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An Integrated Computational Model of Multiparty Electoral Competition

Kevin M. Quinn and Andrew D. Martin

Abstract. Most theoretic models of multiparty electoral competition make the assumption that party leaders are motivated to maximize their vote share or seat share. In plurality-rule systems this is a sensible assumption. However, in proportional representation systems, this assumption is questionable since the ability to make public policy is not strictly increasing in vote shares or seat shares. We present a theoretic model in which party leaders choose electoral declarations with an eye toward the expected policy outcome of the coalition bargaining game induced by the party declarations and the parties' beliefs about citizens' voting behavior. To test this model, we turn to data from the 1989 Dutch parliamentary election. We use Markov chain Monte Carlo methods to estimate the parties' beliefs about mass voting behavior and to average over measurement uncertainty and missing data. Due to the complexity of the parties' objective functions and the uncertainty in objective function estimates, equilibria are found numerically. Unlike previous models of multiparty electoral competition, the equilibrium results are consistent with the empirical declarations of the four major Dutch parties.

Key words and phrases: Monte Carlo method, voting behavior, electoral strategy, coalition formation.

1. INTRODUCTION

Democratic politics is fundamentally about allocating resources among competing interests. Those who win enjoy the perquisites of office and the public policy benefits that governing entails. Those who lose must prepare to compete in the next election. In the United States and other essentially two-party systems, understanding who wins and who loses is simple; one party gets a majority of the vote and wins, while the other party fails to do so and loses. In such systems, both parties are interested in maximizing the number of votes they receive since receiving the most votes implies more or less complete control over both government perquisites and policy. In parliamentary democracies with more than two parties—the most common form of democratic government across the globe—winning and losing is not so clear-cut. In these systems, rarely do parties garner a majority of votes. Typically, two or more parties must join together in a governing coalition. Since the ultimate mix of perquisites and policy is a result of bargaining between coalition partners, no party is likely to get its most preferred outcome. Thus, winning and losing is defined in terms of doing as well as possible *conditional* on the strategies of the other parties. Parties must be concerned with getting votes, but they also must consider their prospects of sharing resources with other parties in a governing coalition (Laver and Shepsle, 1996).

To understand legislative politics and public policy outputs in multiparty systems, it is thus necessary to jointly understand voting behavior, electoral strategy and coalition formation. Much has been written about each stage of the process separately, but little has been done to empirically join these literatures in a principled fashion. This is likely due to the complex interdepen-

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dencies of these stages, as well as the problem of accounting for uncertainty at all levels of the empirical model. In this article we develop a simulation-based methodology that allows us to deal with this complexity.

In this text we offer a method that allows us to test the predictions of one particular model of coalition formation in multiparty democracies. The advantage of this approach over an analytic one is that by incorporating stochastic behavior into the theory, we tie empirical analysis directly to the theoretical model. Further, we gauge the predictions of models that would be otherwise intractable. The disadvantage of the approach is that the generality of the theoretical model is sacrificed, although the method can be used to consider other explanations of coalition formation.

This article is organized as follows. In Section 2, we review current understanding of electoral competition in multiparty democracies. We discuss the 1989 Dutch parliamentary election—the application in this article—in Section 3. Section 4 contains our model and focuses on vote maximization and the policy motivations of political parties. This section discusses how to integrate our estimates of key model parameters into the modeling framework and how to solve for equilibria numerically. In Section 5, we report the findings from the operationalization of the model within the context of the Netherlands in 1989. Here we account for uncertainty in model inputs, present estimates of voter utility functions and apply the results from the statistical model to estimate equilibrium party strategies. The final section concludes with a discussion of the methodological and substantive implications of this research, and some speculative thoughts as to how these results relate to the more traditional, qualitative literature on parties and party systems.

2. UNDERSTANDING MULTIPARTY ELECTORAL COMPETITION

Understanding why political parties put forth a given set of electoral platforms to an electorate is of profound theoretical importance. (We use the terms *electoral platforms* and *electoral declarations* interchangeably throughout the article.) Knowledge of this process informs our understanding of such key issues as representation, realignment and the stability of electoral systems. Indeed, in pure multiparty parliamentary systems, understanding coalition formation means understanding legislative outputs and public policy formation.

Over the past 40 years a great deal has been learned about what equilibrium electoral declarations look like in plurality-rule systems of various sorts (Downs, 1957; Davis and Hinich, 1966; Enelow and Hinich, 1984, 1990; Coughlin, 1992). This literature traces its intellectual roots to the spatial voting model (Hotelling, 1929; Downs, 1957; Black, 1958). The spatial voting model is predicated on the assumption that the policy content of political issues can be represented in a (typically) low-dimensional Euclidean space. This space is typically called a policy space or an issue space. For illustration, consider the simplest one-dimensional case, with a parliament choosing the income tax rate. Currently the tax rate is zero. The choice of tax rate can be thought of as picking a location on $[0, 1]$ or, after suitable transformation, picking a location on the real number line. It is important to note that the policy space need not be defined in terms of monetary consequences; other issues such as social policy can be thought of in the same fashion, with points on the line representing the liberalness of the policy. Higher dimensions arise with multiple issues, which are typically correlated, thus yielding a low-dimensional space. The key assumption is that the policies relevant to decision making map into this space.

To understand individual decision making, the two relevant factors are the policy positions and the ideal points of the actors. In the previous illustration, the location of the status quo is zero and each proposal can be represented by a point on the line. The spatial model asserts that each actor has an ideal point, or preferred policy position, in the space. This ideal point corresponds to the policy that the individual would enact if they had dictatorial power. With the policy locations and the ideal points, the final assumption one has to make to understand behavior is the utility function of the actors. The assumption of symmetric, quadratic utilities (Enelow and Hinich, 1984) is typical, although others use different functional forms (Coughlin, 1992). These functions take the policy locations and ideal points as arguments, and produce a personal utility to the decision maker. The model predicts that individuals will vote for the options from which they derive greatest utility.

The spatial model has been applied in essentially two ways. Some have used the model to understand voting by the mass public (Downs, 1957). Here candidates standing for election can be thought of as the policy locations in the space, and the voters can be thought of as the decision makers. By assuming a specific random utility function, one can use models of multinomial choice to statistically model voting behavior (e.g., Quinn, Martin and Whitford, 1999). The spatial model has also been applied to the study of committee decision making (Shepsle, 1979). In this case, the legislators are the decision makers, who are voting over proposals in the policy space.

One question of great importance when studying multiparty systems is, "What electoral declarations do parties make?" In other words, what location in this Euclidean space will parties present to voters in a given election? What makes this question interesting is the fact that these choices are interdependent. That is, it is not just the location of a *single* party that determines voter choice, but rather it is the locations of *every* party that determine how voters choose. Moreover, the choices the parties make depend crucially on their goals. To understand such an interdependent choice setting, we make use of the game theoretic concept of pure strategy Nash equilibrium (Nash, 1950). This equilibrium concept suggests that each party will choose a position such that it is a best response to the best responses of all opposing parties. Such an equilibrium has the property that it is defection-proof; no party can unilaterally improve their standing by adopting an alternative strategy.

With some exceptions (Wittman, 1983; Shepsle and Cohen, 1990), the main findings from the spatial voting literature are that parties in plurality-rule systems will generally tend to take fairly centrist positions in equilibrium. These "Downsian" convergence results hold even for multiparty systems with high-dimensional issue spaces as long as candidates are motivated by winning and are sufficiently unsure of voter behavior (Enelow and Hinich, 1989; Coughlin, 1992). While scholars have gained a good understanding of electoral competition in two-party systems (and plurality-rule systems more generally), the same cannot be said for multiparty proportional rule (PR) systems. This is particularly interesting since a very large proportion of the world's democracies feature some form of PR.

