

The politics of flatland*

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Abstract

A version of the median-voter theorem holds for two-dimensional spatial models in which voters regard the two dimensions as economic goods or goodlike activities and in which the set of feasible outcomes is constrained by budget or technology. Although mathematically trivial, this fact has widespread analytical uses. After arguing that our two-dimensional model, with its stability property, fits a number of important and general policy areas, we use our analysis to address some prominent theoretical issues.

In the one-dimensional spatial model of voting, voters' ideal points are arrayed along a single issue dimension, and any median of these ideal points must be stable under majority rule: no point is preferred to it by a majority. This simple but powerful result, which we owe to Hotelling (1929), Black (1948, 1958), and Downs (1957: 115), contrasts with extant findings about stability in multidimensional voting models. Not only *need* there be no stable point in an issue space of two or more dimensions, but a number of instability theorems show that there almost certainly *will* be none, given some plausible-looking assumptions.

These theorems come in two varieties, *spatial* and *exchange-based*. In his seminal contribution to spatial voting theory, Plott (1967) showed that a kind of perfect symmetry of voters' ideal points is sufficient for the existence of a stable point. Enelow and Hinich (1983) have shown a weaker but still quite severe condition to be necessary as well as sufficient. McKelvey (1976), Schofield (1978), and Cohen (1979) have proved that almost every possible profile of voter preferences yields a majority-preference cycle that exhausts the issue space. The exchange-based instability theorems, discovered by Kadane (1973), Oppenheimer (1972), and Bernholz (1973, 1974), with correlations and generalizations by Schwartz (1976) and variations by Miller (1976) and Enelow and Koehler (1975), show that the

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outcome of majority voting must be unstable if it requires any vote trading or similar exchange – any packaging of positions from different issues. Schwartz (1981) has generalized this set of theorems, dropping their various restrictive assumptions about individual preferences and the collective-choice rule while allowing the set of feasible alternatives to be any subset whatever of the cross-product of issues.

The lesson often drawn from such results is that the tidy stability feature of one-dimensional voting models not only fails to hold generally for models with two or more issue dimensions, but collapses utterly for such models: when there exist even two issue dimensions, the conditions for stability are so severe that instability is a virtual certainty. Thus Riker (1980): 'Disequilibrium, or the potential that the status quo be upset, is the characteristic feature of politics.' (See also Fiorina and Shepsle, 1982).

Such sweeping conclusions overstate the truth. The spatial instability results rely on two empirically restrictive assumptions. When these are replaced by an alternative pair, no less reasonable on their face, while the number of issue dimensions is assumed to be two, the instability results no longer follow, and a version of the median-voter theorem holds. This is because our assumptions enable us, in a sense, to reduce the two-dimensional case to the one-dimensional case.

Although utterly trivial, this result has gone unremarked in the literature, perhaps because its analytical potential has not been appreciated. After presenting the model, its stability property, and some generalizations, we show how the model fits common conceptions of a great deal of real-world political activity: many policy questions are described and debated in terms of our two-dimensional model. We then use our analysis to address a number of issues raised in the literature on majority voting, answering questions and extending previous results. In particular, we extend Shepsle's (1979) result regarding the stability of decentralized legislatures.

1. Assumptions

The spatial instability theorems all rest on two assumptions:

NO CONSTRAINT The feasible set – the set of alternatives from which a choice is to be made by majority rule – is the whole positive orthant of the issue space: it is not constrained by budget, technology, constitutional principles, or anything else.

SATIATION Every voter has a point of satiation – an ideal point – in the issue space.

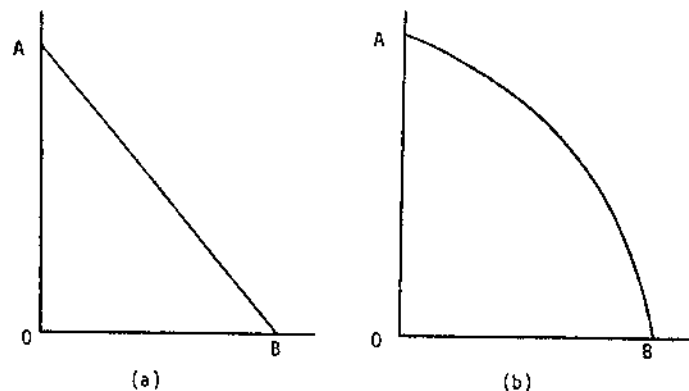


Figure 1.

