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Corresponding Author	Family name	Grofman
	Particle	
	Given Name	Bernard
	Suffix	
	Division	Center for the Study of Democracy, School of Social Sciences
	Organization	University of California
	Address	Irvine, CA, 92697-5100, USA
	E-mail	bgrofman@uci.edu
Author	Family name	Brunell
	Particle	
	Given Name	Thomas
	Suffix	
	Division	Department of Political Science
	Organization	University of Texas at Dallas
	Address	Dallas, TX, USA
	E-mail	tbrunell@utdallas.edu
Author	Family name	Feld
	Particle	
	Given Name	Scott
	Given Name	L.
	Suffix	
	Division	Department of Sociology
	Organization	Purdue University
	Address	West Lafayette, IN, USA
	E-mail	sfeld@purdue.edu
Schedule	Received	10 December 2010
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Abstract In *The Calculus of Consent* (<CitationRef CitationID="CR6">1962</CitationRef>: 235) Buchanan and Tullock assert: (1) *ceteris paribus*, while a coalition controlling less than a majority of voters may control in *either* chamber, the greater the difference in the bases of representation in the two houses, the less likely is any given coalition of voters to control a majority of the seats in *both* chambers; (2) the potential of cross-chamber logrolls (on issues of unequal intensity) increases the likelihood that a minority may effectively control policy making. We link these ideas to social theory approaches to bicameralism and for the empirical study of legislatures.

Keywords Bicameralism – Representation – Majority rule – Supermajorities – Coalitions

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Towards a theory of bicameralism: the neglected contributions of the calculus of consent

Bernard Grofman · Thomas Brunell · Scott L. Feld

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Abstract In *The Calculus of Consent* (1962: 235) Buchanan and Tullock assert: (1) *ceteris paribus*, while a coalition controlling less than a majority of voters may control in *either* chamber, the greater the difference in the bases of representation in the two houses, the less likely is any given coalition of voters to control a majority of the seats in *both* chambers; (2) the potential of cross-chamber logrolls (on issues of unequal intensity) increases the likelihood that a minority may effectively control policy making. We link these ideas to social theory approaches to bicameralism and for the empirical study of legislatures.

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1 Introduction: the effects of bicameralism

While *The Calculus of Consent* is truly a co-authored work, Chap. 16, “The Bicameral Legislature,” is one of the chapters which bear most clearly the hand of Gordon Tullock. Chapter 16 has another much less happy distinction. It is perhaps the most neglected of

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B. Grofman (✉)
Center for the Study of Democracy, School of Social Sciences, University of California, Irvine, CA
92697-5100, USA
e-mail: bgrofman@uci.edu

T. Brunell
Department of Political Science, University of Texas at Dallas, Dallas, TX, USA
e-mail: tbrunell@utdallas.edu

S.L. Feld
Department of Sociology, Purdue University, West Lafayette, IN, USA
e-mail: sfeld@purdue.edu

51 all the original contributions of that remarkable volume.¹ *The Calculus of Consent* is well
52 remembered for such seminal ideas as (1) the two-stage model of social choice,² and (2) the
53 efficiency of logrolling in allowing for reconciling majority rule with differential intensity of
54 preferences across different issues. But, as Wuffle (1986) once observed, no article is likely
55 ever to be remembered for more than one idea, and no book (with the possible exception of
56 Anthony Downs's, *An Economic Theory of Democracy*) is likely to ever be remembered for
57 more than two ideas.³ Thus, the ideas about bicameralism in Chapter 16 are too little known.

58 Chapter 16 is, in our view, of great importance, containing one of the more important
59 insights in *The Calculus of Consent*, namely that the effects of bicameralism on representa-
60 tion are primarily a function of the degree of overlapping of the "interest-group coalitions in
61 each house" (Buchanan and Tullock 1962: 235). More specifically, *ceteris paribus*, while a
62 minority of voters who comprise a majority of the voters in a majority of the constituencies
63 can control a chamber, the greater the difference in the bases of representation in the two
64 houses, the less likely is any given coalition of voters going to be able to control a majority
65 of the seats in *both* chambers. Moreover, Buchanan and Tullock also note that, when cross-
66 chamber logrolling is possible (on issues of unequal intensity), it is easier for a coalition
67 controlling less than a majority of *voters* to still be able to control a majority of legislative
68 *seats* in both chambers, thus linking bicameralism to the critical discussion in B&T of the
69 normative aspects of logrolling.⁴

70 The aim of this essay is threefold:

71 First and foremost we review the main theoretical results of the discussion of bicameral-
72 ism in Chap. 16 and reformulate some of them in a more precise algebraic notation. Also,
73 we derive a further result that, under plausible assumptions about the overlap among the
74 winning coalitions in each chamber, the greater the size of the super majority required for
75 passage in each chamber the greater the efficiency in Buchanan and Tullock cost-benefit
76 terms of a bicameral legislative as compared to a unicameral legislative.