The reasons for the discrepancy between our knowledge of electoral strategy in plurality-rule systems and PR systems are manifold. Nonetheless, one of the key reasons has to do with the linkage between electoral declarations and policy outcomes in the two systems. In multiparty PR systems, policy is ultimately decided by a coalition government composed of a number of the parties who have gained seats in parliament. As Austen-Smith and Banks (1988) showed, the power to determine policy is not monotonically increasing in vote shares or seat shares in certain types of PR systems. This implies that a theoretic model of electoral competition in a multiparty PR system requires a model of cabinet formation that is linked to the electoral declarations put forth by the parties. Because of the complexity of this linkage, few scholars have undertaken such an empirical or theoretical modeling enterprise.

Rather than formulating such a model of multiparty electoral competition, many researchers implicitly or explicitly assume that parties in PR systems choose electoral declarations to maximize vote share or seat share. This has led several researchers to remark upon the apparent discrepancy between the predictions derived from theories of party strategy based on vote maximization and estimates of the actual electoral declarations put forth by parties (Dalton, 1985; Listhaug, Macdonald and Rabinowitz, 1990; Rabinowitz, Macdonald and Listhaug, 1991; Iversen, 1994). Others contend that policy outputs enter the decision calculus of the parties and thus explain the divergence in electoral declarations (Laver and Shepsle, 1996). Our purpose in this article is to compare the Nash equilibrium predictions of vote-maximizing and policy-motivated parties.

We put forth a general modeling strategy that can be used to evaluate equilibrium electoral strategies under a variety of party motivations. Since the relationship between electoral declarations and policy outcomes is extremely difficult to deal with analytically in anything other than the simplest of cases, we calculate equilibria numerically. Our approach allows us to incorporate uncertainty at all stages—-measurement, estimation and postestimation equilibrium computation—into our analysis. One of the dangers of such a computational approach is the possibility that results may depend critically on the values of key parameters that have been set by the researcher. We attempt to minimize this problem by estimating model parameters from a representative national survey of the Dutch electorate. While such an approach decreases the generality of our results, it does increase the validity of our results for the system under study. Our empirical focus is on the Netherlands—a nation with an essentially pure PR system—in the 1989 election. To foreshadow, the results suggest that the electoral declarations actually chosen by the four major Dutch parties in 1989 are much more consistent with policy-seeking behavior than with vote-maximizing behavior.

3. THE 1989 DUTCH PARLIAMENTARY ELECTION

Operationalizing our computational model requires us to obtain estimates of voter ideal points, voter perceptions of party platforms at the time of the survey and voter utility functions. To do this we examine data from the Netherlands in 1989. The Netherlands features a very pure form of PR in which there is a single national district and an extremely low electoral threshold (0.67%). (In other words, all parties receiving two thirds of 1% of the national vote will gain at least one seat in Parliament.) Such features suggest that the incentives for voters to engage in sophisticated voting (contrary to our assumptions) are relatively weak compared to other PR systems. Further, the fact that the Netherlands has a single national district means that district-specific attributes of candidates are constant across the whole nation. This implies that a nationally representative sample survey has the potential to provide the information about voting behavior that we desire.

While a number of Dutch parties have achieved representation in the lower house of parliament in past years, we focus on the four major parties: the PvdA, the CDA, the VVD and the D66. The PvdA (*Partij van de Arbeid*) is a traditional social democratic party with left-wing economic stands and moderate to liberal social positions. The CDA (*Christen Democratisch Appèl*) is a Christian democratic party that was formed from the three major religious parties in 1980. The CDA tends to take relatively conservative positions on social issues (particularly abortion and euthanasia) and moderate to slightly rightist positions on economic issues. The VVD (*Volkspartij voor Vrijheid en Democratie*) is a traditional European liberal party that takes conservative economic positions and moderate positions on social policy. Finally, the D66 (*Democraten 66*) is a relative newcomer to the party system that has fought for reform of the electoral system and a liberal social agenda. It tends to take moderate positions on economic issues. We do not explicitly model the remaining Dutch parties. Instead, we assume that they each receive a constant percentage of the vote and vote against all possible cabinets in the cabinet formation stage of the model. (This is not an entirely unreasonable assumption given Dutch political history prior to 1989, and especially given the attitudes of the major party leaders toward the fifth largest party—*Groen Links*.)

Our data come from the 1989 Dutch Parliamentary Election Study (Anker and Oppenhuis, 1993). This is the eighth national election study to be conducted in the Netherlands, and was designed to study the September 6, 1989 election for the Second Chamber of the Dutch Parliament. This data set contains $N = 1784$ individuals who reported voting for one of the four major Dutch parties. It also included a battery of demographic variables, as well as a battery of five issue questions (on abortion, euthanasia, income equalization, nuclear power and nuclear weapons), where the voters were asked to report their own preferences as well as their perceptions of the positions of the four major parties.

4. A MODEL OF PARLIAMENTARY ELECTORAL COMPETITION

We can think about the process by which electoral declarations lead to policy outputs as being similar to the process in Figure 1. At the outset of election, parties make electoral policy declarations. These declarations, typically formalized in party manifestos, locate the parties in the policy space. Given those declarations, voters cast ballots for the parties. The expectation is that voters choose parties close to them in the policy space. After the election, vote totals are translated into seat shares by an exogenous rule. After seats are allocated, the parties enter a bargaining game, where they ultimately vote over cabinets, portfolio allocations and other perquisites. This game results in a cabinet, typically consisting of more than one party, that forms public policy. Note that a fair amount of knowledge exists regarding each of the five steps individually. An equilibrium in this game consists of a set of party policy platforms and strategies for forming coalition governments such that no party has an incentive to unilaterally change its policy platform or its rule for forming a coalition government. In what follows we assume equilibrium behavior in the later stages of the game and focus on finding equilibrium policy declarations. The sequential structure of this process

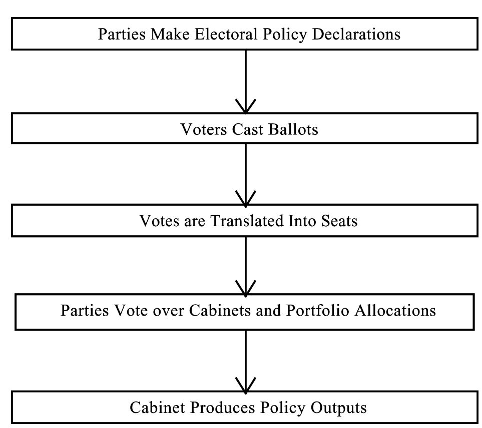

FIG. 1. *Schematic model of parliamentary electoral competition.*

also suggests that equilibrium electoral declarations can be found in the first node by working backward through the process (Selten, 1965).

In the remainder of this section we sequentially operationalize the process sketched above. We then go on to show how equilibrium electoral declarations can be calculated under the assumption of policy-motivated parties and under the assumption of vote-maximizing parties.

