# A test of the accuracy of the median and mean voter theorems as predictions of decision outcomes using a pooled dataset

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## Abstract

The median voter theorem is among the most prominent results of formal political theory. The position of the median voter is often considered to be an accurate forecast of the decision outcome on a controversial issue. An impressive body of theoretical work also supports the position of the mean voter as a forecast of the decision outcome, and moreover suggests that under certain conditions this may be a more accurate predictor than the position of the median voter. The existing empirical tests of the predictive power of the median and mean voters' positions are weak and inconclusive. In this article, we examine the predictive accuracy of several median voter models against their mean counterparts. For the present research, a pooled dataset was assembled containing data from all known studies of decision-making in which data on actors' policy positions and decision outcomes on specific issues have been collected. The pooled dataset contains more than 330 issues and allows the accuracy of the median and mean predictors to be tested in a variety of cultural and institutional contexts. The evidence shows that the median voter is a more accurate predictor of decision outcomes under simple majority voting. In decision situations where super majorities or unanimous agreement is required, predictions based on the mean are more accurate.

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## 1. **Introduction**

The median voter theorem is one of the most prominent results of formal political theory. It holds that if a controversial decision is to be resolved by simple majority voting, the decision outcome will correspond to the position taken by the median voter (Hotelling 1929; Bowen 1943; Downs 1957; Black 1958). There are at least two median voter models, or accounts of the process through which decision-makers' policy positions are transformed into a decision outcome corresponding with the median voter's policy position (cf. Holcombe 1980). First, in *committee decision-making*, the median voter's policy position prevails over all other possible decision outcomes if each possible decision outcome is compared to the others in a pairwise fashion (Black 1958). If a policy scale can be constructed on which the preference of each committee member can be represented as a single-peaked utility function, monotonically decreasing from the most preferred position, the win set of the median voter's position is empty. Hence, no other policy position exists that enjoys the support of a majority of committee members when compared with the median voters' position. The main condition required for a stable outcome corresponding to the position of the median voter is that the positions of an odd number of committee members can be represented on a one-dimensional policy scale, or that these positions display pairwise symmetry in a higher-dimensional policy space (Plott 1967).

Second, in *popular elections* where voters chose between two parties, decision outcomes after the elections will correspond to the position of the median voter due to the competitive behavior of political parties (Downs 1957). According to the Downsian model, parties will converge towards the position of the median voter *before* elections to maximize their likelihood being elected. A more recent account of the democratic process also postulates a close correspondence between the position of the median voter and decision outcomes *after* the elections without assuming that parties converge (McDonald, Mendes and Budge 2004). In this account, the party whose position is closest to the median voter holds enormous power in dealing with other parties when forming coalitions or when exerting power from the opposition, which ensures that policy outcomes are close to the median voter's position.[1]

Similarly, there is a strong theoretical foundation for the mean actor's position as a predictor of the decision outcome. For *committee decision-making*, Caplin and Nalebuff (1991) develop a mean voter theorem as a multi-dimensional analog of the median voter result. They specify the conditions under which the mean voter's position is unbeatable according to a voting rule that requires a supermajority of maximally 64% of votes on an infinite number of dimensions. Ma and Weiss (1993) demonstrate that the mean voter theorem applies in conditions other than the restrictive ones specified by Caplin and Nalebuff, when a 64% supermajority is required. However, they (Ma and Weiss 1995) also show that the mean voter is not always invariant to transformations of voters' positions that nevertheless preserve the order of preferences, which demonstrates that the mean voter theorem is theoretically be less powerful than the median voter theorem.

The mean voter theorem is also central to several models of political decision-making in which it is postulated that actors search for a compromise, rather than take a vote on the basis of a simple majority or supermajority rule (Grofman et al. 2001: 222).[2] Van den Bos (1991) formulates a compromise model, which is the mean average of actors' policy positions, weighted by indicators of their capabilities and the levels of

salience they attach to the issues being decided on (see also Hinich and Munger 1997, 81-83). Achen (2003) furthermore demonstrates that this weighted mean is a first-order approximation of the Nash Bargaining Solution (Nash 1950, Binmore 1987). Achen (2003) considers decision situations in which failure to reach an agreement, the threat point, is far less desirable than any of the alternatives supported by any of the actors. In those situations, the Nash Bargaining Solution generates the same forecast as the mean average of actors' policy positions, weighted by their power and the levels of salience they attach to the issue.[3]

## 2. Empirical research on the median and mean voter theorems

Given the prominence of the median voter theorem and its mean counterpart, studies in political science and public choice have incorporated elements of one or both. While these studies make important contributions to understanding the decision situations they focus on, only few set out explicitly with the aim of testing these two theorems and leave important questions about the relative predictive power of the median and mean predictors unanswered. Until now, few data were available, and the data that were available facilitated only indirect tests of predictive accuracy. Below we discuss the main relevant findings.

### *2.1 Research guided by models of collective decision-making*

Research guided by models of collective decision-making potentially provides the strongest and most direct testing ground on which to compare the accuracy of the mean and median voters' positions as predictions of decision outcomes. Models of collective decision-making contain alternative propositions about the process through which actors' initial positions are transformed into collectively binding decision outcomes through bargaining (e.g. Bueno de Mequita and Stokman eds 1994; Thomson, Torenvlied and Stokman eds. 2003). Models in this tradition are based on the assumption that decision situations can be described by actors' positions on (a set of) unidimensional issues, the level of salience each of the actors attaches to each of the issues, and the capabilities they have at their disposal to influence each other and the decision outcome. Researchers in this tradition focus on actors' positions and decision outcomes on specific substantive issues, rather than on abstract dimensions. This enables the predictions generated by models to be tested systematically, by comparing these predictions with the decision outcomes that were taken. Given that these studies include information on the importance of issues to actors and their capabilities, data collected in this field of research could be used to test the mean and median predictions as well as weighted variants of each.

In practice, however, little attention has been devoted to systematically comparing the median and mean voters' positions as forecasts of decision outcomes. Instead, researchers have focused on the formulation of elaborate models that purport to capture the essence of complex bargaining processes in specific decision-making situations.[4] This has two consequences. First, the accuracy of the median and mean voter theorems has never been empirically tested against each other. Second, the available data are scattered across many different studies, each focusing on a complex model in a specific context.[5] While a systematic comparison of the predictive power of the median and mean has not been conducted, separate studies suggest that, compared with the more complex

bargaining models, the positions of the median and mean voter predict decision outcomes relatively well.[6]

*2.2 Research on the US Congress and comparative public expenditure*

Research on roll call voting in the US Congress has featured discussions of the median and mean legislators. One study in particular provides evidence that the median is a more accurate predictor of policy decisions taken in the US House of Representatives where majority voting is the rule (Grofman et al. 2001). The authors of that study criticize previous roll call analyses for considering the position of the mean legislator only (e.g. Poole and Rosenthal 1997). Grofman et al. (2001) postulate that shifts in the location of the median House member on a left-right dimension more accurately reflect shifts in party control than do shifts in the location of the mean House member. The evidence supports this expectation, since the largest shifts in the location of the median voter are associated with the largest shifts in party control of the House of Representatives and regional realignments.