No Constraint is also assumed by all the exchange-based instability theorems except that of Schwartz (1981); Satiation is irrelevant to those results.

Although it is worthwhile to explore the consequences of No Constraint and Satiation, neither enjoys any general validity. The No Constraint assumption ignores the distinction, commonly and carefully made in social-choice theory, between the set of all conceivable alternatives and the feasible set of the moment (Arrow, 1963: 61; Plott, 1976; Schwartz, 1984; Ch. 10). Economic theory deals entirely with choices from sets constrained by budgets or technology. Formal optimization problems typically require optimization subject to constraints. Clubs, committees, parliaments, democratic politics, and other voting bodies often face predetermined budget ceilings, agendas, or ballot lists. In some contexts Satiation is a reasonable assumption. In others it is not. It is unreasonable, in particular, when each dimension has the formal characteristics of an economic good: other things being equal, more of it is preferred to less.

To derive our median-voter result, we assume that a finite number of voters, Messrs. 1, 2, ..., n , are to choose among alternatives represented by points in two-dimensional Euclidian space. Contrary to No Constraint, we assume that the feasible set is constrained by a (weakly) concave function, represented by the curve AB in Figure 1. It is natural to interpret AB as a budget line or a production-possibility frontier. The feasible set is the closed set ABO .

Contrary to Satiation, we assume that each voter has indifference curves without any satiation point, as in Figure 2a rather than 2b. This means the two issue dimensions are *goodlike*: voters always favor an increase in the level of activity in either dimension when the other dimension is held constant, and they make tradeoffs between the two dimensions, so that a voter

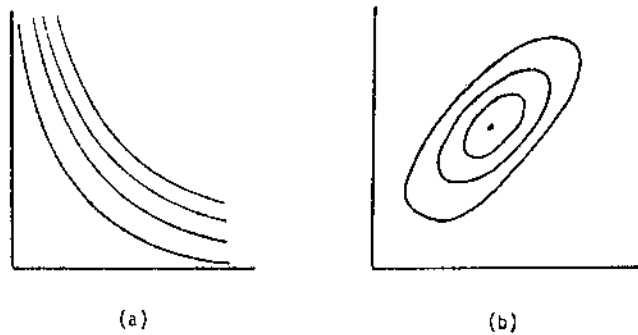


Figure 2.

is willing to trade some amount of activity in either dimension for any given increment of activity in the other dimension. In short, each voter has a utility function on two-space that is strictly increasing and strictly quasi-concave.

It has been suggested to us that even a consumer of two economic goods has a satiation point, the point at which one of his indifference curves is tangent to his budget line. What our assumption rules out, however, is not such an *induced* satiation point, which rises with the subject's budget, but rather a *pure* satiation point, which remains fixed even as budget rises. At an induced satiation point, the subject is as happy as his budget permits. At a pure satiation point, the subject is as happy as his tastes permit.

In the two-dimensional spatial voting examples of Tullock (1967: Ch. 2), voters have satiation points of a sort — *optimal points*, Tullock calls them — even though the two dimensions represent economic goods (food and fireworks at a club's Fourth of July party). This is because voters are simultaneously choosing a budget and its allocation: a voter's satiation point represents his ideal budget (how much he thinks the club should spend for the party) as well as his ideal allocation of that budget (between food and fireworks). We instead assume that the budget has already been chosen, so that higher levels of spending are infeasible and any of the budget that is not spent is simply wasted. In §§3 and 5, however, we examine what happens when voters must choose the budget as well as its allocation, both separately and simultaneously.

2. The theorem

For each voter, there exists a unique point at which one of his indifference curves is tangent to AB ; call it his *tangency point*. A *median tangency point* is a tangency point such that no majority of voters have tangency points on

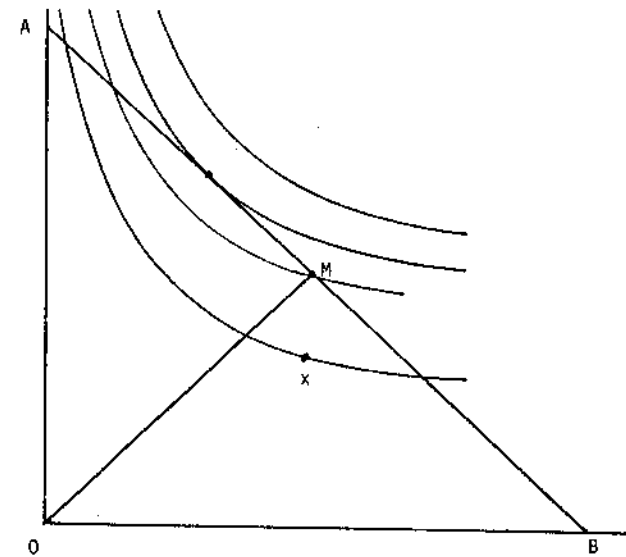


Figure 3.