4.1 Calculating Empirical Electoral Declarations and Citizen Policy Preferences

The key to the spatial voting model is locating voters and parties in the same issue space. To measure voter ideal points we employ a factor analytic measurement model of the responses to the five issue questions in the survey. (See Quinn, Martin and Whitford, 1999, for a justification of this procedure.) An example of one of the issue questions in the Dutch Parliamentary Election Study (Anker and Oppenhuis, 1993) is the following:

> *Abortion*: Some people think that the government should forbid abortion in all circumstances; other people think that every woman should have the right to decide whether she wants an abortion. Of course, there are also people with an intermediate opinion. Suppose we place the people who think that abortion should be forbidden under all circumstances at the beginning of this line (at number 1) and the people who think that every woman has the right to decide for herself at the end of this line (at number 7). First I shall ask you to indicate the position of a number of political parties on this line. If you do not know what position a party has on this issue, please do not hesitate to tell me.
>
> - Where would you place the CDA on this line?
> - And the PvdA?
> - And the VVD?
> - And D66?
> - And where would you place yourself on this line?

In addition to this question on abortion, citizens were asked similarly constructed questions on nuclear power, state attempts to reduce income inequality, euthanasia and the deployment of nuclear weapons.

As in all survey research, item nonresponse is a serious problem. Here we deal with missing data through multiple imputation. We use a multivariate Normal model to characterize the joint distribution of the raw survey data. In addition to the demographic covariates listed in Table 1 and the responses to the issue questions, measures of political knowledge were included in the imputation model to help predict missing responses. We employed the software of King, Honaker, Joseph and Scheve (2001), whose approach is based on the work of Little and Rubin (1987) and Schafer (1997). The primary difference is that the algorithm generates imputations via importance sampling from the posterior distribution rather than using data augmentation or the expectation-maximization algorithm. We treat the vote choice response as a nominal variable. We created and stored five imputed data sets.

Let $i = 1, \ldots, N$ index citizens and $j = 1, \ldots, J$ index parties. Let w_i represent the vector of citizen i's responses to the five issue questions and let $w_i^{(j)}$ represent the vector of citizen i's perceptions of party j on the five issues. Our goal is to use the data on these issue questions to estimate citizen i's ideal point θ_i in the two-dimensional issue space $\mathcal{X}$. We assume that the underlying Dutch issue space is two-dimensional, with one dimension reflecting underlying

TABLE 1
Social-structural covariates used to estimate Dutch voter utility functions, 1989

Variable	Description
Religiosity	Religiosity dummy (0 = not religious, 1 = religious)
Catholic	Catholic dummy (0 = not Catholic, 1 = Catholic)
Social class	Social class scale (0 = lowest social class to 4 = highest social class)
Union member	Union dummy (0 = not union member, 1 = union member)
Income	Income scale (0 = lowest to 6 = highest)
Education	Education scale (0 = lowest to 4 = highest)
Age	Age categories (0 = lowest to 12 = highest)
Rural	Rural dummy (0 = not rural residence, 1 = rural residence)
Urban	Urban dummy (0 = not urban residence, 1 = urban residence)

economic preferences and the other reflecting preferences on social policy. This is consistent with much of the literature on Dutch voting behavior (see Quinn, Martin and Whitford, 1999, for a review). We would also like to make inferences about citizen i's perception of party j's electoral platform (denoted $\psi_i^{(j)}$) in the two-dimensional issue space as well as the mean perception across the population of party j's electoral platform (denoted $\tilde{\psi}^{(j)}$) in the two-dimensional issue space.

The measurement model used to estimate voter ideal points is given by

$$w_i = \Lambda\theta_i + \varepsilon_i, \tag{1}$$

where $\varepsilon_i \sim \mathcal{N}(0, \Sigma)$ and Σ is a diagonal matrix with the rth diagonal element given by σ_{rr}^2. We assume the following priors: $\Lambda_r \sim \mathcal{N}(\bar{\Lambda}_r, \Sigma_{\Lambda_r})$, $\sigma_{rr}^2 \sim \mathcal{IG}(\nu/2, \delta/2)$ and $\theta_i \sim \mathcal{N}(0, \Phi)$, where Λ_r denotes the nonzero elements of the rth row of Λ and $\Phi = \left[\begin{smallmatrix} 1 & \rho \\ \rho & 1 \end{smallmatrix}\right]$. (Some of the elements of Λ are set to 0 for reasons of identification.) Let $\mathcal{N}(a, b)$ denote a normal distribution with mean a and variance b, and let $\mathcal{IG}(a, b)$ denote an inverse gamma distribution with shape a and scale b. We assume a uniform hyperprior for ρ. It is assumed that Λ is $R \times K$ and θ_i is $K \times 1$, where R is the number of manifest issue responses (in this case, $R = 5$) and K is the number of latent issue dimensions (in this case, $K = 2$). In this application, we set $\bar{\Lambda}_r$ to be a vector of zeros, $\Sigma_{\Lambda_r} = 10{,}000I$, $\nu = 2$ and $\delta = 1$.

This measurement model is fitted via Markov chain Monte Carlo (MCMC). We can sample from the distribution of the average voter perception of the party declarations for all parties—denoted $(\tilde{\psi})$—by viewing it as a deterministic function of the model parameters. Appendix A describes the algorithm employed and how the distribution of $(\tilde{\psi})$ is calculated within the MCMC algorithm. It is important to note that our MCMC sampling produces a series of draws that are approximately from $p(\theta, \tilde{\psi} | D_{\text{mis}}, D_{\text{obs}})$. We fit the model to each of the five imputed data sets.

To illustrate the findings from our measurement model, Figure 2 displays the mean perceptions of the party electoral declarations and the underlying density of voter ideal points based on a single draw from the posterior distribution of these parameters. This comports well with our qualitative understanding of the Dutch party system. Table 2 presents the results from our measurement model averaged across the five imputed data sets.

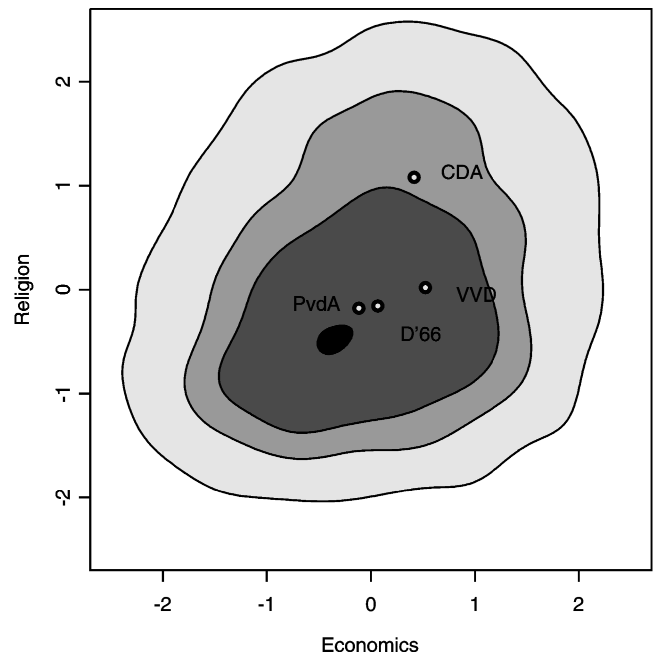

FIG. 2. *Empirical party positions of Dutch parties overlaid on a highest density plot of voter ideal points, 1989. Running from lightest to darkest, the highest density contours represent the smallest regions of the policy space that contain 95, 75, 50, and 1% of the underlying density of voter ideal points.*

4.2 Calculating Seat Strengths Given Electoral Declarations and Citizen Policy Preferences

The next step of the process is to use the measures of voter and party location obtained above to estimate voter utility functions. With this information we can then make inferences about the likely vote share and seat shares of parties for a particular configuration of party electoral declarations. We assume that voters vote expressively in the election according to a probabilistic rule. That is, they tend to vote myopically for the party that puts forth the electoral declaration they most prefer *regardless of the policy consequences*. To operationalize this, we employ a multinomial logit (MNL) model.