Comparative research on public policy expenditures investigates the linkage between voters' income and levels of expenditure, while controlling for other factors that affect these expenditure levels. Of particular interest are studies that compare the median against the mean voters' income as predictions of expenditures (Pommerehne and Frey 1976; Pommerehne 1978; Gramlich and Rubinfeld 1982). Mueller finds, for instance, that variation in public expenditures across different Swiss communities is better explained by the median income of the electorate within those communities than by their mean income (Mueller 1989, 191-193). Pommerehne (1978) compared the 110 largest Swiss municipalities that use direct democracy, and found that the median voter income explains variation in public expenditures significantly better than does mean income in those cities. In the Swiss municipalities with a form of representative democracy, no significant difference was found between the explanatory power of the median and mean voter income.

Romer and Rosenthal (1979) point out that this is a very problematic approach that provides little information about the predictive accuracy of the median and mean voters' positions. In particular, it assumes that a correlation between the locations of median voters, as measured by their incomes, and levels of public expenditure, is evidence that the levels of expenditure correspond to the levels preferred by those voters. This clearly need not be the case. It could well be that the median or mean voters prefer some multiple or fraction of what is actually spent. Moreover, such tests have large methodological problems, and lack adequate comparisons with competing models (Romer and Rosenthal 1979: 161-2). The relationship between voter income and public expenditures is highly complex, and the range of reported income elasticities is very large in these studies (Mueller 1989).

We conclude that most evidence relating to the predictive power of the median and mean voter theorems is at a rather general level, based on indirect evidence, and although suggestive, rather inconclusive. The evidence shows (a) that institutions matter, and (b) suggests that in referenda, that are basically large-*n* committee decision-making with simple majority voting, the median voter prevails. In the following section, we explicate expectations on the relative predictive power of the median and mean voter theorems under different decision-making rules.

## 3 Institutional conditions affecting the relative predictive power of median and mean theorems

The relative predictive power of the median and mean voter theorems is expected to vary among different decision situations. The theoretically most important conditions affecting the relative predictive power of the median and mean suggested by the above-mentioned theoretical and empirical research refer to the *voting rules* applied.

Under simple majority rule, a prediction based on the median voter's position is generally expected to be most accurate. In some committee decision situations, actors hold different numbers of votes, meaning that a decision can be taken by a minority of decision-making actors that hold a majority of votes. In practice, therefore, the power-weighted median is expected to yield the most accurate forecasts of decision outcomes. Here, actors' positions are weighted by a measure of decision-making power corresponding to or based upon the number of votes they hold.

Under supermajority rule, the mean voter theorem suggests that the simple mean of decision-makers' positions is the most accurate predictor. Again, when analyzing real decision situations, it is important to incorporate the relative decision-making power of the actors concerned.

In committees where decisions can only be taken by unanimity, we might expect there to be a drive towards political compromises that are as inclusive as possible. The Nash Bargaining Solution is an example of such an inclusive compromise, and under certain conditions corresponds to the mean of actors' positions weighted by their power and the levels of salience they attach to the issue in question (Achen 2003). We therefore expect the mean of actors' positions, weighted by power and salience, to be the most accurate predictor of decision outcomes under unanimity.

Finally, there are decision situations with no written decision rule. These situations typically include actors with no formal decision-making power, but who nevertheless exert influence on decision-makers. This is also true of many decision situations in international politics. In the absence of a written decision rule, actors' capabilities, or potential to influence each other and the decision outcome, depend on the particularities of the decision situation. Informal power resources may stem from financial resources, information, military might and/or the representation of a large number of people. Further, the extent to which actors are willing to put their potential influence into effect is vital in such situations. Of the predictions we consider here, the one that corresponds closest to this description is the mean of actors' positions weighted by their power and the levels of salience they attach to the issue in question.

## 4. Research Design

Given the importance of power and issue salience when analyzing real decision situations, we compare four variants of the median and mean predictions of decision outcomes: unweighted, weighted by power, weighted by issue salience, and weighted by the multiple of power and issue salience.

To test the relative accuracy of these predictions, and the expectations on the effects of different decision rules, we pool data from existing studies that aim to test applied models of collective decision-making. There are at least four advantages to following this research strategy:

1) The information collected in these studies refers to actors' positions on specific issues, rather than some proxy measure of their preferences, ensuring that the test is as direct as possible.
2) As mentioned above, the information includes estimates of actors' capabilities and the levels of salience they attach to issues. This enables us to test not only the simple median and mean predictors, but also weighted variants of each, as suggested in some spatial models of decision-making.
3) The data were collected according to a standard procedure, ensuring that they are comparable. Although the studies differ with respect to the decision situations they focus on, the main variables that define collective decision-making situations were measured in a comparable way. The data were collected using a combination of (key informant) interviews and document analysis (e.g. Bueno de Mesquita and Stokman 1994; Torenvlied 2000). Expert judgments are well suited for this type of research and have been successfully validated with content analysis (Laver and Garry 2000).
4) The data cover decision situations in various cultural and institutional contexts. This enables us to test robustness of results across these contexts: for example in local, national and international situations. Crucially, the data also allow us to examine the effects of different decision-rules, simple majority, supermajority, and unanimity, on the relative power of median and mean based predictions.

*4.1 Description of the pooled dataset*

The pooled dataset consists of 26 datasets that were collected in 12 studies of collective decision-making. Each of the datasets has a set of actors that is distinct from those found in others in the pooled dataset. A summary of the studies in the pooled dataset is presented in Table 1.

Table 1 about here

Five groups of studies can be distinguished in terms of their general characteristics. The first group is a collection of *international conflict* case studies conducted by Bueno de Mesquita and his collaborators: the Cold War, the Arab-Israel dispute, the war in Kosovo, and the Good Friday Treaty in Northern Ireland. Most of the issues concern the terms of peace agreements and involve countries, supranational (nongovernmental) institutions, and major national interest groups.