either side of it. There must exist either one or two median tangency points (as there must exist either one or two medians in *any* finite, weakly ordered set).

One point *beats* another if a majority of voters prefer the former to the latter. A *stable* point is a member of the feasible set that is not beaten by any point in the feasible set.

Here is our version of the median-voter theorem: Given the assumptions of our model (two dimensions, no satiation points, standard constraint), if M is a median tangency point or a point on AB between two median tangency points then M is stable.

Proof. Draw a line from M to the origin, and let x be any point in the closed set MBO . It is clear from Figure 3 that any voter whose tangency point is at M or to the left of M prefers M to x unless $x = M$. But at least half the voters have such tangency points since no majority of voters have tangency points to the right of M . So x cannot beat M . Likewise, no point in the closed set MAO beats M . Hence, M is stable.

Where the classical median-voter theorem refers to ideal points along a single issue dimension, ours refers to tangency points along a budget line or production-possibility frontier. The only other difference is that our feasible set contains points below AB as well as on AB . This means, in effect, that our assumptions ensure stability by enabling us to reduce the two-

dimensional to the one-dimensional case, or something close to it. We cannot use the same ploy to prove a stability result for three or more dimensions, since the feasibility constraint would then be a hyperplane or a convex cone rather than a line or curve.

We can relax the assumption that the feasible set is the closed set ABO . To prove the existence of a stable point, all we needed were the assumptions (1) that the feasible set is a subset of ABO , and (2) that the feasible set contains some median tangency point or some point on AB between two median tangency points. Note that (2) is weaker than the assumption that AB is a subset of the feasible set. This relaxation allows a great degree of non-convexity while making it easier to add constitutional and other constraints to the budgetary and technological ones already mentioned.

The assumption that voters do not have satiation points also can be weakened, in two ways: First, nothing in our proof precludes as many voters as you please from having satiation points *on or above* AB . (Voters can have satiation points as long as the constraint is binding to them, and their satiation points are not feasible.) A voter might feel that no resources should be spent beyond a certain level, but the given budget might not exceed that level. Second, we can allow as many voters as you please to have satiation points wherever you please, provided the feasible set consists just of AB itself and AB is linear.¹ This proviso means, in effect, that the voters are constrained, by constitutional or other requirements, to allocate all of the given resources.

3. Applications

A great deal of U.S. political decision making can plausibly be interpreted as satisfying either the one-dimensional model of Hotelling et al. or else our two-dimensional model. Here we survey seven types of policy decision to which our model seems applicable – often because public debate or scholarly analysis already is couched in terms of two goodlike issue dimensions. We do not deny that some of these policy areas can be conceived in other terms, nor do we try to prove that policy choices in these areas are best explained by our model. Rather, we argue that it is plausible and even customary to characterize each of these policy areas in terms of two goodlike issue dimensions and that doing so yields some interesting and credible consequences. Our purpose, in short, is hypothetical rather than demonstrative – to recommend a tool for analyzing a large variety of policy decisions under majority rule, not to elaborate and confirm any specific analysis.

i) *Explicit allocational decisions.* Many voting decisions explicitly concern the allocation of a predetermined budget between two good-like activi-

ties – of which voters always prefer more to less, other things being equal. In deciding the level of funding for the Office of Toxic Substances (OTS), the House Appropriations Subcommittee with jurisdiction over EPA (Subcommittee on HUD and Independent Agencies) makes explicit tradeoffs between two broad categories of OTS activity, enforcement and rulemaking. Congressional activity on the 'Defense budget tends to concentrate on procurement and research and development items,' leaving unexamined such other items as personnel and operations (Ripley and Franklin, 1976: 146). In each of these cases, budget is predetermined by procedures detailed in the Budget and Impoundment Act of 1974. Budgetary predetermination is prevalent in American politics: many state constitutions have balanced-budget clauses requiring an independent executive officer to set budget ceilings.