The MNL model can be motivated by a random utility assumption. Let z_{ij} denote the utility to voter i of voting for party j. Assume

$$z_{ij} = x_{ij}'\beta + \varepsilon_{ij}, \tag{2}$$

where ε_{ij} follows a log-Weibull distribution (McFadden, 1974) and

$$y_{ij} = \begin{cases} 1, & \text{if } z_{ij} = \max(z_i), \\ 0, & \text{otherwise.} \end{cases}$$

TABLE 2
Summary of the posterior density of a factor model of the Dutch issue space, 1989 (results are averaged over the five imputed data sets)

Parameter	Posterior mean	Posterior median	Posterior std. dev.	95% BCI Lower	95% BCI Upper
Economic factor					
$\lambda_{\text{abortion}}$	0.000	0.000	0.000	0.000	0.000
$\lambda_{\text{nuclear plants}}$	−0.595	−0.595	0.034	−0.662	−0.528
$\lambda_{\text{equalize income}}$	−0.551	−0.551	0.033	−0.616	−0.484
$\lambda_{\text{euthanasia}}$	0.000	0.000	0.000	0.000	0.000
$\lambda_{\text{nuclear weapons}}$	−0.519	−0.518	0.036	−0.588	−0.450
Social factor					
$\lambda_{\text{abortion}}$	−0.730	−0.730	0.036	−0.800	−0.661
$\lambda_{\text{nuclear plants}}$	0.000	0.000	0.000	0.000	0.000
$\lambda_{\text{equalize income}}$	0.000	0.000	0.000	0.000	0.000
$\lambda_{\text{euthanasia}}$	−0.798	−0.798	0.038	−0.871	−0.722
$\lambda_{\text{nuclear weapons}}$	−0.134	−0.134	0.030	−0.191	−0.074
$\rho_{\text{economic, religious}}$	0.221	0.220	0.029	0.163	0.279
N	1754				
Total Gibbs iterations per data set	5000				
Number of factor models	5				

Then the MNL sampling density is given by

$$f(y|\beta) = \prod_{i=1}^{N}\prod_{j=1}^{J} \Pr(y_{ij} = 1|\beta)^{y_{ij}},$$

where

$$\Pr(y_{ij} = 1|\beta) = \frac{\exp(x_{ij}'\beta)}{\sum_{k=1}^{p}\exp(x_{ik}'\beta)}. \tag{3}$$

In what follows we employ improper, uniform priors for the elements of β.

Historically, sociological factors played the dominant role in explaining voter choice in the Netherlands. As denominational and class lines began to soften in the late 1960s and early 1970s, issue voting became increasingly important. Recent work (Alvarez and Nagler, 1998; Quinn, Martin and Whitford, 1999) suggests that sociological factors and issue preferences play an important, joint role in determining voter behavior. For these reasons we choose to include both sociological variables and issue variables in our empirical model of voting behavior. The specific covariates used in the analysis are presented in Table 1.

To capture the voter issue preferences we include the squared distance between each voter i's ideal policy θ_i and the mean perceived party location of each party $\tilde{\psi}^{(j)}$ as a choice-specific covariate for $j = 1, \dots, J$. Since the MNL covariates X depend on draws from $p(\theta, \tilde{\psi}|D_{\text{mis}}, D_{\text{obs}})$, we take five draws from $p(\theta, \tilde{\psi}|D_{\text{mis}}, D_{\text{obs}})$ for each of the five imputed data sets and then fit a MNL model to each of these 25 data sets. We use the Metropolis algorithm to sample from the posterior density of this model. Note that this allows us to obtain a sample approximately from $p(\beta|D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi})$. Table 3 summarizes the results from the 25 MNL models.

To illustrate the substantive implications of changes in party electoral declarations, we graph the expected vote share of a given party against potential policy locations of the party in the two-dimensional policy space, conditional on the other three parties remaining fixed at their estimated actual locations in the policy space. The vote shares are computed using the coefficient estimates from the vote choice model. Figures 3–6 display the impact changes in party electoral declarations on voting behavior. From these figures we can see that the vote shares of the two largest parties—CDA and PvdA—are quite sensitive to changes in electoral declarations, yet each of these two parties can count on maintaining about 6–10% of the vote regardless of the electoral position taken within the $[-2, 2]$ square. On the other hand, the vote shares of the smaller parties—VVD and D66—are less sensitive to the parties' policy positions. It is also interesting to note that no party could gain a simple majority of the vote given the empirical locations of the other parties.

TABLE 3
Results from the 25 MNL models

Parameter		Posterior mean	Posterior median	Posterior std. dev.	95% BCI Lower	95% BCI Upper
Spatial distance		−0.295	−0.294	0.029	−0.354	−0.241
Religiosity	PvdA	0.101	0.101	0.220	−0.324	0.530
	VVD	0.406	0.402	0.271	−0.106	0.956
	CDA	1.430	1.434	0.268	0.903	1.958
Catholic	PvdA	0.401	0.401	0.185	0.033	0.764
	VVD	0.280	0.298	0.236	−0.277	0.704
	CDA	0.979	0.983	0.195	0.581	1.353
Class	PvdA	−0.639	−0.635	0.114	−0.866	−0.425
	VVD	−0.038	−0.033	0.116	−0.282	0.176
	CDA	−0.316	−0.311	0.104	−0.533	−0.125
Union member	PvdA	1.008	0.996	0.196	0.664	1.433
	VVD	−0.090	−0.115	0.311	−0.650	0.562
	CDA	0.176	0.159	0.250	−0.258	0.710
Income	PvdA	−0.094	−0.093	0.060	−0.215	0.022
	VVD	0.174	0.177	0.069	0.031	0.302
	CDA	0.054	0.055	0.059	−0.064	0.163
Education	PvdA	−0.313	−0.316	0.106	−0.520	−0.103
	VVD	−0.189	−0.191	0.105	−0.387	0.038
	CDA	−0.155	−0.160	0.111	−0.367	0.084
Age	PvdA	0.107	0.107	0.038	0.034	0.181
	VVD	0.102	0.099	0.048	0.015	0.201
	CDA	0.151	0.151	0.042	0.072	0.234
Rural	PvdA	−0.162	−0.178	0.306	−0.724	0.488
	VVD	0.112	0.113	0.302	−0.491	0.686
	CDA	0.027	0.020	0.309	−0.551	0.627
Urban	PvdA	−0.122	−0.116	0.220	−0.561	0.319
	VVD	−0.156	−0.161	0.260	−0.616	0.454
	CDA	−0.112	−0.107	0.261	−0.613	0.393
Constant	PvdA	2.736	2.729	0.334	2.094	3.400
	VVD	−0.042	−0.036	0.427	−0.891	0.761
	CDA	0.746	0.735	0.408	−0.035	1.579