The second group of studies in our pooled dataset concerns *European decision-making* and combines intergovernmental with supranational decision-making. This group includes the studies of Bueno de Mesquita and Stokman (1994) on decision-making in the Council of Ministers of the European Community, and a large study on decision-making in the European Union coordinated by Stokman and Thomson (2004).

The third group of studies consists of *national decision-making* in various counties and in various policy domains. This group includes studies of U.S. national health and energy policy, Dutch agricultural policy, and anti-corruption policy in six Sub-Saharan African countries. There is a large variation among these studies in terms of the number of issues they cover, the number of alternatives on each of the issues and the number of decision-makers involved.

The fourth group consists of studies of *collective bargaining on working conditions.* These studies focus on bargaining between representatives of (umbrella) organizations of employees and employers in The Netherlands at the national level and within industries and large enterprises. These bargaining processes are characterized by dichotomous issues, relatively few actors with informal bargaining power, and large variation among actors in the levels of salience they attach to the issues.

The fifth group concerns studies of *local authority* decision-making. We have two such studies in the data-set: the Amsterdam local authority's decisions on city development and minority policy, and social renewal policy in three Dutch municipalities. These local contexts are characterized by the strong involvement of local political and administrative actors and the presence of a simple majority voting rule.

*4.2 The data: variables, data collection, and measurement*

Each study contains a detailed examination of several (and sometimes many) decision-making situations, and each provides a comparable spatial description of each of these situations. The description of the decision situation begins by identifying the substantive policy questions to be addressed by the collective decision in terms of a number of issue or policy scales. Actors' most preferred positions are then described by placing them at points on these one-dimensional scales. The issue scales, which are standardized in the pooled dataset to run from 0 to 100, are formulated such that policy alternatives represented by scale values further from an actor's position are perceived to be less favorable by that actor. This corresponds to the assumption that actors have single peaked and monotonically decreasing preference functions. The issues need not be inherently of a scale measurement level. Dichotomous, or discrete policy alternatives are represented using the same 0-100 scales. Here, key informants are consulted to obtain estimates of the political distances between policy alternatives. The decision outcomes realized are represented on the same one-dimensional issue scales as the actors' most preferred positions.

In each of the studies in the pooled dataset, estimates of the levels of salience the actors attach to the issues were obtained by interviewing key informants. The salience estimates indicate the relative importance each of the actors attached to each of the issues (on a scale of 0 to 100). Salience is commonly operationalized as the extent to which an actor would be willing to put into effect its potential to influence the decision outcome of a specific issue relative to another issue. A salience estimate of 100 indicates that an issue is of the utmost importance to the actor, and that it would be willing to put into effect all of its potential capabilities to influence the decision outcome. A score of 50 may indicate that an actor would be willing to use arguments but not real expressions of power to influence its negotiation partners. A score of zero indicates that the actor is not involved in the influence process at all. The relations between the salience scores are more important than their absolute values.

Each of the studies in our pooled dataset also contains information on the voting power or relative capabilities of the actors involved in the decision-making. Voting power is defined in terms of formal authority, such as the number of votes an actor has in a committee. In some situations, no formal institutional power relations exist (such as in the case of collective bargaining, or international conflict), or capabilities are not defined exclusively in terms of decision-makers' formal authority to take decisions, but also on

the basis of informal resources. Again, the most common way of obtaining estimates of this variable is to interview key informants who are experts in the field.

*4.3 Predictions, prediction errors and decision-rules*

For each issue in each dataset, we calculated the predictions of the eight variants of the median and mean voter theorems. Since all issue scales are standardized to range from 0 to 100, the maximum possible error on an issue is 100. For each issue we calculated the *prediction error* as the absolute difference between each prediction and the actual outcome. The mean average of these prediction errors (ME) across all issues is used to compare the errors of different predictors. In addition, we apply a non-parametric test, Wilcoxon's matched pairs signed ranks test, to compare pairs of predictors to ascertain whether one is significantly more accurate than the other. A non-parametric test is appropriate because the issues are not selected on the basis of a random sample, and there are undoubtedly interdependencies among the issues within different datasets.

In addition to testing the relative accuracy of the median and mean based predictions, we investigate the conditions, in the form of decision rules, that may account for variation in their predictive power. We distinguish among issues in the pooled dataset on the basis of four decision rules: 'simple majority', 'qualified majority' (which is a supermajority rule used in the European Union's Council of Ministers), 'unanimity', and 'unwritten'. With one exception, the issues within each of the datasets in the pooled dataset are subject to the same decision rule. The exception is the dataset on European Union decision-making (Stokman and Thomson 2004), that contains some issues subject to qualified majority voting and others subject to unanimity.

## 5. Results

*5.1 Testing simple median and mean predictions of decision outcomes*

*Difference in prediction errors*

While the errors of the two predictors are strongly related ($r = .795$; $n = 335$; $p < .001$), there are nevertheless substantial differences between them, such that we can investigate the conditions under which one prediction is more accurate than the other. The information contained in the scatterplot in Figure 1 clearly supports this conclusion in three respects. First, on only 27 of the 335 issues are the differences between the errors of the two models zero, thereby lying on the $45^{o}$-axis. On 161 issues, the mean voter prediction is more accurate than the median; the mean is more accurate on 147 issues. A Wilcoxon's matched pairs signed ranks test reveals that, for the whole pooled dataset, the mean voter prediction is more accurate than the median prediction ($z = -2.04$; $p < .05$).[7] Second, there is a substantial number of issues on which the median voter prediction corresponds exactly to the actual decision outcome, while the mean has a higher prediction error. The median voter prediction is at the extreme of the issue scale when an odd number of actors take positions at these extremes; in such cases, the mean inevitably yields a prediction somewhere in the middle of the issue scale. This feature probably explains why the difference between the median and mean voter predictions is large for the issues on which the median voter perfectly predicts the decision outcome. Third,

where model errors strongly diverge, the mean voter model generally predicts better than the median voter model, indicated by the preponderance of dots below the $45^{o}$-axis.

— Figure 1 About Here —

A visual inspection of Figure 1 also indicates that there is a large variation in the differences between the prediction errors *within* datasets. The association between the average error of the mean voter model and the average error of the median voter model is stronger at the level of the datasets ($r = .878$; $n = 18$; $p < .001$) than at the issue level. This suggests that a comprehensive explanation of the differences between the prediction errors must include variables at the level of the issues within datasets, as well variables that distinguish the datasets from each other.

*Differences in prediction errors across datasets*

We next investigate whether differences between the errors of the simple median and mean predictions are associated with differences among the datasets in terms of the general context in which decision-making took place. Recall that we distinguished between international conflict case studies, European decision-making, national decision-making, collective bargaining on working conditions and local authority decision-making. We find no clear pattern in this respect.