ii) *Separate choice of budget and allocation.* Sometimes a committee or other collectivity is not simply given a budget to allocate but has to choose both a budget and its allocation between two activities. When these two choices are made simultaneously, the outcome need not be stable. Suppose, however, that budget and allocation are decided separately: Messrs. 1, 2, ..., n first choose a budget line, AB , then choose the median tangency point on AB . Because the choice of a budget line ensures the choice of the median tangency point on that line, the budget choice is, in effect, a choice from the locus, L , of median tangency points on all possible budget lines, as shown in Figure 4. It is reasonable and customary to assume that such a choice is one-dimensional, or single peaked, so that the median-voter theorem of Hotelling, Black, and Downs applies to it: the median, M , of voters' ideal points on L beats every other point on L .² Once the budget represented by AB is chosen (because it contains M), our own theorem applies: M beats every other point in ABO . If budget level is voted on again, M will not be overturned because it beats every other point on L . If allocation is voted on again, M will not be overturned because it beats every other point in ABO .

iii) *Regulatory issues.* Economic regulation is often described as a redistribution of market surplus from consumers to producers (Stigler, 1971; Posner, 1971, 1974; Peltzman, 1976). Such regulation often establishes price and entry restrictions, creating monopolistic or oligopolistic rents for producers. In choosing a regulatory scheme, members of a regulatory commission or legislature are choosing the distribution of welfare between these two groups, whose interests may be represented by our two issue dimensions.

If economic regulation is indeed two-dimensional, we would expect regulatory outcomes to be fairly stable. As it happens, of the twenty-one economic regulatory acts passed between 1900 and 1940, twenty remain largely unchanged. Policy has changed little over the last five decades at the Federal Maritime Commission (Mansfield, 1980) or at the Texas Railroad

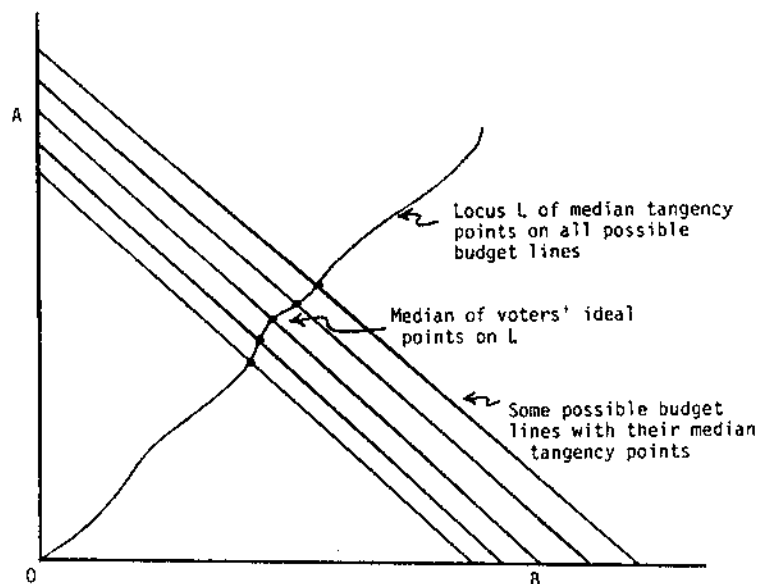


Figure 4.

Commission (Prindle, 1981). Where change has occurred, notably in the regulation of civil aviation, there had been a change in the preferences of the two groups (and therewith their representatives) whose interests are represented by the two dimensions (see Weingast, 1978). With new entrants favoring deregulation, the median-equilibrium outcome shifted toward deregulation.

For environmental regulation, too, the policy problem is two-dimensional. Polluters wish to minimize the costs of environmental regulation to themselves, but all else being equal, would prefer less pollution to more. Environmentalists (and others who bear the external environmental costs of production and consumption) wish to minimize the level of pollution, but all else equal, would prefer to do so at the least cost. Thus, both groups have natural satiation points at zero cost with zero pollution. The current anti-pollution technology guarantees, however, that these satiation points will not be within the set of feasible alternatives, represented by the cross-hatched area in Figure 5.

