"A Theory Waiting to Be Discovered and Used": A Reanalysis of Canonical Experiments on Majority-Rule Decision Making

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The paper offers a reassessment of canonical attempts to address a fundamental question about majority rule: what is the relationship between the preferences held by the participants and the outcomes that emerge from their interactions? Previous work, based on the analysis of abstract spatial models or relying on data from real-world spatial experiments, has yielded a mass of contradictory findings. Our work applies a new technique for estimating the uncovered set, a concept that describes a fundamental constraint on majority rule: given the preferences of decision makers, which outcomes can emerge from majority-rule decision making? By applying the uncovered set to a series of previous experiments on majority rule, we show that their seemingly bizarre and incompatible findings are in fact consistent with a clearly specified theory of how sophisticated individuals make decisions in majority-rule settings.

The limits of our current understanding of majority rule are easily apparent. Using abstract spatial models, Schofield says that for any democratic voting system, given high enough dimensionality "chaos is possible" (1995, 204), but Tullock (1981) asks, "Why so much stability?" Riker claims that "wide swings in political choices are possible and expected" (1982, 108), but Abrams argues that majority-rule cycling "may not be a very likely occurrence" (1980, 101).

Experimental analyses of majority rule have fared little better. The experiments did not seem to reveal the kind of "chaos" that our best theoretical interpretations of the absence of a core seemed to imply (McKelvey 1976; McKelvey and Schofield 1987; Schofield 1978). And yet, the dispersion of results that occurred defied explanation by any other single solution concept. Fiorina and Plott said that they wondered "whether some unidentified theory is waiting to be discovered and used" (1978, 590).

The inability to predict outcomes in majority-rule experiments has been used to bring into question the whole spatial modeling enterprise and the legitimacy of the rational choice agenda (Green and Shapiro 1994, 132–34). Simply put, if we can't predict experiments, in their simplicity, how can we hope to use similar models to make sense of real-world behavior? As an example, Green and Shapiro singled out the "uncovered set." As Green and Shapiro point out, up to now the uncovered set has not been tested against experimental data, "because it is extremely difficult to identify the region encompassed by the uncovered set, even in simple cases where just five legislators with circular indifference curves evaluate policies in two dimensions" (1994, 134). Green and Shapiro clearly regard this as a very telling argument against what they call the "spurious formal precision" of rational choice theory.

Until recently, Green and Shapiro were correct about difficulties in calculating the uncovered set and

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therefore submitting it to empirical investigation. Consequently, we believe it is of great significance to the discipline to report that it is not only possible to calculate the uncovered set for large or small spatial games, but that the puzzling pattern of previous experimental outcomes is in fact quite consistent with the predictions of the uncovered set. In particular, using a new technique for estimating uncovered sets, we reanalyze data from eight previous studies involving 20 different experimental designs and 272 outcomes.[1] We show that the uncovered set is a very good predictor of experimental outcomes. Depending on the experiment, over 90% (often 100%) of majority rule outcomes are contained in the uncovered set. The same results that baffled previous experiments, testing multiple solution concepts, are quite consistent with the uncovered set.

We also show that many of the majority-rule experiments in our analysis used subject preferences (ideal points) that generated large uncovered sets. This finding provides a new interpretation of successive experiments in these settings which yielded significantly different outcomes. The problem is not that subjects were irrational or responded to inadvertent cues, that outcomes were sensitive to strategic behavior, or that anything can happen in majority rule. Rather the preference configurations used in these experiments were such that a wide range of outcomes could result from majority-rule decision process, even those involving sophisticated decision makers.

Finally, the results show a great deal of support for McKelvey's hypothesis that the uncovered set constitutes a "pool" for potential outcomes resulting from the application of a variety of procedural protocols. That is, the uncovered set is robust to a significant variation in agenda control rules and communication rules, as well as configurations of ideal points.

The significance of these results is that majority-rule democracy is not as intractable as previous work has suggested. On the basis of the analyses, there is every reason to hope that we can understand majority-rule processes through the discipline of spatial modeling and rational choice. Indeed, the validity of this discipline is strengthened by the fact that the assumption of sophisticated behavior that implies the uncovered set is supported by data. Majority rule is unstable, but we can hope to predict the range of possible democratic outcomes, under a variety of institutional procedures, within the uncovered set.

[1]De Donder (2000) and unpublished research by Rick K. Wilson use techniques similar to ours.

Why Experiments

One of the primary advantages of experiments is the opportunity they provide to create exactly the right conditions for a critical test between competing theories. A classic example in the use of experiments is the seminal paper by Fiorina and Plott (1978). In this paper, the authors design an experimental setting involving five voters with two-dimensional Euclidean preferences. They then list and describe 16 theories (solution concepts) which make competing predictions about what outcomes will be chosen by such committees under various settings. Fiorina and Plott then run a series of three committee-voting experiments in controlled laboratory conditions. The evidence from the experiments allowed the authors to reject twelve of the 16 competing theories.[2]

This kind of critical test would be extremely difficult to do with real-world committee data. In order to test any solution concept in naturally occurring committee settings, one would have to have fairly complete and accurate preference data and be confident that there were no unknown sidepayments being offered, no vote trades, or past scores to settle that influenced the vote. Fiorina and Plott argue, "if a given model does not predict well relative to others under a specified set of conditions in the controlled world of the laboratory, why should it receive preferential treatment as an explanation of non-laboratory behavior occurring under similar conditions?" (1978, 576). Their argument has been common wisdom among many scholars for at least the last three decades and has led to the virtual explosion of experimental research in the social sciences.

In the context of majority-voting games, the wealth of experimental research is quite astonishing. In this literature, almost every existing solution concept has been used as a predictor. One clear conclusion that comes out of a careful scrutiny of this vast literature is that the solution concept of the core has proven to be a resilient solution concept in many majority-rule voting experiments (Berl et al. 1976; Isaac and Plott 1978; McKelvey and Ordeshook 1984, 1990).

To be more precise, in the so-called spatial theory of electoral competition, developed to study the general problem of aggregating individual preferences into social choices in general and in elections and

[2]Fiorina and Plott conclude that the result of their experiments is consistent with four theories: the core; the von Neumann-Morgenstern solution; Black's voting equilibrium; and the theory of agenda control.

legislative bodies in particular, each aspect of the choice environment is represented as a dimension in a w-dimensional space denoted by X. For convenience, we assume that X is a compact, or closed, bounded subset of Euclidean space, R^w. Alternative outcomes are represented as points in this space. The utility $u_i(x)$ that agent i derives from any outcome $x \in X$, is assumed to be a function of the Euclidean distance between x and ρ_i. So, for example we can assume that $u_i(x) = -\beta_i(||x - \rho_i||^2)$, where ρ_i represents the most preferred outcome, or ideal point of i, in X, $|| \ ||$ is the Euclidean norm on X and β_i is a positive constant. Such a utility function gives a convex preference for agent i. In the case that every voter has just one vote, the key solution concept commonly used is that of the *simple majority core*:

> **Definition 1** *$x^* \in X$ is in the simple majority core if there is no other outcome, y, in the choice space, X, such that over half of the agents prefer y to x^*.*

Although it is safe to conclude that the core generally withstands experimental challenge, a fundamental problem in the study of legislative and other majority-rule decision-making processes is that a *core* rarely exists except in simple one-dimensional games. The so-called Chaos Theorem (McKelvey 1976, 1979; McKelvey and Schofield 1987; Schofield 1978) implies that in multidimensional, majority-based decision-making games, absent institutional constraints, outcomes can occur essentially anywhere, rendering the ultimate result of legislative action indeterminate.