Figure 2 contains information on the relative predictive power of the simple median and mean for each dataset. The comparison variable is the absolute error of the median voter prediction minus the absolute error of the mean voter prediction. If this error-difference is zero, the median and mean voter predictions are equally accurate. If the error-difference is positive, the mean voter prediction is more accurate than the median. If it is negative, median voter prediction is more accurate. The boxplots in Figure 2 provide information on the variation in the relative performance of the median and mean predictions across datasets. The datasets are ordered from the left to the right with respect to context of decision-making (from international conflict to local and industry-level decision-making).

— Figure 2 About Here —

The two datasets on European decision-making lead to different conclusions on the relative predictive power of the median and mean. On the issues in the dataset gathered in Bueno de Mesquita and Stokman's (1994) study on EU Council decisions, the median predicts slightly more accurately than the mean, although this difference is not significant. The dataset gathered in the study reported on by Stokman and Thomson (2004) on EU decision-making contains a much larger number of issues. Here, the mean voter predictions are significantly more accurate than those of the median voter ($z = -3.04$; $p < .005$).

In the datasets on national decision-making there is no significant difference between the accuracy of the median voter and mean voter predictions. Bennett and Payne's (2000) study on regional development under Labour in the United Kingdom contains four datasets. In three of these datasets (Training and Enterprise Councils, Business-links, and Regional Development Agencies datasets) the mean predicts more

accurately than the median (not significant). In the New Deal dataset, the median voter prediction is more accurate (not significant). In the Dutch agriculture policy dataset (Baarda 2000) the median voter prediction is more accurate than the mean voter model, falling just short of statistical significance due to the small number of cases ($z$ = 1.61; n = 8; $p$ = .11). If the three datasets on African national anti-corruption policy (Klein Haarhuis and Torenvlied 2004) are considered together, the mean voter prediction is slightly, but not significantly more accurate than the median voter prediction ($z$ = -1.51; $p$ = .13). However, in the dataset on Tanzanian anti-corruption policy the median voter model predicts most accurately, but not significantly so ($z$ = -.54; $p$ = .59).

Analysis of the datasets concerned with collective bargaining on working conditions does not lead to an unambiguous conclusion on the relative predictive power of the median and mean. Considering the dataset on national bargaining among umbrella organizations of employees an employers' representatives (Torenvlied and Akkerman 2004), the prediction errors of the median and mean voters are exactly the same. For the dataset on industry-wide bargaining in the Dutch metal industry in 1998 (Torenvlied and Akkerman 2004), the median voter model predicts more accurately, but the difference is not significant.

Analyses of the datasets on local authority decision-making produce equally diverse results. For municipal council decision-making in Amsterdam (Berveling 1994) the median voter model predicts better than the mean voter model, although the difference falls just short of statistical significance ($z$ = 1.55; $p$ = .12). If the datasets on local social renewal policy in three Dutch municipalities (Torenvlied 2000) are pooled together, the median and mean voter models have the same prediction errors. For the city of Arnhem and the municipality Weststellingwerf, the mean voter model predicts slightly, but not significantly better than the median voter. For the city of Groningen, the median is a better predictor, but again the difference is not significant.

We conclude that the relative accuracy of the simple median and mean voter predictions is not associated with the general context in which decision-making takes place.

### *5.2 Testing weighted median and mean predictions of decision outcomes*

The analyses reported above do not take into account variation in power of decision-makers, nor the intensity of their preferences. In this respect, the simple median and mean predictions can be considered baseline forecasts that *may* by improved upon by incorporating more information. Many of the studies discussed above focus on committee decision-making where there are written rules of the game including a given distribution of voting power. This is true of the studies on European decision-making, national (parliamentary) decision-making, and municipal council decision-making. Even when decision-making takes place outside formal institutions, actors differ in terms of their power, the potential they have to exert influence on each other and the decision outcomes. Moreover, variation in the intensity of preferences (issue salience) is ostensibly an important feature of collective decision-making. In order to obtain a more realistic comparison of the median and mean voter predictions, we therefore calculate and compare not only the simple median and mean, but also the median and mean weighted by power, salience, and the multiple of power and salience.

— Table 2 About Here —

Table 2 compares the mean errors (ME) of the *simple median voter prediction* with those of weighted median voter predictions. In general, Table 2 shows that the median voter prediction hardly improves at all by including different weights for actors' power and/or the levels of salience they attach to issues. For the datasets on African antic-corruption decisions and those on Dutch municipal policy, the median weighted by power and salience is significantly more accurate than is the simple median. However, in the dataset from the study on Dutch agricultural decision-making, the median weighted by power and salience is significantly less accurate than the simple median. Overall, weighting the simple median by power, salience or the multiple of power and salience does not improve upon the predictive accuracy of the simple median.

— Table 3 About Here —

Table 3 compares of the mean prediction errors (ME) of the *simple mean voter baseline* prediction with weighted mean predictions. For the whole pooled dataset, the error of the mean voter prediction sharply and significantly decreases when weights are introduced that reflect actors' power, the levels of salience they attach to issues, and the multiple of power and salience. This is the case for four studies in the pooled dataset: three of the four studies on national decision-making, and the study on Amsterdam municipal decision-making. It is noteworthy that the prediction errors of the weighted means do not differ significantly from that of the simple means for either of the datasets on European decision-making. Overall, weighting the mean prediction by power and issue salience does pay off in terms of significant improvements in predictive power.

*5.3 The effect of voting rules*

We now turn to our expectations regarding the effects of different voting rules under which decision-making takes place. Voting rules vary among datasets, and within the dataset on decision-making in the European Union. We distinguish among: (a) simple majority voting; (b) qualified majority voting; (c) unanimity decision-making, and (d) unwritten decision rules. We expect that: (1) under simple majority voting the median voter model or its power weighted variant predicts best; (2) under the qualified (super) majority rule, the mean voter model or its power weighted variant predicts best; (3) under the unanimity rule, the mean weighted by the multiple of power and salience predicts best; and (4) under unwritten decision rules the mean weighted by the multiple of power and salience predicts best.

— Table 4 About Here —

Table 4 shows the mean prediction errors of five models under the different rules. The prediction errors vary substantially across issues subject to different voting rules. The errors of all predictors are smallest on issues decided upon by simple majority voting. The outcomes of decisions taken by qualified majority and unanimity voting are more difficult to predict. The issues decided upon in situations where there is no clear voting

rule are most difficult to predict. Below, we test whether our expectations concerning the most accurate predictions under different voting rules are corroborated or refuted by the evidence.

