New Empirical Strategies to Model the Government Formation Process*

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ABSTRACT

The standard approach to the study of government choice involves using a conditional logit (CL) model with the formation opportunity as the unit of analysis. In this paper, we reconsider this approach and make three methodological contributions. First, we employ a mixed logit with random coefficients that allows us to take account of unobserved heterogeneity and relax the independence of irrelevant alternatives (IIA) assumption. We also demonstrate that the existing procedure used to test the IIA assumption and justify the use of the CL model is flawed and biased against finding IIA violations. Our own tests reveal that many government alternatives share unobserved attributes, thereby violating the IIA assumption and making the CL model inappropriate. Second, we move beyond simply presenting the sign and significance of model coefficients, and we suggest various strategies for interpreting the substantive influence of variables in models of government choice. Third, we return to a question that originally motivated this literature, namely, what determines the likelihood that a particular party enters government? We demonstrate that calculating probabilities for *parties* entering office rather than *governments* is straightforward in a mixed logit framework.

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1 Introduction

The theoretical literature dealing with government formation is arguably among the largest and most developed areas in all of comparative politics (Baron & Ferejohn 1989, Laver & Schofield 1990, Austen-Smith & Banks 1988, Laver & Shepsle 1996, Laver 1998, Schofield & Sened 2006). In contrast, empirical work designed to distinguish among different theoretical perspectives and predict the party composition of governments in the real world has, until recently, lagged behind. One reason for this is that empirical scholars were unclear about how to capture the fact that the government formation process involves the selection of a single government from the set of all potential governments. Following Martin and Stevenson's (2001) ground-breaking article, though, a consensus has quickly developed that the conditional logit (CL) model, which treats the government formation opportunity as the unit of analysis and each potential government (individual party or coalition of parties) as a choice category, is the most appropriate empirical strategy for modeling government choice. This has resulted in a rapidly growing empirical literature (Bäck 2003, Diermeier & Merlo 2004, Druckman, Martin & Thies 2005, Warwick 2005, Golder 2006*a*, Indriðason 2008, Skjaeveland, Serritzlew & Blom-Hansen 2007, Bäck & Dumont 2008, Kang 2009, Martin & Stevenson 2010).

The use of the CL model represents a significant advance over previous work, which had used the potential government as the unit of analysis. Two problems plague studies that use the potential government as the unit of analysis. The first has to do with the fact that the number of potential governments within any formation opportunity is $2^p - 1$, where p is the number of legislative parties. This means that countries where a large number of parties win parliamentary seats can have hundreds or even thousands of potential governments in a single formation opportunity, only one of which will enter office. For example, the fourteen parties that won legislative seats in Belgium in 1981 resulted in 16,383 potential governments. A consequence of this is that countries with a large number of parties contribute a disproportionate number of cases to analyses where the potential government is the unit of analysis, obscuring relationships in other countries (2001, 38).[1] The second problem with treating the potential government as the unit of analysis is that it fails to recognize that the probabilities of the various potential governments taking office in a particular formation opportunity are interrelated – as one potential government becomes more likely to take

[1] Although it is possible to try to weight cases in an attempt to avoid this problem (Browne 1970), evidence suggests that the results that are obtained are heavily influenced by the particular weighting scheme being used (Franklin & Mackie 1984).

office, other potential governments must become less likely to take office. A conditional logit model with the government formation opportunity as the unit of analysis corrects both of these problems.

Although the CL model represents an important advance in the study of government choice, significant empirical challenges remain. The first involves addressing the role of unobserved heterogeneity in the government formation process. Qualitative scholars have repeatedly shown that idiosyncratic contextual factors, such as personality clashes and ad hoc critical events, that are difficult or impossible to quantify can often have a significant impact on the choice of government (von Beyme 1985, Pridham 1986, Laver & Schofield 1990, 195-215). Substantively, we would like to understand what role these factors play in influencing the government formation process, and in particular, how these factors might induce variation in the influence of theoretically important variables. Methodologically, ignoring unobserved heterogeneity in the effects of our observed variables is likely to violate the CL model's assumption that the errors are independently and identically distributed (IID) across potential governments, leading to inconsistent parameter estimates. Failure to account for unobserved heterogeneity also leads to inaccurate estimates of substitution patterns – predictions of how the probabilities that potential governments will take office change as the characteristics of a government formation opportunity change. While the CL model recognizes that the probabilities of winning office across potential governments in a formation opportunity are interrelated, it makes the restrictive independence of irrelevant alternatives (IIA) assumption, thereby imposing a particular type of relationship on these probabilities. Using a model that accounts for unobserved heterogeneity and thus relaxes the IIA assumption will allow us to estimate more accurate substitution patterns.

A second challenge involves extracting and presenting quantities of substantive interest from our empirical models. Although it is well recognized that such practices can add greatly to our understanding of the political world (King, Tomz & Wittenberg 2000), it is rare for government formation scholars to interpret the substantive importance of the variables in their CL models of government choice, instead limiting themselves to discussing the sign and statistical significance of their model coefficients. Estimating the substantive significance of variables in models of government choice is difficult, as the choice categories within each formation opportunity are unique.

A third challenge involves understanding the factors that influence the likelihood that particular parties enter government (Laver & Hunt 1992, van Roozendaal 1993, Laver & Shepsle 1996, Mershon 1996).

The fact that the choice alternatives in the CL model refer to potential governments has led scholars to focus almost exclusively on the probability that particular *governments* take office, and to sideline the longstanding question as to why certain *parties* enter office. A few studies have attempted to examine the factors that influence which parties form the cabinet by specifying the political party as the unit of analysis (Druckman & Roberts 2007, Tavits 2008, Warwick 1996). However, this approach has one of the same fundamental flaws as using the potential government as the unit of analysis in studies of government choice, in that it fails to recognize that the probabilities of entering government across the parties in a particular formation opportunity are necessarily interrelated. We wish to return to the question of why some parties enter government and others do not in a way that corrects this methodological problem.

In this article, we make three methodological contributions that help to address these empirical challenges. First, we address the issue of unobserved heterogeneity by introducing the mixed logit model to the study of government formation. A mixed logit with random coefficients allows us to take account of unobserved heterogeneity and improve our substantive understanding of government choice. The mixed logit also relaxes the IIA assumption, allowing us to estimate more flexible and accurate substitution patterns. While addressing the issue of unobserved heterogeneity, we also demonstrate that the commonly used procedure for testing the IIA assumption in CL models of government choice is flawed and biased against finding IIA violations. Correcting these flaws reveals evidence that many potential governments share unobserved or unmeasured attributes, thereby violating the IIA assumption and suggesting that the CL model is almost certainly an inappropriate empirical strategy for studying government choice. Second, we consider several strategies for interpreting the substantive influence of variables in models of government formation. Third, we demonstrate that calculating the probability that particular parties enter office can be done in a straightforward way from either a CL or mixed logit model estimated using the government formation opportunity as the unit of analysis. This provides scholars with a methodologically sound way to renew their investigation into how the characteristics of political parties influence their likelihood of entering office.

2 The Current State of the Art

We begin by illustrating the current "state of the art" approach to empirically modeling the government formation process. In subsequent sections, we point out and correct flaws in this approach.

The dominant approach to studying government formation today involves using the government formation opportunity as the unit of observation, and modeling government choice as a discrete choice problem with each potential cabinet as a choice alternative in a single formation opportunity. This approach leads naturally to McFadden's (1974, 1974a) conditional logit model. In the CL model, the probability that government j is selected out of the set of K potential governments in formation opportunity i is given by:

$$P_{ij} = \frac{e^{x_{ij}\beta}}{\sum_{k=1}^{K} e^{x_{ik}\beta}} \tag{1}$$

where β represents a vector of coefficients and x_{ik} represents a matrix of independent variables associated with potential government k in selection opportunity i.

In Table 1, we replicate a CL analysis of government choice originally conducted by Martin and Stevenson (2001, 45, Model 7). The data for this analysis come from fourteen democratic countries – Austria, Belgium, Canada, Denmark, West Germany, Iceland, Ireland, Israel, Italy, Luxembourg, the Netherlands, Norway, Sweden, and the United Kingdom – from the mid-1940s to the mid-1980s. Given their focus on *coalition* governments, Martin and Stevenson exclude formation opportunities in which a single party controls a legislative majority. This yields a total of 220 formation opportunities and 33,256 potential governments.[2] The particular model specification employed here is designed to test a variety of hypotheses about how institutions and potential government characteristics relating to size and ideology affect the likelihood that a particular cabinet forms. For example, the hypotheses focus on how many parties are in a potential government and whether the potential cabinet contains the largest legislative party, the median ideological party, or the party of the previous prime minister (Leiserson 1968, Van Deeman 1989, Laver & Schofield 1990, Austen-Smith & Banks 1988). They also focus on whether the potential government is a minority coalition, a surplus majority coalition, or a minimal winning coalition (Riker 1962, Laver & Shepsle 1996). They account for whether the potential cabinet is the incumbent government (Strøm, Budge & Laver 1994), whether there are large ideological divisions in the potential government and in the opposition (De Swaan 1973, Warwick 1994, Laver & Schofield 1990), whether the potential cabinet contains an anti-system party (Budge & Hofferbert 1990), and whether the potential government faces an investiture vote (Strøm 1990). And finally, they address whether the parties in a potential government have reached a

[2]For a more complete description of the data, see Martin and Stevenson (2001).

