The Institutional Effect on Majority Rule Instability: Bicameralism in Spatial Policy Decisions

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The constitutional requirement that legislation must be approved by a majority of two chambers increases the likelihood that a core will exist, even in situations in which a core would not exist under a unicameral majority rule. Laboratory experiments were run on forty six-person groups, with constant induced preferences in a two-dimensional policy space. Groups were assigned to one of four treatments. In three treatments, members were assigned to two three-person chambers, and a majority of each chamber was required to make policy decisions. In two of these treatments, the assignment induced a bicameral core; in one it did not. The fourth, a control treatment, was a unicameral, simple majority-rule game with no core. The variance in each of the two cases with a bicameral core was significantly less than in the no-core bicameral or the unicameral treatments. In the cases with a bicameral core, the outcomes clustered closely around the predicted core outcomes. The results provide strong support for the stability-inducing properties of bicameralism and for the core as a predictor of this effect. Players received statistically greater rewards in those treatments in which their role was pivotal in achieving the core.

In *The Federalist Papers* #10, Madison articulated the constitutional problem of curbing unstable majority coalitions: "democracies have ever been spectacles of turbulence and contention; have ever been found incompatible with personal security or the rights of property" (Madison [1787–88] 1945, 81). Madison and others at the Philadelphia convention in 1787 thought that bicameralism would help guarantee stability by making it difficult for these majority coalitions to form. Is it reasonable to hope that institutional rules can in fact induce legislative stability?

Shepsle (1979) and others have suggested that the answer to this question is "yes"; they argue that procedural rules may induce an equilibrium when majority rule would be unstable. To this position, the objection is often made that internal rules of the House or Senate may themselves be overturned by simple majority rule; consequently, procedural rules may be as unstable as policy decisions themselves presumably should be (McKelvey and Ordeshook, 1984).

The U.S. Constitution, however, cannot be easily amended; amendment procedures require the costly construction of extraordinary majorities. Consequently, it is especially important to understand the stability properties of institutional rules imposed by the Constitution. If bicameralism, for example, has a separate and unique effect on legislative stability, then some of the observed stability in Congress may be attributed to an institutional feature that cannot be easily overturned.

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The purpose of this article is to report on experiments that test for an independent effect of bicameralism on legislative stability. The experiments are designed to test the theory of the bicameral core (Hammond and Miller 1987; Tsebelis and Money 1997), which demonstrates that a bicameral legislature is more apt to have stable, undominated policy choices than a unicameral legislature with the same number of legislators holding the same preferences. This article tests the core prediction by holding legislators' numbers and preferences constant while changing the allocation of legislators among two chambers, thereby inducing distinct core predictions, or no core. We argue that experiments are the best means of providing a rigorous, reliable test of this theory. The results are largely in conformity with the prediction of the theory.

Majority Rule Instability and the Bicameral Core

The problem of majority rule instability is profound in a spatial setting, as illustrated in Figure 1. This example is both intuitive and useful for the structure of the article since it provides the setting for the experiments we use to test our hypotheses. There are six voters with clear and reasonable preferences for the outcomes in the two-dimensional space. Each voter has an ideal point shown in the space and prefers outcomes that are closer in the Euclidean space to outcomes that are farther from that ideal point. In particular, each voter has concentric, circular indifference curves around the ideal point. In this setting, despite the fact that each voter's preferences are complete and transitive, the group, operating by simple majority rule, does not have transitive preferences.

To see this, it is useful to introduce the concept of a median line. Any two players would agree that some point on the straight line connecting their ideal points is better than any point off of that line. The line is called the contract curve between the two players. Some of these contract curves split the rest of the voters so that there are two voters on each side of the contract curve. These contract curves are called *median lines* and are shown in Figure 1. For any point not on a given median line, there is always a majority of voters who would prefer some point on the median line. If the three median lines intersected in a single point, that point would be undefeatable by simple majority rule. However, because the three median lines do not intersect in a single point, any point can be defeated by some coalition preferring some other point. The six voters cannot use majority rule to make a reasonable set of choices among the alternatives.

Hammond and Miller (1987) demonstrate that bicameralism can create undominated outcomes in exactly those settings in which simple majority rule results in cycling among alternatives. As an example, let us imagine that players 1, 3, and 6 are in the first chamber, and players 2, 4, and 5 are in the second chamber. This will be known hereafter as *Treatment 136*, after the members of the first chamber. A majority of *both* chambers is required to enact a policy change from the status quo. As a result, many four-person (majority) coalitions are no longer sufficient to implement a policy change.

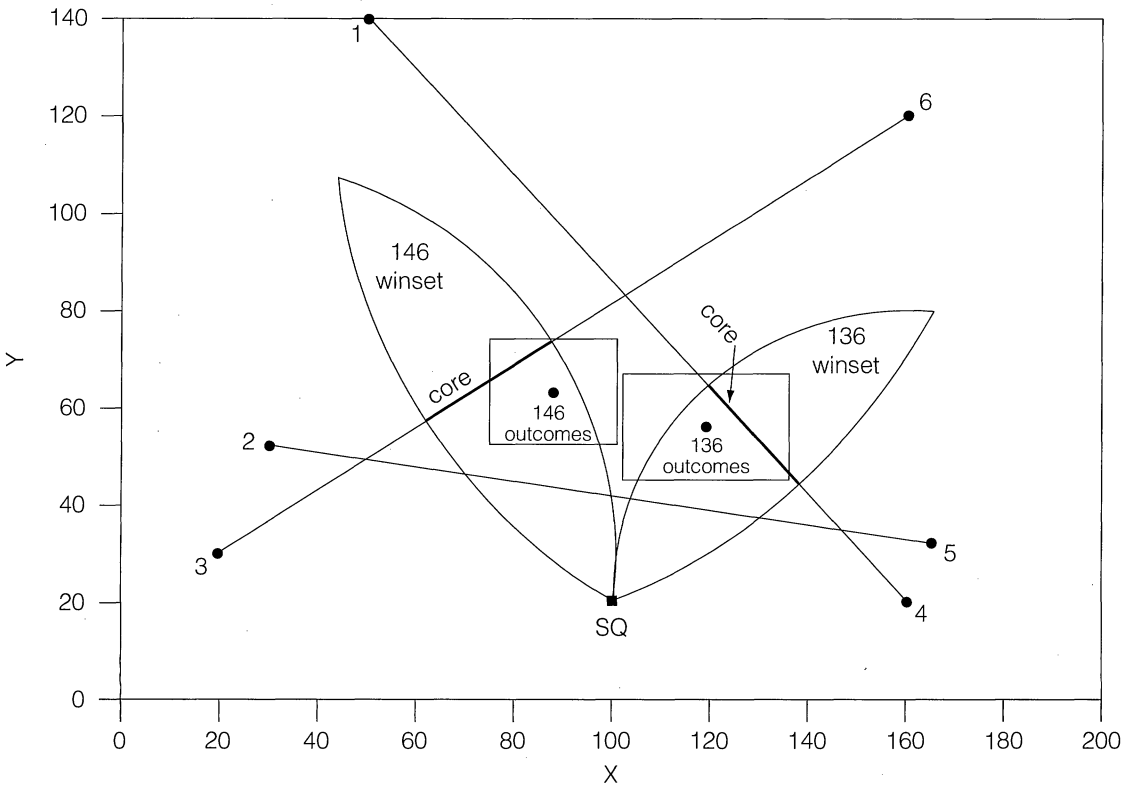
This has an important effect on the median lines. The *1–4* median line not only divides the legislature, it also divides each chamber. That is, there is one member of each chamber on each side of the *1–4* median and one member at each end. We will call a median that divides each chamber in this way a *bicameral median*. The *1–4* bicameral median still dominates points off of it; there is a four-voter coalition of the correct bicameral composition that would vote to move from any point off of the median to some point on it.