*Simple majority*

On the issues decided upon by simple majority voting, the predictions of the power weighted median are most accurate. While this is consistent with our expectation, the error of the power weighted median is not significantly lower than those of the power weighted mean ($z = .83$; $p = .40$), or of the mean weighted by the multiple of power and salience. The power weighted median does predict significantly more accurately than the simple mean ($z = 1.95$; $p < .05$). Further, the simple unweighted median predicts more accurately than the simple mean of actors' positions, although not significantly so ($z = 1.43$; $p = .15$). Therefore, although the differences are not large, the evidence supports the expectation that median based predictions are more accurate under simple majority decision rules.

*Qualified majority*

For issues subject to qualified majority voting, the mean of actors' positions is the most accurate prediction of decision outcomes. On these issues, the mean voter prediction is significantly more accurate than the simple median ($z = 2.89$; $p < .005$). Weighting the mean by power and/or salience does not improve its predictive accuracy. Hence, we have convincing evidence that the *simple mean* provides the most accurate prediction of decision outcomes under qualified majority rule.

*Unanimity*

The mean of actors' policy positions weighted by the multiple of power and issue salience provides the most accurate predictions of decision outcomes under unanimity The mean weighted by power and salience predicts significantly more accurately than does the median voter ($z = 2.03$; $p < .05$). Remarkably, the difference between the simple mean and simple median voter predictions is not significant ($z = .54$; $p = .59$). It is the weighting of the mean with salience and, especially, power that enables the mean to generate more accurate forecasts than its median counterparts. This corresponds to the expectation that decisions taken under unanimity are driven by compromise seeking behavior in which actors' power and issue salience are central.

*Unwritten*

Finally, there is the category of decision-making situations where no decision rule is formally specified. This is the case for the datasets on international conflict resolution, regional policy under Labour in the United Kingdom, and on some of the collective bargaining on working conditions in The Netherlands. In these decision-making contexts, no formal committee voting takes place, or such formal voting was only part of a larger process. A characteristic of such decision situations is that actors negotiate with each other, their influence being defined by a variety of power resources. The mean average of actors' positions weighted by power and issue salience is the most accurate prediction in such cases. The mean weighted by the multiple of power and salience predicts significantly better than the median voter model ($z = 2.76$; $p < .01$). As in the case of

issues decided upon by unanimity voting, the difference between the simple mean voter prediction and the simple median voter prediction is not significant ($z = 1.14$; $p = .26$). Again, the weighting of the mean by salience and, especially, power strengthens the predictive accuracy of the mean. Hence, these decision situations strongly resemble unanimity voting in committees.

## 6. Conclusion

This article provides an empirical test of the predictive accuracy of the median and mean voter theorems, as well as weighted variants of these. On the basis of the theoretical literature, we formulated expectations on the relative performance of these theorems in predicting decision outcomes under different decision rules. By pooling together all available data collected within the framework of models of collective decision-making, this analysis improves upon existing studies that provided indirect or inconclusive evidence in support of one or the other voter theorem. In particular, we demonstrate that within the particular studies and datasets in our analysis there is substantial variation in the accuracy of the median and mean of actors' positions as predictions of decision outcomes. This finding corroborates the results of earlier empirical studies. By pooling comparable datasets, we are able to investigate the effect of decision rules on the accuracy of these predictions, effects that could not have been found without comparing different datasets.

The effects of decision rules concern the absolute sizes of the prediction errors as well as the relative performance of the different predictions. In general, decision outcomes on issues subject to simple majority voting can be predicted more accurately than on issues subject to more inclusive or unwritten decision rules. On the relative performance of the different predictions, the median is, as expected, the most accurate when decisions are taken by simple majority. For issues subject to qualified (super) majority voting, the simple mean is the most accurate prediction. When decisions have to be supported unanimously, or when the decision rule is unwritten, weighting the mean by actors' issue salience and, especially, power gives the most accurate predictions. Clearly, empirical support for the median and mean voter theorems varies among decision rules.

The results presented here should help researchers select the most appropriate baseline predictions for their analyses. The errors of predictions of decision outcomes based on the median or mean of actors' positions are often used as baselines upon which more complex models should be able to improve. We show that the most appropriate baseline depends crucially upon the decision rule that applies in the decision situation being studied. When decisions are taken by simple majority voting, the median is the appropriate baseline. When decision outcomes must be supported by a supermajority or unanimity of actors, or where the decision rule is unwritten, a prediction based upon the (weighted) mean is the most appropriate baseline.

In addition to the decision rule, there are surely other factors that account for variation in the relative accuracy of the median and mean voters' positions as predictors of decision outcomes. Future research should examine these more systematically. The fact that there is substantial variation in the predictive accuracy of the median and the mean within datasets suggests that many of these factors are to be found at the level of the issues on which decisions are taken. Some of these factors relate directly to

assumptions underlying the median and mean voter theorems. For instance, the median voter theorem assumes that the number of decision-makers is *odd*. An even number of decision-makers could reduce the accuracy of the median if few decision-makers are involved, and if the distribution of their positions is bipolar. A large *number of decision-makers* may indicate a highly complex decision-making process, making it difficult for either the median or the mean to generate accurate predictions. Further, the *measurement level* of the issue scale may also affect the relative performance of predictions based on the median and mean of actors' positions. Decision outcomes on dichotomous issues, with two alternatives each located at an extreme, are almost never predicted accurately by the mean, since the mean prediction is usually located around the center of the issue scales. By contrast, the prediction of the median in such situations, providing there are not an equal number of actors located at both extremes, will be located at one of the two extremes.[8]

As several previous studies have demonstrated, the application of more complex decision-making models need not lead to improvements in the accuracy of baseline predictions, such as those provided by the (weighted) median and mean voters' positions (Thomson, Torenvlied and Stokman 2003, Stokman and Thomson 2004). It could well be the case that, at least under certain conditions, predictions based on even *less* information are more or no less accurate than those of the median or mean voters' positions. To at least some extent, the structure of the political space within which decision-making takes place constrains the possible decision outcomes that can be realized (cf. Duverger 1954, 245; Stokes, 1963). For example, on a dichotomous issue the outcome must, by definition, be located at one of the extremes. Similarly, on issues where there are several policy alternatives, the number of alternatives and their location in relation to each other will also influence the location of the decision outcome. Predictions of decision outcomes could be formulated on the basis of information on the structural characteristics of the issues, such as the number of alternatives considered and the location of these alternatives, without incorporating information on the actors who support those alternatives. Comparison of the errors of these predictions would test Stokes' notion that the ability to structure the political space provides actors with an important potential to influence decision outcomes.