Table 1: Conditional Logit Model for Government Choice

Dependent Variable: Choice of Government (1, 0)	
Regressor	M & S Model 7
Minority Coalition	-0.85*
	(0.48)
Minimal Winning Coalition	0.55**
	(0.26)
Number of Parties in the Coalition	-0.31**
	(0.14)
Largest Party in the Coalition	1.40***
	(0.27)
Median Party in the Coalition	0.32
	(0.20)
Ideological Divisions in the Coalition	-2.92***
	(0.85)
Ideological Divisions within Majority Opposition	2.64***
	(0.83)
Previous Prime Minister in the Coalition	-0.13
	(0.25)
Incumbent Coalition	1.89***
	(0.20)
Minority Coalition where Investiture Vote Required	-0.91***
	(0.34)
Anti-System Presence in the Coalition	-19.13***
	(3.71)
Pre-Electoral Pact associated with the Coalition	2.72***
	(0.62)
Anti-Pact associated with the Coalition	-4.10***
	(1.04)
Formation Opportunities	220
Potential Governments	33,256

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed).

Note: Unstandardized coefficients are shown with standard errors in parentheses. This model specification is equivalent to Martin and Stevenson's (2001, 45) Model 7.

pre-electoral coalition agreement, and whether at least one party in a potential government publicly refuses to go into office with another party from the same potential cabinet (Golder 2006*a*, Golder 2006*b*).

With few exceptions, interpretation of these kinds of CL models in the government formation literature is limited to examining the sign and statistical significance of the coefficients. With this in mind, the results presented in Table 1 indicate that minimal winning coalitions, governments containing the largest party, minority governments faced with an ideologically-divided opposition, incumbent governments, and governments with pre-electoral pacts are all more likely to form than governments without these characteristics. Conversely, additional parties, ideological divisions within the government, minority governments in systems where investiture votes are required, an anti-system party in the government, and anti-pacts associated with the coalition make potential cabinets less likely to enter office.

In the following sections, we illustrate that this approach to the study of government formation – a CL model with interpretation limited to examining the sign and statistical significance of the coefficients – has several flaws that once corrected lead to a better understanding of the government formation process.

3 Unobserved Heterogeneity in the Government Formation Process

A key substantive and methodological problem confronting scholars interested in the government formation process has to do with the role played by unobserved heterogeneity, or variation in unobserved contextual factors, across government formation opportunities. Qualitative researchers and country specialists have long pointed out that unobserved or unmeasured factors, such as personality clashes, ad hoc critical events, and general eccentricities on the part of political actors, can have a significant impact on the government formation process (Laver & Schofield 1990, 195-215). More generally, qualitative researchers are concerned with *causal complexity*, where the effect of any one variable may depend on which other contextual factors are present or absent (Braumoeller 2003, Jervis 1997, Ragin 1987). In our case, the concern is that observed variables that are crucially important for government choice in some contexts might be largely irrelevant or even obstacles in others because of idiosyncratic or case-specific contextual factors.

For example, it seems reasonable to think that policy divisions in a potential coalition might play a crucial role in the choice of government in some contexts but be largely inconsequential in others depending on how parties value the tradeoff between office and policy at particular points in time (Müller & Strøm 1999). Idiosyncratic events can also play an important role in the choice of government. Prior to the 1997 legislative elections in Norway, for instance, the Norwegian PM Thorbjørn Jagland declared that his Labor government would resign if it received less than 36.9% of the national vote (the percentage Labor had won in the previous election). Although the elections resulted in the Labor Party being the plurality winner, the fact that it won only 35% of the vote effectively ruled it out as a possible governmental party. The end result was the installation of a minority coalition government that controlled only about a quarter of the seats in parliament. As Strøm (2000, 284) notes, "[h]ad Jagland not committed himself to his game plan, he most likely could have continued in office after the election." In this particular example, any potential cabinet containing the incumbent PM party, the incumbent government, or the largest party were effectively ruled out due to an idiosyncratic event – an inadvisable pre-electoral declaration by the incumbent prime minister.

If we can observe (and measure) these types of case-specific contextual factors, then we can capture the conditional relationship between our observed variables and government choice through the use of multiplicative interaction terms (Brambor, Clark & Golder 2006, Kam & Franzese 2007, Berry, Golder & Milton 2010). Unfortunately, it is often the case that this kind of heterogeneity is caused by characteristics of the particular formation opportunity that are either unobserved or difficult to measure in a reliable and systematic fashion. And even if plausible measures are available, including them in empirical models can be a challenge. As an example, consider Martin and Stevenson's (2010, 10) recent attempt to capture one likely source of unobserved heterogeneity through the use of party-specific fixed effects. Such a strategy requires estimating a large number of additional parameters (73 party-specific dummy variables are required to replicate Martin and Stevenson's (2001, Model 7)), which can create multicollinearity problems for those covariates related to party characteristics. Moreover, it also necessitates some ad hoc restrictions on the coefficients for those party-specific dummy variables related to parties that have never entered government in order to avoid a separation problem (Zorn 2005). For example, Martin and Stevenson (2010, 12) constrain the coefficients for these party-specific dummy variables to be -3.

For these reasons, quantitative scholars have typically assumed that the only meaningful variation that exists across cases is captured by the observed variables in their models and, therefore, that idiosyncratic or case-specific contextual factors, such as Jagland's 1997 pre-electoral declaration in Norway, can be safely relegated to a random error term that is independently and identically (IID) distributed across observations. Unfortunately, this assumption is problematic when studying government formation on both substantive and methodological grounds.

Substantively, we wish to relax the assumption that all government formation opportunities are homogeneous, with the only interesting variation across cases captured by our observed variables. Although we cannot observe all of the contextual factors that influence government choice, understanding how these unobserved factors introduce variation into the effects of the variables that we can observe is valuable substantive information. Some potential government alternatives may be more (or less) attractive than others for reasons that are not fully captured by the independent variables in our models. For example, government alternatives that contain parties from particular ideological families, say the far right family, might be more or less acceptable in some countries than in others due to historical or other circumstances. In general, it is easy to think how features specific to particular countries or elections might make some government alternatives more or less attractive than others. By allowing this kind of heterogeneity and causal complexity to play a role in our empirical model, we help to bridge the gap between general theoretical models and case-specific studies, thereby building a more nuanced picture of government choice (Beck & Katz 2007, Western 1998). Unfortunately, the CL model cannot handle unobserved heterogeneity (Train 2009, 42).

4 Tests for IIA Violations in Government Formation Data

Methodologically, ignoring unobserved heterogeneity in the effects of our observed variables is likely to violate the CL model's assumption that the errors are independently and identically distributed (IID) across potential governments, leading to inconsistent estimates (Cameron & Trivedi 2005, 513). In particular, unobserved heterogeneity is likely to mean that the error terms associated with the potential cabinets in each government formation opportunity will be negatively correlated, as increases or decreases in the influence of the observed variables will systematically advantage some potential cabinets and disadvantage others.

Failure to address any violations of the IID assumption for our error term will also lead us to estimate incorrect substitution patterns between potential governments. In other words, we will incorrectly estimate how the probability that a potential government takes office as its characteristics or those of other potential governments in a formation opportunity change. This follows from the fact that the IID error term in the CL model is the basis for the well-known independence of irrelevant alternatives (IIA) assumption. Due to the types of unobserved heterogeneity described previously, it seems implausible that the IIA assumption will hold in the government formation setting, where there can be tens, hundreds, or even thousands of potential governments that share some unobserved characteristics.

Whether the IIA assumption is indeed violated in a particular setting is an empirical question, though, and one that can be evaluated with formal statistical tests such as the Hausman-McFadden test (Hausman 1978, Hausman & McFadden 1984). Remarkably, a number of recent studies have undertaken Hausman-McFadden tests and claim to have found no evidence of IIA violations in CL models of government choice. As we now demonstrate, though, previous empirical work has reached this conclusion because the commonly-used procedure for testing the IIA assumption in CL models of government choice is flawed and biased against finding IIA violations.