Health and safety regulation also fits our model. In the congressional debate over the Toxic Substances Control Act, for example, the dimensions of controversy were, naturally enough, human health and technological innovation (McCubbins and Page, 1983). Tradeoffs between these two dimensions are evident throughout the act and are spelled out explicitly in the preamble.³ Similarly, the major tradeoff considered in the debate over the

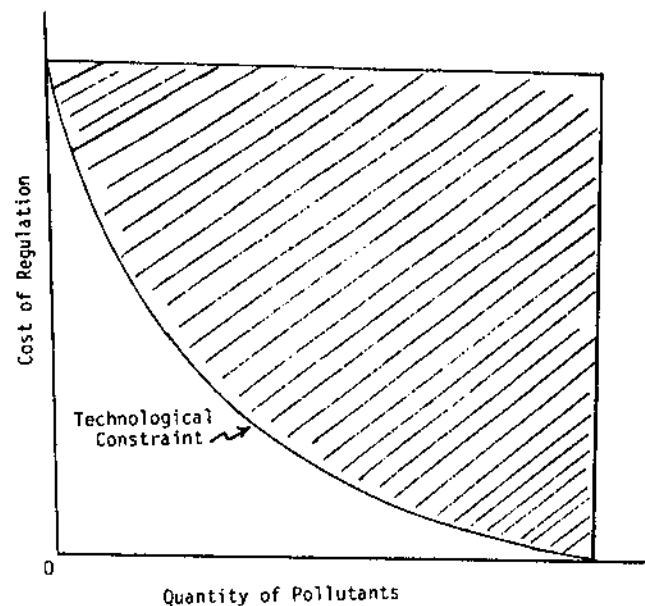


Figure 5.

Federal Food, Drug, and Cosmetics Act was between human health and costs to industry, particularly to patent-medicine manufacturers (Jackson, 1970). In effect, Ripley and Franklin (1976) describe the debate over strip-mining legislation in terms of two dimensions: congressmen made tradeoffs between the quality of the environment and the price of energy (pp. 99–103). Anderson, Brady, and Bullock (1978) suggest that the debate over energy policy fits this two-dimensional framework (pp. 51–58, 98–100). As our model predicts, environmental, safety, and health regulations have remained stable in form and substance over the last five decades (McCubbins, 1982: Ch. 10).

iv) *Haves vs. have-nots*. Often policy decisions concern the allocation of social product between prosperous and nonprosperous classes of citizens — between haves and have-nots. Medicare was explicitly redistributive between two classes (Marmor, 1973), and the debate focused on the interests of those classes (see also Ripley and Franklin, 1976; Friedman, 1969; and Anderson, Brady, and Bullock, 1978). Mortgage subsidy programs, old-age assistance, and Aid to Families with Dependent Children are similarly two-dimensional (see Ripley and Franklin, 1976). Rural electrification redistributes wealth from urban to rural areas through public-works programs and construction loans. Protective tariffs transfer surplus from domestic consumers and foreign producers to domestic producers. In each case the

big question is two-dimensional: how much of the pie does each of the two contending sides get? The constraint, the size of the pie, is derived from the production-possibility set. And in each case the program is well entrenched, exhibiting remarkable stability (Wilson, 1980).

v) *Guns vs. butter*. National political controversies often concern the allocation of resources between national security and domestic improvements — guns and butter. Although voters differ in their marginal rates of substitution, just about everyone would like to do as much as possible, all else constant, in each of the two categories. For the most part, then, voters do not have satiation points — or, at least, none that fall below reasonable budget ceilings — but do have different points of tangency with the budget line. As our analysis predicts, the allocation of resources for national security is relatively stable, hovering about 6% of the GNP since the Second World War.

vi) *Macro-economic policy*. Sometimes fiscal policy is debated in terms of tradeoffs between full employment and price stability, two goodlike issue dimensions (Anderson, Brady, and Bullock, 1978: 182–88). To be sure, the issue is not always so simple: such additional dimensions as public-sector size sometimes come into play.

vii) *Private vs. public*. Often ideological differences between political candidates (and parties) concern the allocation of social product between private and public consumption (or the private and public sectors): conservatives differ from 'liberals' in favoring more private and less public consumption. In this interpretation, *AB* represents the technology available to political parties, given constitutional limits on their activities. If the vertical axis represents public spending and the horizontal axis private spending then most conservatives will have tangency points to the right of those of most liberals. Given the constancy over time of public opinion regarding the relative size of the public and private sectors (Page and Shapiro, 1982), our model explains why public spending has remained fairly stable as a proportional share of GNP.