Yet, in a series of experiments beginning with Fiorina and Plott (1978) and McKelvey, Ordeshook, and Winer (1978), a variety of authors found patterned clusters of outcomes that were not consistent with the indeterminacy that theory suggested should be characteristic of noncore settings. A number of solution concepts, including the von Neumann-Morgenstern solution, the bargaining set, the competitive solution, and others have been offered as solution concepts when the core does not exist. The experimental evidence regarding these solution concepts is mixed. For example, McKelvey, Ordeshook, and Winer (1978) offered experimental data from a two-dimensional spatial setting supporting the competitive solution; a few years later, they published data from a discrete-voting setting that failed to support this solution concept (McKelvey and Ordeshook 1983).[3] Overall, no one solution concept seemed capable of capturing the patterns of outcomes observed in these experiments.

The Uncovered Set

An attractive alternative solution concept is the uncovered set (McKelvey 1986; Miller 1980). This concept has not yet been subjected to experimental testing because it has been impossible to calculate in all but the simplest cases. Recently, however, Bianco, Jeliazkov, and Sened (2004) have developed a computer algorithm that uses a grid search method to approximate the interior of the uncovered set. The availability of this new solution concept allows us to do something that social scientists rarely get to do: we can go back to *all* of the previously published majority-rule experiments where no core exists and use them, after the fact, to test the validity of the uncovered set. As a prelude, this section provides a nontechnical introduction to the uncovered set, as well as references to more technical discussions of the concept that are readily found in the literature.

Let N denote the set of n voters or legislators and assume n is odd. For any agent, $i \in N$, preferences are defined by an ideal point ρ_i as explained earlier.

> **Definition 2** *Let x, y, z be elements of the set X of possible outcomes. A point x beats another point y by majority rule if it is closer than y to more than half of the ideal points. A point x is covered by y if y beats x and any point that beats y beats x. The uncovered set includes all points that are not covered by other points.*

The uncovered set has several important properties. The uncovered set is never empty (McKelvey 1986, 290, Theorem 1). If the core is not empty for a set of voter preferences, then the uncovered set coincides with the core (McKelvey 1986, 285; Miller 1980, 74, Theorem 1).[4] The uncovered set is always a subset of the Pareto set (Miller 1980, 80, Theorem 4; Shepsle and Weingast 1984, 65, Proposition 3).[5]

The significance of the uncovered set lies in its potential to specify the set of possible majority-rule voting outcomes in legislatures and elsewhere. The Chaos Theorem shows that in such majority-rule settings individuals voting sincerely over an arbitrary,

[3]An adequate survey of this literature is beyond the scope of this paper. To get a feel for the predictive power of different solution concepts readers may start with Fiorina and Plott (1978) and move "down" our reference list as long as their interest may take them.

[4]The majority core (or "Condorcet winner") is a (set of) point(s) that beat all other points in a policy space.

[5]A point x is unanimously preferred to a point y if x is closer than y to all ideal points. The Pareto set is the set of points such that there is no point that is unanimously preferred to any point in the Pareto set.

imposed agenda could lead to outcomes occurring anywhere within the alternative space. But where would rational voters with control over their own agendas end up? Outcomes under these circumstances would be contained within the uncovered set.

Indeed, previous work shows that if voters consider the ultimate consequences of their behavior, rather than choosing myopically between alternatives presented at each point, outcomes of social choice situations will lie in the uncovered set (Feld et al. 1987; Feld, Grofman, and Miller 1989; McKelvey 1986; Miller 1980; Shepsle and Weingast 1984). As Cox argues,

> If one accepts . . . that candidates will not adopt a spatial strategy *Y* if there is another available strategy *X* which is at least as good as *Y* against any strategy the opponent might take, and is better against some of the opponent's possible strategies, then one can conclude that candidates will confine themselves to strategies in the uncovered set.[6] (1987, 419)

While Cox's argument focuses on candidates and electoral politics, its logic applies equally to legislatures and legislation: outcomes that lie outside the uncovered set are unlikely to be seriously considered by sophisticated decision makers, who know that such proposals are unlikely to survive whatever voting procedures are used. Thus, if we know which outcomes are in the uncovered set, we know what is possible in an electoral or legislative setting—what might happen when proposals are offered and voted on.[7]

Another important feature of the uncovered set has to do with the controversy about the importance of institutions in majority-rule voting. Since Shepsle (1979), it has been common to attribute to institutional procedures the observed stability in majority-rule games without a core. Different institutional procedures, it is argued, result in different majority-rule outcomes, even when preferences are held constant. This presents the troubling prospect that agenda control and other forms of influence over voting procedures could constitute an underlying form of arbitrary (and ultimately nondemocratic) influence over majority-rule decision making.

McKelvey (1986), however, proposed that a wide range of voting procedures could in fact induce a noncooperative game with equilibria inside the uncovered set. This hypothesis, if true, would be of enormous significance to our understanding of majority rule, because it would indicate that there are limits to the arbitrariness of the outcomes that can be achieved through procedural control. McKelvey demonstrated, for instance, that two-candidate elections, cooperative behavior in small committees, and strategic voting with an endogenous agenda should all produce outcomes within the centrist uncovered set. In the spirit of this hypothesis, this paper allows us to examine the robustness of the uncovered set to a variety of procedures used by multiple experimenters with different research interests.

Retrodicting the Uncovered Set

Our test of the uncovered set uses previously published committee voting experiments—thus "retrodicting." Most social science research is conducted in a similar fashion, using existing data sets to see if theoretical or statistical models do a good job in predicting the outcomes as they appear in the data. What makes our test particularly powerful is that we use data collected to test other solution concepts for majority rule. Furthermore, we test the uncovered set against several different data sets that were collected by numerous different researchers for many different purposes using several alternative experimental designs, none of which was in any way designed to accommodate the particular solution concept we put to the test here.