However, in Treatment *136*, this is the only median line for which this can be said. The *3–6* median, for example, is not a bicameral median. There are two members of the second chamber (players 4 and 5) who would not support a move to that median. Furthermore, they could *veto* such a move despite the fact that a majority of voters support it. The coalition of voters 1, 2, 3, and 6 (shown as *1236*) constitutes a majority coalition, but a *powerless* majority, in Treatment *136*.

The powerlessness of some majorities leads directly to stability. With bicameral Treatment *136*, the core will consist of a subset of the unique bicameral *1–4* median. The location of the core on that median depends on the location of the status quo. Suppose the status quo is at (100,20). The set of points that a coalition would prefer to a given status quo will be called that coalition's winset from that status quo. Figure 1 shows two such winsets. The winset to the left is that preferred by coalition *1236*. Coalition *1456* could enforce the winset to the right.

The core of bicameral treatment *136* is the intersection of the *1456* winset with the *1–4* median line. Consequently, a move from (100,20) to (130,52.7) is possible. The coalition supporting such a move consists of two members of both chambers. However, a move *from* (130,52.7) to any other outcome is no longer possible. The coalition supporting the move consists of three members of one chamber and just one of the other. In fact, *no* move from (130,52.7) is theoretically possible in Treatment *136*. That point is *undominated*. In fact, the core consists of the entire line segment darkened on the *1–4* median in Figure 1, including (130,52.7).

FIGURE 1 Mean Policy Decisions and Dispersion in the Two Bicameral Core Conditions



The existence of a core is due to the bicameral assignment of members to chambers. When a core exists, one median line is a bicameral median. In their extensive analysis of bicameralism, Tsebelis and Money (1997) show that the bicameral core, when it exists, will always be a line segment on that median line. The ends of that median line will be at the ideal points of a pivotal member for each chamber, who can guarantee some point on the median line. To use the apt terminology of Tsebelis and Money (1997, 211), conflict between the two chambers is reduced to "one privileged dimension of conflict" along that median line, with each pivotal voter representing, in some sense, her chamber to the other. But is there empirical evidence in support of this theory?

Empirical Research on Bicameralism

While some previous research on bicameralism has pointed to its stability-inducing effects, the results are largely suggestive. Weingast (1998), for example, has argued that the representation by states in the Senate gave slave-owning interests a veto power over threats to their interest. The Civil War resulted when increases in the number of free states undermined the influence of that veto.

Riker (1992, 105) made a parallel but explicitly normative argument. He argued that bicameralism allows legislatures to find the simple majority-rule equilibrium when it exists, at the same time that it discourages cyclic behavior when such equilibrium does not exist. Riker further claims that the benefits of bicameralism can be seen in a comparison of the twentieth-century policies of the effectively unicameral Great Britain with the United States.

While there seems to be a growing theoretical interest in the policy effects of institutions in general, the evidence reviewed by Riker is suggestive at best. Indeed, it is difficult to imagine what kind of comparative research could be definitive regarding the effects of institutional features such as bicameralism. Any cross-sectional study which found a correlation between bicameralism and stability would be open to the criticism that there could be some third factor or set of factors (for example, a "legalistic culture") which had brought about both bicameralism and stability.

Furthermore, even the most elaborate empirical study could not test whether bicameralism resulted in the stable outcomes predicted by the core, without being able to calculate the core; but calculating the core would require complete information about the policy preferences of each of the legislators, which are unobservable in natural legislatures. The most careful of comparative studies of institutional effects (see, e.g., Weaver and Rockman 1993) is simply not going to be conclusive. In sum, the problem of sorting out the effect of bicameralism in a world in which no other factors are held constant, and preferences are unobservable, is almost insurmountable.

While empirical research of this sort plays a crucial role in political science, the testing of a preference-based solution concept requires controlled data regarding actor preferences. The best way to get this data is to induce preferences in the laboratory. With these preferences, a specific solution concept can be calculated and compared to the outcomes achieved. In this case, the core varies with the particular assignment of a fixed set of voters to the two chambers. If the outcomes chosen systematically track the core predictions, holding all other factors constant, then a causal link between bicameralism and stability can be inferred, in a way that would be impossible with naturally occurring data.

Miller, Hammond, and Kile (1996) have conducted tests of bicameralism with six voters choosing from a policy space consisting of five discrete alternatives—letters A through E, worth differing amounts to each of the six voters. Alternative A was the predicted core in seven randomly assigned experiments, and Alternative D was the predicted core outcome in eleven experiments. Alternative A was in fact chosen six out of seven times when it was predicted, and alternative D was chosen nine out of eleven times when it was selected. This data allowed the null hypothesis of no association between treatment and outcome to be rejected with an alpha less than .005.

The inferences that can be drawn from this study, however, are limited. Miller, Hammond, and Kile did not have a control treatment with no bicameral core—for example, a treatment with identical preferences using simple majority rule. Consequently, while Miller, Hammond, and Kile can demonstrate that different bicameral assignments of legislators had a systematic effect on the outcome, they cannot claim that bicameralism was *more* stable than simple majority rule. By recomposing the two chambers so that every median is a bicameral median, we can create another control feature lacking in Miller, Hammond, and Kile. The bicameral treatment with *no core* can be created. This design feature allows us to examine whether it is something generic to bicameralism, or the specific existence of a bicameral core, that has an effect on stability.

Furthermore, the setting employed by Miller, Hammond, and Kile was not a very taxing one. With only five alternatives to be chosen among, the cognitive difficulty of considering the entire range of alternatives was not great. In a continuous two-dimensional policy space, however, subjects often find it difficult to locate and consider a significant number of alternatives. It is important to discover whether this stability can also be revealed in the much more challenging setting of two-dimensional policy space.

A two-dimensional policy space much more closely resembles the kind of policy space faced by real-world legislators. Poole and Rosenthal (1991) have argued convincingly that American legislators, over almost the entire range of U.S. history, have faced a primary economic policy dimension and a secondary social policy dimension. Legislative voting on a very high proportion of issues seems to be understandable, by the participants as well as by political scientists, in terms of these two dimensions. While the political and social world may consist of more than two dimensions, a test under these conditions is more robust and more realistic than a setting with five discrete alternatives.

Finally, by examining bicameralism in a two-dimensional policy space, it is also possible to examine a distributional hypothesis: bicameral stability advantages some, at the expense of others. In Treatment *136*, for example, players 4 and 5 are in effect given a veto over all policy changes, by virtue of their proximity as a majority coalition within the second chamber and by virtue of the pivotal role of player 4 in negotiating with the first chamber. This should result in a distributional advantage to players 4 and 5, at least compared to an alternative design in which players 4 and 5 are separated into two chambers.

Consequently, the design that is implemented is one in which the number of voters and their preferences are held constant, as shown in Figure 1. The bicameral assignment of the six voters is the treatment variable. The assignment is manipulated in such a way as to create different second-chamber veto blocks or to minimize the separation of the chambers in such a way as to result in no core. The selected outcomes should demonstrate a stable difference in policy selections and track the core when it exists.

Experimental Design

The design requires a series of committees to render policy decisions under four different conditions. In the

first condition, the *Unicameral Control Treatment*, the committee members will deliberate under simple majority rule. Given the absence of a core in this spatial setting, these committees should show signs of instability. Decisions should have far greater variability and show evidence of voting cycles.

The remaining three treatments involve a bicameral decision rule with a majority of two chambers required to pass a motion. The first bicameral treatment, Treatment *136*, was discussed above and is depicted in Figure 1. In this treatment, the bicameral core falls along the *1–4* median line, and players 4 and 5 constitute a veto block within the second chamber.