77 Second, we look at the practical implications of those results for the operation of bicam-
78 eralism in the United States. In particular, we look at five constituency characteristics that are
79 politically important, and compare mean and median on these characteristics across districts
80 in the U.S. House of Representatives and across states in the U.S. Senate. And, drawing on

83
84 ¹While there are a number of public choice scholars who have cited to the chapter's discussion of bicameral-
85 ism (e.g., Crain and Tollison 1977; Grofman et al. 1991; Tsebelis and Money 1997; Diermeier and Myerson
86 1999; Borcherding 2002; Brauning 2003; Mueller ?Mue2002), B&T's discussion of bicameralism is not
87 cited in some of the more important theoretically or empirically oriented books on legislative behavior or
88 representation written by political scientists (e.g., Sartori 1968: Chap. 8; Shugart and Carey 1992)

89 ²The first tier involves the adoption of a constitution. The second level specifies the voting rule for each dif-
90 ferent domain of political decision-making choice. While constitutional choice requires unanimous consent,
91 the constitution is also allowed to provide for future decision-making by k of N voting rules (for various
92 $k < N$), with the choice of k as reflecting a trade off between the relative costs/benefits of being able to allow
93 actors to achieve ends they desire, on the one hand, and being able to prevent the imposition on them of costs
94 to which they did not consent, on the other.

95 ³Wuffle went on to suggest that most articles are remembered for fewer than one idea, and that even the count
96 of ideas remembered from *An Economic Theory of Democracy* almost never exceeds three (convergence to
97 the median voter position in two-party competition, rational ignorance, and information shortcuts).

98 ⁴Chapter 16 is important not merely for its discussion of bicameralism, *per se*. It treats bicameralism as part
99 of an integrated discussion of veto, veto override, and committee games in which we are asked to look not
100 only at the rules for electing members of a legislature but also at the rules for making decisions within a
legislature. For space reasons we will not discuss these other more general topics (see brief discussion in
Grofman 2000).

our own earlier work (Grofman et al. 1991; Brunell 1999), we link these findings to empirical results about changing patterns of the relative policy liberalism of the House and the Senate, and to differences in the party composition of the two chambers.

Third, we link the theory in Chap. 16 to recent work in spatial social choice on bicameral voting. If constituencies in the two chambers do not come from identical distributions (over, say, a two-dimensional issue space), then majority rule instability that is manifest within each chamber taken separately, may not be found when we consider the bicameral voting game. In effect, bicameralism functions in a way that is analogous to super-majoritarian decision-making, and creates a set of stable (undominated) outcomes.

2 The central arguments in Chap. 16 of the calculus of consent

2.1 The calculus of consent and the discussions in the *Federalist Papers* about bicameral legislatures

We begin our discussion of the fundamental insights in Chapter 16 by comparing the Buchanan and Tullock approach to that in *Federalist # 62*.

Buchanan and Tullock note (1962: 236) that: “if the bases of representation can be made significantly different in the two houses, the institution of the bicameral legislature may prove to be an effective means of securing a substantial reduction in the expected external costs of collective action without incurring as much added decision costs as a more inclusive rule would involve in a single house.” In *Federalist # 62* Madison downplays the possibility that the House and the Senate would agree on legislation that would be injurious to the public welfare. The basic logic is that “. . . the improbability of sinister combinations will be in proportion to the dissimilarity in the genius of the two bodies” Certainly, this sounds remarkably like the Buchanan and Tullock claim that the external costs of sub-majority coalitions (factions) will be reduced in a bicameral legislature to the extent that the bases of representation in the two houses are different since this increases the size of the necessary winning coalition. However, we must be cautious in directly equating Madison’s views with those of Buchanan and Tullock, even though they are certainly closely related.

Buchanan and Tullock (1962: 236) assert that because “the two-house system will involve considerably higher decision-making costs than the single-house system, given the same rules for choice under each alternative,” then “unless the two-house system is expected to produce some offsetting reduction in external costs, there is little reason for its rational support.” Or, to put it another way, in terms of the cost-benefit framework used by Buchanan and Tullock, “unless the bases of representation are significantly different in the two houses, there would seem to be little excuse for the two-house system. In contrast, the *Federalist Papers* provide a much broader set of justifications for bicameralism than does *The Calculus of Consent*.

In the *Federalist Papers*, a number of differences in the “genius” of the two houses are identified—not just differences in representational base—including the fact that one house was popularly elected and the other indirectly elected, the longer term length of the upper house (intended to insulate it for immediate electoral pressures and permit its members time for deliberation and the opportunity for considering a long-run time horizon), the greater eligibility requirements for the upper chamber, and the greater size of the lower chamber (intended from the inception, because of its status as the “popular” chamber). Moreover, for the *Federalist* authors, the justification for bicameralism is rooted in a notion of divided and balanced government, in which a golden mean is sought between monarchic (energy,

151 secrecy, unity of command and control), aristocratic (enlightenment, reflection, historical
152 perspective), and democratic (responsiveness to the popular will) elements.

153 Madison states, the rationale for bicameralism in the *Federalist* as follows:

154 “In Republican government the legislative authority necessarily predominates. The
155 remedy for this inconvenience is to divide the legislature into different branches: and
156 to render them by different modes of election and different principles of action, as
157 little connected with each other as the nature of their common functions and their
158 common dependence on the society will admit.”

159
160 Other arguments for bicameralism in the *Federalist Papers* show how certain specific
161 features of the Senate, e.g., its longer term, staggered elections, and its mode of indirect
162 election, contribute to the likelihood that Senate members will be wiser and more mature
163 than House members and that the Senate will, in the famous phrase, act as “the saucer to the
164 House’s cup”, cooling the “passions” of the more “popular” body by interposing a period of
165 calm and delay.⁵ In the next section we restate and clarify the central argument in Buchanan
166 and Tullock (1962) on the link between the differences in the bases of representation and
167 the likelihood of inter-chamber agreement.