Our testing procedure is as follows. First, we searched for previously published committee voting experiments where the voters' (two-dimensional) ideal points were arranged such that there is no core.[8] Our search revealed eight published experiments: Fiorina and Plott (1978); Laing and Olmsted (1978); McKelvey, Ordeshook, and Winer (1978); McKelvey and Ordeshook (1984); Wilson (1986); Wilson and Herzberg (1987); King (1994); and Endersby (1993).[9] In these papers, 20 simple majority-rule experiments

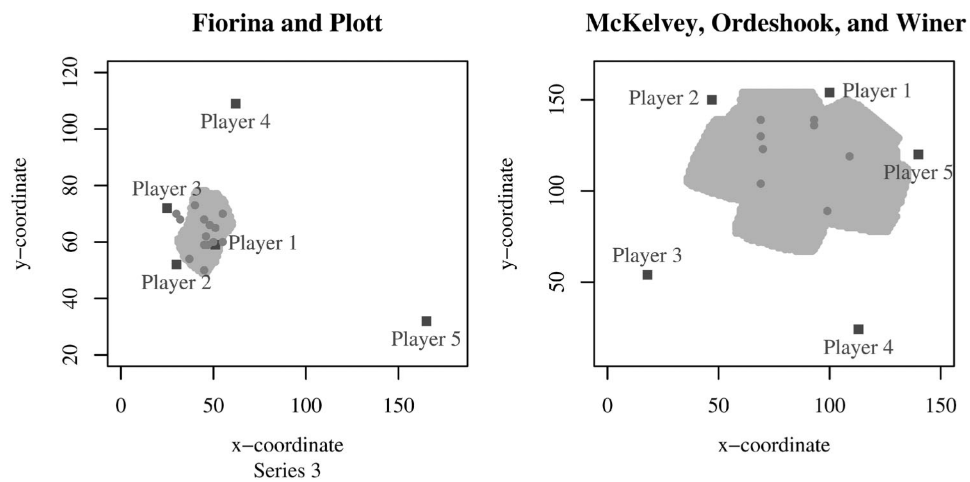
[6]See also Calvert 1985; Grofman et al. 1987; McKelvey 1986; Ordeshook and Schwartz 1987; Shepsle and Weingast 1984, 1994.

[7]Subject, of course, to caveats about exogenous, unchangeable rules such as limitations on which proposal can be brought to a vote, super-majority rules, germaneness requirements, etc.

[8]Experiments where voters' ideal points yield a nonempty core were not considered, since the uncovered set is equal to the core when a core exists.

[9]Initially, four other experimental articles were selected but were later removed from the analysis; three using discrete alternative spaces and one using a two-dimensional alternative space. The uncovered set in the two discrete experiments (McKelvey and Ordeshook 1982, 1983) is very large: 12 of 17 alternatives in McKelvey and Ordeshook (1982) and 12 of 15 alternatives in McKelvey and Ordeshook (1983) fall in the uncovered set. Uninterestingly, these large uncovered sets correctly predicted most of the outcomes. A discrete experiment (Miller and Oppenheimer 1982) and a spatial experiment (Eavey 1991) were both removed from analysis because both articles examine fairness and universalism and therefore manipulated cardinal payoffs in unusual (nonsmooth)

FIGURE 1 Canonical Experiments: Experimental Outcomes Plotted on Uncovered Sets



were reported. All consist of five- or seven-person committees that were asked to use majority-rule voting to select a specific policy from a two-dimensional policy space. In each experiment, committee members were given Euclidean preferences over the policy space. Each member had an ideal point where his/her utility was maximized; utilities fall as the policy chosen by the committee moves away from that ideal. After outcomes were chosen, committee members received monetary payments associated with the final outcome. Members were not allowed to make deals to transfer these payments or any shares of these payments after the conclusion of the experiments.

With the ideal points from these experiments, we use the Bianco, Jeliazkov, and Sened (2004) computational model to estimate the interior of the uncovered set for each experiment's configuration of ideal points. Then, we plot the estimated uncovered set, overlay the experimental outcomes as they were reported in the original publications, and assess whether the experimental outcomes are contained within the estimated uncovered set. Finally, we utilize a binomial test to assess whether outcomes are occurring in the uncovered set more often than we would expect by chance alone, given a process that is constrained by the Pareto set. We compare the percentage of outcomes occurring in the uncovered set (observed-π) with the percentage of outcomes that one would expect to find in the uncovered set given a uniform distribution of outcomes throughout the Pareto set (hypothesized-π). If the observed-π is significantly higher (one-tailed test) than the hypothesized-π, then we will reject the null hypothesis that outcomes in the uncovered set are no more likely than other outcomes in the Pareto set.[10]

Results

Our presentation of results begins with two canonical papers: Fiorina and Plott (1978) and McKelvey, Ordeshook, and Winer (1978), shown in Figure 1. We then survey the other experiments listed above.

Fiorina and Plott (1978)

This article conducts committee decision experiments using three preference configurations to assess the validity of 16 competing social choice solution concepts.[11] Both Series 1 and Series 2 configurations contain a core and are not used in this analysis. However, the preference configuration used in Series 3 is one in which a core does not exist. Outcomes from this experiment are shown in Figure 1, with the uncovered set in grey.[12]

Fiorina and Plott were unsure how to interpret the results of these experiments, as none of their 16

ways. The effect of these nonstandard utility functions has interesting ramifications for the uncovered set, but this is a topic best saved for future examination.

[10] This also allows us to control for the size of the uncovered set. If the uncovered set is quite large relative to the Pareto set then a large proportion of outcomes occurring in the uncovered set is somewhat unsurprising. However, if we can show that the percentage of outcomes in the uncovered set is significantly higher than we would expect to see by chance, then we can be confident that the uncovered set is performing well, despite its large size.

[11] The experiments used a formal amendment procedure. Committee members operated under Robert's Rule of Order with the experimenter acting as chair. For a transcript of the proceedings see Plott (1976).

[12] There are two outcomes located at (50, 60).

solution concepts exhibited much predictive power. Enter the uncovered set. Most (12 of 15) of the committees chose final policies located inside the uncovered set and one committee chose a final policy very close to the boundary of the estimated interior of the uncovered set. The uncovered set turns out to be a much better predictor of policy outcomes than any of the 16 theories tested by Fiorina and Plott.

These experiments display the elegance of the uncovered set. While the Pareto set is able to correctly predict all (100%) outcomes, the uncovered set is able to predict a high percentage (80%) of the experimental outcomes while only occupying 11.8% of the Pareto set. Since the uncovered set is only a fraction of the size of the Pareto set, it is a more efficient predictor of voting outcomes and thus leads to better predictions. The uncovered set performs far better than is expected by chance; the observed-π of .800 is significantly higher than the hypothesized-π of .118 ($p = .000$).

McKelvey, Ordeshook, and Winer (1978)

This article conducts one series of experiments in which there is no core.[13] The goal was to evaluate the predictive power of the competitive solution.[14] The competitive solution predicts that outcomes will fall on a number of points—generally five points in five-person experiments—where players who pivot between two potential coalitions receive the same payout in either coalition. The authors allow open and free communication (except for discussion of exact monetary payoffs), and negotiation continues until a majority of the committee jointly signs a written agreement.

The right-hand plot in Figure 1 shows the uncovered set and outcomes for these experiments.[15] The uncovered set contains all of the experimental outcomes. Compared to the competitive solution, the uncovered set does very well. Five of eight outcomes are "closely predicted" by the competitive solution; the three others are not even close. The binomial test shows the observed-π of 1.00 to be significantly higher than the hypothesized-π of .566 ($p = .012$).

Laing and Olmsted (1978)

Laing and Olmsted use a series of four experiments to test the competitive solution.[16] The preferences, outcomes, and uncovered sets for these experiments are in Figure 2.[17] In all configurations, full and open communication was allowed.