Treatment *146* is also shown in Figure 1. Here players 1, 4, and 6 are in the first chamber, and players 2 and 3 constitute a veto block within the second chamber. The *3–6* contract curve is the unique bicameral median. The core consists of the intersection of the winset from the status quo with the *3–6* bicameral median.

The third bicameral treatment is Treatment *135*, in which players 1, 3, and 5 are in the first chamber. Each of the three median lines now splits each chamber; consequently, there are *three* bicameral medians, each capable of attracting bicameral coalitions away from the other two medians. The bicameral core is empty in this treatment; consequently, it constitutes the Bicameral Control Treatment, much like the Unicameral Control Treatment.

The purposes of the experiments are threefold. First, the objective is to determine whether Treatment *146* and Treatment *136*—the two core treatments—are more "predictable" than the two treatments that do not induce a core (Treatment *135* and the Unicameral Control Treatment). Second, we wish to test whether the core is a good predictor of the outcomes in those treatments where a core exists. Third, we test whether the core is a better predictor than alternative solutions, such as the winset. If we find affirmative evidence for these three objectives, then there is good reason to believe that one of the most fundamental features of our Constitution has the capacity to play a role in generating stability in a democratic system.

Experimental Methods

A total of forty six-person committee experiments were completed. The 240 subjects included undergraduate and graduate students from the school of business, the school of engineering, and the college of arts and sciences at a private midwestern university. Subjects were recruited by advertising an experiment in collective decision making in classrooms, via an electronic bulletin board, and by sign-up sheets posted at the student center. The advertisements guaranteed a minimum payment of $3.00 with the opportunity to earn more based on the collective decision. Ten committees were convened in each of the four treatments.

The experimenter read aloud the instructions for the experiment. Participants were randomly assigned player numbers before entering the room where the experiment was held. The instructions were virtually the same in all conditions except for the description of the decision rule. In the simple majority condition, instructions stipulated that a minimum of four votes was needed to pass a proposal or to adjourn the meeting. In the bicameral conditions, the decision rule stipulated the need for at least two votes from each chamber (known as "Group I" and "Group II"). For each of the three bicameral conditions the instructions listed the relevant group members, i.e., in treatment 135, "group I consists of players 1, 3, and 5."

Each subject had a chart showing the set of circular indifference curves around her own ideal point. Subjects took a pretest to make sure that they could read the payoffs for any policy in the two-dimensional space. Subjects who had difficulty, as revealed by a pretest, were given additional help. No subject had information about the payoffs of other subjects. Instructions indicated that they could reveal any ordinal information about their own payoffs to other subjects; they were prohibited from sharing cardinal payoffs. This was done as a means of prohibiting a pooling of payoffs, which would have made their individual ordinal payoffs irrelevant.

The mode of deliberation, constant across all treatments, is free and open discussion. This lack of constraint on deliberation is consistent with previous experiments testing theories from cooperative game theory. (See for example Fiorina and Plott [1978] and McKelvey and Ordeshook [1978]). As the latter note (McKelvey and Ordeshook 1978, 614), unrestricted bargaining and coalition formation is assumed with most such solution concepts. This does not assume that an examination of the effects of more formal or restrictive deliberation procedures would not be worthwhile. We would expect that such effects would undoubtedly be discovered (see McKelvey and Ordeshook 1984). This prohibition against discussion of cardinal values and side-payments was virtually the only limitation on the discussion. They were allowed to reveal their own ideal points if they chose.

The alternative (100,20) was the default outcome, or status quo. A group that did not agree to any changes would receive the payoffs associated with that point. The meeting was adjourned when at least two members of each group raised their hand in agreement with a voiced motion to adjourn from any member of the committee. There was no fixed time limit, although there was necessarily some awareness that the experiment could not go on indefinitely. As a result, people who were more anxious to leave may have lost bargaining influence compared to

subjects who were willing to bargain longer. However, no constraint was imposed by the experimenter, and presumably any such subject differences were a source of random error, distributed equally across treatments.

Experiments proceed by incremental steps, and this experiment is no different. Bicameral legislatures not only require simultaneous majorities in each chamber, they normally deliberate separately by chamber. Naturally, each feature of bicameralism could have its own effect on the outcome; that is, the outcomes might be different if players 1, 3, and 6 deliberate separately from the other three voters, even if a majority of each separate chamber were *not* required for a decisive vote.

However, at the present time, we lack a theory of separate bicameral deliberation, and we therefore lack any hypothesis about what effects separate deliberations may have on the outcome. More importantly, if we were to require each chamber to deliberate separately at the same time we manipulated the voting rule, we would hopelessly confound the impact of bicameral deliberation with bicameral majority rule. Our experimental design, in the classic tradition of experimental research, examines the impact of bicameral majority rule only. In all three bicameral treatments, the opportunities for deliberation among the six players are exactly the same as they are in the unicameral control treatment. The advantage of this design is that we can confidently assert that any effect we find is due only to the change in the voting rule from treatment to treatment. Presumably, any effects found with this experimental design would only be accentuated if separate chamber deliberations were added to the changes in voting rule. Further research on the effect of variations in deliberative structure is encouraged.

Process Results: Information Sharing and Bargaining Success

One potential obstacle to reaching the core would be strategic misrepresentation by negotiators. It is well known that, in bilateral negotiations, strategic position taking by subjects can obscure the existence of mutually beneficial bargains. If a buyer and seller both make exaggerated initial offers and protest too vigorously about their inability to make concessions, then they may fail to discover the actual range of feasible agreements, resulting in bargaining failure. This is even more likely when negotiations are multidimensional (Bottom and Paese 1997).

The potential for bargaining failure within multilateral negotiations could be even greater, and could prevent the achievement of core outcomes. The core is defined as the set of outcomes in which every decisive coalition achieves its value; if any coalition fails to realize its potential, then noncore outcomes may occur.

Indeed, results indicate that this was a much more cognitively difficult exercise than the discrete experiments of Miller, Hammond and Kile, where the choices were limited to a small number of discrete alternatives. In this experiment, subjects had to find a relatively small, petal-shaped winset from the status quo (100,20). In order to reach agreement on an outcome in the core, all the subjects in a given coalition had to be willing to reveal that they were better off at the core outcome than at the status quo, but strategic considerations could make them reluctant to reveal this information, for fear of weakening their future bargaining positions. Furthermore, the outcomes in each winset were significantly worse than the status quo for two subjects, who could be expected to object, which would introduce a definite level of tension to the proceedings. Subjects had to be willing to incur the dissatisfaction of some committee members at the same time that they encouraged cooperative coalition formation within a decisive coalition.

In these experiments, subjects typically began by trying to deal with one issue dimension at a time; this strategy was inconsistent with reaching the core, since the core regions always required *diagonal* moves from the status quo. To make substantial improvements for any coalition, it was necessary to explore *trade-offs* between dimensions—either to the northwest or to the northeast. Only after these trade-offs were explored did the effect of bicameralism become clear: one or the other diagonal move supported by four voters did not have the requisite bicameral support.

This was a tedious and intellectually challenging process which, apparently, improved greatly with group discussion and negotiation. Some groups began with very little discussion; they chose initially to make written proposals that they would send around the table. Other committees were less reluctant to initiate negotiations, and in fact did not make any written proposals until they were certain that a coalition would back it. Consistently, the committees that opted for more discussion rather than less were more successful in reaching outcomes near the core.

