 10 years. The three-dimensional analogs

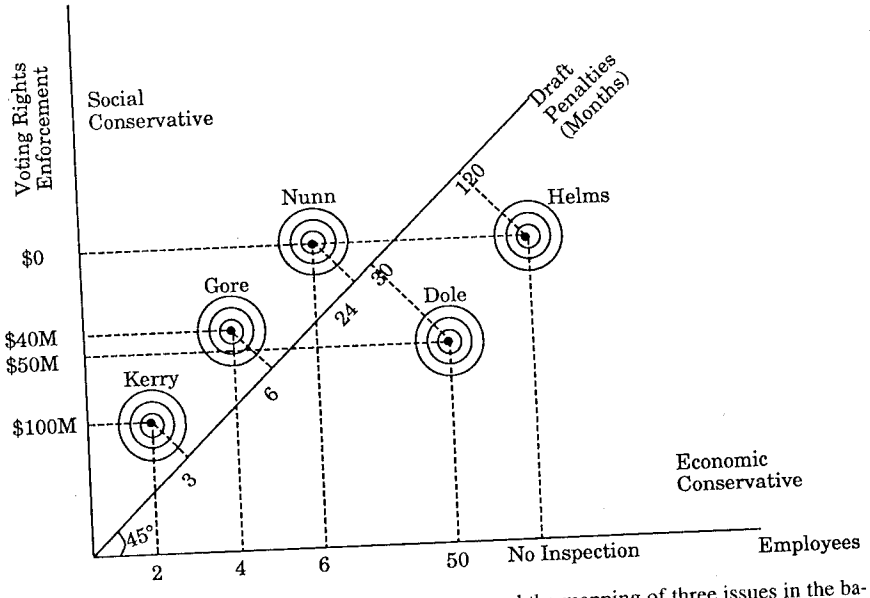

Figure 2.4. Two-dimensional indifference contours and the mapping of three issues in the basic space. Lines from each senator show ideal points on the issues. The circular indifference contours indicate that preference is decreasing in distance from the ideal point.

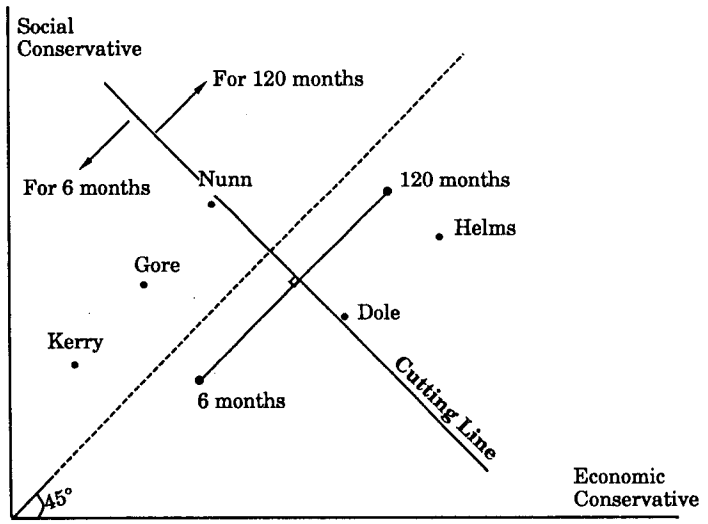

Figure 2.5. Cutting line on a roll call for punishment for draft evasion. The outcomes are on a line parallel to the 45° line. The cutting line is the perpendicular bisector of the line joining the outcomes. Positions on the draft issue combine aspects of economic conservatism and social conservatism.

of circular indifference contours and cutting lines are spherical indifference surfaces and separating planes.

Just how many dimensions are needed to describe the structure of roll call voting is an empirical question. The analysis we present shows a structure that is largely unidimensional, with a second dimension having a smaller, although sometimes important, influence. As we show in chapter 3, virtually no substantive concern is served by going beyond two dimensions.