When considering the ratio of probabilities between alternatives A and B in the CL model, the denominators drop out, and with some rearranging we have:

$$P(A)/P(B) = e^{(x_a - x_b)\beta} \tag{2}$$

This is the basis for the IIA assumption imposed by the CL model – a change in the attributes of one potential government changes the probabilities of choosing the other governments in a way that preserves the ratios of probabilities between potential governments. That is, if government A is estimated to be twice as likely to form as government B, then IIA requires that this must remain true no matter how the attributes of government C might change. This assumption will be violated if, for instance, two potential governments have unobserved attributes that cause their error terms to be correlated.

Hausman-McFadden tests (hereafter HM tests) compare the coefficients estimated by the full CL model under examination ($\hat{\beta}_F$) with the coefficients obtained by estimating a restricted version of this CL model that omits one or more choice categories ($\hat{\beta}_R$). An intuitive understanding of the HM test for IIA violations emerges from examining the ratio of probabilities between two choice alternatives presented in Eq. (2). Since the observed data x_a and x_b remain the same no matter which other choice alternatives are included in the model, the only way for this ratio to change in response to a violation of the IIA assumption is for β to change. The test statistic is:

$$H_{IIA} = (\hat{\beta}_R - \hat{\beta}_F)'[\hat{V}(\hat{\beta}_R) - \hat{V}(\hat{\beta}_F)]^{-1}(\hat{\beta}_R - \hat{\beta}_F) \tag{3}$$

where $\hat{\beta}_F$ is restricted to only include those coefficients also included in $\hat{\beta}_R$, and where $\hat{V}(\hat{\beta}_R)$ and $\hat{V}(\hat{\beta}_F)$ are the estimated variance-covariance matrices from the full and restricted CL models respectively. This test statistic is distributed χ^2 with degrees of freedom equal to the number of coefficients in $\hat{\beta}_R$. Significant values of H_{IIA} indicate a significant difference in β across the two models, which is evidence that the IIA assumption has been violated.

HM tests have typically been employed in settings where the number of alternatives is relatively small. Most often researchers test for IIA violations with multiple HM tests, with each test omitting one of the choice alternatives. However, it is not immediately obvious how to conduct tests of this type in a situation with thousands of choice alternatives, such as the government formation process. Dropping a single alternative out of the thousands of choices available is unlikely to produce a statistically significant change in the model coefficients, even if there is an IIA violation. Martin and Stevenson (2001, 39) propose a procedure for testing the IIA assumption in the government formation context that has been adopted in subsequent studies. They begin by randomly dropping 10% of the alternatives from each formation opportunity (never dropping the government that actually formed) and conducting an HM test for IIA violations. They then repeat this process 20 times and report the average p-value of the Hausman-McFadden tests.[3] Subsequent studies have also adopted this approach, in some cases dropping up to 50% of the choice alternatives from each formation opportunity (Druckman, Martin & Thies 2005, Golder 2006*a*, Skjaeveland, Serritzlew & Blom-Hansen 2007, Bäck & Dumont 2008). To the best of our knowledge, not one of these studies has ever reported evidence of a violation of the IIA assumption, and have therefore proceeded with a CL model.

Unfortunately, this now-standard testing procedure for IIA violations in the government formation literature is flawed and biased against finding IIA violations. First, dropping a certain percentage of potential governments from each formation opportunity at random does not represent a plausible (or, indeed, possible) change to the choice set of potential governments in the real world. For example, such a procedure might lead to the removal of a potential single-party government made up of Party A from the choice set while leaving cabinets that include Party A as possible government alternatives. It is clearly impossible in the real world to have cabinets that include Party A be part of the choice set when Party A has itself been removed from the choice set. As the purpose of dropping choice alternatives in the HM test is to remove some subset of choices the could plausibly serve as a substitute for some of the remaining choices, dropping potential governments at random is a mistake. A better strategy is to drop all potential cabinets that include a particular party, thus examining how the choice probabilities for the potential governments change when a particular party (and all the potential cabinets that include this party) is removed from the legislature.

Second, an insignificant average p-value from a set of HM tests does not mean that the IIA assumption

[3] Although Martin and Stevenson attribute this test procedure to McFadden (1974a), we found no description of it in the cited article.

has not been violated. If any *one* HM test is significant, then this indicates that removing that choice alternative or set of choice alternatives has produced evidence of an IIA violation. For instance, if most potential government coalitions are independent, but a small subset are related for some unobserved reason, then the average p-value on a set of HM tests will likely be insignificant, but the IIA assumption would still be violated. Finally, it is necessary to employ a Bonferroni correction for the test p-values to take account of the fact that some IIA violations are likely to appear by chance given the large number of HM tests that are typically conducted when studying the government formation process.

To study whether our corrections to the standard HM test employed in the government formation literature reveal evidence of IIA violations, we performed a set of HM tests on the CL model presented in Table 1, sequentially correcting each of the three problems described above.

We first conducted 100 HM tests, randomly dropping 10% of the potential governments from each formation opportunity (never dropping the government that actually formed). The mean p-value from these tests was 0.86, which in previous work would have led scholars to conclude that there were no IIA violations and, therefore, that the CL model was an appropriate empirical strategy for examining government choice. However, rather than averaging the p-values from the tests, we examined each individual p-value to determine if any one test found an IIA violation. We found that the HM test produced a p-value of less than 0.05 in 5 of the 100 tests, indicating multiple violations of the IIA assumption.

We then applied a Bonferroni correction to the p-values of these tests. This correction adjusts the p-value required for statistical significance when multiple tests are applied by dividing the significance level by the number of tests conducted. Specifically, if an analyst conducts n statistical tests on the same data, then the Bonferroni correction involves evaluating each individual test at a statistical significance level of $1/n$ times what it would be if only one test were being conducted. Given that we wanted to limit the risk of making at least one Type I error – rejecting the null of IIA when the null is true – to a significance level of $\alpha = 0.05$ ("familywise" alpha) for the family of tests, the Bonferroni correction required that the p-value from any individual HM test be less than $\alpha = 0.05/100 = 0.0005$ ("testwise" alpha) for us to conclude that IIA was violated (Abdi 2007). Even with this conservative Bonferroni correction, we found that 2 out of the 100 HM tests we conducted produced evidence of IIA violations.

Finally, rather than conducting a series of HM tests in each of which we drop a random subset of potential governments, we conducted a series of tests that sequentially dropped each political party and all the potential governments containing this party from a single formation opportunity at a time. For example, one of the HM tests involved dropping all potential governments in the 1949 Austrian government formation opportunity that included the *Österreichische Volkspartei* (Austrian People's Party), while another test involved dropping all potential governments in the 1987 Irish government formation opportunity that included Fine Gael. Although the average number of potential governments that were dropped in any given test corresponded to less than 0.5% of the entire sample, we still found evidence of IIA violations when dropping the potential governments related to 12 parties (4 after the Bonferroni correction). That is, even when we just drop the potential cabinets related to a *single* party in a *single* formation opportunity from the whole data set (220 formation opportunities and 33,256 potential governments), and even with a Bonferroni correction, we found clear evidence of IIA violations in this CL model.

Overall these tests for IIA violations provide strong evidence that some potential governments are perceived as substitutes for unobserved reasons and, therefore, that the CL model is an inappropriate empirical strategy in the government formation context. Further, even if IIA tests fail to indicate the presence of IIA violations, it is generally unwise for scholars to conclude that there are no IIA violations, as there is growing evidence that IIA tests of all sorts frequently fail to identify IIA violations, even in Monte Carlo studies where the data are explicitly constructed with IIA violations (Cheng & Long 2007). Perhaps the best advice on IIA violations is that models that make the IIA assumption, such as the conditional logit, should only be used when the choice categories "can plausibly be assumed to be distinct and weighed independently in the eyes of each decision maker" (McFadden 1974). This is clearly not the case for potential government alternatives in government formation opportunities.

5 Mixed Logit Models and the Government Formation Process

These substantive and methodological concerns with unobserved heterogeneity and IIA violations can be addressed with a mixed logit (MXL) specified as a random coefficients model (Train 1998, McFadden & Train 2000, Glasgow 2001).

Substantively, we want to specify a model where the effects of the independent variables are allowed to vary across government formation opportunities. For example, we might want to allow for the possibility that the effect of ideological divisions within a potential government might vary depending on how the parties value office versus policy, something that is very difficult to observe, let alone measure. Ideological differences might have a strongly negative effect in some situations but have no effect in others, depending on the value that the parties in question place on policy. We can allow the effects of such independent variables to vary across formation opportunities through a random coefficients setup in our MXL model, where the independent variables have a mean effect β that is adjusted upward or downward by some amount η_i in each government formation opportunity i.