Some committees evidently failed to reach the core simply because they failed to discover those outcomes in the winset that would make the decisive coalitions better off. One such case was in Treatment *146* and resulted in outcome (110,60). In this case, five subjects made six proposals, all around (but none inside) the winset for the decisive *16/23* coalition, all of which failed. The difficulty was in finding the narrow region that made both

player 6 and the blocking coalition of players 2 and 3 better off than the status quo. Player 6 took a relatively aggressive bargaining position, and player 2 countered with aggressive initial proposals on his side. Players 2 and 3 were the only people to vote for player 2's proposals, which evidently led player 3 to conclude that she was never going to succeed in getting a payoff much higher than her status quo payoff of $2.25. As a result, player 3 then made a proposal that conceded everything to the other side, to which players 1 and 6 supported by player 2 objected. No doubt sensing disarray and frustration from the other side, the "powerless" player 5 offered a "compromise" proposal for which disenchanted player 3 agreeably voted. Here, the failure to achieve the core certainly had something to do with the negotiating failure of the *16/23* coalition, and this in turn could be traced to their inability to locate and consider outcomes in the winset, which they could theoretically have imposed to their advantage. Results such as these indicate the nature of the significant obstacles to be overcome in locating and agreeing to the core.

Results: Bicameral Cores and Stability

Given the cognitive difficulty of the negotiation problem, the results nevertheless reveal a striking differentiation between the two bicameral core treatments, shown in Table 1. (See also Appendix A.) Seven of the ten cases in Treatment *136* were in the *136* winset. Eight of the ten cases in Treatment *146* were in the *146* winset. This pattern is significant at the .005 level.[1]

Figure 1 shows the mean outcome for the two bicameral core treatments, *136* and *146*. The mean for each treatment was quite close to the predicted core. In each case, the deviation from the core was toward the center of the policy space, which may indicate some social effect toward greater coalitional inclusiveness and egalitarianism, as discussed in the later section on distributional results.

The rectangles in Figure 1 indicate the region that is within one standard deviation of the mean, in each dimension, for each core treatment. The rectangle for Treatment *136* overlaps the Treatment *136* core, but not the core for Treatment *146*. Similarly, the rectangle for Treatment *146* overlaps the core for Treatment *146*, but not the other core. The two rectangles do not overlap.

In addition to this graphical evidence, three statistically significant tests of the experimental data provide support for the three objectives outlined previously. Again, these objectives are to show that the core treatments are more "predictable" than the noncore treatments, to show that the core is a good predictor of the outcomes in those treatments with a core, and to show that the core is a better predictor than the winset of the status quo.

First, given the X and Y coordinates of each outcome, it is possible to examine the difference of X and Y coordinates from the nearest point in each core. Table 2 examines the mean X and Y differences for the outcomes in each treatment with each core. Table 2 reveals that the outcomes in Treatment *136*, for example, were on average much closer to the bicameral core for Treatment *136* than they were to the alternative core; on average, they were 6.9 points to the left and 1.5 points down from the bicameral core. Similarly, the outcomes for Treatment *146* were much closer to the predicted bicameral core.

Second, Table 2 also reveals the results of a two-sample Hotelling's T-test, examining the null hypothesis that the X and Y distances from each set of treatment outcomes are not significantly different from zero. By rejecting the null hypotheses we establish that the Treatment *136* outcomes are *distinct* from the Treatment *146* core. Additionally, the Treatment *146* outcomes are *distinct* from the Treatment *136* core. In addition, the bicameral no-core Treatment *135* is significantly distant from the Treatment *136* core. In the case of the unicameral no-core treatment, the outcomes were sufficiently dispersed that neither core could be rejected as a solution concept.

Third, we wanted to know whether the winset was a sufficient alternative solution concept, or whether the core actually served as an "attractor" within the winset. To discover this, we examined the history of negotiations, to see if later outcomes were closer to the core than earlier ones. We performed paired t-tests in which we test

[1] *Null hypothesis: No effect of treatment variable on distribution of outcomes by predicted winset.*

	Outcomes in winset 136	Outcomes in neither winset	Outcomes in winset 146	Row Totals
Treatment 136	8	1	1	10
Treatment 146	0	3	7	10
Column totals	**8**	**4**	**8**	**20**

Chi square of 13.5 with 2 d.f. *Null hypothesis can be rejected at p = .005.*

TABLE 1 Descriptive Statistics on the Policy Decisions of Experimental Committees

Treatment	Central point In core	Decision centroid (*s.d.*)	Mean # of Successful Proposals (*s.d*)
*Bicameral 136**	**130, 52.7**	**119, 55.8** *17.4, 11.0*	**2.1** *1.0*
Bicameral 146	**73.5, 64.8**	**88.0, 62.5** *12.7, 10.6*	**2.2** *1.4*
Bicameral 135	**None**	**85.1, 63.9** *28.2, 17.7*	**2.6** *2.0*
Unicameral Control	**None**	**103.2, 57.7** *40.0, 12.5*	**3.3** *1.7*

**Note:* In bicameral treatments, the three numbers denote the players in the first chamber.

TABLE 2a Mean Difference between X and Y Coordinates of Treatment Outcomes and X and Y Coordinates of the Closest Point in Treatment 146 Core (*standard deviations in italics*)

Treatment	X diff.	Y diff.	Hotelling's T-squared	F*	p**
136	32.0 *15.8*	–17.2 *11.2*	65.6	29.1	<u>.0002</u>
146	6.4 *9.5*	–6.9 *10.9*	4.57	2.0	.193
135	6.2 *19.4*	–3.8 *21.6*	1.43	.636	.554
Unicameral (no core)	23.2 *30.7*	–10.8 *15.4*	6.19	2.75	.123

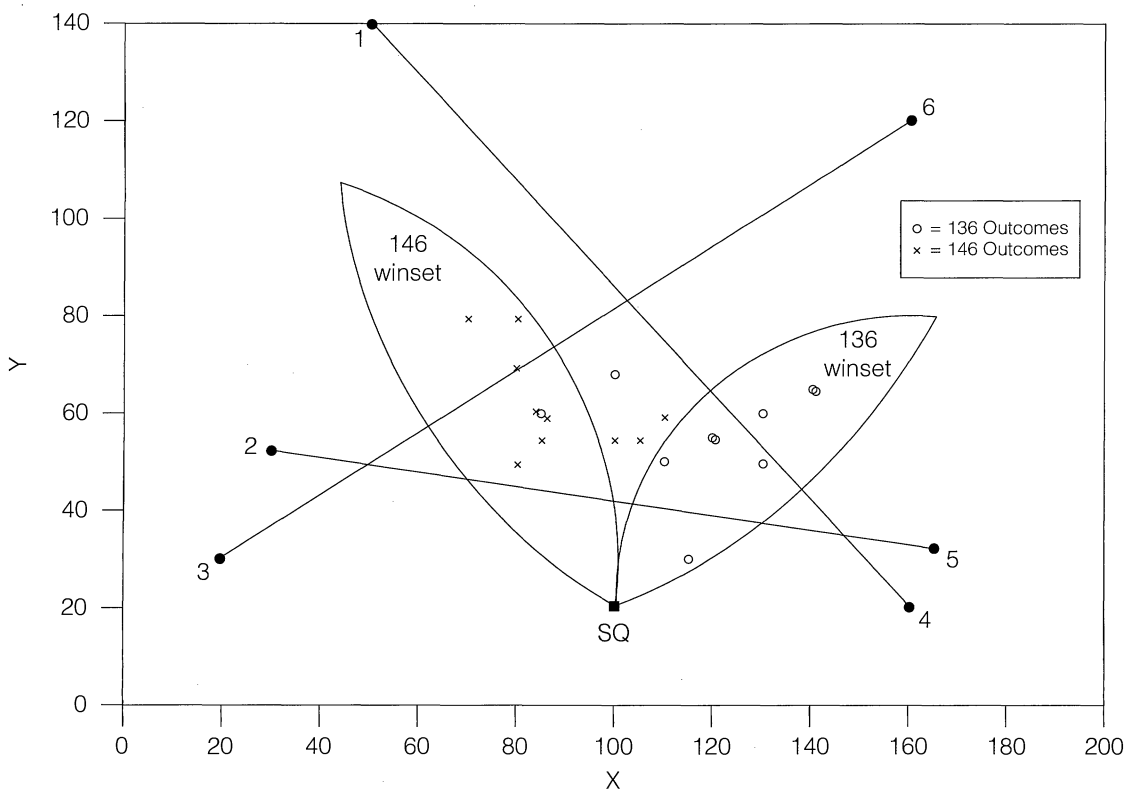
TABLE 2b Mean Difference between X and Y Coordinates of Treatment Outcomes and X and Y Coordinates of the Closest Point in Treatment 136 Core (*standard deviations in italics*)