168 In the succeeding section we will look at the connections between Buchanan and Tul-
169 lock’s work on bicameralism and the recent literature on supramajoritarian, weighted, and
170 compound voting games in the spatial context, especially Hammond and Miller (1987),
171 Miller et al. (1996), and the Tsebelis and Money (1997) on the stability properties of bi-
172 cameralism.⁶ In the final section we will look at recent empirical work on the U.S. House
173 and Senate. There we will focus on ways in which the Buchanan and Tullock perspective
174 on differences in the bases of representation between the two houses of the U.S. Congress
175 might be operationalized, and what its implications are for partisan and policy differences
176 between the chambers.⁷

177 2.2 The basic model

178
179 Buchanan and Tullock consider two polar bases of interest group representation in the two
180 chambers: in the first, there is “complete diversity.” In Buchanan and Tullock’s (1962: 237)
181 words “The only requirement for complete diversity is that the members of a constituency of
182 a representative in one house be distributed evenly over all of the constituencies for the other
183 house.” We translate this as requiring that the distribution of constituency characteristics be
184 the same in the districts in each house and be independent of that in the other house. The
185 other polar type is “complete identity” in the constituency basis of the two houses; i.e.,
186 every district in each chamber is mirrored by a proportional number of districts of the same
187 constituency characteristics in the other chamber. Buchanan and Tullock also consider cases
188 intermediate between these two polar types.

189 A crosscutting type of classification scheme involves the nature of the set of issues that
190 are being considered. Here the two polar types are “equal intensity” issues, where the major-
191 ity and the minority are equally intense in their concerns about the bill’s passage or defeat,

194 ⁵Of course, once members of the U.S. Senate were no longer elected by state legislatures but directly elected
195 by the people of their state, the differences in motivation and accountability between House members and
196 Senators lessened, but these other differences do remain.

197 ⁶See also Hammond and Miller (?HamMil1989).

198 ⁷A third body of potentially relevant literature, that dealing with the relative power of the two houses and the
199 power of the legislature vis-à-vis other branches of government (see e.g., Brams 1989) takes us beyond the
200 scope of this essay.

Table 1 Size of potential winning majorities in chambers using simple majority

	Equal intensity	Unequal intensity (logrolling possible)
Unicameral legislature	0.5	0.25
Identical constituencies in the two chambers	0.5	0.25
Maximally divergent constituencies in the two chambers	0.5	0.4375 (7/16)

and “unequal intensity” issues, the most important case of which is when the minority is more intense than the majority. (If the majority is the more intense, of course, the bill can be expected to pass.)

2.3 Simple majority

We show in Table 1 Buchanan and Tullock’s principal conclusions about the implications for representation of each of the six cells generated by this 3×2 typology, under the assumptions that each chamber uses simple majority rule and that there are a very large number of voters.

We see from Table 1 that, with simple majority voting in each chamber, the proportion of voters needed to control both chambers will range from $1/4$ to $1/2$ within a single chamber. The size of winning voter coalitions also ranges from $1/4$ to $1/2$. We also see from Table 1 that, *ceteris paribus*, unicameral and bicameral chambers will differ only for issues of unequal intensity.

When we look at the *unequal* intensity case, in a *single chamber* legislature, a bare majority of voters in a bare majority of constituencies would be sufficient to logroll a winning coalition. Thus, in the first row of the last column, we have shown $1/4$. For the case shown in the second row of the last column, where the bases of representation in the two chambers are identical, again $1/4$ of the voters could, in principle, enact legislation of their choice.

In contrast, in the third row of the last column, where the basis of representation in the two chambers is maximally diversified, roughly $7/16$ of the voters would, on average, be in a winning coalition in this cell. The key argument is that “the agreement finally reached will represent the minimum number of voters required to form that effective coalition which involves a minimum of bargaining costs”), and thus the expected coalition would not be as small as $1/4$ “even on the assumption of fully rational behavior on the part of all members” (1962: 240).

The argument has to do with the threat power of members of a barely winning coalition, who would seek to extort excess gains to preserve their membership in the coalition, given that to replace them one would either need to find some other voter who was pivotal in the same House and Senate district, or to find two voters, one pivotal in the House district and one pivotal in the Senate district. If we assumed that those pivotal in only one chamber would be half as expensive as those pivotal in two, then we may assume that the winning coalition will consist of the $1/4$ of the voters needed to control one chamber plus the $1/4$ of the voters needed to control the other chamber less the overlap among these two sets. If the two coalitions are unrelated, this will be given by

$$1/4 + 1/4 - (1/4 * 1/4) = 7/16 \quad (1)$$

251 The formula in (1) represents a situation in which, in a bare majority of districts in one house
252 there is a bare majority of voters in the coalition, and the same is true for a bare majority of
253 the voters in the other house, but there is “only a random overlap between the voters in the
254 coalitions which control the majority in each house” (1962: 240; also see their Fig. 22 on
255 p. 241).⁸