As with one dimension, a pattern of voting constrained to a low-dimensional mapping can be consistent with strategic behavior. To see this, we can recall the Common Situs Picketing Bill example. In this scenario, a moderate saving amendment (A) defeats a more liberal committee bill (B) on an initial vote and then is matched against the status quo (Q). With a single dimension, only four strict preference orderings are possible: B > A > Q (B is preferred to A, which is preferred to Q); A > B > Q; A > Q > B; and Q > A > B. But, unless the three options are on a line in two dimensions, two dimensions will produce the other two possibilities, B > Q > A and Q > B > A. This is shown in figure 2.6. Although the saving amendment is closer to Q than B is, it is off the line joining B and Q. The three cutting lines mark off six regions of the space that correspond to the six types of legislator preferences. Below each type, we give (assuming A wins the initial vote) first its sincere voting pattern and then its strategic pattern. If, in a final vote, Q loses to A but beats B, in strategic voting, the initial B-versus-A vote is again really an A-versus-Q vote. Even in strategic voting, voters are split by a cutting line. This split provides information about the true locations of the A and Q outcomes.

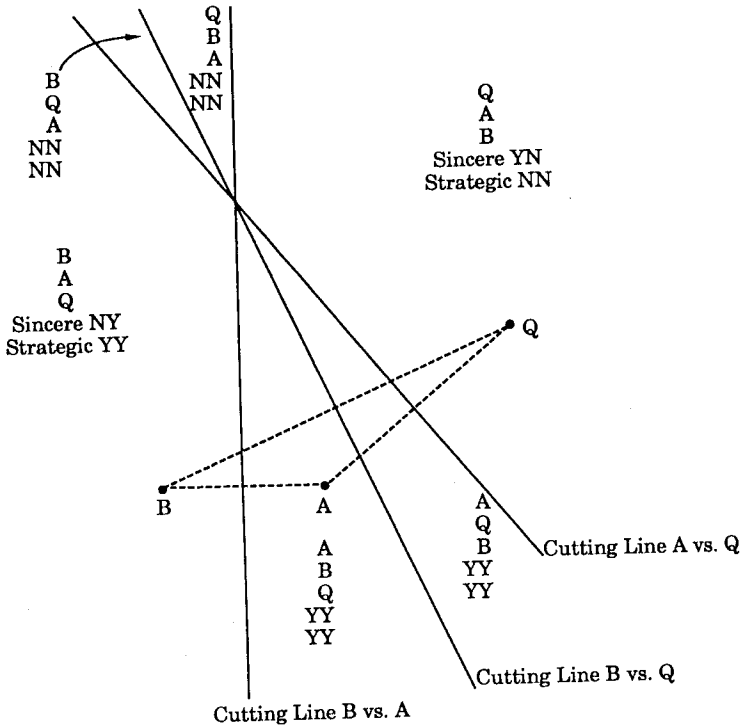

Figure 2.6. Sincere and strategic voting in two dimensions. With three alternatives, there are six types of strict preferences in two dimensions. The three cutting lines between the three pairs of alternatives determine six wedges or pie slices. Each slice corresponds to one of the preference types. If the status quo (Q) defeats the bill (B) in the final vote but loses to the amended bill, legislators who have the preferences QAB and BAQ vote differently on the initial vote between A and B if they are strategic than if they are sincere.

Even with two dimensions, however, about 15 percent of the individual votes fail to fit a simple spatial structure. This is illustrated in figure 2.7, which shows votes on the Panama Canal Treaty and on the National Science Foundation (NSF) budget. The ideal points of northern Democrats are marked by D tokens; of southern Democrats, by S; and of Republicans, by R. Some locations are so close that there is overlapping, but a particular letter always overlaps the same letter. The top panels show all the senator locations and the cutting line. The bottom panels show that there are some errors—Yea voters on the Nay side of the cutting line, and vice versa. Nevertheless, the errors tend to be close to the cutting line.

A probabilistic model accounts for this pattern. The closer a legislator is to an alternative, the more likely he is to vote for it. At one extreme, if one alternative is at the legislator's ideal point and the other alternative is very far from it, he has a probability close to one of voting for the closer alternative. At the other extreme, if the alternatives are equidistant from him, the legislator acts as if he based his decision on a coin toss. Since legislators close to the cutting line are close to equidistant from the two alternatives, their actual votes are more likely to be errors than are the votes of legislators with ideal points far from the cutting line.