Treatment	X diff.	Y diff.	Hotelling's T-squared	F*	p**
136	–6.9 *14.7*	–1.5 *8.9*	2.5	1.1	.369
146	–31.4 *12.7*	–1.7 *10.6*	91.8	40.8	<u>.0001</u>
135	–35.9 *26.7*	1.3 *14.2*	32.99	14.66	.0021
Unicameral	–20.0 *35.8*	–3.0 *11.5*	3.78	1.68	.246

*with 2,8 d.f.

** The theory suggests that the Treatment 146 outcomes will be different from the Treatment 136 core, and vice-versa. The p values for these two critical tests are underlined.

FIGURE 2 Bicameral Core Outcomes for Treatments 136 and 146



the hypothesis that the distance between a committee's first move and their final move rendered them closer to the core. For the seven committees that made at least two moves in condition *136*, the results are robust. We can reject the null hypothesis that the mean difference is zero, at a high level of confidence (p= .0025). The subjects chose outcomes that were significantly closer to the core in later stages of their negotiations. This result shows the core attracts outcomes from elsewhere in the winset, in the *136* treatment. In Treatment *146*, there were only five committees that made at least two moves, so the test of convergence is weaker. While they moved on average closer to the core, we cannot reject the null hypothesis of zero movement toward the core (p = .124) in this treatment.[2] We now examine the outcomes in each treatment separately.

Treatment *136*

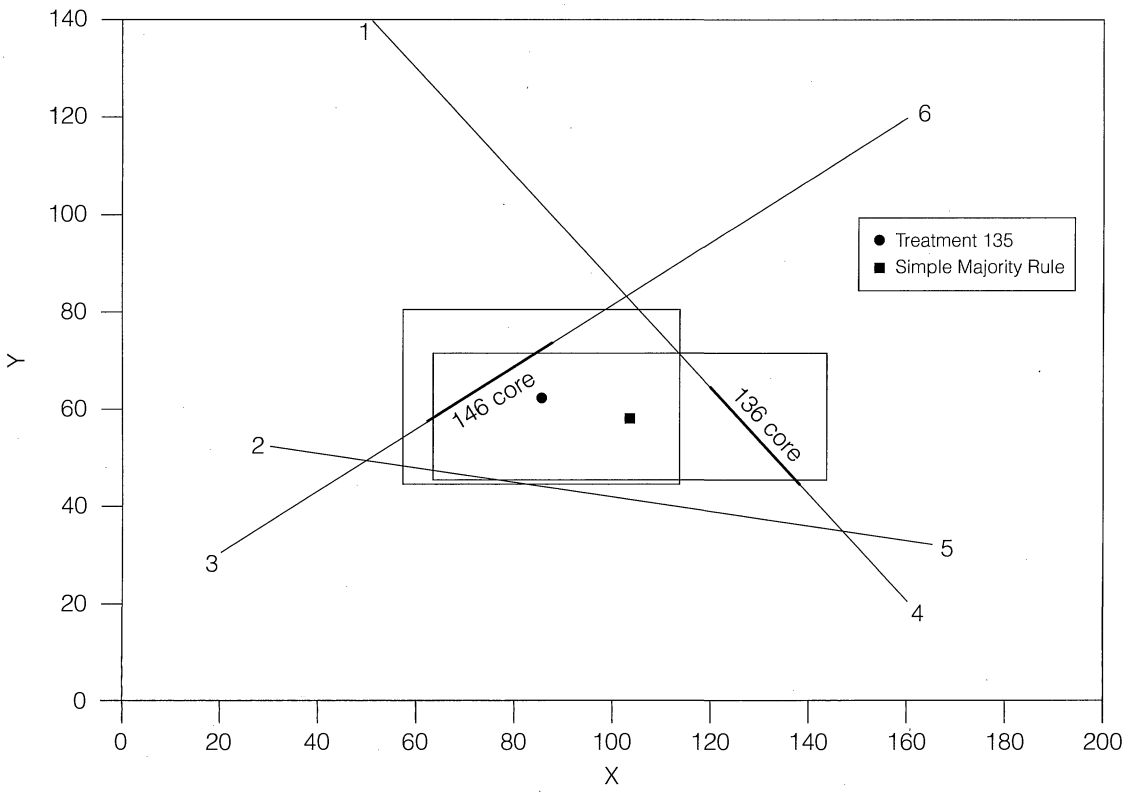
Nearly every outcome was in or near the winset defined by the *16/45* coalition's preferred points from the status quo as shown in Figure 2. That coalition supported at least one successful proposal in nine of the ten experiments.

All but the last two committees achieved an outcome with an X-coordinate of 110 or greater and therefore in the region of the predicted core. The two exceptions are interesting examples of failed-coalition formation. The committee that ended at (100,68) was also the only committee in this treatment that failed to form the decisive 16/45 coalition. This case illustrates the fact that the core is only successful when every coalition succeeds in guaranteeing its value; when the players of the crucial 16/45 coalition failed to agree, the outcome was relatively far from the core.

The other anomaly in Treatment *136* was the final outcome at (85,60). This trial experienced the greatest number of successful proposals (four) and the greatest number of unsuccessful proposals (nineteen) in the treatment. Surprisingly, *not a single proposal was anywhere near the predicted core.* The two proposals closest to the core were (108,55) and (90,70). These outcomes are not too far apart from each other, and both were supported by three members of the 16/45 coalition, but (108,55) failed to get player 1's vote, and (90,70) failed to get player 4's vote. Since the hypothesized core is on the *1–4* contract curve, players 1 and 4 have to get together in

[2] The authors wish to thank an anonymous referee for suggesting this test.

FIGURE 3 Mean Policy Decisions and Dispersion for the Conditions with an Empty Core



order to make the core happen; this case of bargaining failure made that impossible. As often happens in two-sided negotiations, the aggressive bargaining positions of players 1 and 4 kept them from understanding that there really was an area that they could agree on that would make them both better off. The inability of this coalition to get its act together kept the hypothesized core from being a good predictor in this instance.

Treatment *146*

In this Treatment, the core was on the *3/6*-contract curve and in the *16/23* winset from the status quo. The outcomes were in or close to that winset in every case, except the final outcome at (110,60). This final outcome was also the only case in which the *16/23* coalition did not succeed in passing at least one successful proposal.

Players 3 and 6 were both represented in seventeen of the eighteen successful coalitions, a circumstance which guided the outcomes close to their contract curve and consequently to the Treatment *136* core. The principal exception, at (110,60), is discussed later in the article. Overall, the standard deviations were smallest in this treatment, indicating the least variance around the core.