If we could observe this adjustment for each formation opportunity, then the probability that government j is selected in formation opportunity i is simply the conditional logit probability from Eq. (1), with each probability adjusted by adding the constant term η_i to β:

$$P_{ij} = \frac{e^{x_{ij}\beta + x_{ij}\eta_i}}{\sum_{k=1}^{K} e^{x_{ik}\beta + x_{ik}\eta_i}} \tag{4}$$

Of course, η_i is not actually observed because it is a function of the unobserved or unmeasured factors that affect government choice. We solve this problem by specifying a joint probability distribution $g(\eta|\Omega)$ for η, where Ω are the fixed parameters of the distribution g – this specifies the distributions of our random coefficients. We can then obtain the unconditional probability that a potential government is selected by integrating the term in Eq. (4) over all possible values of η weighted by the density function of η as given by g:

$$P_{ij} = \int \left[\frac{e^{x_{ij}\beta + x_{ij}\eta_i}}{\sum_{k=1}^{K} e^{x_{ik}\beta + x_{ik}\eta_i}} \right] g(\eta|\Omega) d\eta \tag{5}$$

This is the mixed logit model, so named because the choice probabilities are a mixture of CL probabilities, each with different values for the ηs and a weight determined by the mixing distribution g. Estimating this mixed logit gives us β and Ω – the means and covariance matrix of our random coefficients. Note that while η varies across government formation opportunities, it does not vary across potential governments in a single formation opportunity. This introduces correlation across potential governments into the factors that affect the probability that a cabinet will enter office, thereby relaxing the IIA assumption, even if the covariance matrix of the random coefficients Ω is diagonal.

Mixed logit models are extremely flexible and researchers can specify any distribution they wish for the ηs. In general, MXL models cannot be estimated through standard maximum likelihood techniques because the integral for the choice probabilities in Eq. (5) has no closed-form solution. Instead, they are estimated through maximum simulated likelihood. For each formation opportunity, a value for η_i is drawn from $g(\eta|\Omega)$ and used to calculate $\hat{P}_{ij}$, the conditional choice probability in Eq. (4). This process is repeated R times and the integration over $g(\eta|\Omega)$ is approximated by averaging over the R conditional choice probabilities for each formation opportunity. A simulated log-likelihood function is then created from these simulated probabilities and is maximized with conventional maximum likelihood techniques. In our estimates below we use 125 Halton draws to calculate the conditional choice probabilities. The use of quasi-random sequences such as Halton draws allows for a better coverage of the interval over which the integration is to be performed (for a given number of draws) than if we were to draw randomly, greatly increasing the speed of estimation (Train 2009, 228).[4]

To demonstrate how a mixed logit can contribute to our substantive understanding of government choice, we compare the results from a conditional logit estimated by Martin and Stevenson (2001, 45, Model 7) to those from a mixed logit estimated on the same data. The mixed logit specification is nearly identical to that of the conditional logit, except that four of the coefficients are now assumed to be randomly distributed.[5] The random coefficients are assumed to be uncorrelated, with the mean of each random coefficient given by β and the variance of each random coefficient given by the appropriate element in Ω.

We specify that the coefficients on *Previous Prime Minister in the Coalition* and *Incumbent Coalition* follow normal distributions to allow for the possibility that incumbents, whether the incumbent prime ministerial party or the incumbent government as a whole, are advantaged when it comes to getting into government in some situations but disadvantaged in others.[6] The Norwegian example from earlier already suggests

[4]In theory, a random coefficients multinomial probit (MNP) model could also address our substantive and methodological concerns with unobserved heterogeneity and IIA violations (Hausman & Wise 1978, Haaijer et al. 1998), and MNP models have been employed in the political science literature in this capacity in the past (Alvarez & Nagler 1998*b*, Alvarez & Nagler 1998*a*, Schofield et al. 1998, Quinn, Martin & Whitford 1999). However, estimating a MNP model involves solving a $K-1$ dimensional integral, where K is the number of choice alternatives in the dataset. In the government formation setting, where the number of potential governments in a single formation opportunity can number in the thousands, estimating a MNP is a practical impossibility with standard maximum simulated likelihood techniques. The mixed logit model does not face the same estimation hurdle, as the dimension of integration is defined by the number of random coefficients in the model, not the number of choice alternatives.

[5]It is worth noting that while it is possible to place random coefficients on all of the covariates in a model, identification can sometimes be empirically difficult (Revelt & Train 1998, 650).

[6]An appealing characteristic of the normal distribution is that it can be justified in terms of the central limit theorem – when a large number of random shocks, some positive and some negative, change the effect of a particular covariate in an additive manner,

that idiosyncratic case-specific events can affect both the likelihood that the incumbent PM party and the likelihood that the incumbent government as a whole are returned to office. There is also good reason to believe that things like the performance of incumbent parties in office or how the previous cabinet terminated that are not captured in the original Martin and Stevenson (2001) model are likely to influence the probability that the incumbent government and PM party are reselected (Glasgow, Golder & Golder 2010, Martin & Stevenson 2010).

We specify that the coefficients on *Ideological Divisions in the Coalition* follow a lognormal distribution. The lognormal assumes that the distribution of coefficients on a covariate is non-negative, but non-positive distributions can be estimated by simply entering the negative of the covariate into the model. We selected a lognormal distribution because ideological divisions within a potential government are not theoretically expected to increase the likelihood that it will enter government, but it may have a negative effect, with the severity of the negative effect varying across government formation opportunities. For instance, there is evidence that some political parties are more "ideologically pure" than others, and are less likely to moderate their ideological positions in an effort to gain power (Adams et al. 2006). For similar reasons, we also specify that the coefficients on *Ideological Divisions within Majority Opposition* follow a positive lognormal distribution. Theory indicates that minority governments are always more likely to form when potential majority coalitions are ideologically divided. However, it seems reasonable to think that the magnitude of this positive effect may vary from one government formation opportunity to another depending on how parties value the tradeoff between office and policy.

The results from estimating the CL and MXL models described above are presented in Table 2. The mixed logit results are shown in the first two columns, with the four covariates with random coefficients shown at the bottom. The conditional logit results are shown in the third column.

To some extent, the *fixed* coefficients in the mixed logit lead to the same substantive insights as the corresponding coefficients in the conditional logit. For example, both models indicate that minimal winning coalitions, governments containing the largest party, and governments based on pre-electoral agreements are more likely to enter office. Both models also indicate that minority coalitions, governments containing anti-system parties, and governments containing parties that have publicly refused to govern together are

then the distribution of the effect of this covariate becomes normal (Hensher & Greene 2003).

Table 2: Mixed Logit and Conditional Logit Models for Government Choice

Dependent Variable: Choice of Government (1, 0)

Regressor	Mixed Logit		Conditional Logit
Minority Coalition	-1.48**		-0.85*
	(0.65)		(0.48)
Minimal Winning Coalition	1.01***		0.55**
	(0.31)		(0.26)
Number of Parties in the Coalition	-0.10		-0.31**
	(0.15)		(0.14)
Largest Party in the Coalition	1.41***		1.40***
	(0.32)		(0.27)
Median Party in the Coalition	0.53**		0.32
	(0.24)		(0.20)
Minority Coalition where Investiture Vote Required	-1.03*		-0.91***
	(0.55)		(0.34)
Anti-System Presence in the Coalition	-20.58***		-19.13***
	(4.33)		(3.71)
Pre-Electoral Pact associated with the Coalition	3.90***		2.72***
	(0.84)		(0.62)
Anti-Pact associated with the Coalition	-5.36***		-4.10***
	(1.14)		(1.04)
	Mean Coefficient	Std. dev. of Coefficient	
Incumbent Coalition	1.29**	4.26***	1.89***
	(0.53)	(1.17)	(0.20)
Previous Prime Minister in the Coalition	0.08	0.11	-0.13
	(0.29)	(0.81)	(0.25)
	Mean ln(Coefficient)	Std. dev. of ln(Coefficient)	
Ideological Divisions in the Coalition	-2.55	5.47**	-2.92***
	(2.91)	(2.49)	(0.85)
Ideological Divisions within Majority Opposition	1.62***	-0.01	2.64***
	(0.22)	(0.46)	(0.83)
Formation Opportunities	220		220
Potential Governments	33,256		33,256

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed).

Note: The first two columns present the results from a mixed logit model, while the final column presents the results from a conditional logit model. Standard errors are shown in parentheses. The random coefficients on *Incumbent Coalition* and *Previous Prime Minister in the Coalition* are normally distributed, while the random coefficients on *Ideological Divisions in the Coalition* and *Ideological Divisions within Majority Opposition* are lognormally distributed. As each of the lognormal distributions is parameterized in terms of the underlying normal, we report parameters μ and σ^2 that represent the mean and variance of the log of the coefficients: $\ln\beta_k \sim N(\mu, \sigma^2)$.

less likely to enter office. However, there are important substantive differences. In contrast to the CL model, for example, the mixed logit indicates that governments containing the median legislative party are more likely to enter office and that the number of parties in a coalition has no statistically significant effect on a coalition's probability of becoming the government.