The first "Bear" configuration, so called by Laing and Olmsted because of the difficulty of calculating the competitive solution, is shown in the top left-hand plot. Seventeen of the 19 experimental outcomes fall inside the uncovered set. The second, "Two Insiders" configuration, is displayed top-right. All but one of the outcomes is inside the uncovered set. The uncovered sets in both of these experiments perform significantly better than expected by chance ("Bear": observed-$\pi = .944$, hypothesized-$\pi = .641$, $p = .004$; "Two Insiders": observed-π = .947, hypothesized-π = .776, $p = .052$). The third, "House" configuration, is displayed bottom-left.

The uncovered set for this experiment contains the lowest percentage of outcomes of any of the experiments in this paper. Still, about 74% of all outcomes fall in the set. This is better than expected by chance (observed-π = .737, hypothesized-π = .573, $p = .112$). The final, "Skew Star," configuration is displayed in the bottom right of Figure 2. Fifteen of 18 outcomes are in the uncovered set. One result, located on the boundary of the uncovered set near Player 2, can safely be categorized as a "near miss." The results of these experiments occur in the uncovered set significantly more than expected by chance (observed-$\pi = .882$, hypothesized-$\pi = .625$, $p = .020$).

McKelvey and Ordeshook (1984)

The articles discussed up to this point allowed unstructured negotiation processes. McKelvey and

[13]These experiments were run using an informal set of procedures in which committee members were allowed to make proposals at any time that were then discussed and informally voted on among the members. Experimental participants were allowed to participate in more than one experiment, but no two subjects were allowed to play together more than once. Half the committees were assigned linear payoff functions, the other half nonlinear.

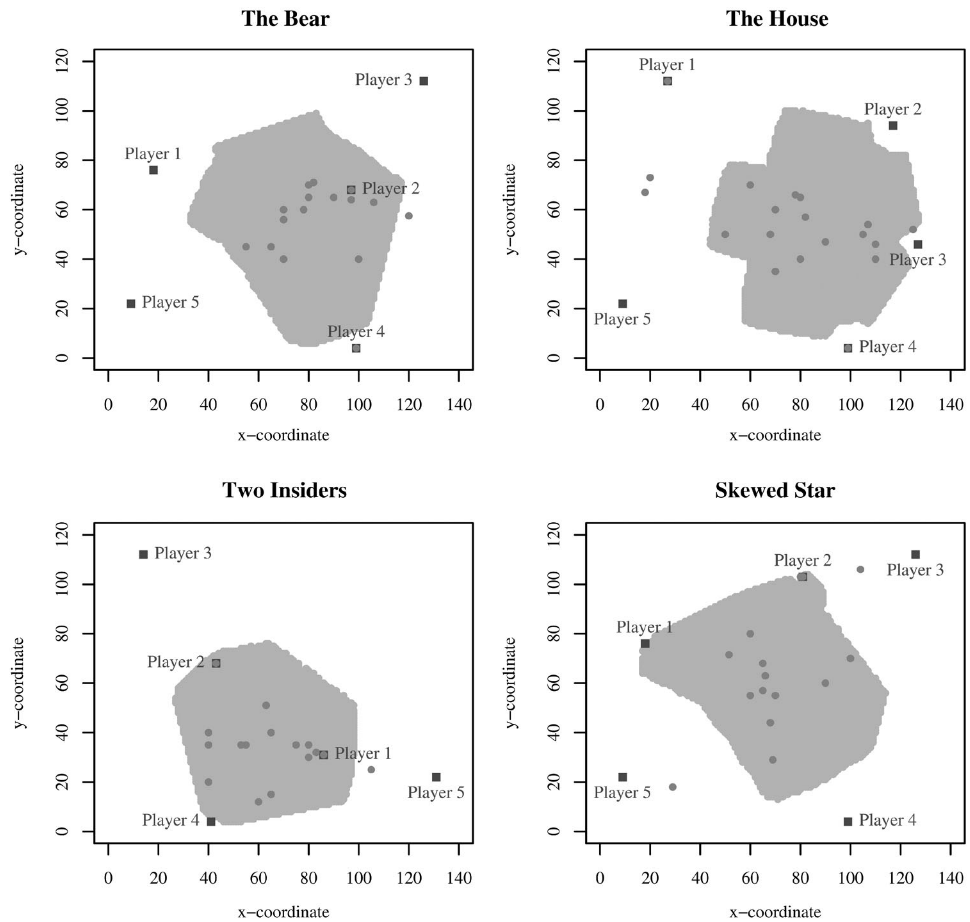
[14]See McKelvey, Ordeshook, and Winer (1978, 605–607) for a complete definition and examples of the competitive solution.

[15]*X* and *Y* coordinates for ideal points and experimental outcomes are not reported in McKelvey, Ordeshook, and Winer (1978). Values are estimated using a figure of this experiment appearing in McKelvey and Ordeshook (1987).

[16]These experiments were conducted in much the same manner as McKelvey, Ordeshook, and Winer (1978), with the difference being that subjects participated in multiple rounds of experiments convened in the same committee.

[17]Game A_2 has three outcomes located at (80,70) and two outcomes located at (97,68). Game *B* has three outcomes located at (86,31) and two outcomes located at (40,40). Game C_2 has three outcomes located at (60,80) and two outcomes located at (66,63).

FIGURE 2 Laing and Olmsted (1978) Experimental Outcomes Plotted on Uncovered Sets



Ordeshook (1984),[18] on the other hand, conducts four series of noncore experiments to test the effects of procedural rules on committee voting. The procedural rules were all a great deal stricter than in the experiments mentioned above. This gives us a chance to begin to examine the robustness of the uncovered set to procedure.

Series 1 and Series 2 are two different five-person preference configurations, labeled PH and PHR. PHR is simply a rotated version of PH. With both, the experimenters emulate a "germaneness" rule by allowing committees to consider and vote on moves in only one dimension (*X* or *Y*) at a time. This is a marked contrast with Fiorina and Plott (1978) and earlier experiments. They then use two different communication conditions for each series. In the "closed" procedure, subjects must be recognized by the chair and comments must be relevant only to the proposal (and dimension) under question. In the "open" procedure, anyone may speak without being recognized, and they can communicate with each other directly about tradeoffs and bargains that involve both policy dimensions at once.[19] In accordance with Shepsle (1979), McKelvey and Ordeshook hypothesized that the closed procedure would limit outcomes to the median voter's preferred policy in each dimension, or the stable point.[20] They further predict that committees will choose competitive solutions under the open-agenda process.

The stable point correctly predicts three of 32 outcomes in the two closed-rules experiments, with two

[18]In the interest of space, figures for the remaining experiments are located on a web appendix at journalofpolitics.org.

[19]Both Series 1 and 2 are transformations of the preference configurations in McKelvey, Ordeshook, and Winer (1978). McKelvey and Ordeshook use a probabilistic payoff scheme to reduce the likelihood of side payments.