Treatment *135* (Bicameral No-core Control)

Treatment *135* was a control in that the bicameral coalitions allowed movement from any of the three median lines and thus created no stable core. The mean of the bicameral control (Treatment *135*) is almost exactly at the mean of the Treatment *146* outcomes. This seems to be caused by the fact that it was easier to form the 13/26 coalition than the 15/46 coalition, although both coalitions were equally decisive in this treatment. Nine of the ten Treatment *135* committees had at least one successful proposal by the 13/26 coalition, and in seven of these instances, it was the first coalition to form (See Appendix B). Moves generated by the 13/26 coalition imposed an outcome equivalent to the 16/23 coalition in Treatment *146*.

While the mean of this treatment was close to the mean of Treatment *146*, the variance was much larger, as shown by the size of the rectangle in Figure 3. Table 3 reveals that Treatment *135*, the no-core bicameral treatment, had significantly greater variance in its x-coordinate than did either of the bicameral core treatments. The reason for this variance seems to be the absence of a core: once an initial move was made, it was still relatively easy to construct coalitions that would make large subsequent moves.

TABLE 3a Ratios of Variances in X Coordinates

Hypothesis: Treatments that have no core will have significantly more variance than treatments that have a bicameral core. (We predict significantly greater variance in no core than in core treatments, as underlined.)

Treatment	*Variance*	Ratio to Treatment 136	Ratio to Treatment 146	Ratio to Treatment 135 (No core)
136	*302.76*			
146	*161.29*	1.88		
135 (no core)	*852.64*	2.81#	5.28**	
Unicameral (no core)	*1600.00*	5.28**	9.92**	1.88

TABLE 3b Ratios of Variances in Y Coordinates

Treatment	*Variance*	Treatment 136	Treatment 146	Treatment 135 (No core)
136	*120.78*			
146	*112.36*	1.07		
135 (no core)	*321.48*	2.66#	2.86#	
Unicameral (no core)	*156.25*	1.29	1.39	2.06

# denotes an F statistic that is significant at .10 with 9,9 d.f.

* denotes an F statistic that is significant at .05 with 9,9 d.f.

** denotes an F statistic that is significant at .005 with 9,9 d.f.

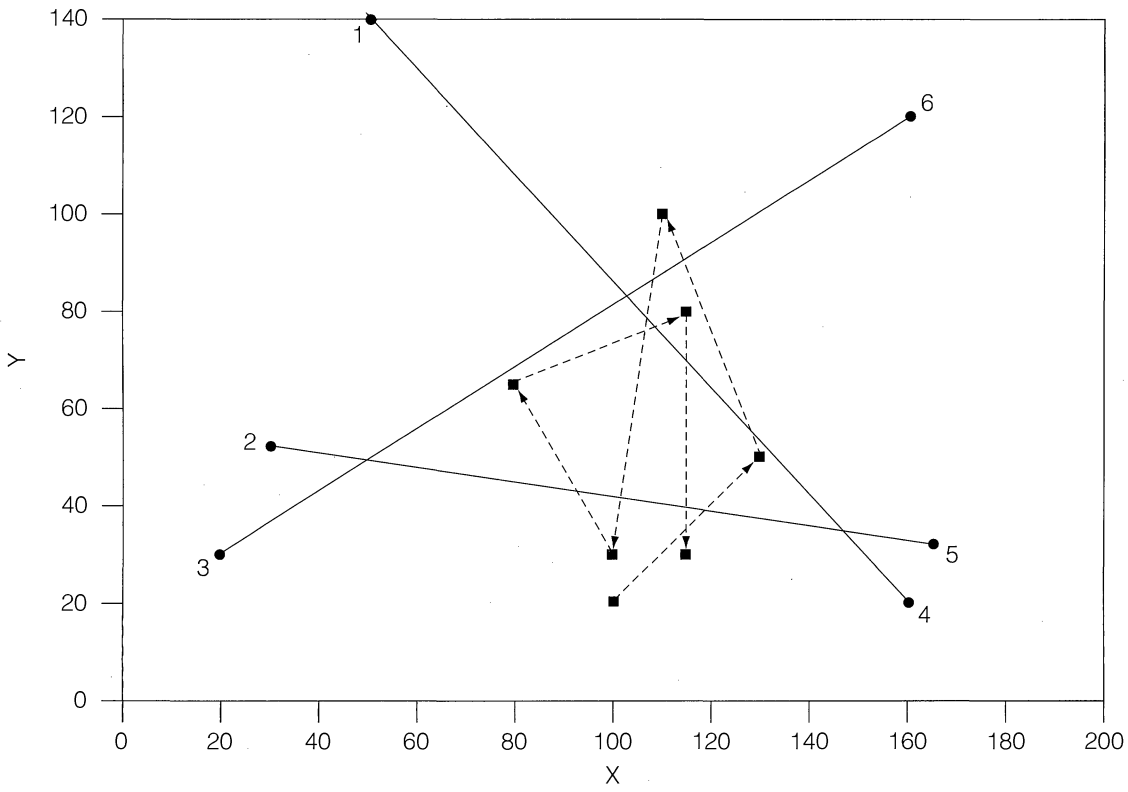
This instability in the absence of the core is most dramatically illustrated by the case that ended in outcome (115,30) after six successful proposals, shown in Figure 4. It will be remembered that in Treatment *135*, each of the three median lines was capable of attracting a decisive bicameral majority. In each of the six successful moves, a minimal-winning four-person coalition was constructed to move the status quo from the region of one median line to the region of another. The moves approved by the committee demonstrated that a virtually perfect majority rule cycle had taken place in the first three moves. Then, yet another complete cycle took place in three more moves, with each of the same three bicameral coalitions forming one more time. This is a dramatic realization of the potential for majority rule cycles, creating complete policy instability.

Unicameral Control Treatment

As with the bicameral Treatment *135*, there was no core. Some experimental sessions formed and reformed coalitions, moving around the policy space. The standard deviation in the X coordinates of the outcomes was 40.0, indicating a large variation back and forth between feasible winsets. Overall, the variance of the X dimension was significantly greater than the variance in either of the two bicameral-core treatments (Table 3). The variance was so great that the range of expected outcomes contained *both* bicameral cores. This is graphically illustrated in Figure 3, which shows that the typical results included both the Treatment *146* and the Treatment *136* core regions.

It is also revealing that the mean number of successful proposals was greatest, at 3.3, in this treatment.

FIGURE 4 An Example of Instability: A Committee Completes Two Full Voting Cycles in Treatment 135



Note: Broken lines depict the sequence of approved motions in the committe. The final policy was (115.30).

Because every four-person coalition was decisive, the difficulty in finding a coalition that could agree to yet another policy shift was minimal. The theoretical instability of simple majority rule in unicameral legislatures was made palpable in both the greater number of successful proposals and in the greater dispersion of final outcomes.

Distributional Results: Fairness vs. Pivotality

In other experiments, results sometimes supported a "fairness" result over the theory of the core (Miller and Oppenheimer 1982; Eavey 1991). A "fairness" hypothesis can serve as an alternative hypothesis to the theory of the bicameral core in this setting.

As in other committee experiments, there was often an early, explicit search for an outcome that would support a coalition of the whole—that is, earn the support of every voter. However, given the payoffs in this design, this was difficult to find. By design, there was no point that would gratify the aspirations of all the players, or what Eavey has called a "fair" outcome. The closest alternative to a "fair" outcome was the Rawls point in the vicinity of (95,35), where the worst off player received a little more than $3 (Rawls 1971). The closest any committee came to this point was the Treatment *135* (no core) committee that found the point (90,50), guaranteeing the worst off player (Player 5) a little more than $2.00. This group took fifteen informal straw votes before selecting (95,35)—the Rawls point—but by a minimal winning coalition of 13/26, not a coalition of the whole. The same coalition then abandoned the Rawls point for (90,50), well within the winset of the coalition. Thus, there seemed to be no successful attempts to achieve a unanimous coalition and virtually no successful appeals to fairness, with one exception.