**Appendix. Studies in the data set**

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## Tables and figures

Table 1. Data sets in the pooled analysis (*** not yet, * partly added to pooled dataset)

| Study | Description and aim | Data sets | Valid number of issues | Number of decision-makers | |
|---|---|---|---|---|---|
| | | | | Average | Range |
| Laumann, Knoke and Kim, 1987 *** | Development of model of participation in U.S. health and energy policy domains | a. Health | | | |
| | | b. Energy | | | |
| Bueno de Mesquita and various contributors 1984, 1990, 1998, 2001 *** | Several small n-case studies .re. applications of expected utility model on international conflict between states | a. International War | 2 | 29 | 22-36 |
| | | b. Iran | 2 | 23 | 18-27 |
| | | c. Arab-Israel | 2 | 11 | 11-12 |
| | | d. Kosovo | 4 | 27 | 25-33 |
| Berveling, 1994* | Test of two-stage model on two policy domains in city of Amsterdam, 1986-1994 | a. IJ-shore 86-90 | 23 | 29 | 12-62 |
| | | b. IJ-shore 90-94 | 18 | 22 | 10-35 |
| | | c. Minorities 86-90 | | | |
| | | b. Minorities 90-94 | | | |
| Bueno de Mesquita and Stokman, 1994 | Test of several collective decision-making models. EU regulatory decision-making in early 1990s. | EU 1990s | 16 | 10 | 8-12 |
| Bueno de Mesquita, Newman and Rabushka, 1996 *** | Application of expected utility model to future of Hong Kong. | Hong Kong [#] | 2 (12) | 18 | 18 |
| Rojer, 1996, 1999 *** | Test of exchange model and expected utility model on collective bargaining in twelve Dutch industries or enterprises in 1993-1994. | Collective bargaining | 202 | 4 | 2-10 |
| Torenvlied, 1996, 2000 | Test of policy implementation model on local social renewal policy in three Dutch cities, 1992-1995. | a. Weststellingwerf | 15 | 26 | 16-34 |
| | | b. Groningen | 17 | 34 | 34 |
| | | c. Arnhem | 6 | 28 | 19-30 |
| Baarda, 1999 | Environmental decision-making and effect study. Dutch national agriculture policy 1996-1997. | Dutch agriculture | 8 | 13 | 12-16 |
| Bennett and Payne, 2000 | Transition of local and regional development under Labour in the United Kingdom 1997-2000 | a. TECs | 12 | 27 | 21-31 |
| | | b. Business Link | 18 | 31 | 31 |
| | | c. RDA | 13 | 16 | 16 |
| | | d. New Deal | 5 | 21 | 21 |
| Bueno de Mesquita, McDermott and Cope, 2001*** | Good Friday Agreement Northern Ireland 2000 | e. North Ireland [$] | 4 (11) | 9 | 17-23 |
| Torenvlied and Akkerman, 2004 | Two-level analysis of national and industry-wide collective bargaining in the Netherlands 1997-1998. | a. Foundation 1997 | 11 | 6 | 6 |
| | | b. Metal 1998 | 12 | 5 | 5 |
| Klein Haarhuis and Torenvlied, 2004 | Spatial analysis of national anti-corruption programs in seven sub-Saharan African countries, 2001-2002.[&] | a. Benin | 2 | 6 | 6 |
| | | b. Ethiopia | 5 | 3 | 2-6 |
| | | c. Ghana | 3 | 5 | 5-6 |
| | | d. Kenya | 4 | 8 | 5-11 |
| | | e. Tanzania | 5 | 5 | 3-5 |
| Thomson et al., 2004 | Test of several models of collective decision-making on many different EU policy areas 1999. | EU 1999 | 162 | 16 | 2-17 |
| Van Houten 2004*** | Two-level analysis of national and industry-wide collective bargaining in the Netherlands 2000-2002. | a. Foundation 2000 | 13 | | |
| | | b. Metal 2002 | 16 | | |
| Total (mid June) | | 33 | 341 | | |

*Notes*.
[&] For two countries in this study (Malawi and Uganda) policy outcomes could not be obtained ???;
[#] Incomplete data set: available two issues on liberalization China are part of larger set of twelve issues on the future of Hong Kong; [$] Incomplete data set: available four issues part of larger set of eleven issues on Good Friday Agreement in Northern Ireland.

Table 2. Mean Prediction Error (ME) of Different Median Voter Models and Test of Significance of Differences with Simple Median Voter Model

| | | Simple | Power weighted | | Salience weighted | | Power * Salience weighted | |
|---|---|---|---|---|---|---|---|---|
| Study | N | ME | ME | z-score† | ME | z-score† | ME | z-score† |
| *International* | | | | | | | | |
| EU Council 1990s | 15 | 23.87 | 36.47 | -1.27 | 31.27 | -1.17 | 28.67 | -0.70 |
| EU Policy 2001 | 162 | 28.40 | 28.94 | -0.23 | 28.77 | -0.28 | 29.40 | -0.67 |
| *National* | | | | | | | | |
| Development UK | 48 | 28.21 | 27.60 | 0.58 | 21.71 | 1.89* | 23.29 | 1.53 |
| Dutch Agriculture | 8 | 13.50 | 13.50 | 0.00 | 21.00 | -1.83* | 19.75 | -1.84* |
| African AC policy | 19 | 53.89 | 40.47 | 0.87 | 49.69 | 1.13 | 29.25 | 1.80* |
| *Local* | | | | | | | | |
| Amsterdam '86-'90 | 23 | 19.30 | 13.43 | 0.37 | 22.83 | -0.37 | 13.43 | 0.37 |
| Dutch Local Policy | 37 | 15.35 | 13.00 | 0.54 | 15.54 | -0.19 | 11.13 | 1.72* |
| *Collective bargaining on labor conditions* | | | | | | | | |
| Metal industry 1998 | 12 | 41.67 | 48.00 | -0.34 | 50.00 | -0.58 | 58.33 | -0.63 |
| Dutch Lab. Fnd. 97 | 11 | 50.00 | 49.36 | 1.10 | 36.36 | 1.00 | 27.27 | 1.51 |
| Total | 335 | 28.38 | 27.95 | 0.05 | 27.82 | 0.37 | 26.38 | 1.52 |

*Note.* † Z-score obtained from Wilcoxon's matched pairs signed rank test. Tested is difference with *simple* median voter model. Positive sign implies improvement, negative sign deterioration in prediction error;
* $p < .10$;