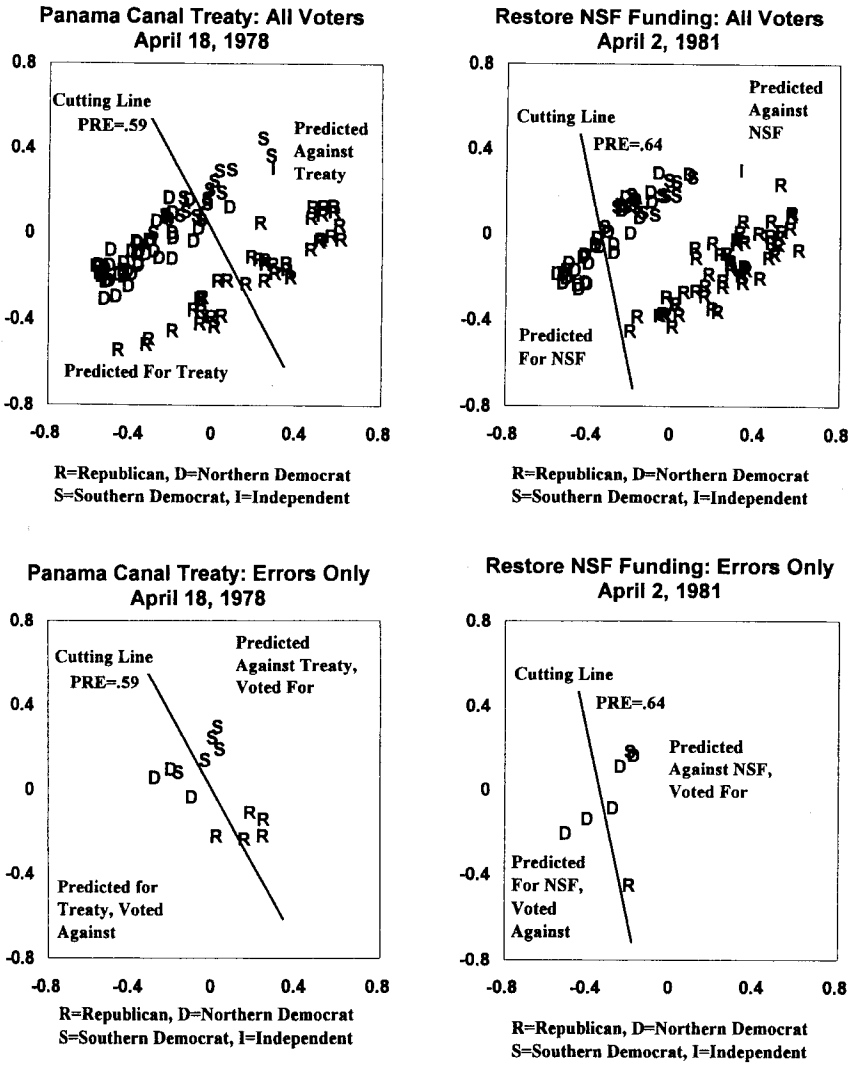

Figure 2.7. Ideal points, cutting lines, and errors on two roll calls. Each token corresponds to a senator's ideal point. Errors are concentrated near the cutting lines. The ideal points and cutting lines are the estimates of the D-NOMINATE model, with a linear trend in legislator positions. (The "Independent" is Harry Byrd, Jr. [VA].)

Estimation

Our discussion has concerned a set of examples in which all the spatial locations were known. But our task is to recover the locations of some 11,000 legislators and 70,000 roll calls from the 11,000,000 recorded individual decisions of Congresses stretching from 1789 to 1985.[11] How do we do this?

Minimizing Classification Errors in One Dimension

If we had but a single dimension with errorless voting, we could easily recover the order of the legislators and the roll call midpoints. We could use a brute-force technique whereby we tried all possible orderings until we found the right one. But even for a single House, where there are 435 men and women who can be voting on more than 1,000 items, brute force will abuse even the mightiest of computers. Fortunately, a simple iterative procedure works quite well and, in practice, needs only a few steps to converge to an ordering that minimizes classification error. This technique resembles arranging a deck of cards by first sorting the cards by suit and then sorting by order within the suit. To illustrate, say we started with the following highly erroneous ordering of the previously cited senators,