The exception was in Treatment *146* and resulted in an outcome of (105,55), mentioned earlier. This session was the experiment in which notions of redistributional justice seem to have had the clearest effect. A transcript of the (105,55) experiment, for instance, reveals aware-

ness that Treatment *146* had given players 4 and 5 virtually no power. As the group became aware of their bicameral restraints, they moved incrementally to (105,55). Before adjournment was proposed, player 2 offered (85,90), a position closer to the core. Player 3 complained that the payoff she would receive at (85,90) was almost the "same" as the current outcome at (105,55). Player 5 caught this complaint and turned it into an appeal for fairness: "She said that's the same. So if it's the same, and it is going to kill us [players 4 and 5], it is better to stick." Eventually, the near-core proposal (85,90) passed with the customary (for this treatment) 16/23 coalition, replacing (105,55); but players 4 and 5 renewed pleas to return to (105,55) on grounds of fairness. At this point, player 6, who had just voted for (85,60), reversed himself and proposed to return to (105,55), as strongly urged by players 4 and 5. His proposal passed with the votes of players 3, 4, and 5.

This exercise resulted in the lowest payoffs for players 2 and 3 of any Treatment *146*-committee meeting, at $1.49 and $1.80, respectively. It also resulted in the highest payoffs for players 4 and 5 of any Treatment 146 meeting, at $3.74 and $3.75, respectively. Ironically, the latter two players' appeals to fairness resulted in their earning more than the veto players—2 and 3. This was the single case in which the players given the least leverage by the bicameral rules of the game were able to turn that very powerlessness into an effective bargaining tool, by an appeal to fairness.

A crucial element in this response was the inability of the committee to locate one of the outcomes slightly closer to the core that would have kept player 3 more committed to the 16/23 coalition. The fact that players 4 and 5 controlled the floor with their harangue certainly could have contributed to this omission. Also crucial, however, was the fact that Player 6 lost very little by reversing himself on the two proposals under discussion: his payoff went from $12.11 to $11.26 by supporting (105,55). The factors expressed by players 3 and 6, respectively—indifference due to alienation and generosity—seem to have been triggered by the particular cardinal values of the payoffs on the floor at the time. It is possible to hypothesize that, with different cardinal payoffs attached to the same ordinal payoff charts, the alienation and generosity could be systematically enhanced, changing the outcomes sharply. A series of experiments, not reported in this article, suggest strongly that the likelihood of noncore outcomes caused by the appearance of alienation and generosity can be greatly affected by cardinal payoffs. In other words, the viability of a fairness outcome is dependent on the cardinal payoffs.

In this design, with the effect of alienation and generosity minimized, the data support our claim that the Rawls point is not a good predictor of outcomes. We performed a Hotelling test to determine whether x values and y values were significantly distant from the Rawls point (Hotelling 1931). In all four treatments, we are able to reject ($p<.005$) the null hypothesis that the distances are zero. This extremely robust result demonstrates that the fairness hypothesis cannot adequately explain the results. Having ruled out the Rawlsian fair point, what were the distributional implications of these bicameral experiments? Since subjects did not all do equally well, who benefited relative to whom?

From a theoretical perspective, bicameralism clearly should have distributional consequences. Notice in Table 4 that the central outcome in each bicameral core is very inegalitarian, with the benefits going toward those pivotal players who constitute the veto bloc in the second chamber. In Treatment *136*, players 4 and 5 should theoretically be able to get $15.95 and $14.00 each, but less than $1.00 each in Treatment *146*, where they are divided between the two chambers. In Treatment *146*, players 2 and 3 should theoretically be able to get $13.75 and $8.40, but less than $0.25 each in Treatment *136*.

Bicameralism clearly has distributional consequences like the ones predicted, moderated only somewhat by appeals to fairness. Table 4 indicates that the theoretical disadvantage of various players is strongly realized in the distributional consequences of the actual play. The core favors those votes that are necessary to constitute the appropriate bicameral coalition. In Treatment *146*, Player 4 averages only $1.42, compared to $10.81 under Treatment *136*. Player 5 is similarly disadvantaged, averaging $1.91 compared to $8.95 under Treatment *136*.

Similarly, players 2 and 3 are powerless to stop the virtually inevitable 16/45 coalition in Treatment *136*. They average $1.86 and $0.88 in Treatment *136*, compared to $9.17 and $4.14 in Treatment *146*. These are precisely the differences one would expect given the locations of the respective cores.

Overall, players 2 through 5 each did much better when the bicameral structure gave them pivotal, rather than powerless, positions. Outcomes are systematically pulled toward the core, with modest concessions at the margins toward greater equity. Players 1 and 6, whose votes are both necessary in each of the core treatments, received comparable amounts under each treatment.

In the two no-core treatments, the variance in individual payments was higher than it was in the core treatments. This indicated both greater uncertainty about

Table 4 Payoffs to Each Player in Each Experimental Committee by Treatment

Treatment	1	2	3	4	5	6
136	**7.10**	**1.86**	**0.88**	**10.81**	**8.95**	**13.82**
s.d.	*2.02*	*3.80*	*1.35*	*5.95*	*4.89*	*3.07*
Predicted*	6.40	0.20	0.19	15.95	14.00	13.80
146	**9.99**	**9.17**	**4.14**	**1.42**	**1.91**	**11.26**
s.d.	*1.46*	*5.23*	*2.39*	*1.57*	*1.34*	*0.56*
Predicted*	10.85	13.75	8.40	0.36	0.76	11.09
135	**9.63**	**8.334**	**4.86**	**3.20**	**2.61**	**10.30**
s.d.	*3.12*	*6.56*	*4.06*	*4.97*	*2.76*	*3.91*
Unicameral Control	**7.84**	**6.21**	**4.26**	**6.70**	**6.60**	**11.98**
s.d	*3.20*	*8.34*	*5.39*	*6.65*	*7.32*	*5.07*

*Predicted outcomes for Treatments 136 and 146 are the payoffs for each player at the center of the respective cores.

outcomes and the absence of a consistent bias toward one set of players or another. The unicameral no-core treatment was especially uncertain; it resulted in standard deviations in payoffs that were higher for *each* player than in either core treatment. Making the normal assumption that economic actors favor less variance in wealth, there is a strong presumption that the instability in majority-rule decision making has a real economic cost that may be moderated by effective bicameralism.

Conclusions

Majority-rule instability was apparent in the "bicameral no-core" experiments of Treatment *135*, as well as in the Unicameral Control Treatment. In Treatment 135, a series of successful moves within a given group of subjects could (and did) take the policy outcome around the triangle given by the median lines, with large distributional consequences for the players.

The two treatments with a bicameral core were significantly more stable than the two noncore outcomes; there was significantly less variation in the crucial X-dimension coordinates which differentiated the two core regions (Table 3). This indicates that bicameralism reduces instability when it creates a stable core, but not otherwise.

Not only did Treatments *136* and *146* reveal more stability, the core was a useful predictor of that stability. In the treatments with a core, the appropriate coalitions for getting to the core from the status quo appeared and, on average, achieved outcomes that were significantly closer to the predicted than the alternate core (Table 2).

In addition to inducing stability, the bicameral core affected the pattern of payoffs to different players. Players 2 and 3 were advantaged in Treatment *146*, since they constituted a veto block in the second chamber. Players 4 and 5 were advantaged in Treatment *136* for the same reason.

The predicted patterns appeared despite the cognitive difficulties in locating outcomes suitable for coalitional agreement and despite the strategic difficulties in negotiating those outcomes. They also appeared despite the willingness of some fraction of subjects, some of the time, to vote for outcomes that were not individually beneficial—possibly due to frustration with the coalition formation process and/or due to responsiveness to appeals for distributional fairness. The core exerted a discernible "pull" on legislative decision making, with only modest compromises on the margin toward greater equality in payoffs.