257 2.4 Super-majoritarian decision-making

259 Although the discussion is rather elliptical, Buchanan and Tullock discuss the consequences
260 for coalition formation of bicameral legislature supramajoritarian decision-making. The
261 question becomes important in their view only for the case of unequal intensity issues. For
262 unequal intensity issues, even a two-chamber legislature has an effective majority of voters
263 needed for agreement which is less than $1/2$, since only a majority of the voters in k
264 of the N constituencies are needed to agree. For the unequal intensity case, Buchanan and
265 Tullock (1962) argue that the effective majority in a single chambered legislature operating
266 under a de jure decision rule of j/n is only $j/2n$. Thus, in terms of voter coalitions,
267 in logrolling around issues of unequal intensity, a one-chamber legislature using a $7/8$ rule
268 can be thought of as acting as if it were using a $7/16$ rule. On the other side of the coin,
269 a bicameral legislature operating under a simple majority rule in each chamber requires the
270 same proportion of voters to reach agreement ($7/16$) on unequal intensity issues as does a
271 one-chamber legislature under a de jure $7/8$ rule (cf. Table 1).
272

273 In the case of unequal intensity issues, a bicameral legislature with some degree of di-
274 versity in the bases of representation in its two chambers has a larger “effective majority”
275 than does a single-chamber legislature. Thus, we can use bicameralism with majority rule in
276 each chamber as an institutional tool to impose a requirement for increased voter agreement
277 before unequal intensity issues can be passed, without at the same time paying the price of
278 greater transaction costs within the legislature imposed by use of supramajoritarian deci-
279 sion rules. This is especially important since these transaction costs would have to be paid
280 not merely to reduce the likelihood of passage of unequal intensity issues (likely to be high
281 in external costs), but on all bills, including those which we might otherwise prefer to see
282 passed by a simple majority.

283 Buchanan and Tullock make the important point that, in the mixed case, the costs of bar-
284 gaining are lower than in the complete diversity case and, perhaps even more importantly,
285 “this system greatly favors the voters who are arranged as to have the advantage of a sort
286 of prefabricated bargain” i.e., voters who are the majority or near majority group in con-
287 stituencies in both chambers. Writing before the passage of *Baker v. Carr*, they suggest for
288 example, that “American farmers possess what amounts to a built-in coalition in the two
289

291 ⁸For equal intensity issues, logrolling will not occur, and thus: “Given that the electorate in each constituency
292 is large and that there are quite a number of constituencies (which is the situation in real life), it is highly
293 likely that a majority of the constituencies will have a majority reflecting a majority of the whole electorate”
294 (Buchanan and Tullock 1962: 243). Hence, for a one-chamber legislature, for equal intensity issues, the
295 expected proportion of voters in a winning coalition is $1/2$, as is shown in parentheses in cells (1)–(3) in
296 Table 1. If we posit diversity in constituency base little changes. “Again, if the number of voters is very large
297 and the number of constituencies quite large, the laws of combinations and permutations would result in
298 a majority of constituencies in both houses being in agreement with the majority of the whole population.
299 ... Cases in which the voters were distributed in such a way that they failed of a majority in one house or the
300 other would be... relatively uncommon” (at p. 243). Thus, we have treated row one (cells (1)–(3)) as one in
which the expected proportion of voters in the winning coalition is only trivially greater than $1/2$.

houses of our legislature. This gives them a great advantage over less fortunately situated groups (1962: 246).⁹

Buchanan and Tullock (1962: 244) point out that “(t)he advantage gained by the use of the two-house legislature. . . is rather dissipated by the simple majority method of voting” On the same page they go on to suggest that “departures from the simple majority voting rule, however, can improve the situation.” We shall make this suggestion more precise by generalizing the 7/16 result for simple majority rule bicameralism in the unequal intensity case given above to the case of any j/n rule with $j \geq (n + 1)/2$.

For large n , for a j/n rule, and for legislatures using simple majority, (1) generalizes to

$$(j/n) - ((j/n)/2)^2 \tag{2}$$

Note that the limiting value of (2) is 3/4.

If j/n is 3/4 in each house, for example, then in a bicameral legislature, under the specified assumptions, if a bare majority of voters control each district in each chamber, but there is only random overlap among the voters in the winning coalition in each house, the effective majority needed for logrolling is $3/4 - 9/64 = 39/64 (= 0.61)$.¹⁰

For the Buchanan and Tullock model, something like a decision rule of slightly over 0.58 in each chamber will give us a situation in which, under not unreasonable assumptions about voter distribution, exactly a bare majority of voters is needed for successful logrolling on unequal intensity issues, since¹¹

$$(0.58) - (0.29)^2 \cong 0.50$$

There are three critical points in the above analyses.

First, the two-chamber legislature differs from the single-chamber legislature in terms of the effective majority involved in the passage of legislation only in the case of unequal intensity issues (regardless of whether the voting is simple majority or supramajoritarian).

Second, “(e)ven in the two-house legislature the intense minority can pass its measures with less popular support than can an equal-intensity majority” (Buchanan and Tullock 1962: 244).

Third, for unequal intensity issues, for j/n decision rules, for bicameral legislatures and maximum diversity in the constituency bases of the two houses, we can have effective majorities ranging from slightly under a majority (7/16, for $j/n = 1/2$) to well over a majority (3/4, for $j/n = 1$). Furthermore, we can express the relative efficiency for a given decision rule (j/n), of a bicameral legislature as opposed to a unicameral one, in Buchanan and Tullock cost-benefit terms, as the difference between the value in (2) and $(j/n)/2$. The latter is the size of the voter coalition needed to control a single chamber legislature; the former is the size of the likely voter coalition needed to control a bicameral legislature. This difference is given by (3).

$$(j/n) - ((j/n)/2)^2 - (j/n)^2 = (4jn - 5j)/4n^2 \tag{3}$$

⁹Buchanan and Tullock (1962: 248) also briefly discuss the advantage to groups whose constituency size is smaller than average, e.g., voters from small states.