It is apparent that the mixed logit's ability to allow for unobserved heterogeneity through the use of random coefficients also adds to our substantive understanding of the government formation process.

Although there are no differences in the inferences one would draw regarding *Previous Prime Minister in the Coalition* across the two models, consider the mixed logit results related to *Incumbent Coalition*. The statistically significant mean coefficient indicates that the incumbent government is more likely to enter office than other potential governments, just as the CL model reveals. However, note that the standard deviation on the *Incumbent Coalition* coefficient is large relative to its mean and statistically significant. This indicates that the effect of being the incumbent government on entering office varies considerably from one formation opportunity to the next, and is in fact negative 38.1% of the time.[7] This result contradicts the inference from the conditional logit model that incumbent governments are *always* advantaged when it comes to government formation.

Now consider the lognormal coefficients on *Ideological Divisions in the Coalition* and *Ideological Divisions within Majority Opposition*. A coefficient β_k follows a lognormal if the log of β_k is normally distributed. In our mixed logit, we parameterize the lognormal distribution in terms of the underlying normal, estimating parameters μ and σ^2 that represent the mean and variance of the log of the coefficient: $\ln\beta_k \sim N(\mu, \sigma^2)$. While the standard deviation is statistically insignificant for *Ideological Divisions within Majority Opposition*, the large and statistically significant standard deviation for *Ideological Divisions in the Coalition* indicates the presence of considerable unobserved heterogeneity in the influence of ideological divisions on the probability that a coalition will enter office. In other words, the negative effect of ideological divisions within a potential government matter much more in some formation opportunities than others.

In some cases the discovery of unobserved heterogeneity in the effect of a covariate in an MXL model may be a precursor to further theory development, leading scholars to think about exactly what unobserved or unmeasured factors might be causing it. These factors can then be included as conditioning variables in future analyses. Indeed, two recent studies suggest that at least some of the unobserved heterogeneity in the effect of *Incumbent Coalition* has to do with the performance of incumbent parties while in office and with whether the incumbent government ended in public conflict or not (Glasgow, Golder & Golder 2010, Martin & Stevenson 2010). It is worth noting, though, that many of the factors that qualitative country experts believe are being ignored by large-N quantitative scholars, and which lead to possible unobserved heterogeneity, are case-specific, and it will be impossible to construct a general theory to explain them. For

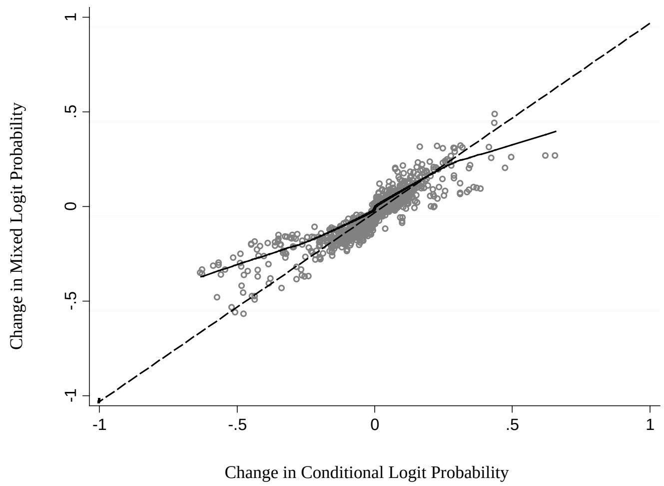
[7] This calculation is based on the estimated mean and standard deviation of the normally distributed random coefficient.

example, it is hard to come up with a general theory to explain the reckless pre-electoral declaration by the Norwegian PM that ruled out all potential cabinets that included his party from forming the government in Norway in 1997.

The statistically significant standard deviations on the random coefficients in the mixed logit presented in Table 2 clearly indicate the presence of unobserved heterogeneity, which demonstrates that the CL model's assumption that the error term is IID across potential governments has been violated. A widespread misconception is that since CL parameter estimates are often similar to the parameter estimates produced by models that relax the IIA assumption, IIA violations are inconsequential. This is incorrect. A failure to address violations of the IID assumption for our error term will lead to inconsistent parameter estimates (Cameron & Trivedi 2005, 513). IIA violations will also lead us to estimate incorrect *substitution patterns* between potential governments. In other words, we will incorrectly estimate how the probability that a potential government takes office changes as its characteristics or those of other potential governments change. Previous research suggesting that IIA violations are "rarely relevant" (Dow & Endersby 2004) has only considered differences in parameter estimates, neglecting to study how IIA violations influence predicted substitution patterns.

We demonstrate how IIA violations can lead to incorrect substantive inferences in the present context with the help of Figure 1, which plots the predicted change in probability for each potential government in our data set if we switch largest party status between the largest and second largest parties in each government formation opportunity. The changes in probability estimated by the CL model are plotted on the horizontal axis, while the changes for the MXL model are plotted on the vertical axis. The probability changes would line up along the dashed 45 degree line if the CL and MXL models produced the same estimated changes in probabilities in this hypothetical scenario. The solid black line (a lowess curve) summarizes the actual relationship between the CL and MXL probabilities, demonstrating that the CL model tends to overestimate the changes in the probability that a potential government will form when the identity of the largest party changes. This is a clear indication that any counterfactual analysis we might undertake with the CL model is likely to be substantively misleading.

Figure 1: Comparing Mixed Logit and Conditional Logit Substitution Patterns



Note: Figure 1 plots the predicted change in probability for each potential government in our data set as we switch largest party status from the largest to the second largest party in each government formation opportunity. The changes in probability estimated by the CL model are plotted on the horizontal axis, while the changes for the MXL model are plotted on the vertical axis. The probability changes would line up along the dashed 45 degree line if the CL and MXL models produced the same estimated changes in probabilities for this hypothetical scenario. The solid black line – a lowess curve with bandwidth 0.2 – summarizes the relationship between the CL and MXL probabilities.

6 Substantive Interpretation of Models of Government Formation

To date, nearly all empirical studies of the government formation process have simply reported the sign and statistical significance of the model coefficients, and made no effort to interpret the substantive importance of these coefficients. Substantive interpretation can be difficult in models of government choice due to the large number of choice alternatives, each of which is unique to a particular government formation opportunity. The large number of choice alternatives with near zero probabilities also poses a challenge – for instance, nearly 95% of the choice probabilities from the MXL and CL models presented in Table 2 are less than 0.01. However, with some care, the same techniques that are regularly used to interpret non-linear models in other political science settings can easily be applied to models of government formation.

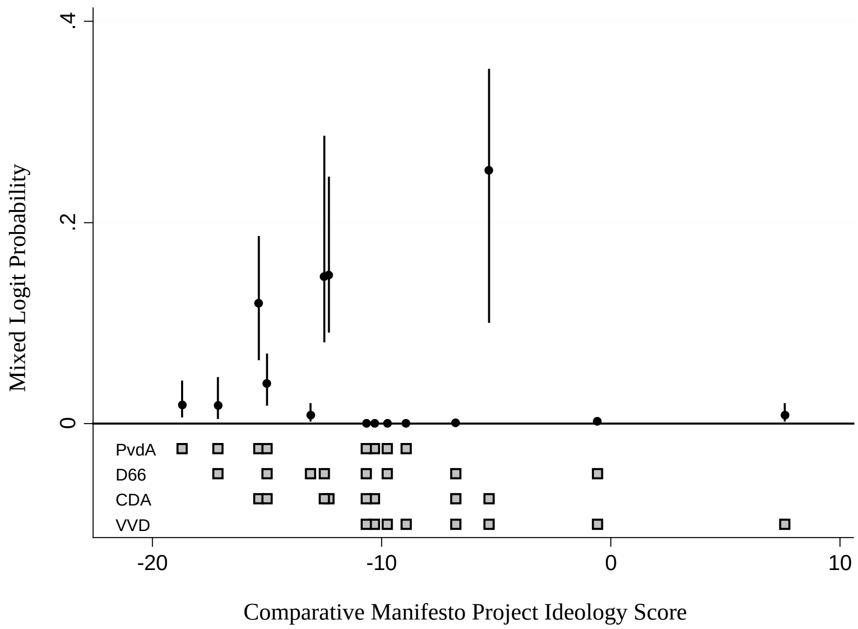
In a recent study, Martin and Stevenson (2010) calculated odds ratios for changes in some independent variables in an effort to report the substantive significance of their model coefficients. We could use the results from the CL model presented in Table 2 in a similar way to, say, calculate the odds that a potential government containing the largest party would form versus some alternate government. Such a calculation – $\frac{e^{1.40\times 1}}{e^{1.40\times 0}} = 4.06$ – suggests that a potential government containing the largest party is 4.06 times as likely to form as a potential government without the largest party, holding all other variables constant.