Table 3. Mean Prediction Error (ME) of Different Mean Voter Models and Test of Significance of Differences with Simple Mean Voter Model

| | | Simple | Power weighted | | Salience weighted | | Power * Salience weighted | |
|---|---|---|---|---|---|---|---|---|
| Study | N | ME | ME | z-score† | ME | z-score† | ME | z-score† |
| *International* | | | | | | | | |
| EU Council 1990s | 15 | 24.47 | 24.53 | 0.28 | 22.87 | 0.95 | 21.00 | 1.42 |
| EU Policy 2001 | 162 | 23.21 | 22.83 | 0.64 | 23.48 | -0.44 | 22.94 | 0.03 |
| *National* | | | | | | | | |
| Development UK | 48 | 25.75 | 23.10 | 2.52** | 22.42 | 2.41** | 19.46 | 3.72*** |
| Dutch Agriculture | 8 | 31.75 | 32.00 | -0.56 | 33.38 | -0.77 | 32.25 | -0.49 |
| African AC policy | 19 | 46.89 | 34.18 | 1.23 | 47.75 | -0.20 | 30.38 | 1.99* |
| *Local* | | | | | | | | |
| Amsterdam '86-'90 | 23 | 25.30 | 14.67 | 2.46** | 22.78 | 2.91*** | 13.33 | 2.98*** |
| Dutch Local Policy | 37 | 15.78 | 12.97 | 0.69 | 15.54 | 0.34 | 12.28 | 0.91 |
| *Collective bargaining on labor conditions* | | | | | | | | |
| Metal industry 1998 | 12 | 43.58 | 47.00 | 0.34 | 46.17 | 0.26 | 49.67 | 0.27 |
| Dutch Lab. Fnd. 97 | 11 | 50.00 | 49.55 | 0.30 | 46.09 | 1.25 | 44.82 | 1.88* |
| Total | 335 | 26.11 | 23.93 | 2.31** | 25.34 | 1.74* | 22.99 | 3.32*** |

*Note.* † Z-score obtained from Wilcoxon's matched pairs signed rank test. Tested is difference with *simple* median voter model. Positive sign implies improvement, negative sign deterioration in prediction error;
* $p < .10$; ** $p < .05$; *** $p < .005$;

Table 4. Mean Errors of Six Voting Models under Different Decision-Rules

| | | Median | | | Mean | | |
|---|---|---|---|---|---|---|---|
| Decision Rule | N | Simple | Power | Salience—Power | Simple | Power | Salience—Power |
| Simple Majority | 68 | 16.47 | 13.20 | 13.05 | 20.88 | 15.86 | 15.26 |
| Qualified Majority | 111 | 30.63 | 32.03 | 32.90 | 25.24 | 25.59 | 25.31 |
| Unanimity | 77 | 27.39 | 28.84 | 23.91 | 24.37 | 23.01 | 22.27 |
| Unwritten | 79 | 36.43 | 33.62 | 30.08 | 33.54 | 29.27 | 26.53 |
| Total | 335 | 28.38 | 27.95 | 26.38 | 26.11 | 23.93 | 22.99 |