Even if each of these seven types of policy question can be conceived in terms of two goodlike issue dimensions, a combination of two or more of them cannot. We hypothesize, however, that there is a tendency in political debate and congressional voting not to combine these questions. Politicians might debate and decide the allocation of the federal budget between guns and butter and separately debate and decide the allocation of the butter budget between haves and have-nots, but they do not usually debate or decide, as a single question, the allocation of the federal budget among guns, butter for the rich, and butter (or oleomargarine) for the poor.

4. Implications

Besides showing that at least one important two-dimensional voting model guarantees stability, our little theorem casts light on four issues that have been raised in the literature:

i) *Stability of two-party politics*. The peculiar stability sometimes attributed to certain (more or less) two-party polities, such as Great Britain, might be explained on the basis of our model as follows: Each party has a permanent *primary constituency* — a fairly well-defined class whose interests it tries to promote. The two dimensions represent the interests of the two constituencies. *AB* represents social product or welfare surplus — whatever it is that the government can allocate. Apart from cost, every voter regards the interest of each primary constituency as worth serving. Thus, voters have no satiation points. *Swing voters*, who belong to neither primary constituency, profit to some extent from policies that favor either primary constituency, although they prefer a mixed policy to the more extreme allocations favored by the primary constituencies. Each party tries to win favor with sufficiently many swing voters to secure a majority of votes. (Here we follow Downs, 1957: 144, in simplifying real voting schemes: pure majority rule differs, for example, from representation by single-member constituencies.) Our theorem suggests that the winning party's platform will be nearer than that of the losing party to the median tangency point of the electorate.

ii) *No vote trading on two-dimensional allocational issues*. By virtue of the theorem of Schwartz (1981), the outcome of majority voting — or, for that matter, any collective-choice process — must be unstable if it requires vote trading. Because this is true however the feasible set be constrained and whatever voter preferences may be, nothing in the theorem conflicts with our assumptions (standard constraint and nonsatiation). Thus, since our assumptions imply stability, they further imply that *the final voting outcome cannot require vote trading*: when voters decide by majority rule how to allocate a given budget between two activities, they have no incentive to trade votes.

This consequence will be less surprising if looked at as follows: Think of *AB* as a budget line. Owing to our nonsatiation assumption, every voter wants to spend the entire budget. But the game of choosing among points on the budget line is constant sum, hence strictly competitive. Consequently, mutual gains from trade are impossible.

iii) *Stability of redistributive choices in a democracy*. A classic case of instability under majority rule is that of three people deciding by majority rule how to divide a dollar (or other infinitely divisible good) among themselves. Ward (1960) generalized this example, arguing that purely redistributive choices always are unstable in a democracy. This assumes a multidimensional model in which each dimension represents the interest of a single

voter or, at most, a group comprising a minority of voters (Frohlich and Oppenheimer, 1978: 126). Often, however, redistributive questions are cast in terms of only *two* dimensions, representing the interests of *haves* and *have-nots*. In such cases, strictly redistributive choices are, if anything, peculiarly stable. The U.S. social security system, for example, has proved remarkably stable. Although the median outcome shifts with changes in the demographics of the American electorate, the system has endured (and expanded) for the last half century.

iv) *Stability in decentralized legislatures.* Shepsle (1979) has constructed a model of decentralized legislatures in which (1) every legislator has separable preferences, (2) decisions are made by autonomous subcommittees with nonoverlapping and selfselected memberships, (3) each subcommittee chooses along a single issue dimension, representing its jurisdiction, and (4) there is no collusion between subcommittees. In this model, the vector consisting, for each dimension, of the median ideal point of the subcommittee responsible for that dimension is stable in the following sense: no group has the power and incentive to overturn it. Shepsle's result is important because Congress seems to approximate the model. Even assuming, however, that subcommittee jurisdictions are quite narrow, assumption (3) is rather strong. But our theorem shows that (3) can be relaxed as follows: each subcommittee *either* chooses along a single dimension *or else* chooses from a two-dimensional space for which there is a predetermined budget constraint and no satiation points or no feasible points below the budget. The second part of this relaxed assumption seems especially realistic for Appropriations subcommittees, whose choices are constrained (ideally, at least) by a concurrent budget resolution.