Nunn Helms Gore Kerry Dole

and we observed only that the splits were Kerry against the others on the B-2; Kerry and Gore against the other three on Cambodia; Dole and Helms against the other three on Tower; and Helms against the others on MLK, Jr. The (nonunique) placement of roll call midpoints below minimizes classification errors:

Nunn Helms *Cambodia Tower MLK, Jr.* Gore *B-2* Kerry Dole

Note that this placement of the roll call midpoints minimizes classification errors only if the the substantively liberal outcome on each issue is supported by senators placed at the right end of the order. Thus Kerry and Dole are both predicted to oppose further funds for the B-2 bomber. The placements of the roll calls lead to five classification errors. Dole is incorrectly classified on B-2, Cambodia, and Tower; and Nunn is incorrect on Tower and MLK, Jr.

After this first step, the next step is to see if, holding the midpoints fixed, we can move the senators, one by one, and reduce the classification errors. The following rearrangement eliminates all but two errors, Dole on MLK, Jr. and Nunn on Cambodia:

Helms Dole *Cambodia Tower MLK, Jr.* Nunn Gore *B-2* Kerry

But after this step, we can hold the legislators constant and rearrange the midpoints and eliminate all the errors:

Helms *MLK, Jr.* Dole *Tower* Nunn *Cambodia* Gore *B-2* Kerry

This order is correct; it is just the mirror image of the commonsense order assumed in the example given earlier. Our recovery example was deliberately chosen to emphasize that what is at the left and right is just a convention. An ordering and its mirror image both contain the same information.[12]

Of course, actual data will contain errors, but we could nonetheless apply the classification-error-minimization procedure to the data. Doing so offers an important advantage. The sorting process is, in statisticians' lingo, a robust way of finding out where the senators and cutting lines are located. Thus, the recovery based on optimal classification isn't likely to be sensitive to the process generating the errors; that is, to whatever causes roll call voting to be a less than perfect fit to the spatial model.

Unfortunately, optimal classification also has a couple of disadvantages. First, it gives us no information about the locations of the alternatives. Only the midpoint is relevant to the classification. Any pair of outcomes that have the same midpoint make the same classification predictions. So we can't work back from classifications to identify roll call outcomes. Second, classification is impractical in a setting of more than one dimension.

NOMINATE

Because of these disadvantages, we developed an alternative procedure, which we have named NOMINATE; this stands for *NOMINA*l *T*hree-step *E*stimation. This procedure can be used with relative ease in multidimensional settings. It involves a specific probabilistic model, which allows us to use the pattern of errors to recover the outcome coordinates. Think first of Yea and Nay outcomes that are very close to each other. In this case, most legislators will be nearly indifferent and will be voting with probabilities close to 0.5. Then consider a second roll call with the same cutting line, but with Yea and Nay outcomes that are very far apart. In this case, preferences will be sharper and more probabilities will be close to 1 or 0. Fewer errors should occur.

It is evident, paradoxically, that we need errors to recover the roll call outcomes. We oversimplified earlier when we said we could recover the outcome locations in the case of errorless strategic voting. In fact, we could recover only the cutting lines.[13] Without errors, the midpoint in one dimension or the cutting line in two dimensions or the separating hyperplane in higher dimensions is nicely tied down and identified by the basic liberal/conservative split on a roll call in one dimension, or, more generally, by the split of the Euclidean space into Yea and Nay camps. In contrast, the Yea and Nay locations are revealed only by the pattern of errors.

The use of errors to identify outcome locations has two potentially severe problems. First, our model includes a signal-to-noise ratio. This parameter measures how strong the spatial component of the voting decision is in relation to whatever generates errors. We assume the signal-to-noise ratio is constant across all of American history. (Attempts at relaxing that assumption did not make important improvements in our ability to account for the data.) Although some roll calls are almost certainly noisier than others, the data do not provide enough information to identify both the noise level and how far the outcomes are from the cutting line. Thus our outcome estimates will be much "noisier" than our estimates of legislator positions or cutting lines. We

do have simulation evidence (discussed in appendix A) that shows that our recovery of legislator positions and cutting lines is quite robust and can sort out the mix of signal-to-noise ratios across roll calls. (Variations in noise across legislators are a smaller problem. A legislator is analogous to a roll call midpoint. Unless the legislator's voting pattern is extremely noisy, his position will be pinned down by his overall pattern of voting, even when there is little or no error.)[14]