**Figure 1. Relation between the errors of the median and mean voter models**

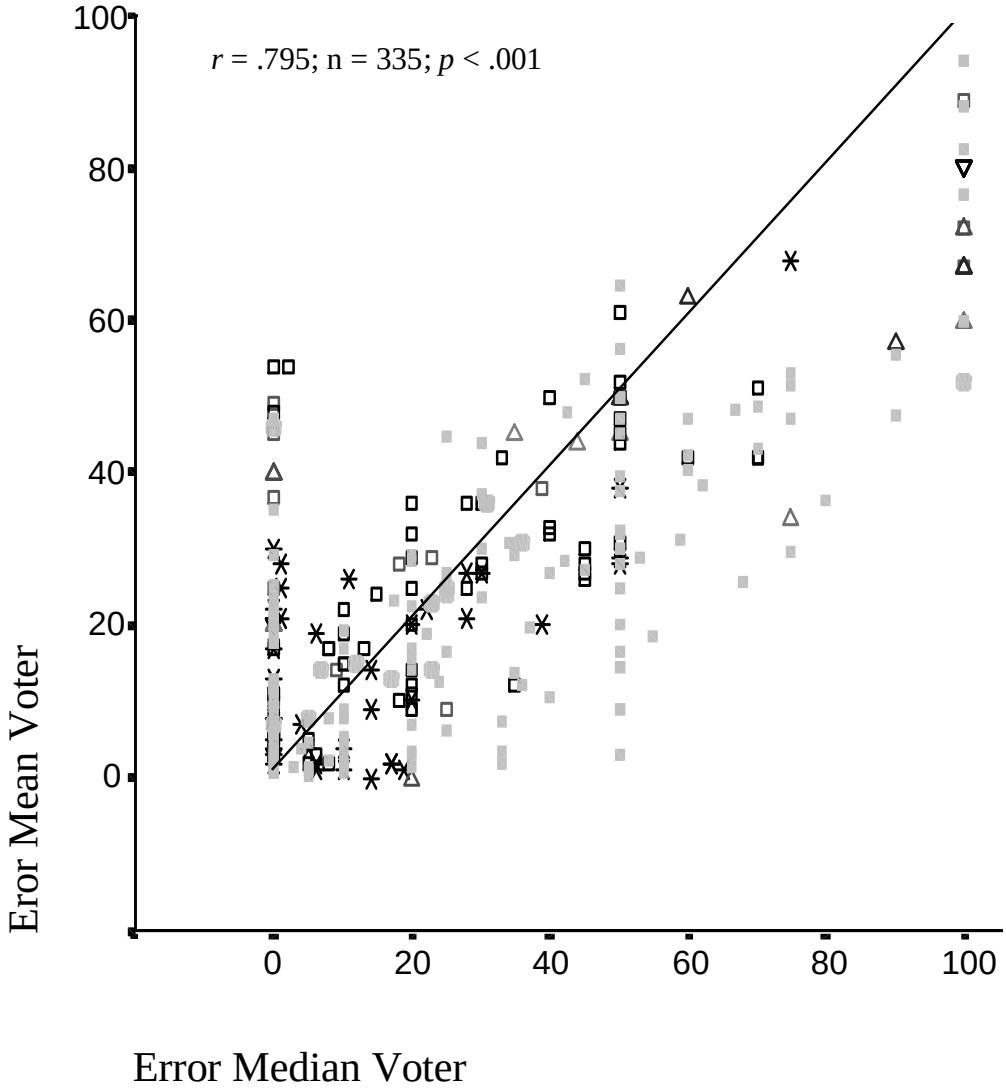
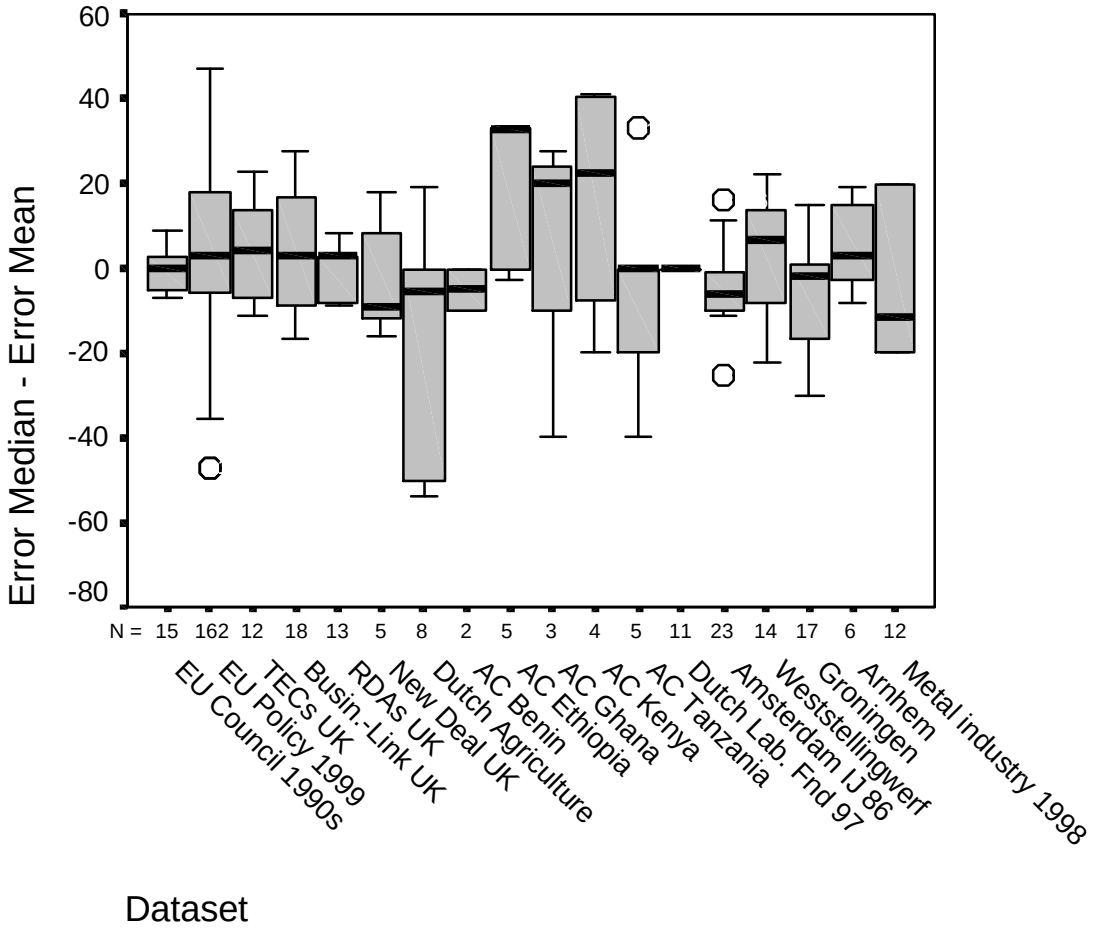


**Figure 2. Difference in error between the median and mean voter models in the datasets**




*Note*. The box is the interquartile range, with the median value as a line in the middle of the box. The 'whiskers' are the upper and lower quartile, ± 1.5 times the interquartile range. O = value of outliers.

## Footnotes

[1] The account of the median voter theorem given in popular elections also assumes that party ideologies can be represented as points on a single dimension, such as a left-right dimension or the amount of expenditure on a particular policy program. It also assumes that voters have single peaked preferences on these dimensions, so that they will vote for the party closest to their most preferred position.

[2] Such decision situations often concern negotiations that do not take place within a committee and where no formal vote is taken. Therefore, the term *voter* theorem is somewhat misleading, since what is being referred to is the mean average of the actors' policy position, regardless of whether or not they hold formal decision-making power.

[3] Divergent arguments are forwarded on the relevance of the mean voter in *popular elections*. Enelow and Hinich (1984) show that in a probabilistic voting model, in which voters may abstain due to alienation or ideological indifference, the optimal ideological location for political parties is the mean of voters' most preferred positions, weighted by 'policy significance'. Moreover, they infer that a multidimensional mean voter, based on candidates' perception of probabilistic voting by the electorate, is far more stable than in models of deterministic voting. However, Coughlin (1984) demonstrates analytically that under probabilistic voting in a two-candidate—one-dimensional election, the median voter position is a Nash equilibrium for both parties if voter preferences are symmetric around the median and based on quadratic utility.

[4] These bargaining models incorporate variants of the median and mean voter theorems as forecasts of the expected outcome used by actors during the bargaining process. For example, Bueno de Mesquita's (1994; 1997) expected utility model postulates that actors use the weighted median (weighted by capabilities and salience) to formulate an expectation of the decision outcome. If an actor believes it can bring the decision outcome closer to its policy position by challenging another actor, it may do so. Similarly, Stokman and Van Oosten's (1994) exchange model postulates that actors use the weighted mean as their expectation of the decision outcome.

[5] An exception is Achterkamp (1999) who systematically compares three complex bargaining models in different contexts, and also compares these against predictions based on the mean. However, this study does not consider a comparison of the median and mean predictions.

[6] For example, in Bueno de Mesquita and Stokman's evaluation (1994), the compromise model – the mean position weighted by decision-makers' capabilities and the levels of salience they attached to the issues – did not generate significantly less accurate predictions than the more complex bargaining models proposed by the authors.

[7] A t-test gives the same result ($t = 2.28$; $df = 334$; $p < .05$).

[8] Holcombe (1989), by contrast, argues that the median voter theorem is not applicable to dichotomous policy issues, i.e. where a middle alternative or a range of middle alternatives is absent. His argument pertains to *party competition in popular elections*. Parties are less likely to take a radical position on bimodal issues when voter preferences are highly salient, and associated with ethical issues, when the median voter is located at one of the extremes. Indeed, Medoff, Dennis and Bishin (1995) show that in voting for the Freedom of Abortion Access bill in 1994, Senators' personal characteristics rather than constituent preferences determined the outcome of decision-making.