5. Conclusion: Why so much stability?

So asked Gordon Tullock (1981) in his famous challenge to a Public Choice community enthralled by various instability theorems with their intimations of universal political chaos:

If we look at the real world . . . we observe not only is there no endless cycling, but acts are passed with reasonable dispatch and then remain unchanged for very long periods of time. Thus, theory and reality seem to be not only out of contact, but actually in sharp conflict. (p. 189)

A partial answer to Tullock's question is that so much of American politics fits our two-dimensional model with its stability property. This, however, is only the beginning of a long story. Here are a few topics demanding further investigation:

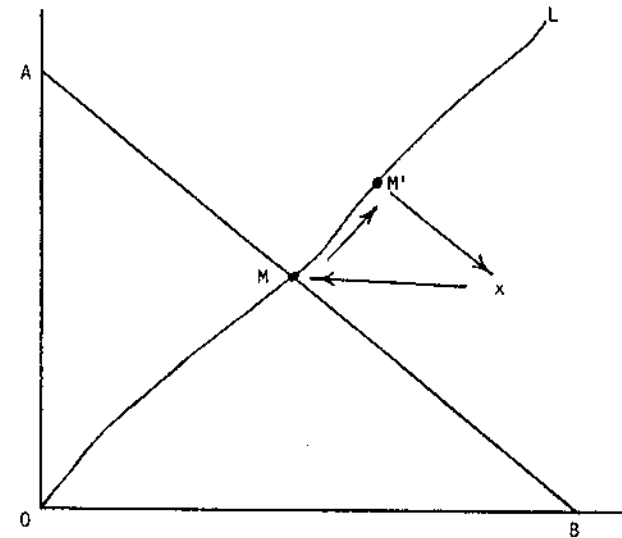


Figure 6.

i) Besides the broad policy areas we have surveyed, there are likely to be others that fit our model. In addition to identifying these, it would be interesting to identify policy areas that cannot be made to fit our model – limits on the model's domain of application.

ii) Some policy questions are conventionally framed in terms of our two-dimensional model when they could as easily be framed in terms of three or more issue dimensions – witness redistributive questions, which we usually discuss in terms of the interests of *haves* vs. *have-nots*, older vs. younger generations, urban vs. rural populations, and the like. Why is this? One possible explanation might be based on the stability of our two-dimensional model: perhaps the practice of framing so many policy questions in terms of two goodlike issue dimensions is a convention that somehow evolved because of its stabilizing effect.⁴ Part of what has to be explained, of course, is why it is (if it is) that society tends to select stabilizing practices.

iii) When the constraint AB is a budget line, stability depends on the assumption – true in many cases – that the budget is chosen prior to or separately from its allocation between the two dimensions. Can the tendency to separate budgetary from allocative decisions be given a general explanation? Can it be explained, in part, by the stability it helps ensure?

iv) Factor analysis of polling data from U.S. presidential elections shows the U.S. electorate to have preferences represented in two issue dimensions (Weisberg and Rusk, 1970; Rusk and Weisberg, 1972; Enelow and Hinich, 1984). To apply our model, we can assume that AB represents social product or prevailing political technology. But can the two issue dimensions be



regarded as goodlike, so that voters have no satiation points? The problem is that although one of the dimensions seems to be 'social' and the other 'economic,' it is not clear how more precisely to describe them.

v) Suppose budget and allocation are decided simultaneously (as a single package) rather than separately. It is still true, of course, that the M of Figure 4 – the median point on the locus L of median tangency points on all possible budget lines – beats every other point on L and every point in ABO . Once M is reached, then, it will not be overturned in favor of any other point on L or any other point in ABO . But it might be overturned in favor of a point x that lies above AB but off L , as in Figure 6. Because x would be beaten by the median tangency point M' on the potential budget line that intersects x , while M' would in turn be beaten by M , a cycle would result: M would not be stable. Still it has a partial stability property: it is downward stable though not upward stable. This means that if instability causes a budget revision, the result must be a budgetary increase, not a decrease. Can this finding be used either to demonstrate or to explain excessively high budgets? Does M have any further (partial) stability properties? Can any normative justification be given for the choice of M over the likes of x ?

NOTES

1. Nonlinearity makes it possible for one voter to have two tangency points.
2. Although reasonable, this assumption is not necessary. Suppose a particular voter has a satiation point when considering budget level and allocation together. Then one of his indifference contours might be tangent to L at more than one point.
3. On TOSCA, see Library of Congress, *The legislative History of the Toxic Substances Control Act*, Washington, D.C.: U.S. Government Printing Office, 1976.
4. On related stabilizing norms or practices, see Mayhew (1974) and Weingast (1979).

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