[20]The stable point is defined as the point located at the intersection of the horizontal line that passes through the median ideal point on the *y*-coordinate and the vertical line that passes through the median ideal point on the *x*-coordinate. It is a special case of what later was to be referred to as the Structure Induced Equilibrium (Shepsle 1979, 1986) in the literature.

more outcomes occurring very close to the stable point. The competitive solution predicts none of the 34 experiments conducted under open rules, with one "close miss." Compared with the weak predictive ability of Shepsle's stable point in the closed condition and the competitive solution in the open condition, the uncovered set does well in both conditions. All of the outcomes with the "closed" procedure were in the uncovered set. In addition, all of the outcomes in the PHR-Open experiments were in the uncovered set, as were all but one near miss for the PH-Open experiments. The uncovered set performs significantly better than the Pareto set for all four experiments (observed-$\pi = 1.00$, hypothesized-$\pi = .583$, and $p = .000$ for the PH-Closed experiment; observed-$\pi = .938$, hypothesized-$\pi = .583$, and $p = .002$ for the PH-Open experiment; observed-$\pi = 1.00$, hypothesized-$\pi = .574$, and $p = .000$ for the two PHR experiments). Despite the use of a closed rule, these experiments surprisingly do not show evidence of outcomes occurring at the stable point for groups voting under both open and closed communication procedures. In contrast to the stable point, the uncovered set performs remarkably well under important variations in both communication and agenda control.

Endersby (1993)

Endersby, in a direct extension of McKelvey and Ordeshook (1984), compared a series of noncore experiments to test the effects of both procedural rules and communication restrictions on committee voting.[21] Endersby started with the PH and PHR preference configurations and examined three combinations of procedural and communication conditions for each, for a total of six experiments. "Closed Rule-Closed Communication" was like McKelvey and Ordeshook's "Closed" condition in that communication was highly restricted and only allowed on one dimension at a time. "Open Rule-Closed Communication" examined the same strict communication condition, but allowed discussion of both policy dimensions. "Open Rule-Open Communication" allowed both dimensions of policy to be considered in an informal and fluid communication setting. Like McKelvey and Ordeshook, Endersby expected to see quite different outcomes in these three different combinations of procedural rules and communication levels. Endersby predicts that closed rule outcomes will cluster around the stable point and open-rule outcomes will be more varied. He further predicts that closed communication will lead to more variance among outcomes than will open communication.

Whether the outcomes are significantly more clustered in the "Closed Rule-Closed Communication" condition is debatable. What is not debatable is the performance of the uncovered set. All the outcomes of these six series of experiments are located in the uncovered set. The uncovered set performs significantly better than the Pareto set for all six experiments (observed-$\pi = 1.00$, hypothesized-$\pi = .583$, and $p = .005$ for the three PH experiments; observed-$\pi = 1.00$, hypothesized-$\pi = .574$, and $p = .004$ for the three PHR experiments). This is but another remarkable illustration of how the uncovered set is a robust predictor of outcomes regardless of restrictions to procedure or communication.

Wilson (1986)

These experiments analyze the influence of different variations in agenda institutions.[22] In the first series, a forward agenda is used.[23] Committees are given a status quo and are allowed to propose changes to it. If a proposal receives majority support, it is accepted as the new status quo. The second series uses a backward-agenda procedure. Committee members are allowed to submit proposals to amend the status quo. Any proposal receiving a second approval is placed on the agenda. Voting on the proposals took place only after all proposals were received.[24] Voting first occurred between the last two proposals placed on the agenda. Winners were then pitted against the next proposal located by moving backward up the agenda. At the last vote, the current winner was pitted against the original status quo. Wilson predicts that experiments conducted under a backward-agenda procedure will result in a win for the status quo or a point that is in the win set of the status quo. They should thus be more clustered than in the forward agenda. The status quo for both series was (129, 218), a point in the uncovered set, so this allows us to examine the stability of points in the uncovered set.

[21]The article reports eight experiments, but only six were conducted. Endersby uses the same preference configurations as McKelvey and Ordeshook (1984) and is able to incorporate two of their experiments into his experiment design.

[22]These experiments differ from the previous experiments in that they were conducted with committee members communicating via computer. In all previous experiments committee interactions were conducted through face-to-face contact.

[23]All of the experiments previously reported in this paper use a forward agenda.

[24]Proposals to change the status quo were no longer accepted after 15 minutes or after a majority supported a proposal to adjourn, whichever came first.

Interestingly, in seven of the 12 backward-moving agenda experiments the original status quo at (129, 218)—a point in the uncovered set—were retained. The other five backward-moving agenda outcomes were also in the uncovered set, implying that majority-rule instability exists, but is constrained by the size of the uncovered set. Overall, the uncovered set performs significantly better than the Pareto set in the backward-agenda experiments (observed-$\pi = 1.00$, hypothesized-$\pi = .766$, and $p = .041$). Furthermore, all but one of the outcomes from the forward-moving experiments were in the uncovered set, and the lone exception was once again very close to the boundary. In part because of the large size of the uncovered set in this experiment, the uncovered set does not perform significantly better than the Pareto set in this series of experiments (observed-π = .917, hypothesized-π = .766, and p = .191). However, if the two series of experiments are pooled then the uncovered set does perform significantly better than the Pareto set (observed-π = .958, hypothesized-π = .766, and $p = .014$). Clearly, these experiments indicate that the uncovered set is robust to another important procedural variation.

Wilson and Herzberg (1987)

Wilson and Herzberg conduct two sets of experiments to examine how a committee member with the power to block proposals will affect outcomes. They administer two identical series, except that a blocking member is introduced in the second series.[25] The authors predict that committee voting with a blocking member will result in outcomes that are closer to the blocking member's ideal point than the outcomes under simple majority rule with no blocking power. This is consistent with the theory of the core, since the creation of a blocking player creates a set of undominated outcomes.[26] Testing the uncovered set with the blocking experiment data is therefore inappropriate, but the first control series uses simple majority rule and therefore provides data appropriate for testing the uncovered set. These experiments were conducted with committee members interacting via computer. Thus, communication is extremely limited—a fact that could limit coalition formation and render the uncovered set less predictive.

Seventeen of the 18 outcomes are located in the uncovered set—the other one is located extremely close to the boundary of the uncovered set. Thus, in spite of the extremely limited, computer-mediated negotiation, the uncovered set successfully predicted 94% of the outcomes. The uncovered set also performs significantly better than the Pareto set (observed-$\pi = .944$, hypothesized-$\pi = .766$, and $p = .054$).

King (1994)

King (1994) explores how changes in the voting rules on the Financial Accounting Standards Board affect outcomes. One of the voting rules he examines is simple majority rule with seven voting members and a nonvoting chair. This voting rule is interesting in that it allows us to examine the predictive power of the uncovered set in a body comprised of more than five members.

Again, all of the outcomes in these experiments are located well within the uncovered set and the uncovered set performs better than the Pareto set (observed-π = 1.00, hypothesized-π = .562, and $p = .031$).

Summary

The uncovered set does an excellent job of predicting the outcomes of the experiments examined in this paper. Table 1 gives the percentage of outcomes that are within the uncovered set for each of the experiments analyzed here.