Although calculating log odds like this is a standard approach to interpreting CL coefficients, it is likely to produce misleading estimates of the substantive effects of coefficients in models of government choice, since in many cases changing the value of a variable for one potential government logically implies changes in the values of variables for other potential governments in a formation opportunity. This has important implications for the substantive effects we calculate. For instance, the probability that a particular potential government forms if it no longer contains the largest party will depend on which other potential government in the formation opportunity *does* contain the largest party. Further, changes in which potential government includes the largest party will also produce other changes in this counterfactual case, such as changes in the set of minimal winning and minority coalitions. This problem is analogous to calculating the odds ratio for a single variable that is also part of an interaction term – without accounting for the interaction term, statements about the substantive effect of the variable will be misleading. In effect, the substantive effect of a covariate in models of government choice cannot accurately be captured with a single value – the substantive effect will vary both across formation opportunities and within formation opportunities depending on how the characteristics of the various potential governments in a formation opportunity change. For this reason, our preference for calculating substantive effects for model coefficients is to create one or more hypothetical cases (either based on real-world cases or hypothetical cases of interest created by the researcher), and calculate predicted probabilities for various counterfactuals.

As an example of this kind of substantive analysis, we start with a hypothetical case based on the government formation opportunity resembling the one that took place in the Netherlands following the 1981 election. We base our hypothetical case on a Dutch government formation opportunity because it is widely recognized that Dutch elections are representative of the types of elections that occur in multiparty parliamentary democracies (Rose & McAllister 1986), and because we wish to follow in a long line of studies that have used Dutch elections to demonstrate methodological advances in the use of discrete choice models (Alvarez & Nagler 1998*b*, Schofield et al. 1998, Quinn, Martin & Whitford 1999, Glasgow & Alvarez 2005). Although there were ten parties in the Dutch legislature in 1981, we focus on potential governments involving the four largest political parties.

In Figure 2 we present the predicted probabilities for every potential government that could be formed

Figure 2: The Predicted Probability of Entering Office for Various Potential Governments (Netherlands 1981)



Note: The results presented here are for a government formation opportunity resembling the one that took place in the Netherlands in 1981. The four major parties in the Dutch legislature are shown at the bottom, with grey squares indicating which parties belong to each potential government. The potential governments are presented in ideological order from left to right, based on the seat-share weighted average of the CMP ideological scores for each party: PvdA -18.7, D66 -13.1, CDA -12.3, VVD 7.6. Estimates are based on simulations using 10,000 draws from the estimated coefficient vector and variance-covariance matrix.

from the four major parties in the 1981 Dutch election using the results from the mixed logit model in Table 2. These potential governments are presented in ideological order from left to right, based on the seat-share weighted average of the Comparative Manifesto Project (CMP) ideological scores for each party (Budge et al. 2001). The *Christen-Democratisch Appel* (CDA), the *Democraten 66* (D66), and the *Partij van de Arbeid* (PvdA) were all centrist parties, with the CDA slightly to the right and the PvdA and D66 slightly to the left. The *Volkspartij voor Vrijheid en Democratie* (VVD) was more ideologically distinct and clearly on the right. The four major parties are listed at the bottom of the graph, with grey squares indicating which parties belong to each potential government. For each potential government, we calculated 10,000 predicted probabilites using draws from the estimated coefficient vector and variance-covariance matrix – the means and 95% confidence intervals (based on the 2.5th and 97.5th percentile of the 10,000 probabilities) are presented here. Note that the 95% CIs will not necessarily be symmetrical around the mean.

An examination of Figure 2 reveals several features of our model of government choice. For example, ideologically-divided coalitions such as the PvdA-VVD and D66-VVD coalitions have a very low probability of forming, even lower than single-party minority governments. Potential governments involving the largest party (CDA) tend to have a higher likelihood of forming, with the incumbent CDA-VVD coalition having the highest probability.

Counterfactual analyses for these kinds of hypothetical cases are also relatively straightforward. To illustrate this, we focus on four of the potential governments shown in Figure 2 that received attention from political actors and media at the time: CDA-VVD, CDA-PvdA, CDA-D66, and CDA-PvdA-D66. In Table 3 we present the predicted probabilities that each of these potential governments enter office based on the mixed logit model presented in Table 2. In the first column, we indicate the mixed logit predicted probabilities that each of the four potential governments would enter office in the baseline scenario where the independent variables take on the actual values observed in the real-world formation opportunity. Standard errors are shown in parentheses. As indicated at the top of the first column, the CDA was the largest party. In the subsequent columns, we indicate the predicted probabilities that each potential government enters office when we transfer largest party status from the real-world largest party to one of the other three parties. It is important to note that when we transfer the largest party status from one party to another that this can result in other changes such as whether potential governments are minimal winning or minority, and whether they contain the median ideological party; all of these changes must be taken into account when calculating predicted probabilities in the counterfactual scenarios. Finally, we also indicate the change in predicted probability from the baseline scenario to the counterfactual one, and whether the change is statistically significant.

As was already apparent from Figure 2, a CDA-VVD government is the most likely outcome in the baseline scenario, followed by a CDA-D66 and then a CDA-PvdA government. Changing largest party status from the CDA to the PvdA increases the likelihood of a CDA-PvdA or CDA-PvdA-D66 coalition, and reduces the probability of a CDA-VVD coalition, while changing largest party status from the CDA to the VVD has the opposite effect i.e. the probability of a CDA-PvdA coalition decreases but that of a CDA-VVD coalition increase. These two counterfactuals reveal that as a large, centrist party, the CDA was likely to be a member of the governing coalition whether the largest party was on the left or the right. In

Table 3: The Substantive Influence of Largest Party Status on Government Formation (Netherlands 1981)

	Largest Party and *Party Size*						
	CDA	CDA→PvdA		CDA→VVD		CDA→D66	
Coalition	Predicted Probability	Predicted Probability	Change in Probability	Predicted Probability	Change in Probability	Predicted Probability	Change in Probability
CDA-VVD	0.25	0.19	-0.06**	0.52	0.27***	0.13	-0.12***
	(0.06)	(0.06)	(0.03)	(0.09)	(0.08)	(0.05)	(0.03)
CDA-PvdA	0.12	0.19	0.07***	0.004	-0.12***	0.002	-0.12***
	(0.03)	(0.05)	(0.02)	(0.002)	(0.03)	(0.002)	(0.03)
CDA-D66	0.15	0.06	-0.08**	0.07	-0.08***	0.28	0.14*
	(0.05)	(0.03)	(0.03)	(0.04)	(0.03)	(0.09)	(0.07)
CDA-PvdA-D66	0.04	0.06	0.02***	0.05	0.01	0.02	-0.02
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)

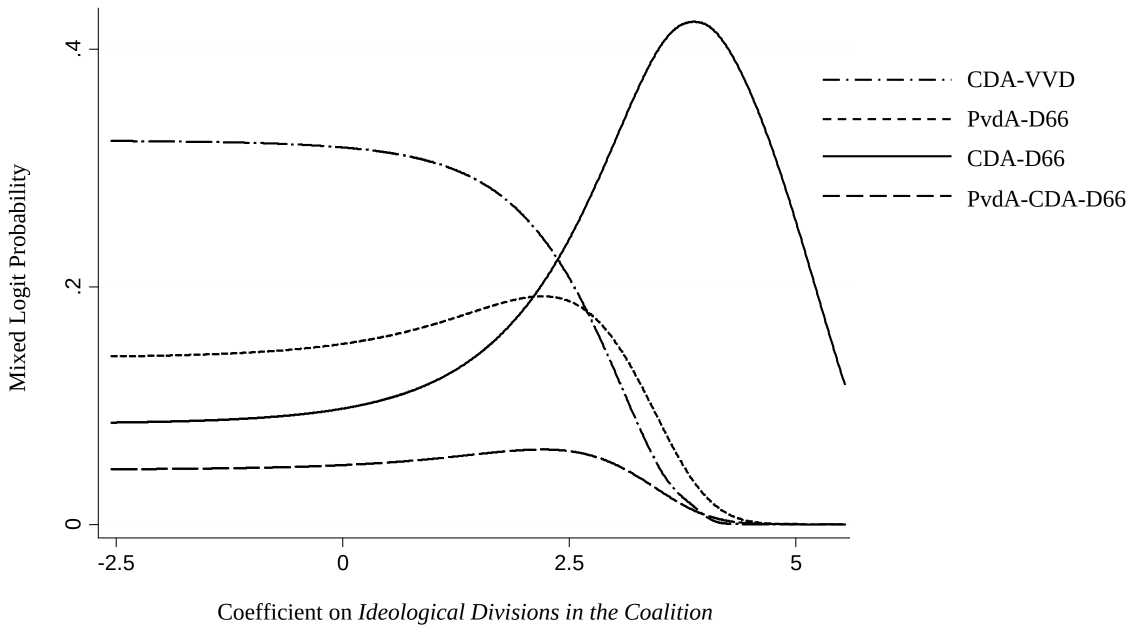
Note: The results presented here are for a government formation opportunity resembling the one that took place in the Netherlands in 1981. The first column indicates the mixed logit predicted probabilities for four selected potential governments in the baseline scenario when the independent variables take on the actual values observed in the real-world selection opportunity. The remaining columns indicate either predicted probabilities or changes in predicted probabilities as we transfer largest party status from the CDA to one of the other three major parties. Note that in some cases this change in largest party status also leads to changes in whether potential governments are minimal winning or minority, and whether they contain the median ideological party. Standard errors are shown in parentheses. Statistically significant changes in predicted probability are indicated: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed). Estimates are based on simulations using 10,000 draws from the estimated coefficient vector and variance-covariance matrix.

contrast, the probability of both the CDA-VVD and CDA-PvdA coalitions declines when the D66 becomes the largest party, and the probability of the CDA-D66 coalition does not significantly increase. This is because the D66 is replacing the CDA as the largest *centrist* party in this particular counterfactual.