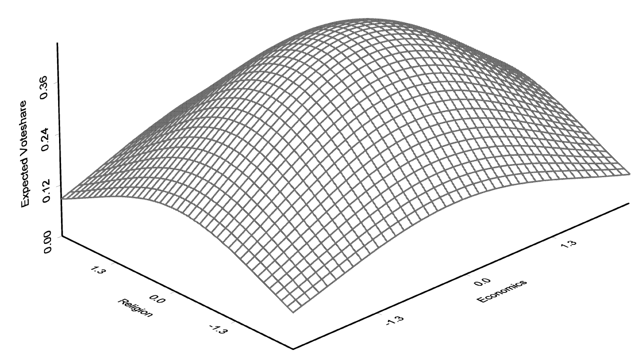

FIG. 3. *Expected CDA vote share at various electoral declarations conditional on empirical locations of the other Dutch parties, 1989.*

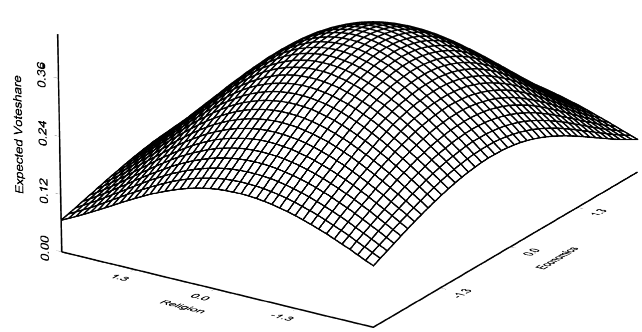

FIG. 4. *Expected PvdA vote share at various electoral declarations conditional on empirical locations of the other Dutch parties, 1989.*

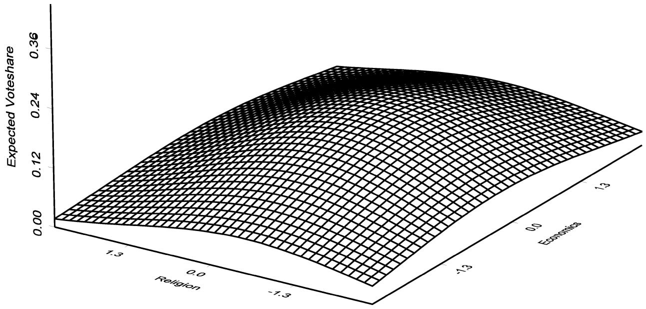

FIG. 5. *Expected VVD vote share at various electoral declarations conditional on empirical locations of the other Dutch parties, 1989.*

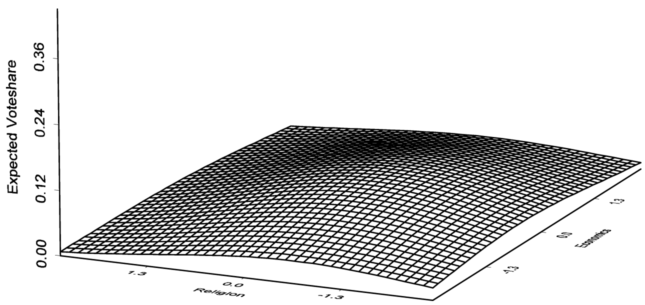

FIG. 6. *Expected D66 vote share at various electoral declarations conditional on empirical locations of the other Dutch parties, 1989.*

With knowledge of the voters' utility functions [embodied in $p(\beta|D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi})$] we can go on to make inferences about the vote shares and seat shares that would accrue to parties if they were to put forth a different set of electoral declarations. Calculating vote shares for parties is simple because it only requires plugging new values of the covariates into equation (3) and calculating the voting probabilities for the voters. A deterministic rule maps votes into parliamentary seats. We assume the d'Hondt rule (see Cox, 1997) translates citizens' votes in the parliamentary election into seats, which is the actual institutional rule used in the Netherlands.

4.3 Calculating Equilibrium Cabinets and Policy Outcomes Given Electoral Declarations and Seat Strengths

With knowledge of the policy positions and seat shares of the parties, we can go on to examine the formation of governments and public policy in the Parliament. To model cabinet formation and policy enactments we use a version of Laver and Shepsle's (1996) model of cabinet formation. The Laver–Shepsle model assumes the existence of a K-dimensional policy space $\mathcal{X} \subseteq \mathbb{R}^K$. Parties $j = 1, \ldots, J$ are assumed to have fixed policy positions $\psi_j \in \mathcal{X}$. As noted above, in the Dutch application, the set of parties is assumed to consist of PvdA, CDA, VVD and D66. It is assumed that parties are motivated by public policy and attempt to produce public policy that is most consistent with their policy positions. More concretely, we assume that the utility party j attaches to a particular policy outcome is given by the negative squared distance between ψ_j and the policy outcome in question. In addition to a policy position, each party is assumed to have a nonnegative seat strength. This is simply the number of seats the party in question controls in the parliament.

Given the set of parties and the parties' policy positions, utility functions and seat strengths, the Laver–Shepsle model works as follows. (See Chapters 3 and 4 of Laver and Shepsle, 1996, for a more detailed discussion of their model.) Stage I of the model consists of a party from the set of parties being chosen to propose a cabinet. A cabinet consists of an allocation of the various ministry portfolios (i.e., the Finance Minister, the Home Affairs Minister, etc.) to the parties. Following the actual parliamentary rules used in the Dutch Parliament, we assume that the party with the largest seat strength is allowed to make the first proposal. We make the simplifying assumption that political competition is primarily over two ministries — the Finance Ministry and the Ministry of Home Affairs. (Laver and Shepsle, 1996, page 153, presented evidence from a survey of country experts that suggests this assumption is reasonable.) Each ministry corresponds with one of the issue dimensions in the policy space. In Stage II of the model, parties controlling ministries under the Stage I proposal are allowed to veto the proposed cabinet by refusing to accept the portfolios they were allocated. If the cabinet is vetoed, we go to Stage I and a new party is allowed to propose a cabinet. If no party vetoes a proposed cabinet we move to Stage III of the model. In Stage III, the Parliament as a whole votes for either the proposed cabinet or for the status quo cabinet (the last cabinet approved by a majority of the Parliament). For our purposes, the game stops when a parliamentary majority approves a cabinet.

Laver and Shepsle assumed that a cabinet produces public policy dimension by dimension. In other words, the party that controls a particular ministry sets policy on the dimension that corresponds with that ministry. For instance, in the Dutch case we assume the policy space is two-dimensional. The first dimension corresponds to economic policy controlled by the Finance Ministry and the second dimension corresponds to social policy controlled by the Ministry of Home Affairs.

A cabinet may consist of CDA controlling the Finance Ministry and PvdA controlling the Ministry of Home Affairs. In this case, CDA would set economic policy to its preferred mix of economic policies (given by the first element of ψ_{CDA}) and PvdA would set social policy to its preferred mix of social policies (given by the second element of ψ_{PvdA}).

An equilibrium cabinet in the Laver–Shepsle model is an allocation of ministerial portfolios that is majority preferred to all other possible allocations of ministerial portfolios. It is important to remember that parties are assumed to be motivated not by controlling portfolios but by the policy outcomes that result from a particular cabinet. Thus a party may well prefer not to be a member of a governing coalition if staying in opposition produces public policy that is more in line with its policy preferences. Equilibrium cabinets can be found by searching through the set of cabinets that are majority preferred to the status quo cabinet (the cabinet in place at the time of the election). To summarize, once we know the parties' policy declarations and the associated seat strengths, we can find equilibrium cabinets and policy outcomes using the Laver and Shepsle (1996) model.