Second, to recover the outcome coordinates, we need to assume a specific form of preferences, not just the ordinal assumption that preference is decreasing in distance. Basically, preference decreases, as shown in figures 2.2 and 2.3. (The mathematical specification appears in appendix A.) Not all specifications that decrease in distance will do the trick. When preferences are quadratic in distance—a form that often facilitates theoretical modeling—the outcomes cannot be recovered, even when errors are present. The form assumed in NOMINATE is exponential, or bell-shaped, utility (see figure 2.2). This form is perhaps a politically realistic one in that voter preferences are not very sensitive to small departures from the ideal point, shift sharply for intermediate changes in outcome locations, but then show little distinction between outcomes that are very far from the ideal point.

The procedure we use to recover the space works in an alternating fashion, directly analogous to our illustration of ordinal sorting. We start with an initial configuration of legislators and a signal-to-noise ratio. We then sequentially process the roll calls, estimating the outcome coordinates. We then reestimate the signal-to-noise ratio, keeping all spatial coordinates fixed. And then we sequentially process the legislators, keeping the roll call coordinates and the signal-to-noise ratio fixed. As we move the parameters of the model, we don't try to minimize classification errors. Instead, we try to maximize the probabilities the model assigns to the observed votes. That is, if a senator voted Yea on a roll call, we would like the corresponding ideal point to be as close as possible to the Yea outcome and as far as possible from the Nay outcome. Of course, we have to trade off the senator's probabilities on this particular roll call against her probabilities on all the other roll calls. We continue the described iterations until we find that the locations have stabilized. A global iteration of the model is a passage through the roll calls, the signal-to-noise ratio, and legislator steps. Stability occurs after a sequence of three or four of the global iterations.

The results of the estimation are likely to be quite accurate with respect to legislators' ideal points and roll call cutpoints or cutting lines. A typical legislator in American history cast 900 votes during his career (and many more in the modern period)—900 is a rough but reliable indication of the effective number of observations used to estimate the legislator locations. The roll call cutpoints and cutting lines are also pinned down sharply, particularly in the modern House, where the effective number of observations is close to 435 on most roll calls. Less accurate estimates pertain to earlier periods, particularly to the first several Senates where there were as few as 26 senators.

As mentioned above, our estimates of roll call outcomes are much less reliable than the estimates of legislator locations or roll call cuts. Consequently, this book contains no discussion of the outcomes for individual roll calls. The average location of sets of outcomes, such as all winning outcomes in a House, will, by an appeal to the law of large numbers, be quite accurately estimated.[15] A discussion of winning outcomes is contained in chapter 4.

Legislators' Positions over Time

With respect to legislators, we need to ask not only what a legislator's position is at any point in time, but how her position changes over time. A strong hypothesis is that the legislator has a constant position over time. Rather than adapt to changing constituent preferences, congressmen enter a house and stay put until they die with their ideological boots on. If this hypothesis is maintained, we can then, using the fact that periods of service overlap, place all the legislators in a house of Congress in a common space for all of American history. In fact, we can estimate a common space as long as there is a sufficient degree of constraint on how legislators are allowed to move. We impose such a constraint by limiting their movement to polynomial functions of time. The simplest function assumes that legislators maintain constant positions throughout their congressional careers. The next simplest is a linear trend, which allows a legislator to become, in one dimension, either more conservative or more liberal during his career. With linear trends, legislators can thus never do ideological flip-flops; switching back and forth is possible only with quadratic and higher polynomials. Empirically, however, we find that essentially all movement is captured by a simple linear movement, as illustrated in figure 2.8. Our dynamic procedure is named D-NOMINATE.