¹⁰This result is compatible with the numerical calculations on p. 242 of *Calculus*, but Buchanan and Tullock do not provide any derivation of the results they give.

¹¹Recall that, were voters to be perfectly distributed for the purpose of minimizing the needed coalition size, we know that, for unequal intensity issues, $(j/n)/2$ is the minimum number of voters needed to control both chambers if j/n is the decision rule in each chamber.

This function is maximized as $j/n \rightarrow 1$, and approaches a value of $1/4$. For $j/n = 1/2$, it equals $3/16$; for $j/n = 3/4$, it equals $15/64$.

3 Linking Buchanan and Tullock to recent social choice work on bicameralism: spatial majority rule voting games

One of the advantages of bicameralism touted by the *Federalist Papers* was that it insured deliberation. But deliberation would seem to imply the potential for change. A rather different feature of bicameralism that has recently been investigated by social choice theorists (esp. Hammond and Miller 1987, ?1989) is its potential, for a fixed set of preferences, to establish a structure-induced equilibrium consisting of alternatives (policy positions) that once in place cannot be dislodged, i.e., such that, if a member of this set is chosen, it will be difficult or impossible to replace it with some other alternative.

These positions are in the core in a *bicameral* majority rule voting game because, although there are alternatives that a majority of senators prefer to them and there are alternatives that a majority of House members prefer to them, there are no alternatives that a majority of senators *and* a majority of representatives prefer to them. This stability of a bicameral majority rule voting game stands in contrast to the disequilibrium (majority rule cycling) characteristics of majority rule spatial voting games within a single committee or other legislative body (McKelvey 1976, 1979; Riker 1982).¹² This insight can be linked to the insights of Buchanan and Tullock on the importance of differences in the bases of representation in the chambers by showing how divergent policy preferences are critical to the creation of a bicameral core, as well as to ideas in the *Federalist Papers*.

In particular, Hammond and Miller (?HamMill986: 21) have proposed an alternative translation into contemporary public choice terminology of our earlier quote from Madison, that "... the improbability of sinister combinations will be in proportion to the dissimilarity in the genius of the two chambers." They suggest it is equivalent to stating that, "when the ideal points of the two chambers are sufficiently separated from each other, there will be a core to the bicameral game."¹³ We shall show how that translation is in fact simply another way of conceptualizing the central point about bicameralism made by Buchanan and Tullock, namely that, with diversity in the bases of representation in the two chambers, bicameralism increases the "effective majority" needed to act.

We can imagine a one dimensional alignment of the voters in each chamber. As we move along the line we can identify the median voter in chamber 1 and the median voter in chamber 2. Positions in between these two medians are invulnerable to defeat, since any proposal to change from an alternative on this line segment in either direction can be defeated in at least one chamber, and this is true even for the median of the other chamber. If we look at choices based on voters, and posit unidimensionality, we can identify the median voter in each constituency in each chamber and then the chamber median, i.e., the median

¹²In a single chamber legislature governed by simple majority any policy supported by the votes of one majority can usually be upset by a policy supported by a different majority.

¹³Hammond and Miller also look at the role of veto rules and legislative veto overrides in creating stable outcomes, but that takes us beyond the scope of the present essay. The Hammond and Miller work on the effects of institutional rules is an important contribution to the literature on what has come to be called *structure-induced equilibria* (Shepsle 1979; Shepsle and Weingast 1981; Denzau and Mackay 1983; Krehbiel 1988; Feld and Grofman 1988). However, Hammond and Miller provide no empirical analysis of actual bicameral legislatures, while the empirical analyses in Tsebelis and Money (1997) are limited to France.

voter in the median district. What is generally true in each chamber is that the median voter in the median district need not be the overall median; thus the median voter in the two chambers need not coincide. Only when both median voters line up on the same side of an issue (i.e., on a vote between some alternative and the status quo) will legislation pass. In effect, this requires a supermajority of voters to be in agreement.

We can extend these intuitions to the case where alternatives are embedded in some multidimensional space rather than being unidimensional in character. That games with veto players have a core is well known (Schofield et al. 1988). It is also well known that committee systems which structure one-issue-at-a-time decision making will also create a core (Black and Newing 1951; Shepsle 1979; Shepsle and Weingast 1981; Feld and Grofman 1988). Results in Hammond and Miller (1987; see also ?HamMil1989) have to do with the stability of bicameralism games among sets of legislators in two chambers.¹⁴

First we state a central theorem about bicameralism in Hammond and Miller and then show how it can be reconceptualized. We will adapt the notation and terminology in the review essay on spatial social choice by Feld and Grofman (1987). Following Hammond and Miller, we illustrate the analysis in a two-dimensional issue-space and assume that each actor has an ideal point in this two-dimensional space and decides among alternatives according to which is closer to his/her ideal point.¹⁵ Proofs have been omitted.

We begin with some key definitions.

Definition A *median line* for a legislative chamber is one in which the number of legislator ideal points lying on or to a given side of the line constitute a majority of the chamber's members, and the same is true for the other side of the line.