The actual government that formed following the 1981 Dutch elections was a center-left, three-party coalition comprising the PvdA, CDA, and the D66. To a large extent, this outcome can be explained by idiosyncratic contextual factors specific to the 1981 Dutch formation opportunity. At this point in Dutch political history, forming a stable government was quite a challenge. The previous election, held in 1977, was followed by the longest delay in forming a government ever recorded in Europe - a record-setting 208 days (Golder 2010). This delay was due in part to policy disagreements between potential coalition parties, personal conflicts between party leaders, and the strategic choices by a couple of parties that rendered certain coalitions all but impossible to form (Irwin 1983). The eventual outcome of the 1977 government formation process was a CDA-VVD coalition. Many Dutch voters considered this outcome to be illegitimate because the social-democratic PvdA was seen as having won a 'landslide victory' in the elections (it was the largest party and had made an historic gain of 10 legislative seats) and yet did not manage to enter government. The CDA-VVD government made matters worse by implementing a more right-wing policy in response to the economic problems of the time than much of the Dutch electorate wanted. During the legislative term, the PvdA played a purely obstructionist role in opposition. In contrast, the progressive-liberal D66 acted as a much more "reasonable opposition" and saw its popularity rise as a consequence (van Mierlo 1981, 300). Ideological divisions between potential coalition partners were particularly salient in the 1981 elections given the unpopularity of the right-wing economic policies favored by the VVD and the fact that much of the Dutch electorate had thought that a PvdA-led left-wing government, rather than a right-wing government, should have formed in 1977. That the D66 made it into government with the CDA and PvdA can be explained by its perceived good performance while in opposition and its subsequent increase in legislative seats.

As a substantive example of how idiosyncratic case-specific factors like those in the 1981 Dutch formation opportunity can influence the government formation process, Figure 3 illustrates how heterogeneity in the effect of *Ideological Divisions in the Coalition* affects the mixed logit predicted probabilities of entering office for the potential governments presented in Table 3. The four lines indicate how the predicted

Figure 3: The Predicted Probability of Becoming the Government as the Coefficient on *Ideological Divisions in the Coalition* Varies (Netherlands 1981)



Note: To calculate the mixed logit predicted probabilities, we set the values of the independent variables to be the same as those characterizing the potential governments in the 1981 government formation opportunity in the Netherlands. The only thing that we varied was the value of the logged coefficient on *Ideological Divisions in the Coalition*, across a range that captured most of the changes in probability. The mean logged coefficient on *Ideological Divisions in the Coalition* is -2.55.

probability of entering office for each of these potential governments changes as we vary the magnitude of the logged coefficient on *Ideological Divisions in the Coalition* from -2.5 to 5.5, holding all else constant.

Of the four potential governments examined here, the ideological divisions were greatest in the incumbent CDA-VVD coalition and smallest in the CDA-D66 and CDA-PvdA coalitions. As Figure 3 illustrates, the predicted probabilities that the various coalitions enter office change quite dramatically as we change the importance of ideological divisions. As the logged coefficient on *Ideological Divisions in the Coalition* increases, ideological divisions between coalition partners make a potential government less likely to form. As a result, we see that the probability of a CDA-VVD government declines sharply as we go from left to right in Figure 2, whereas the probabilities of a CDA-D66 or CDA-PvdA government increase. For sufficiently large values of the logged coefficient, the predicted probability that either the CDA-D66 coalition or the CDA-PvdA coalition enters government is larger than that associated with the CDA-VVD coalition. Given the high salience of ideological divisions in the 1981 Dutch formation opportunity, this may explain why the VVD did not make it into government. Note that as the importance of ideological divisions continues to increase, we see that the probability of forming a government for even relatively ideologically compatible coalitions such as CDA-D66 eventually decline; this is because single party governments become the most likely outcome at this point. It is also worth noting that for much of the range of values for the logged coefficient on *Ideological Divisions in the Coalition* in Figure 2, the CDA-VVD coalition has the highest predicted probability of becoming the government and the PvdA-CDA-D66 coalition has the lowest. Interestingly, the PvdA-CDA-D66 government that formed following the 1981 elections was extremely short-lived and was replaced by a caretaker government after just 8 months. The next duly-mandated government that formed following new elections in 1982 was a CDA-VVD coalition.

7 Parties Joining Governments

Thus far, we have focused on the choice of government and, hence, on how government characteristics influence the likelihood of entering office. However, scholars have also long been interested in how *party* characteristics influence the probability of being in government (Laver & Hunt 1992, Laver & Shepsle 1996, Mershon 1996, Peleg 1981, Van Deeman 1989, van Roozendaal 1992, van Roozendaal 1993).

Traditionally, empirical scholars interested in examining how party characteristics influence the likelihood of being in government have employed a binary choice model with individual legislative parties as the unit of analysis (Warwick 1996). For example, Druckman and Roberts (2007) employ a logit model with parties as the unit of analysis to determine the likelihood that Communist-successor parties enter government in post-transitional Eastern European democracies. Similarly, Tavits (2008) uses a probit model with parties as the unit of analysis to examine whether parties that had previously defected from a government are less likely to be chosen as coalition partners in the future.

An obvious drawback of this approach is that it treats each party as independent of all the others and fails to recognize that the government formation process involves the selection of a single government (one or more parties) from the set of all potential governments in a given formation opportunity. In many cases, the likelihood that a party enters government will depend on the characteristics of the other parties in the government formation opportunity and/or on the characteristics of the potential governments of which it is a member. For example, the probability that a small conservative party enters office will likely be diminished if a labor party wins more seats, but increased if it is a member of several minimal winning coalitions. This suggests that the government formation opportunity, not the party, is the appropriate unit of analysis when estimating the probability that a party will enter government.

It turns out that we have already calculated all of the information necessary to determine the probability that a particular party enters government while using the formation opportunity as the unit of analysis. Conditional logit and mixed logit models, which use the government formation opportunity as the unit of analysis, yield a predicted probability for each potential government in the choice set – that is, for each possible combination of parties that could form a government. Obtaining the probability that a particular party enters government in a particular formation opportunity is simply a matter of summing the choice probabilities from the CL or MXL models across the potential governments that contain the party of interest. For example, we could calculate the probability that the CDA enters office in the 1981 Dutch government formation opportunity by summing the probabilities across all potential governments that contain the CDA. While calculating the probability that a specific party will enter government is easy, and can extract a great deal of additional substantive information from our existing models of the government formation process, we are unaware of any previous study that has taken advantage of this approach.

To demonstrate how calculating the probabilities that specific parties enter office can add to our substantive understanding of the government formation process, we return to our hypothetical case based on the 1981 Dutch government formation opportunity. In this example, we change the identity of the largest party from the CDA to the PvdA. In Table 4, we present the predicted probabilities that the political parties in our hypothetical case enter office as calculated from three different models – a binary logit with the political party as the unit of analysis, a conditional logit with the government formation opportunity as the unit of analysis, and a mixed logit with the government formation opportunity as the unit of analysis. The CL and MXL model specifications are those presented in Table 2, while the binary logit specification is necessarily limited to only those variables specific to individual political parties.[8] For each model, the first column presents the probability that each party enters government under the baseline scenario where the independent variables take on the actual values observed in the real-world formation opportunity, while the next two columns present the predicted probabilities and change in probability from the baseline when we

[8]These are the dummy variables for largest, median, previous prime ministerial, and incumbent parties, as well as a measure of the party's anti-system tendencies.