Estimating the dynamic model is very similar to estimating a static model. The only real difference is that, when a legislator's position is estimated, the coefficients of the time polynomial, as well as the constant, must be estimated. Of course, our dynamic estimation for all of congressional history used a very large data base that could only

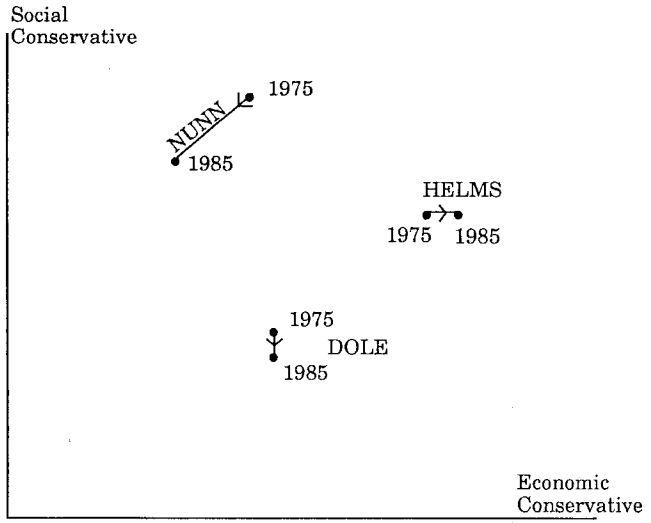

Figure 2.8. Linear movement of senators. In the linear-trend model, senators' ideal points move on lines throughout their careers. Some senators, such as Nunn, move more than other senators, such as Dole. Typically, they move very little, relative to the space, as illustrated by the figure.

be manipulated with a supercomputer. Estimating a two-dimensional model with a linear trend for the House of Representatives required about three hours of CPU time on a Cyber 205 supercomputer.

Summary of the Model and Estimation Methods

The technically inclined reader will find the details of our model and the estimation procedure in appendix A. To summarize: First, we have adopted a simple spatial model with probabilistic voting. Second, assuming this model is a correct model of actual behavior, we have developed a method for recovering the positions of legislator and roll call outcomes solely from observed individual roll call decisions; that is, the method is blind to any external information, such as political parties, about the legislators and the roll calls. The direct linkage of the recovery method to the spatial model is our innovation to modern methods of roll call analysis introduced by MacRae (1958, 1970). Third, the recovery of legislator positions and roll call cutting lines is likely to be very accurate even if the technical assumptions of our procedure are violated. And fourth, the recovery of roll call outcomes may be very sensitive to the technical assumptions.

In the remainder of this book, we employ D-NOMINATE to estimate dynamic models of roll call voting. To estimate static models for a single Congress, we used W-NOMINATE, an improved version of NOMINATE. Having established the methodological basis for the remainder of the book, we can now proceed to a discussion of the results of the analysis.

3

The Spatial Model: Accuracy and Dimensionality

In this chapter, we investigate the performance of low-dimensional spatial models and discuss the substantive meaning of the dimensions. With respect to performance, we show that a simple spatial model adequately accounts for the roll call data. Our preferred model has only two dimensions; it limits temporal change in the positions of individual legislators to simple linear functions of time. In fact, this very simple model improves only marginally, albeit significantly, on an even simpler model that is one-dimensional, with legislators being constrained to a fixed position throughout their congressional careers. These basic results are presented in the first section of this chapter, which gives the overall fit of the various spatial models that we estimated.

In the second section, we address the issue content of the first and second dimensions; the first dimension almost always picks up the fundamental economic issues that separate the two major political parties of the time, while the second dimension divides the parties internally over regional issues (usually race). In the third section, we offer supporting evidence for our basic finding of low dimensionality; this section also confronts the controversy this finding has created in the relevant literature.

Overall Fit of the Spatial Models

We applied the D-NOMINATE algorithm to all roll call votes cast in the House and the Senate from 1789 to 1985 (the first 98 Congresses and the first session of the 99th).[1] All roll calls with at least 2.5 percent minority voting were included (97 – 3 and closer votes if 100 Senators voted). For a given Congress, every legislator who cast at least 25 votes was included.[2] Applying these criteria, 9,759 members of the House and 1,714 senators were included in the analysis. For the House, 32,953 roll calls were analyzed, and the total number of individual decisions was 8,110,702. For the Senate, there were 37,281 roll calls and 2,317,915 decisions.

One-, two-, and three-dimensional spatial models were estimated, and time polynomials up to degree 3 (cubic) were estimated for the legislators. A two-dimensional model with a linear time trend (like the one shown in figure 2.8) for the legislators accounts for about 85 percent of the individual decisions. Adding dimensions and higher-order time trends did not appreciably increase the fit of the model.

A straightforward method to measure the fit of the model is simply to count, across all roll calls, the percentage of correct classifications.[3] The classification results for