Definition A *bicameral median line* for a bicameral legislature is a line which is a median line for both chambers, i.e., one in which the number of legislator ideal points lying on or to a given side of the line constitutes a majority of the members of *each* chamber, and the same is true for the other side of the line.

Lemma *Two groups must have at least one median line in common and (except at knife-edge) must have an odd number of median lines in common.*

Lemma *If there is a bicameral median line, then the ideal point of at least one voter in each chamber must lie on the line.*

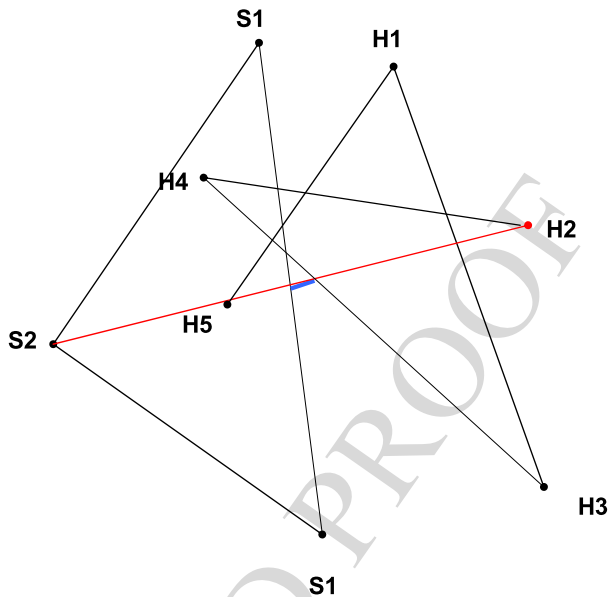
Theorem 1 (Hammond and Miller 1987, Theorem 2) *If a bicameral legislature has a unique bicameral median line, and there exists a point on that line such that none of the median lines for one of the chambers intersect the line above that point, and none of the median lines for the other chamber intersect the line below that point, then there exists a core.*¹⁶

¹⁴They also look at bicameral games with veto overrides but we will not consider this extension to tricameral games.

¹⁵Two dimensions capture most of the important politics in many parliaments.

¹⁶An immediate, but not particularly helpful corollary to this theorem is that, in a bicameral legislature, "if the Pareto sets of the two chambers do not intersect, then there is a core."

451 **Fig. 1** A bicameral bore for a
452 three member senate and a five
453 member house
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472 In general, if any such point exists, there may be more than one such point, and the set
473 of such points will form a line segment. Such a point or line segment is what Miller and
474 Hammond refer to as a *bicameral contract core*.

475
476 **Definition** The *star-angles* defined by a set of voter ideal points are the angles defined
477 by the intersection of pairs of *extremal median lines* (a.k.a., *limiting median lines*), i.e.,
478 median lines which mark the transition from one winning coalition to another. The *star-*
479 *figure* defined by a set of voter ideal points is defined by the limiting median lines which
480 intersect at each star angle.
481

482 The next result holds only for an odd number of voters.

483
484 **Theorem 2** *In a bicameral game without a core among the combined set of actors (i.e.,*
485 *the set of legislators taken as a whole), if there is a bicameral (contract) core then such a*
486 *core includes that portion of the bicameral median line that is between the star-figures for*
487 *each group (i.e., not in either star-figure). See Fig. 1, showing a three-member Senate and a*
488 *five-member House.*
489

490
491 We should also note that if one chamber has a core, the bicameral game must also have a
492 core. It is also easy to see that

493
494 **Lemma** *The core of a composite voting game is the union of the cores in the component*
495 *games.*
496

497
498 If we now turn from the legislator level to the voter level, the connection between this
499 result and the Buchanan and Tullock result is the recognition that the minimal rule for the
500 bicameral game can be expected to be greater than simple majority; i.e., unless the voter

501 coalition is large enough to control more than a bare majority of seats in each house, it
502 simply will not be large enough to overturn the status quo.

503 Moreover, as recognized by Hammond and Miller (1987), their results connect to earlier
504 results (e.g., Greenberg 1979) on the size of supramajoritarian role needed to guarantee a
505 core and the work of Kramer (1977) on the min-max rule, the minimum supramajoritarian
506 decision rule that, if required for passage of a new bill, would make at least one alternative
507 invulnerable to overthrow if it were the status quo. If the “effective majority” imposed by
508 bicameralism and a specific arrangement of voter ideal points in two dimensions is greater
509 than $2/3$, a core is guaranteed.

510 McKelvey et al. (1980) have also shown conditions *sufficient* for a core. These conditions
511 are weak, e.g., a min-max rule just barely greater than $1/2$ in two dimensions, one just
512 barely greater than $(w - 1)/w$ more generally, where w is the number of dimensions. Thus
513 we are led to expect that bicameral games virtually always have a core—at least if there is
514 any real heterogeneity in the distribution of ideal points of members, which in our terms
515 translates simply as heterogeneity in the distribution of constituency characteristics as they
516 affect overlap in constituencies. Tsebelis and Money (1997: 85-90) have shown that, even
517 if there is not a unique bicameral median line then, in two dimensions, the area bounded by
518 the two lines that are tangent to both chamber *yolks*¹⁷ (one from above and one from below)
519 contains the bicameral *uncovered set*.¹⁸ Thus, if the yolks of the two chambers are small,
520 the area between these two tangent lines serves as a kind of “fat” median line, and can play
521 much the same role as a core.