Overall, about 94% of the experimental outcomes examined fall within the uncovered set. Even in the Laing and Olmsted C_1-House experiments, the percentage of outcomes in the uncovered set is over 70%. These findings are strong evidence in favor of the uncovered set as a general solution concept for majority-rule games, especially in light of the fact that no alternative theory approaches this level of predictive power. The predictive power of the uncovered set is particularly impressive given the wide range of procedures used in these experiments (e.g., free communication versus not, close versus open rules, agenda setters versus none).

The uncovered set also performs well regardless of the relative size of the uncovered set. It is not

[25]These experiments are conducted with committee members interacting via computer. Members are only allowed to make proposals, second proposals, and vote. No other communication is allowed. Proposals in these experiments require a second to be voted on.

[26]Technically speaking, these blocking experiments are not simple majority-rule games. The existence of a blocking player creates a core, consisting of a triangle with the blocker's ideal point as one vertex, and bounded by the median lines between the blocker and players 4 and 5, and the median line between players 1 and 3. If the blockers fully utilize their power as blockers, outcomes should be in this triangle.

Table 1 Summary of the Uncovered Set's Predictive Power

Article	Experiment	Total Outcomes	% in Uncovered Set
Fiorina and Plott	Series 3	15	80.00%
McKelvey, Ordeshook, and Winer	Competitive Solution	8	100.00%
Laing and Olmsted	A_2—The Bear	19	89.47%
	B—Two Insiders	19	94.74%
	C_1—House	19	73.68%
	C_2—Skewed Star	18	83.33%
McKelvey and Ordeshook	PH-Closed Communication	17	100.00%
	PH-Open Communication	16	93.75%
	PHR-Closed Communication	15	100.00%
	PHR-Open Communication	18	100.00%
Endersby	PH-Closed Rule Closed Communication	10	100.00%
	PH-Open Rule Closed Communication	10	100.00%
	PH-Open Rule Open Communication	10	100.00%
	PHR-Closed Rule Closed Communication	10	100.00%
	PHR-Open Rule Closed Communication	10	100.00%
	PHR-Open Rule Open Communication	10	100.00%
Wilson	Forward Agenda	12	91.67%
	Backward Agenda	12	100.00%
Wilson and Herzberg	Simple Majority Rule	18	94.44%
King	Non-Voting Chair	6	100.00%
Total		272	93.75%

surprising that large uncovered sets have a large percentage of outcomes fall inside it. It is therefore impressive that the uncovered set performs so well when compared to the Pareto set, since the binomial test used to compare the two sets is in practice testing the performance of the uncovered set while controlling for its relative size. These results are summarized in Table 2.

The uncovered set performs statistically better (at $\alpha = .10$) than the Pareto set in 18 of the 20 experiments. This is true when the uncovered set is very large (about 77% of the Pareto set in the Wilson and Wilson and Herzberg experiments) and very small (about 12% in the Fiorina and Plott experiments).[27] This shows that the uncovered set is both an accurate predictor of outcomes and has an efficiency improvement over the Pareto set.

As can be seen from the figures, outcomes do not appear to be evenly distributed throughout the uncovered set. This leads us to wonder what, if any, structure exists within the uncovered set. Assume, for example, that outcomes are normally distributed within the uncovered set, rather than being uniformly distributed as the binomial test assumes. Then a high number of outcomes would be expected to occur in the central portion of the uncovered set. Unfortunately, the irregular shape of the uncovered set and the Pareto set will not allow us to test a normal distribution hypothesis directly.

In an effort to explore if there is any structure to the distribution of outcomes in the uncovered set, we examine how the yolk performs as a predictor of outcomes. While the yolk has not been advanced as a solution concept, the yolk is a centrally located subset of the uncovered set and will therefore allow us to test if outcomes in the uncovered set have a tendency towards being located in the central portion of the uncovered set.[28]

The yolk predicts about 56% of the 272 outcomes we analyze. In the individual experiments the success of the yolk ranges from about 12% of outcomes to 90% of outcomes. While the binomial tests show that the yolk is often an efficiency improvement over the

[27]If the uncovered set performs well as a prediction tool only when the uncovered set is large but poorly when the uncovered set is small, then we would conclude that the uncovered set is not a good predictive tool. To test this, we examine whether the predictive power of the uncovered set (% of outcomes in uncovered set) and the uncovered set's size (relative to the Pareto set) are correlated. The correlation between the two is positive ($r = .301$), but not significant at the $\alpha = .10$ level.

[28]The yolk has a history of being used as a centrist "stand-in" for the uncovered set. McKelvey was able to show that the uncovered set was within a circle four times the radius of the yolk (1986, 304, Theorem 5).

Table 2 Binomial Test—Comparison of the Pareto Set and the Uncovered Set

Article	Experiment	Hypothesized π	Observed π	P-value
Fiorina and Plott	Series 3	.118	.800	.000
McKelvey, Ordeshook, and Winer	Competitive Solution	.566	1.00	.012
Laing and Olmsted	A_2—The Bear	.641	.944	.004
	B—Two Insiders	.776	.947	.052
	C_1—House	.573	.737	.112
	C_2—Skewed Star	.625	.882	.020
McKelvey and Ordeshook	PH-Closed Communication	.583	1.00	.000
	PH-Open Communication	.583	.938	.002
	PHR-Closed Communication	.574	1.00	.000
	PHR-Open Communication	.574	1.00	.000
Endersby	PH-Closed Rule Closed Communication	.583	1.00	.005
	PH-Open Rule Closed Communication	.583	1.00	.005
	PH-Open Rule Open Communication	.583	1.00	.005
	PHR-Closed Rule Closed Communication	.574	1.00	.004
	PHR-Open Rule Closed Communication	.574	1.00	.004
	PHR-Open Rule Open Communication	.574	1.00	.004
Wilson	Forward Agenda	.766	.917	.191
	Backward Agenda	.766	1.00	.041
Wilson and Herzberg	Simple Majority Rule	.766	.944	.054
King	Non-Voting Chair	.562	1.00	.031

Note: Hypothesized-π is the percentage of the Pareto set covered by the uncovered set. This is the amount of expected outcomes that will fall in the uncovered set given a uniform distribution of outcomes across the Pareto set. Observed-π is the percentage of outcomes actually occurring in the uncovered set. The p-values reported are the probability of there being observed-π or greater percentage of outcomes falling in the uncovered set, given the hypothesized-π is true (one-tailed test).

uncovered set, the yolk cannot achieve the predictive power of the uncovered set and thus should not be seen as a predictor of outcomes.[29] The fact that a disproportionate number of outcomes occur in the yolk indicates that there is likely some internal structure in the uncovered set that we are not yet able to explain. Outcomes located in the central portion of the uncovered set seem more likely to occur than outcomes located on the boundaries of the uncovered set.

Why Are the Uncovered Sets so Big?

Most of the experiments analyzed here have large uncovered sets. (The lone counterexample is Fiorina and Plott 1978.) These findings conflict with intuitions about the size of the uncovered set (e.g., Adams and Merrill 2003; Shepsle and Weingast 1984). Moreover, if these results are examples of a general phenomenon, they have important implications for the usefulness of the uncovered set as a solution concept and for our understanding of majority rule. Insofar as uncovered sets are large, they are less useful as predictors, in that they do not narrow the set of possible outcomes down to a relatively small size. This finding also breathes new life into Chaos Theorem results: if the uncovered set is large, then the set of potential outcomes from majority-rule processes is similarly large, suggesting that agenda setting and other forms of sophisticated behavior can have an important influence on outcomes.