When the chambers are sufficiently "separated," bicameralism can reduce the variance in policy choices. The statistically significant pattern is for outcomes to track the bicameral core, when it exists. These results, achieved in a controlled laboratory setting, have a degree of internal validity that is lacking in most research on bicameralism. That is, we may confidently attribute the differences in results to the treatment variable—the bicameral composition—holding constant voter preferences and other institutional features.

Naturally, this mode of research does not replace the need for careful empirical research in natural legislative settings. However, if the laboratory experiments had gone the other way—showing no impact of bicameralism in a controlled laboratory setting—then we would have had reason to doubt whether field research would ever have found more positive results. With positive re-

sults in this setting, field research may be undertaken in less controlled settings with more confidence that empirical results attributable to bicameral institutions are not in fact due to other, spurious causes.

By disempowering some majority coalitions, stability in majority-rule decision making may be enhanced. At the cost of a distributional bias in outcomes, bicameralism helps provide the kind of democratic policy stability that Madison and other Founders seemed to be seeking.

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Appendix A
The Policy Decisions of Experimental Committees: Core Treatments

Bicameral core treatment 136 (Underlined outcomes are in the predicted 136 winset)			*Bicameral core treatment 146* (Underlined outcomes are in the predicted 146 winset).		
Final Outcome	Successful Proposals	Dominant Coalition	Final Outcome	Successful Proposals	Dominant Coalition
140,65	1	16/45*	85,60	1	16/23#
110,50	3	16/25 16/25 16/45*	85,60	3	16/23# 16/23# 16/25
130,60	2	16/45* 13/245	80,50	3	16/23# 46/235 16/35
120,55	2	36/25 16/45*	105,55	5	146/35 16/23#
120,55	3	136/25 16/45* 16/45*			14/35 16/23# 46/35
140,65	2	136/25 16/45*	100,55	1	16/23#
			80,80	1	16/23#
130,50	1	16/45*			
			70,80	1	16/23#
115,30	1	16/45*			
			85,55	3	16/23# 46/35
100,68	2	16/42 13/245			16/23#
			80,70	3	16/23#
85, 60	4	36/25 16/25 16/45* 136/25			46/35 16/23#
			110,60	1	16/35
Means:					
119, 55.8	**2.1**		**88,62.5**	**2.2**	
central point in core: 130,52.7			central point in core: 73.5, 64.8		

*Predicted dominant coalition for Treatment 136.
#Predicted dominant coalition for Treatment 146.

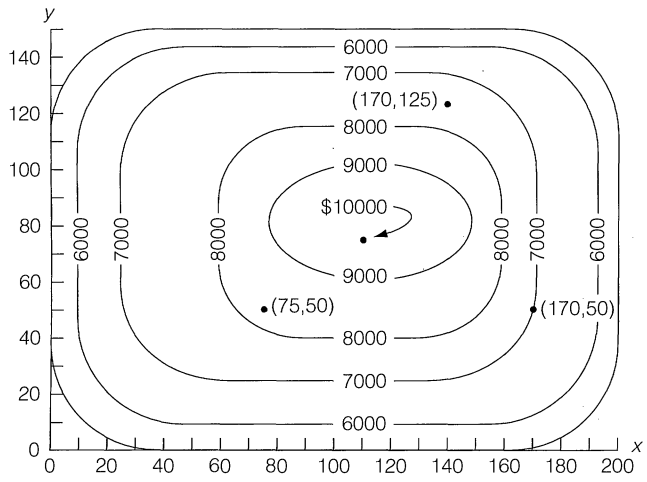
Appendix B
The Policy Decisions of Experimental Committees: No-Core Treatments

Bicameral Control Treatment 135 (no core)			*Unicameral Control Treatment (no core)*		
Final Outcome	Successful Proposals	Dominant Coalition	Final Outcome	Successful Proposals	Dominant Coalition
87,60	2	13/26	115,50	3	1456
		13/26			1236
					1456
115,60	2	135/26			
		15/46	90,40	4	1234
					1456
90,50	2	13/26			1236
		13/26			2345
115,30	6	15/46	60,75	2	1234
		13/26			2346
		35/24			
		13/26	125,65	5	3456
		15/46			1256
		35/24			1236
					2456
70,80	1	13/26			1456
50,80	1	13/26	165,40	2	1356
					2456
110,50	4	13/26			
		35/24	75,50	3	1356
		15/46			2345
		35/24			2356
34,90	1	135/24	110,60	3	2346
					12456
120,64	6	15/46			12456
		13/26			
		35/24	30,70	3	1234
		13/26			1456
		15/46			1234
		15/46			
			122,57	7	1235
80,50	1	13/26			1256
					1246
					1256
					1456
					1456
					1456
			140,70	1	1456
Means:					
85.1,63.9	**2.6**		**103.2,57.7**	**3.3**	

Appendix C
Instructions for Participants

You are about to participate in a decision-making experiment in which one of numerous competing alternatives will be chosen by majority rule. The purpose of this experiment is to gain insight into certain features of complex political processes. The instructions are simple. If you follow them carefully and make good decisions, you might earn a considerable amount of money. You will be paid in cash.

The alternatives are represented by points on the blackboard. Players will adopt as their decision one and only one point. Your compensation depends on the particular point chosen by the players (see enclosed payoff chart). For example, suppose your payoff chart is that given in Figure 1 and that the players' final choice of alternative is the point (x,y) = (170,50). Your compensation in this event would be $7,000. If the policy of the players were (140,125), your compensation would be computed as follows.



The point (140,125) is halfway between the curve marked $7,000 and the curve marked $8,000. So, your compensation is halfway between $7,000 and $8,000; i.e., $7,500. If the policy is one-quarter of the distance between two curves, then your payoff is determined by the same proportion (i.e., at (75,50) which is one-quarter of the way between $8,000 and $9,000, you get $8,250).

The compensation charts may differ among individuals. *This means that the patterns of preferences differ and the monetary amounts may not be comparable. The point that would result in the highest payoff to you may not result in the highest payoff to someone else.* You should decide what decision you want the players to make and do whatever you wish within the confines of the rules to get things to go your way. *The experimenters, however, are not primarily concerned with whether or how you participate so long as you stay within the confines of the rules.* Under no circumstances may you mention anything *quantitative* about your compensation. You are free, if you wish, to indicate which ones you like best, etc., but you cannot mention anything about the actual monetary amounts. Under no circumstances may you mention anything about activities that might involve you and other players after the experiment; i.e., no deals to split up afterward or no physical threats.

Procedures. The process begins with an existing motion (100,20) on the floor. During the meeting, the experimenter will act as chair, although he will not be able to vote.

Players 1, 3, and 6 are designated as *Group A.* Players 2, 4, and 5 are designated as *Group B.* The rule is simple majority rule. Any player may make suggestions at any time. You may freely write on your charts in order to keep track of suggestions.

Formally proposed changes in the current motion on the floor must be made in writing on one of the available 3×5 cards. Any player may make suggestions at any time. You may freely write on your charts in order to keep track of suggestions.

Once a formal proposal has been made, the card is passed around the table. If a player agrees to the change, then he/she would sign the card. Any player who does not agree to the change would not sign it. If the card has a total of two signatures from Group A and two signatures from Group B, the proposal is approved and replaces the current motion on the floor. If not, then the proposal has not passed, and the motion on the floor remains the same. Players may pass as an unlimited number of proposals.

The proposal process will continue until a motion to adjourn the meeting is passed. Such a motion may be made by any player and will result in an immediate show of hands. It will pass if two players from Group A and two players from Group B approve adjournment. Your compensation will be determined by the motion on the floor at the time of adjournment.

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