522 523 524 **4 Observed constituency differences between the U.S. senate and the U.S. house and** 525 **their implications for representation and policy stability** 526

527 Buchanan and Tullock’s theoretical treatment of bicameralism has had virtually no empirical
528 follow-up in the nearly five decades since its publication. To get a handle on the actual ef-
529 fects of bicameralism in the U.S., we will compare the actual distributions of demographic
530 characteristics of the constituencies in the U.S. House and Senate, and then compare the
531 distribution of the scores of Congressmen and Senators from various states in terms of their
532 mean/median ideological propensities as evidenced by measures of roll-call voting patterns
533 such as ADA scores. Our aim is to better understand how the different bases of represen-
534 tation in the two chambers can be expected to impact on the size/likelihood of blocking
535 coalitions in the bicameral voting game. Here we draw on early empirical work by Froman
536 (?Fro1965), Kernell (?Ker1973), and various other authors.

537 One simple way to think about the basic point made by Buchanan and Tullock is that, if
538 two chambers have a different representational base, a set of voters who together comprise a
539 majority of the voters in a majority of the constituencies in one chamber will not, in general,
540 comprise a majority of the voters in a majority of the constituencies in the other chamber.
541 Thus, we would expect that some bills that pass one chamber will die in the other. This
542 expectation is strongly confirmed.

545
546 ¹⁷The yolk is the smallest circle tangent to all median lines (McKelvey 1986). For two alternatives s and y , if
547 y is further than 2 yolk radii from the center of the yolk than x is, then x is majority preferred to y (McKelvey
548 1986; Miller et al. 1989).

549 ¹⁸The uncovered set can be thought of as a *near core* concept. An alternative is *uncovered* if it is majority
550 preferred to every alternative either directly or at one remove (Feld et al., ?Feletal1988).

551 In each chamber well over 90% of all legislation introduced into Congress never makes
552 it out of committee on to the floor, but bills which do get past committee tend to pass that
553 chamber. In 1984, for example, about 80% of the bills on the House floor passed. Nonethe-
554 less, only roughly 50% of the bills that passed the House that year were enacted into law.
555 Most of those bills were lost when they were referred to Senate committees and never heard
556 of subsequently, although a few did die in conference or by presidential veto.¹⁹ In like man-
557 ner, roughly half of all Senate bills die in the House.

558 Yet another obvious implication of the Buchanan and Tullock approach is that sometimes
559 different parties (i.e., different coalitions of voters) will control each chamber. In fact, at the
560 national level, from the 1930s until 1994, the House was thought to be inevitably Democrat,
561 while the Senate was contestable and did change partisan control. Similarly, a remarkably
562 high proportion of all states have divided legislatures, as high as 40% in some recent periods.

563 While Buchanan and Tullock are concerned to demonstrate that *less than a majority*
564 of the voters may control both branches of a legislature when logrolling is possible, it is
565 useful to turn to the other side of the ledger, the proportion of votes for passage we would
566 expect on bills that pass both branches. If a bill passes one branch of the legislature with
567 only a bare majority of votes, it is virtually certain that the voters who control the majority
568 in the constituencies that supported the bill will not control a majority of the seats in the
569 other chamber unless the two chambers have identical bases of representation. Thus, we
570 would expect that bicameralism will create *supraminimal* coalitions in each house, since
571 foresighted members will seek to put together a coalition that not only will win their own
572 chamber but will constitute at least a (bare) majority in the other chamber as well.

573 To get a handle on how constituency differences between the U.S. House and the U.S.
574 Senate can convert simple majority rule in each house into what is effectively super-
575 majoritarian decision making, we examine the distribution across constituencies in the
576 House and the Senate of demographic attributes such as percent black, percent non-white,
577 percent of adults who have graduated high school, percent urban, and mean income—which
578 are all important voter characteristics that differentiate constituencies and shape legislator
579 preferences. There may be important differences between the two chambers in the *mean*
580 value of these variables because the Senate is not apportioned on the basis of equal popula-
581 tion. Moreover, there may be differences between the chambers even in the *median* values
582 of important constituency variables because of “natural” geographic effects or because of
583 gerrymandering in the House.²⁰

584 We show in Table 2 the frequency distribution of these five attributes. There are several
585 facts which strike one from Table 2. First, certain demographic groupings are underrepre-
586 sented or overrepresented in the Senate as compared to the House. For example, the median
587 state (unweighted) has consistently (over four decades) had a higher black proportion than
588 the median House district, while the typical House district has been consistently more ur-
589 ban than the typical state. On the other hand, in characteristics like high school graduates,
590 House-Senate differences seem minimal.

593 ¹⁹Of course, we have to be careful how to interpret such data, since differences between chambers will, in an
594 anticipatory fashion, affect the nature of the legislation that is introduced in each chamber.

595 ²⁰A review of the gerrymandering literature would, however, take us too far afield from our present concerns.
596 Here we simply note that one effect of gerrymandering is to skew distributions of voters in such a way that
597 the median voter in the median constituency is not the same as the overall median voter, and the Senate is
598 accordingly insulated from the deliberate manipulation of constituency difference effects since state boundary
599 remain fixed. However, differences between the characteristics/preferences of the median voter in the median
600 constituency may also occur because of “natural” geographic concentration effects.