In this section, we discuss a simple explanation for the size of the uncovered sets in these experiments. Our explanation focuses on the configuration of ideal points that is typically used in these experiments: a rough circle of points arranged around an empty center.[30] Such a configuration would result from two

[29]We argue that for a solution concept to be an ideal predictive tool it should be highly predictive (contain a high percentage of outcomes) and efficient (as small as possible). The uncovered set and the Pareto set both contain a high percentage of outcomes, but the uncovered set is more efficient and therefore a superior predictive tool. While the yolk is often statistically more efficient than the uncovered set (this is true in 17 of the 20 experiments analyzed), it fails at being highly predictive and is therefore not an improvement over the predictive power of the uncovered set. Figures showing the yolk for all experiments analyzed, tables reporting the percent of outcomes in the yolk, and binomial tests comparing the uncovered set and the yolk at be found at journalofpolitics.org.

[30]Sixteen of the 20 experiments analyzed in this article use preference configurations that match this description.

kinds of changes in the Plott (1969) symmetry conditions (ideal points arranged in pairs around a central ideal point): either moving the center ideal point out to the perimeter, or deflecting one or more points so that they are no longer in opposing pairs. Most of the experiments analyzed here implement both changes—the exception is Fiorina and Plott, who keep one ideal point in the center and deflect one opposing pair.

Simply moving one opposing pair a short distance and retaining the central ideal point yields a small uncovered set, as shown in Fiorina-Plott results in Figure 1. However, implementing both changes, and in particular leaving the center empty, substantially increases the size of the uncovered set. This is exemplified by the McKelvey, Ordeshook, and Winer configuration, also shown in Figure 1.[31]

Analysis of additional preference configurations reveals an important fact about the size and shape of the uncovered set.[32] It appears that distributions of ideal points that are relatively close to Plott symmetry conditions have relatively small uncovered sets.[33] However, the presence or absence of an ideal point in the center makes a big difference in the size of the uncovered set. There is a large increase in the size of the uncovered set when the central ideal point is moved out to the perimeter.

This suggests a new explanation for the variation in outcomes seen in most of these experiments. Simply put, without knowing it, the designers of these experiments used ideal point distributions that generated large uncovered sets. Thus, the tendency for majority rule to "wander" in these experiments was not due to an inherent chaos, or to misunderstanding or collusion by experimental subjects. Rather, the variation was driven by the distribution of preferences, a distribution that generated large uncovered sets. The point is not that our results confirm that "anything can happen." Rather, a large uncovered set implies that sophisticated decision makers using majority rule can arrive at a wide range of possible outcomes. However, this result is not inevitable—it all depends on the preferences held by decision makers. Some preference distributions generate small uncovered sets, as in the Fiorina-Plott example.

This analysis suggests the appropriate direction for future experimental research. Future experiments should systematically vary preference configurations from treatment to treatment, to see if treatment effects can be explained by the uncovered set. In addition, some treatments should include preference configurations associated with both smaller and larger uncovered sets, in order to see if the uncovered set remains a valid solution concept when the uncovered set is only a small fraction of the Pareto set.

Conclusion

Near the end of their seminal article, Fiorina and Plott consider the difficulty of finding a solution concept that can accurately predict outcomes in both spatial voting games with core solutions and those without a core. They note, "the *nonexistence* of a [core] equilibrium is *not* associated with experimental chaos . . . Perhaps some general theory exists which could explain both Series 2 (core solution) and Series 3 (no core solution)" (Fiorina and Plott 1978, 590, emphasis in original). Is the uncovered set the general theory they seek? The evidence from this paper cannot rule out the uncovered set.

The power of the uncovered set as a solution concept is particularly appealing in light of its relationship to the core. As Fiorina and Plott point out, "if some as yet undeveloped theory is driving Series 3 (no core solution) experiments, it had better specialize to the equilibrium/core when the latter exists" (1978, 590). This is exactly what the solution concept of the uncovered set does. When a core exists, the uncovered set coincides with the core. Because of this fact, the uncovered set can claim for itself the success that the core has displayed in experimental settings (Berl et al. 1976; Fiorina and Plott 1978; Isaac and Plott 1978; McKelvey and Ordeshook 1984, 1990).

The success of the uncovered set as a solution concept is a rare instance in the current state of affairs in political science where the elegance and strength of the rationale for a theoretical solution concept is so beautifully matched by a remarkable success as a predictor of actual experiments. This success is all the more impressive given that none of these experiments was constructed with the uncovered set in mind and that the experiments were run by such a diverse set of

[31]In the experiments discussed here, the Pareto set is typically the perimeter around all of the ideal points.

[32]A figure showing these additional configurations and commentary explaining their effect on the size of the uncovered set can be found in the web appendix at journalofpolitics.org.

[33]Green and Shapiro claim that "the size of the uncovered set tends to grow as the distribution of legislators' ideal points become more asymmetrical" (1994, 134). This is true only if there remains a centrally located legislator. If there is no centrally located legislator, as in the majority of the experiments examined in this paper, the uncovered set tends to shrink as the distribution of legislators' ideal points become more asymmetrical.

individuals for such a diverse set of research questions with a remarkable diversity in experimental designs. The experimental procedures used specified open and closed communication, forward and backward agendas, formal and informal voting processes, and open and closed agenda control. As McKelvey (1986) speculated in his classic article on the "Institution-Free Properties of Social Choice," the uncovered set proved to be robust to these institutional variations. The assumption of sophisticated voting implies the uncovered set as a solution concept. The success of the uncovered set as a prediction tool, under various institutional rules, implies that this assumption cannot be rejected, despite procedural variance. The variation in outcomes attributable to procedural variance is thus constrained by the boundaries of the uncovered set.

Finally, our application of the uncovered set to previous experiments provides an explanation for the observed variation in experimental outcomes. Simply put, these experiments inadvertently used preference distributions that were associated with wide ranges of feasible outcomes—a finding that is apparent only now, given our estimates of the uncovered sets for these experiments. These results provide a new set of bounds on claims that in the absence of institutional constraints, majority-rule procedures are susceptible to agenda setting and other forms of strategic behavior. Our work suggests that the potential for mischief depends on the distribution of preferences that decision makers bring to the process, and the range of feasible outcomes—the uncovered set—generated by these preferences.

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References

Abrams, Robert. 1980. *Foundations of Political Analysis*. New York: Columbia University Press.

Adams, James, and Samuel Merrill III. 2003. "Voter Turnout and Candidate Strategies in American Elections." *Journal of Politics* 65 (1): 161–89.

Berl, Janet, Richard D. McKelvey, Peter C. Ordeshook, and Mark D. Winer. 1976. "An Experimental Test of the Core in a Simple N-Person Cooperative Nonsidepayments Game." *Journal of Conflict Resolution* 20 (3): 453–79.