4.4 Finding Equilibrium Policy Declarations

Suppose that party j is looking down the game tree and is choosing its electoral declaration ψ_j. Party j's goal is to find the value of ψ_j that maximizes its utility given its beliefs about the values of the other quantities in the model $(\psi_{-j}, D_{\mathrm{mis}}, D_{\mathrm{obs}}, \theta, \tilde{\psi}, \beta)$. We say that a collection of party electoral declarations ψ is an *equilibrium configuration* of electoral declarations if no party can unilaterally choose a different electoral declaration and improve its payoff.

To search for equilibrium configurations of electoral declarations we need to define the parties' utility functions and show how to calculate expected utility. In what follows, we let $u_j(\psi_j|\psi_{-j}, D_{\mathrm{mis}}, D_{\mathrm{obs}}, \theta, \tilde{\psi}, \beta)$ denote the utility j receives from putting forth electoral declaration ψ_j given particular values of $\psi_{-j}, D_{\mathrm{mis}}, D_{\mathrm{obs}}, \theta, \tilde{\psi}$ and β.

We look at two possibilities for $u_j(\psi_j|\psi_{-j}, D_{\mathrm{mis}}, D_{\mathrm{obs}}, \theta, \tilde{\psi}, \beta)$. First, that parties are motivated by maximizing vote share. Under this assumption, the utility that party j gets from electoral declaration ψ_j is simply the fraction of the votes j would expect to receive given this policy declaration and the values of the other model parameters.

The second type of party motivation we explore is that parties are motivated by public policy in a fashion consistent with the Laver and Shepsle (1996) model. As noted above, given values of all the model parameters, it is possible to find the policy outcome of the ultimate coalition bargaining game induced by the electoral declarations, voter ideal points and the voter utility functions. We assume that the payoff party j gets from a particular policy outcome is the negative squared distance between the spatial location of the policy outcome and the party's true ideal point (which we take to be $\tilde{\psi}^{(j)}$). While it is not possible to easily write down this functional relationship between policy declarations and utility, it is possible to evaluate this utility function at particular values of the model parameters. This will prove important when calculating expected utility below.

Since $D_{\mathrm{mis}}, \theta, \tilde{\psi}$ and β are not known with certainty, we need to average over these quantities to calculate the expected utility of an electoral declaration. If we knew the joint distribution of the quantities given the observed data we could still calculate expected utility according to

$$\begin{aligned} &U_j(\psi_j|\psi_{-j}, D_{\mathrm{obs}}) \\ (4)\quad &= \iiiint u_j(\psi_j|\psi_{-j}, D_{\mathrm{mis}}, D_{\mathrm{obs}}, \theta, \tilde{\psi}, \beta) \\ &\qquad \times p(D_{\mathrm{mis}}, \theta, \tilde{\psi}, \beta|D_{\mathrm{obs}})\, dD_{\mathrm{mis}}\, d\theta\, d\tilde{\psi}\, d\beta. \end{aligned}$$

Rather than try to deal with the right hand side of Equation (4) directly, we use the rules of conditional probability and proceed to factor $p(D_{\mathrm{mis}}, \theta, \tilde{\psi}, \beta|D_{\mathrm{obs}})$ into smaller chunks and construct a Monte Carlo estimate of $U_j(\psi_j|\psi_{-j}, D_{\mathrm{obs}})$. This works as follows.

- For $l = 1, \ldots, L$:
  - Draw $D_{\mathrm{mis}}^{(l)}$ from $p(D_{\mathrm{mis}}|D_{\mathrm{obs}})$.
  - Draw $(\theta^{(l)}, \tilde{\psi}^{(l)})$ from $p(\theta, \tilde{\psi}|D_{\mathrm{obs}}, D_{\mathrm{mis}}^{(l)})$.
  - Draw $\beta^{(l)}$ from $p(\beta|D_{\mathrm{obs}}, D_{\mathrm{mis}}^{(l)}, \theta^{(l)}, \tilde{\psi}^{(l)})$.
- Calculate

$$\begin{aligned} &\hat{U}_j(\psi_j|\psi_{-j}, D_{\mathrm{obs}}) \\ (5)\quad &= \frac{1}{L}\sum_{l=1}^{L} u_j(\psi_j|\psi_{-j}, D_{\mathrm{mis}}^{(l)}, D_{\mathrm{obs}}, \theta^{(l)}, \tilde{\psi}^{(l)}, \beta^{(l)}). \end{aligned}$$

Such an estimate can be made arbitrarily accurate by increasing the number of random draws L. As noted above, draws from $p(D_{\mathrm{mis}}|D_{\mathrm{obs}})$, $p(\theta, \tilde{\psi}|D_{\mathrm{obs}}, D_{\mathrm{mis}}^{(l)})$ and $p(\beta|D_{\mathrm{obs}}, D_{\mathrm{mis}}^{(l)}, \theta^{(l)}, \tilde{\psi}^{(l)})$ are available from MCMC sampling. As a practical matter, we saved five draws of D_{mis} from $p(D_{\mathrm{mis}}|D_{\mathrm{obs}})$, five draws of $(\theta, \tilde{\psi})$ from $p(\theta, \tilde{\psi}|D_{\mathrm{obs}}, D_{\mathrm{mis}})$ for each of the five previous draws of $D_{\text{mis}}^{(l)}$ and five draws from $p(\beta|D_{\text{obs}}, D_{\text{mis}}, \theta, \tilde{\psi})$ for each of the 25 previous draws of $(\theta, \tilde{\psi})$.

Because of the intractability of the parties' expected utility functions it is not feasible to characterize equilibrium declarations analytically. Instead equilibria are found via an iterative *tâtonnement* process. This works as follows:

1. Randomly assign starting declarations.
2. Randomly permute parties.
   (a) Party 1 maximizes expected utility conditional on the other parties' electoral declarations.
   (b) Party 2 maximizes expected utility conditional on the other parties' electoral declarations.
   (c) Similarly for remaining parties.
3. (a) If no movement in the last two permutations, return current configuration of electoral declarations. These are supported in equilibrium.
   (b) Else go to step 2.

While such an algorithm is not guaranteed to find all potential equilibrium declarations, the declarations that it returns (if any) will in fact be part of a pure strategy Nash equilibrium. The advantage of focusing on declarations that are arrived at through such an adaptive process is that they are consistent with a very simple model of human reasoning in which each player mentally works through such a process of adaptive optimization until a steady state is reached. Rational players would then play the appropriate equilibrium strategies (see Fudenberg and Tirole, 1991, Section 1.2.5, for a more detailed discussion).

5. EQUILIBRIUM RESULTS

5.1 Vote Maximization

We begin by examining the case in which the parties are motivated solely by vote maximization. As noted above, the assumption of vote-maximizing parties is fairly common in the substantive literature on multiparty electoral competition as well as some of the rational choice literature. As we show below, this assumption is not supported by the 1989 Dutch data.

With vote-maximizing parties, $u_j(\psi_j|\psi_{-j}, D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi}, \beta)$ is simply the vote share that party j can expect from choosing ψ_j given $\psi_{-j}, D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi}$ and β. We numerically found constellations of electoral declarations that are supported in Nash equilibrium given the vote-maximizing specification of party utility. Figure 7 displays these equilibrium platforms.