Table 2 Means and medians for demographic and socioeconomic variables in the U.S. Senate and House (first value shown in the mean, the second is a median)

	Senate				House			
	1970	1980	1990	2000	1970	1980	1990	2000
Percent High School Graduate	41.8	53.3	67.9	76.7	40.6	52.6	67.1	76.4
Income	41.1	53	67.5	76.1	40.6	51.8	66.4	74.9
	5568	9031	16677	28280	5630	9533	16572	28951
	5377	9165	16640	29177	5608	9606	17114	30700
Percent Black	4.8	6.34	6.6	7.25	4.4	5	5.5	5.4
	9	9.04	9.14	10.1	10.5	11	11.4	11.8
Percent Urban	62.4	66.3	67.1	68.8	68	74.4	77.1	79.3
	61.5	65.8	67	67.6	69.5	73.4	73.7	75.2
Percent NonHispanic White	92.3	90.6	88.6	86.7	94.6	93.7	87.2	86.8
	89.6	88.1	85.5	83.5	88.8	87.6	81.3	80.5

From a Downsian perspective (Downs ?Dow1957), information on the *median* rather than the *mean* constituency is what we want. We see from Table 2 that the median State is about 62%–68% urban (with the exact percentage depending upon decade); while the median House district is about 68%–79% urban, with the differences greater at present than in earlier periods. Thus, to create a winning coalition around urban issues in *both* chambers would be easier in the House than in the Senate. And Senators from the less urban states would need side-payments or some type of logroll to support a pro-urban bill.

This would suggest that the Senate should be less liberal than the House. However, with respect to ADA scores and related measures of liberalism, there is a considerable early literature in political science (with a seminal piece by Froman (?Fro1963); and an important follow-up by Jacobson 1973) that makes an argument that constituency distribution differences in characteristics such as urbanism and percent minority will make the *Senate* more liberal.

The intuition is that characteristics like percent non-white tend to have a more sharply skewed distribution in the House than in the Senate, i.e., more states have a non-trivial African-American proportion than is the case for House districts (Froman ?Fro1963: 80; Jacobson ?1971). However, while it is true that the difference between medians and means for blacks and Hispanics is greater in the House than in the Senate, mean-median differences between chambers in other categories are minimal to nonexistent. (See Table 2.)

From roughly 1960 until 1980 the Senate median member was more liberal than the House median member (Grofman et al. 1991), but when the GOP takes over the Senate in 1980 that chamber leapfrogs the House. After the 1986 election, though, the Senate has usually been just slightly more liberal than the House, but the differences are usually trivial. To try to explain the finding that, until recently, the Senate was noticeably more liberal than the House we need to take into account party composition.²¹

²¹It is clear (McCubbins and Sullivan 1984; Grofman et al. 1991; cf. Fenno 1978; Bullock and Brady 1983) that it is not the median voter in the *geographic* constituency but rather the median voter in the representative's *electoral* constituency (those who actually vote for him) that is critical in constraining a representative's legislative policy stance. Given tendencies toward party-line voting in the electorate, this means that the representative's party affiliation plays a critical intervening role.

We would expect that, the more Democratic the chamber, the more liberal it would be. In the Senate, in states that elect senators of opposite parties, the Democratic senator from the state is on average roughly 40 points more liberal in ADA terms than is the Republican (Grofman et al. 1991).²²

Another interesting question about the effects of bicameralism is how the *range* of ideological positions is constrained or expanded by the nature of the number and location of constituency units, e.g., in the House as opposed to the Senate. We would expect that a statewide constituency narrows the range of ideological variation of representatives, as compared to the more numerous and less heterogeneous congressional districts within the state, especially once we control for party. But this difference is impacted by the way in which constituency boundaries are drawn. If constituencies are “arranged” to be homogeneous, there will be a substantial range of position reflected by the various legislators and conflicts among divergent views must be resolved within the legislature. In contrast, if constituencies are “arranged” to be heterogeneous, i.e., to mirror statewide characteristics, then we might expect that more representatives will all have relatively “centrist” views. Increasingly, constituencies in the House are drawn to concentrate supporters of each party, and, as the party support bases become more distinct as they have over the past several decades, we get a much greater *range of variation* in House constituency characteristics than we do for states.

We can get a good sense of the how the diversity issue plays within states, by comparing the voting patterns of House members within a state to the behavior of that state’s senators, controlling for party. Using data from 1960–2006, the mean absolute difference in DW-NOMINATE scores of senators of the *same* party from a given state is only 0.112 points (0.105 for Democratic senators and 0.122 for Republican senators).²³

5 Conclusion

The simple point with which we wish to end this paper is that the theoretical analysis offered in Chap. 16 of *The Calculus of Consent* offers an as yet almost entirely unexplored goldmine of inspiration for empirical work. It is not just the U.S. Congress that is available to study; there are 49 states with bicameral legislatures!

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²²As noted in an earlier footnote, the “real” constituency of a representative is his election constituency and that can be expected to be non-centrist, especially if there is a bimodal distribution of ideology within the constituency.

²³During the same time period, the mean range in the DW-NOMINATE scores of Democratic congressional delegations within the same state is 0.316, while for Republican congressional delegations within a state the mean range is 0.259. Similar results obtain for other roll-call voting measures such as that generated by the Americans for Democratic Action (ADA). For example, in California, even two decades ago, before party differences had sharpened quite as much as they have at present, Democratic congressmen in 1987 had ADA scores ranging from 55 to 100, while Republican congressmen from that state had ADA scores ranging from 0 to 25.

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