Table 4: Probabilities of Parties Entering Government When Changing the Identity of the Largest Party

Netherlands 1981	Binary Logit			Conditional Logit			Mixed Logit		
	CDA	CDA→PvdA		CDA	CDA→PvdA		CDA	CDA→PvdA	
	Predicted Probability	Predicted Probability	Change in Probability	Predicted Probability	Predicted Probability	Change in Probability	Predicted Probability	Predicted Probability	Change in Probability
CDA	0.91	0.67	-0.25***	0.88	0.59	-0.29***	0.92	0.70	-0.22***
	(0.02)	(0.06)	(0.05)	(0.03)	(0.08)	(0.07)	(0.03)	(0.08)	(0.07)
PvdA	0.22	0.61	0.38***	0.34	0.71	0.37***	0.27	0.58	0.32***
	(0.02)	(0.06)	(0.05)	(0.06)	(0.06)	(0.07)	(0.05)	(0.08)	(0.07)
VVD	0.62	0.62	0	0.30	0.14	-0.17***	0.35	0.24	-0.11**
	(0.03)	(0.03)	—	(0.05)	(0.03)	(0.04)	(0.07)	(0.06)	(0.04)
D66	0.22	0.22	0	0.31	0.37	0.07***	0.29	0.32	0.03
	(0.02)	(0.02)	—	(0.03)	(0.03)	(0.02)	(0.05)	(0.05)	(0.03)

Note: The results presented here are based on a government formation opportunity resembling the one that took place in the Netherlands in 1981. The first three columns present the predicted probabilities from a binary logit that uses the political party as the unit of analysis, the next three columns present the predicted probabilities from a conditional logit that uses the government formation opportunity as the unit of analysis, and the last three columns present the predicted probabilities from a mixed logit that also uses the government formation opportunity as the unit of analysis. For each model, the first column indicates the predicted probabilities for each party in the baseline scenario when the independent variables take on the actual values observed in the real-world selection opportunity, while the next two columns indicate the predicted probabilities and changes in predicted probabilities as we transfer largest party status from the CDA to the PvdA. Standard errors are shown in parentheses. Statistically significant changes in predicted probability are indicated: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed). "—" indicates that there was no change in predicted probability and, hence, no estimated standard error. Estimates are based on simulations using 10,000 draws from the estimated coefficient vector and variance-covariance matrix.

transfer largest party status from the CDA to the PvdA.

The most immediately obvious finding from Table 4 is that the binary logit model – the empirical strategy employed in the existing literature – predicts no changes in the probability of entering government for any parties except for those that gained or lost largest party status. Recall that the binary logit model uses political parties as the unit of analysis, and thus treats each political party as an independent observation that is not influenced by the changing fortunes of other parties. This is a completely implausible assumption in the government formation context. For instance, we would expect the probability that the VVD enters office to decline if the CDA loses its largest party status. This is because the VVD is the closest ideological party to the CDA and many of the likely scenarios where the VVD enters office involve some form of coalition with the CDA. In contrast to the binary logit model, both the CL and MXL models use the government formation opportunity as the unit of analysis, and are thus able to capture this sort of interdependence among parties.

Although the results produced by the CL and MXL models are somewhat similar, some important differences emerge as the MXL model relaxes the IIA assumption and allows for a more accurate estimation of the substitution patterns across parties. For example, the CL model predicts a decrease in the probability that the VVD enters office that is more than 50% larger than that predicted by the more accurate MXL model. The difference between the two models is even more striking with respect to the D66, where the CL model predicts a statistically significant increase in the probability that the D66 enters office that is more than double that predicted by the MXL model, where the change in probability is small and statistically insignificant. If we were to rely on the CL probabilities in this last case, then we would make a mistaken inference about the effect of the CDA's largest party status on the probability that the D66 enters office. This is another clear demonstration of how the IIA assumption underlying the CL model leads to incorrectly estimated substitution patterns.

As another demonstration of how calculating party-specific probabilities can add to our understanding of the government formation process, we now examine how the CDA's ideological position affects the probabilities that the four major parties in the 1981 election make it into government. The ideological positions of the legislative parties in our data set come from the Comparative Manifesto Project and are estimated by subtracting the percentage of statements in a manifesto devoted to thirteen issues that are construed as 'left-wing' from the percentage of statements devoted to thirteen issues that are construed as 'right-wing' (Budge et al. 2001). A party that devotes its entire program to the left-wing issues would score -100, while a party that devotes its entire program to right-wing issues would score +100. The ideological positions of the Dutch parties for which data are available in 1981 range from -28.6 for the *Politieke Partij Radicalen* (PPR, a small left-wing party) to 7.6 for the VVD.

In Figure 4, we present the predicted probabilities from the mixed logit model presented in Table 2 for each of the four major parties in the 1981 Dutch election joining the government as the ideological position of the CDA varies across the observed ideological range. The fact that the CDA held the most legislative seats in this formation opportunity helps to explain its consistently high probability of entering office. As the CDA's ideological position varies from left to right, the ideological distance between the CDA and the VVD decreases, increasing the probability that the CDA and the VVD will form a governing coalition. The spikes in probability for the PvdA and D66 occur when they have an identical ideological position to the CDA, increasing their chances of forming a governing coalition with the CDA. The discontinuities in the

Figure 4: The Predicted Probability of Being in the Government as the CDA Moves From Left to Right Across the Policy Space (Netherlands 1981)

Note: To calculate the mixed logit predicted probabilities, we set the values of the independent variables to be the same as those characterizing the parties and potential governments in the 1981 government formation opportunity in the Netherlands. Each of the four lines indicate how the predicted probability of being in government changes for a given party as we move the CDA's ideological position across the observed ideological range of the party system (-28.6 to 7.6).

probabilities are due to the changing identity of the median ideological party (from the PvdA to the CDA to D66) as the CDA's ideological position varies from left to right. Again, this sort of interdependence among parties cannot be captured by existing models that use the party as the unit of analysis.

8 Conclusion

Understanding why certain parties get into government but others do not is crucial to our understanding of democratic politics. The reason for this is that the government formation process represents a key step in the delegation chain linking citizen preferences to policy outcomes (Lupia 2003, Strøm 2003).

The current "state of the art" in the voluminous literature comprising empirical studies of government formation is to use the government formation opportunity as the unit of analysis and employ a conditional logit (CL) to model the choice of a single government out of the set of all potential governments. Although the adoption of the CL model represents a significant advance in the study of government choice, it is not an ideal empirical strategy because it cannot deal with unobserved heterogeneity and it makes the implausible assumption of the independence of irrelevant alternatives (IIA). As we have demonstrated, the IIA test commonly employed in the government formation literature to justify the use of a CL model is flawed and biased against finding IIA violations. Our own IIA tests, although extremely conservative, reveal strong evidence of IIA violations, thereby indicating that the CL model is almost certainly an inappropriate empirical strategy in the government formation context.

The mixed logit model that we present in this paper represents both a substantive and methodological advance over the conditional logit model and is something that should appeal to both qualitative and quantitative scholars. Qualitative scholars often question the utility of constructing general theories of government formation and testing them with cross-national statistical models because they believe that these theories and tests inevitably omit idiosyncratic case-specific factors, such as personality clashes and ad hoc critical events, that can have an important impact on the government formation process (Laver & Schofield 1990, 195-215). Although quantitative scholars generally recognize that these types of case-specific factors can be important for things like government choice, they have essentially ignored them in their analyses under the presumption that doing so does not affect their results or that there are no empirical strategies to handle them. As we have demonstrated, though, both of these presumptions are wrong.

Ignoring unobserved heterogeneity in discrete choice settings such as that of government formation results in inconsistent estimates and incorrect substitution patterns that leave counterfactual analyses and substantive inferences suspect. As we have demonstrated, the substantive inferences drawn from our mixed logit results were, in many cases, quite different from those that one would have drawn from the inconsistent conditional logit results. In addition to solving various methodological problems, we also showed that the mixed logit provides valuable substantive information about how unobserved contextual factors introduce variation into the effects of our observed variables that is simply not available from more traditional estimation strategies. For example, we demonstrated that there was considerable heterogeneity in the effect of ideological divisions between coalition partners and in the effect of being the incumbent government on entering office. In some sense, the mixed logit creates common ground between qualitative and quantitative scholars by providing a way for political scientists to test cross-national theories of government choice while also taking account of case-specific contextual factors.

Finally, our paper also demonstrates how government formation scholars can use the mixed logit model to examine how party characteristics influence the likelihood of entering government while using the government formation opportunity as the unit of analysis. Over the last decade or so, it appears that many scholars have been unwilling to address the question of which parties make it into government because they were unsure as to how to do this in a methodologically appropriate manner. We show how a simple calculation using the results from a mixed logit model can overcome the perceived methodological limitations associated with traditional models and allow scholars to return to this fundamental question that originally motivated the government formation literature.

The introduction of easy to use code places all of the techniques we describe in this paper well within the reach of the applied researcher.

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