Bianco, William T., Ivan Jeliazkov, and Itai Sened. 2004. "The Limits of Legislative Actions: Determining the Set of Enactable Outcomes Given Legislators Preferences." *Political Analysis* 12 (3): 256–76.

Calvert, Randall. 1985. "Robustness of the Multidimensional Voting Model: Candidate Motivations, Uncertainty, and Convergence." *American Journal of Political Science* 29 (1): 69–95.

Cox, Gary. 1987. "The Uncovered Set and the Core." *American Journal of Political Science* 31 (2): 408–22.

De Donder, Philipe. 2000. "Majority Voting Solution Concepts and Redistributive Taxation." *Social Choice and Welfare* 17 (4): 601–27.

Eavey, Cheryl L. 1991. "Patterns of Distribution in Spatial Games." *Rationality and Society* 3 (4): 450–74.

Endersby, James W. 1993. "Rules of Method and Rules of Conduct: An Experimental Study on Two Types of Procedure and Committee Behavior." *Journal of Politics* 55 (1): 218–36.

Feld, Scott L., Bernard Grofman, Richard Hartley, Marc Kilgour, and Nicholas Miller. 1987. "The Uncovered Set in Spatial Voting Games." *Theory and Decision* 23 (2): 129–55.

Feld, Scott, Bernard Grofman, and Nicholas Miller. 1989. "The Geometry of Majority Rule." *Journal of Theoretical Politics* 1 (4): 379–406.

Fiorina, Morris P., and Charles R. Plott. 1978. "Committee Decisions under Majority Rule: An Experimental Study." *American Political Science Review* 72 (2): 575–98.

Green, Donald P., and Ian Shapiro. 1994. *Pathologies of Rational Choice Theory: A Critique of Applications in Political Science*. New Haven: Yale University Press.

Grofman, Bernard, Guillermo Owen, Nicholas Noviello, and Amihai Glazer. 1987. "Stability and Centrality of Legislative Choice in the Spatial Context." *American Political Science Review* 81 (2): 539–53.

Isaac, Mark, and Charles Plott. 1978. "Cooperative Game Models of the Influence of the Closed Rule in Three Person, Majority Rule Committees." In *Game Theory and Political Science*, ed. Peter C. Ordeshook. New York: New York University Press, pp. 283–322.

King, Ronald R. 1994. "An Experimental Investigation of Super Majority Voting Rules: Implications for the Financial Accounting Standards Board." *Journal of Economic Behavior and Organization* 25 (2): 197–217.

Laing, James D. and Scott Olmsted. 1978. "An Experimental and Game-Theoretic Study of Committees." In *Game Theory and Political Science*, ed. Peter C. Ordeshook. New York: New York University Press, pp. 215–81.

McKelvey, Richard D. 1976. "Intransitivities in Multidimensional Voting Models and Some Implications for Agenda Control." *Journal of Economic Theory* 12: 472–82.

McKelvey, Richard D. 1979. "General Conditions for Global Intransitivities in Formal Voting Models." *Econometrica* 47 (5): 1085–1112.

McKelvey, Richard D. 1986. "Covering, Dominance, and Institution-Free Properties of Social Choice." *American Journal of Political Science* 30 (2): 283–314.

McKelvey, Richard D., and Peter C. Ordeshook. 1982. "Two-Candidate Elections Without Majority Rule Equilibria." *Simulation and Games* 13 (3): 311–35.

McKelvey, Richard D., and Peter C. Ordeshook. 1983. "Some Experimental Results that Fail to Support the Competitive Solution." *Public Choice* 40 (3): 281–91.

McKelvey, Richard D., and Peter C. Ordeshook. 1984. "An Experimental Study of the Effects of Procedural Rules on Committee Behavior." *Journal of Politics* 46 (1): 182–205.

McKelvey, Richard D., and Peter C. Ordeshook. 1987. "A Decade of Experimental Research on Spatial Models of Elections and Committees." California Institute of Technology Social Science Working Paper 657.

McKelvey, Richard D., and Peter C. Ordeshook. 1990. "A Decade of Experimental Research on Spatial Models of Elections and Committees." In *Advances in the Spatial Theory of Voting*, eds. James M. Enelow and Melvin J. Hinich. Cambridge: Cambridge University Press, pp. 99–144.

McKelvey, Richard D., Peter C. Ordeshook, and Mark D. Winer. 1978. "The Competitive Solution for N-Person Games Without Transferable Utility, With an Application to Committee Games." *American Political Science Review* 72 (2): 599–615.

McKelvey, Richard D., and Norman Schofield. 1987. "Generalized Symmetry Conditions at a Core." *Econometrica* 55 (4): 923–33.

Miller, Gary J., and Joe A. Oppenheimer. 1982. "Universalism in Experimental Committees." *American Political Science Review* 76 (3): 561–74.

Miller, Nicholas. 1980. "A New Solution Set for Tournament and Majority Voting." *American Journal of Political Science* 24 (1): 68–96.

Ordeshook, Peter C., and Thomas Schwartz. 1987. "Agenda and the Control of Political Outcomes." *American Political Science Review* 81 (1): 179–99.

Plott, Charles R. 1969. "A Notion of Equilibrium and Its Possibility under Majority Rule." *American Economic Review* 57 (4): 787–806.

Plott, Charles R. 1976. "Transcript of a Five-Member Committee Experiment." California Institute of Technology Social Science Working Paper 110.

Riker, William H. 1982. *Liberalism Against Populism: A Confrontation Between the Theory of Democracy and the Theory of Social Choice*. San Francisco: W. H. Freeman.

Schofield, Norman. 1978. "Instability of Simple Dynamic Games." *Review of Economic Studies* 45 (3): 575–94.

Schofield, Norman. 1995. "Democratic Stability." in *Explaining Social Institutions*, eds. Jack Knight and Itai Sened. Ann Arbor: University of Michigan Press.

Shepsle, Kenneth A. 1979. "Institutional Arrangements and Equilibria in Multidimensional Voting Models." *American Journal of Political Science* 23 (1): 27–59.

Shepsle, Kenneth A. 1986. "Institutional Arrangements and Equilibrium in Multi-dimensional Voting Models." In *Political Science: The Science of Politics*, ed. Herbert F. Weisberg. New York: Agathon Press, pp. 51–81.

Shepsle, Kenneth A., and Barry R. Weingast. 1984. "Uncovered Sets and Sophisticated Voting Outcomes with Implications for Agenda Institutions." *American Journal of Political Science* 28 (1): 49–74.

Shepsle, Kenneth A., and Barry R. Weingast. 1994. "Positive Theories of Congressional Institutions." *Legislative Studies Quarterly* 19 (2): 149–81.

Tullock, Gordon. 1981. "Why So Much Stability?" *Public Choice* 37 (2): 189–202.

Wilson, Rick K. 1986. "Forward and Backward Agenda Procedures: Committee Experiments on Structurally Induced Equilibrium." *Journal of Politics* 48 (2): 390–409.

Wilson, Rick K., and Roberta Herzberg. 1987. "Negative Decision Powers and Institutional Equilibrium: Experiments on Blocking Coalitions." *Western Political Quarterly* 40 (4): 593–609.

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