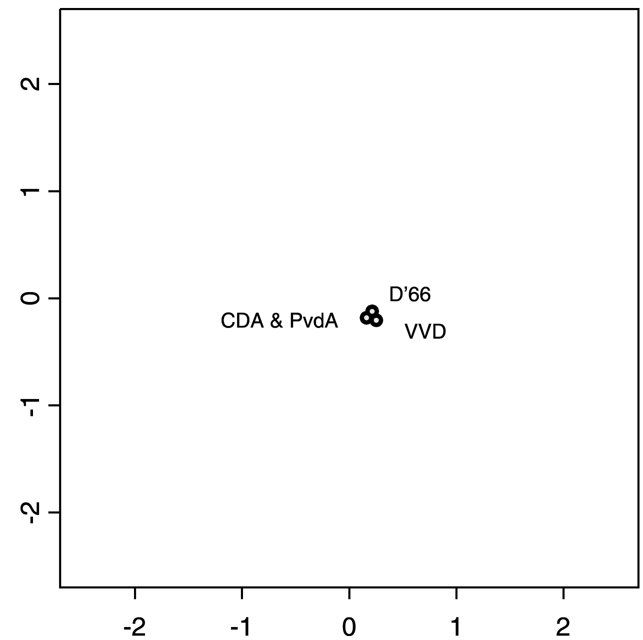

FIG. 7. *Equilibrium electoral declarations with vote-maximizing parties, 1989.*

As we expect, the vote-maximizing equilibrium declarations are very centrist and located very near the mean of the voter distribution. (For similar, theoretic results, see, Lin, Enelow and Dorussen, 1999, and Erikson and Romero, 1990.) The minor departures from the mean voter position are due to the inclusion of the sociological variables in the voter utility functions. A cursory comparison of Figures 7 and 2 reveals that the equilibrium declarations with vote-maximizing parties are quite different from the empirical party declarations. Based on our 1989 data, the four major Dutch parties did not take electoral positions that are consistent with vote-maximizing behavior and equilibrium play.

5.2 Policy-Seeking Parties

Next we assume that parties put forth electoral declarations to influence the policy outcome of the impending cabinet formation game. To calculate $u_j(\psi_j|\psi_{-j}, D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi}, \beta)$ in this case, we calculate the vote shares that are implied by $\psi, D_{\text{mis}}, D_{\text{obs}}, \theta, \tilde{\psi}$ and β; allocate seats according to the d'Hondt method; calculate the equilibrium cabinet and associated policy output based on the Laver and Shepsle (1996) model; and then calculate the negative squared distance between this policy outcome and party j's ideal policy. Averaging over all 125 draws of the model parameters gives us an estimate of the expected utility of ψ_j to

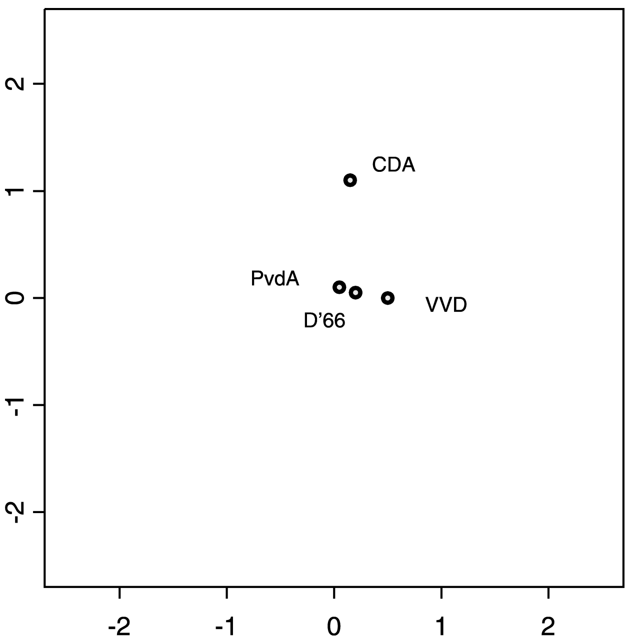

FIG. 8. *Equilibrium electoral declarations with policy-seeking parties, 1989.*

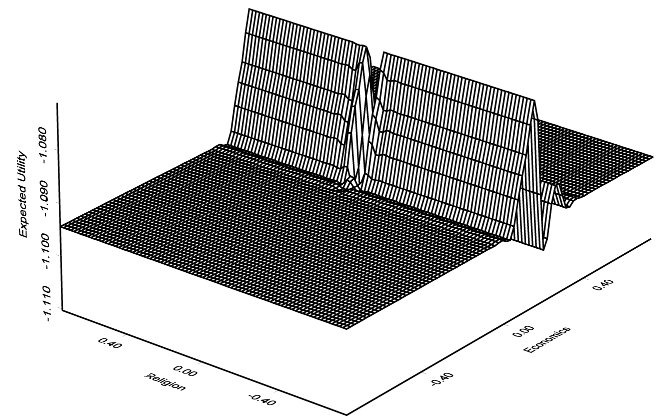

FIG. 9. *Expected utility to CDA of various electoral declarations, 1989.*

party j given the other party declarations and the observed data.

Once again we calculate Nash equilibria numerically based upon this specification of utility. Figure 8 displays the equilibrium party declarations in which parties are motivated by policy goals. This figure reveals a configuration of party positions that is much more in line with the empirical locations depicted in Figure 2.

To provide some intuition as to why we see such divergence in electoral declarations with policy-seeking parties we examine the CDA's expected utility function conditional on the equilibrium declarations of the other parties and the observed data. Figure 9 depicts this function. First, note that this is not an easy function to maximize. Because of the low dimensionality of the search space, we employed a very simple grid search on the $[-2, 2]$ square. [Before implementing the grid search, we experimented with various derivative-free optimization algorithms, including the Nelder and Mead (1965), simplex method. Due to the complexity of the objective function, as illustrated in Figure 9, these methods did not converge. In all of the Nash finding grid searches, we multistarted them from various points in the space, and have achieved the same equilibrium from each run. We have also used various grid sizes for the grid search. Of course, this in no way guarantees that the equilibrium is unique, but we do know that it is an equilibrium.] More importantly, Figure 9 provides important insight into why policy-seeking parties will tend to diverge from the center of the voter distribution. At its equilibrium declaration, the CDA is able to control economic policy but not social policy—there will always be a majority in parliament who are willing to block cabinets in which CDA can enact its rather extreme (relative to the other parties) preferred social policies. The only way that CDA can gain control over social policy is to move south of the PvdA's position. However, since we assume that parties must try to enact policy consistent with their electoral declarations, the CDA would actually be forced to enact social policy *that is more liberal than the social policy pursued by the PvdA in equilibrium*. This is why we see the dip in the CDA's expected utility as it takes centrist positions. If the CDA were to take extremely liberal social positions (corresponding to negative values on the social dimension), it once again is unable to implement social policy and consequently its utility is roughly the same as when it chooses extreme, conservative positions.

We also make a preliminary attempt to examine the extent to which these equilibrium results are dependent upon the salience of policy issues estimated from the 1989 data. As noted previously, issue voting has become increasingly prevalent in the Dutch electorate in recent years. Would we expect to see a different constellation of party declarations in equilibrium if voters attached increasing amounts of weight to issue concerns?

To examine this we computed a policy-maximizing equilibrium in which the MNL coefficient on spatial distance was set to be equal to the values drawn from the MNL posterior minus 1.00. This implies that voters are behaving in a much more deterministic manner. The equilibrium results (not shown here) are nearly identical to those from the empirically calibrated policy-seeking model. This suggests that the policy-seeking equilibria may be relatively robust to modest changes in the model parameters.

As a conjecture, we speculate that this model may help elucidate some of the microfoundations underlying the observations of scholars such as Lipset and Rokkan (1967) regarding the relative stasis in most party systems. It may well be the case that once an electoral equilibrium is reached, it may take very large changes in either voter preferences or the preferences of party leaders to result in noticeable shifts in the policy declarations of parties. Further, this model suggests that the reason many European parties in PR systems have not completely muted their programmatic appeals and become true "catchall" parties has less to do with ideological consistency as suggested by scholars such as Kirchheimer (1966) and more to do with the nonmonotonic relationship between seats and political power. Finally, it must be remembered that the real reason we see electoral divergence in our model is because parties are assumed to have diverse policy preferences. To understand the reasons for this, it is useful to return to the more traditional literature on party recruitment.

6. CONCLUSION

The results presented here strongly suggest that to understand electoral competition in multiparty democracies, it is not enough to know voter preferences and the dimensionality of the issue space. Instead, expectations of postelectoral coalition bargaining very likely exert a substantial effect on the electoral declarations of political parties.

This leaves us with the theoretical challenge of developing models of multiparty electoral politics that are based on richer assumptions about party motivations. In large part, this theoretical enterprise revolves around the correct specification of the parties' objective functions. The specification of these objective functions presupposes an understanding of (1) how electoral declarations translate into seat strengths, (2) how electoral declarations and seat strengths translate into governing coalitions, and (3) how electoral declarations, seat strengths and coalition structures translate into policy outcomes and government perquisites. The approach that we have adopted is but one of many ways to specify parties' objective functions.

The power of the computational approach presented in this article is that it does not require the ability to write down the parties' objective functions in closed form. Instead, all it requires is that one can evaluate the objective functions at any point in the policy space. While computational solutions lack the generality of analytical results, it is our belief that in areas such as multiparty electoral competition, where the phenomena under study are both extremely complex and where simple theoretical models seem at odds with empirical reality, a combination of empirical analysis and computational modeling offers great promise. By comparing the computed results of specific models against empirical observations, we can gain a better understanding of the strengths and weaknesses of the underlying theoretical models with the hope of continually refining and generalizing such models.

Further, just as numerical methods are often used to solve applied general equilibrium models in economics to better understand the policy impact of various types of government intervention, the modeling strategy sketched here can be used to gain insight into the normative consequences of demographic and institutional changes. For instance, it may be interesting to examine the effect of the Dutch population becoming increasingly secular. Would such a change result in different coalition governments or has the history of the Dutch party system put the CDA in a position where it can continue to be a major player in coalition politics despite the loss in votes that would come from the increasing secularization of politics? Using our modeling strategy it is sensible to entertain a counterfactual change in the composition of the voting public since (with nonstrategic voters) this should not affect voting behavior. Additionally, it would be possible to explore the implications of including the addition of another party into the political sphere (after making strong assumptions about the effect of sociological characteristics), changes in the distribution of voter preferences and the case when voters choose purely on the issues.

It is worth emphasizing that when conducting such counterfactual exercises one must be careful to entertain counterfactuals that are consistent with assumptions under which the model parameters were estimated. For instance, it is not possible for the model sketched here to answer the question of what would happen to equilibrium electoral declarations if an external shock such as a war or economic crisis gave political elites the opportunity to engage in heresthetic maneuvers that changed the dimensionality and components of the issue space. Such heresthetical changes would yield an entirely different spatial representation, which would be impossible to explore given our model.

Additionally, it would be impossible to explore the possibility of policy-minded sophisticated voting. Similarly, relaxing the independence of irrelevant alternative assumptions makes exploring the implications of party change impossible.

Substantively, this modeling strategy has the potential to clarify the microfoundations underlying more traditional qualitative analyses of European party systems. It is important to recognize that studying party declarations, voting behavior and coalition formation independently cannot provide answers to fundamental questions about multiparty democracies. To do so, it is vital to integrate these separate levels of analysis into a single theoretical and empirical model. The methodology we provide here allows us to do so.

APPENDIX: MCMC ALGORITHM FOR THE MEASUREMENT MODEL

The algorithm used to fit the measurement model is the following:

1. For $i = 1, \dots, N$, draw θ_i from $\mathcal{N}(\hat{\theta}_i, V_{\theta_i})$, where $V_{\theta_i} = (\Phi + \Lambda'\Sigma^{-1}\Lambda)^{-1}$ and $\hat{\theta}_i = V_{\theta_i}(\Lambda'\Sigma^{-1}w_i)$.
2. For $r = 1, \dots, R$, draw Λ_r from $\mathcal{N}(\hat{\Lambda}_r, V_{\Lambda_r})$, where $V_{\Lambda_r} = (\Sigma_{\Lambda_r} + \sigma_{rr}^{-2}\Theta'_{\Lambda_r}\Theta_{\Lambda_r})^{-1}$, $\hat{\Lambda}_r = V_{\Lambda_r}(\Sigma_{\Lambda_r}^{-1}\bar{\Lambda}_r + \sigma_{rr}^{-2}\Theta_{\Lambda_r}w_r)$ and Θ_{Λ_r} denotes the columns of Θ that correspond to Λ_r.
3. For $r = 1, \dots, R$, draw σ_{rr}^2 from $\mathcal{IG}[(\alpha + n)/2, (\beta + e_r)/2]$, where $e_r = (w_r - \Theta\Lambda'_r)'(w_r - \Theta\Lambda'_r)$.
4. Draw ρ via the Metropolis step:
   - Let $\rho^{(c)}$ denote the current value of ρ.
   - Draw $\rho^{(p)}$ from $\mathcal{N}(\rho^{(c)}, \delta)$, where δ is a user defined tuning parameter.
   - Set $\rho = \rho^{(p)}$ with probability
   $$\min\left\{1, \frac{p(\rho^{(p)}|w, \Lambda, \Sigma)}{p(\rho^{(c)}|w, \Lambda, \Sigma)}\right\};$$
   else set $\rho = \rho^{(p)}$, where $p(\rho|w, \Lambda, \Sigma) = f(w|\Lambda, \Sigma, \rho)p(\Lambda)p(\Sigma)p(\rho)$.

Iterating through this sequence of draws yields a series of draws from the joint posterior of $(\Lambda, \Theta, \Sigma, \rho)$. With the exception of the Metropolis step to sample the factor correlation coefficient, this algorithm is very similar to that in Lopes and West (1999).

We can sample from the joint distribution of the voter ideal points (θ) and the average voter perception of the party declarations at the time of the survey ($\tilde{\psi}$) by viewing it as a deterministic function of the model parameters. We can do so from $p(\theta, \tilde{\psi}|D_{\text{obs}}, D_{\text{mis}})$ by inserting the following steps into the MCMC sampling scheme:

- For $i = 1, \dots, N$ and $j = 1, \dots, J$, draw $\psi_i^{(j)}$ from $\mathcal{N}(\hat{\psi}_i^{(j)}, V_{\psi_i^{(j)}})$, where $V_{\psi_i^{(j)}} = (\Phi + \Lambda'\Sigma^{-1}\Lambda)^{-1}$ and $\hat{\psi}_i^{(j)} = V_{\psi_i^{(j)}}(\Lambda'\Sigma^{-1}w_i^{(j)})$.
- Calculate $\tilde{\psi}^{(j)} = \frac{1}{n}\sum_{i=1}^{n}\psi_i^{(j)}$.

This assumes that the voters use the same perceptual process to map party declarations from the five-dimensional issue space to the two-dimensional "predictive" space as they use to map their own preferences from the higher dimensional space to the lower dimensional space.

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