Equilibrium Results in Committee Settings: Theory and Experiments on Decision Costs

by

Roberta Herzberg
Indiana University

and

Rick K. Wilson
Rice University

Paper prepared for delivery at the Midwest Political Science Association Meeting, April 9-11, 1987, Chicago, Illinois

Introduction

Every deliberative body faces important problems for bringing together varied Interests and translating these desires Into policy. The problems of decision making, however, are not limited to differences across preferences. The way in which the deliberative body is organized often has an effect on policy choices. Indeed a substantial corpus of research has emerged over the past decade, delineating ways in which policy equilibrium arises from structural characteristics of collective choice institutions (see Shepsle and Weingast, 1984). While structural components detailing agenda control and Jurisdictional bounds have been well specified, other Institutional features may also Induce policy stability. In this paper we explore the effect of decision costs on collective choices. While such costs are often acknowledged, they remain rarely studied.

One example of decision costs is illustrated by the hue and cry raised by legislators at the end of a session as to the mountain of legislation to be climbed before adjourning. This reflects the fact that only a finite amount of time exists in which to accomplish all the of the tasks modern legislators set for themselves. Typically this means considering far more legislation than It is possible to pass. Indeed, the problem of an impending election confronted most members of the 99th Congress. The press of the election made consideration of legislation quite costly. Important spending bills were bundled together under a major omnibus bill and hurriedly passed in both Houses with little discussion. On the other rand. major legislation, such as a product liability bill (SB 2760) was summarily dropped as harried members sought to adjourn the session in order to turn toward constituents and electioneering. (Congressional Quarterly, September

27, 1986, p. 2316). The 99th Congress was not unusual on this score in either a contemporary or historical sense. Pushing back almost 100 years, the end-of-session crunch of legislation stalled an omnibus Rivers and Harbors package in Conference Committee, even though members of both Houses pleaded for its passage, since the bill was almost universally supported and it represented a major source of funding for local transportation projects (Congressional Record, V. 34, 56th Congress, 2nd Session).

Our general question here, is what is the effect of decision costs on collective decision making? This raises a broad normative question and a narrower technical question. The former asks whether decision making costs lead to better or worse choices. The latter question examines a prior, empirical, question as to whether decision making costs affect collective choices. It is on this latter question that we focus. Once It is answered, then attention can be focused on the first, more important normative quest ion.

In this study we focus on an explicit component of decision costs — costs which are incrementally added to each stage of a decision. We are interested in whether these costs change the strategies of decision makers. To get at this question, we use elements of formal theory to compare settings with and without decision costs. We then provide evidence from laboratory experimental settings to test our formal concepts. From our theory and experiments we are able to offer several generalizations about the effect of one class of decision costs on collective choices.

Decision Costs

Although formal theory points to the prevalence of disequilibrium results, empirical evidence points to the remarkable stability exhibited by choices in most majority rules processes. This has led researchers to consider other decision making procedures to see If they generate stable collective choices. One major Intellectual thrust has been to examine structurally-induced equilibrium. Shepsle (1979) and others have shown that specific procedural rules can induce stability into a decision setting leading to a set of equilibrium outcomes. Such results are valuable for linking institutional procedures with collective choices. However, this work is limited by focusing almost exclusively on agenda procedures. We wish to follow in this general tradition of structurally-Induced equilibria, but we have shifted our attention to Institutionally derived decision making costs.

Decision costs are regarded as omnipresent In most decision settings. However, those costs are also difficult to capture with a simple generalization since they are often specific to structural features of the decision setting. Quite often such features are assumed as part of the decision maker's utility function. Our concern is not with those costs which are subsumed Into a utility function, but with costs which are a function of the institutional structure of the decision arrangement. Such costs represent important constraints on the choices of strategies in decision making settings and should be regarded as a separate element of a member's decision calculus — in much the same way as a particular feature of an agenda process makes certain strategies more or less valuable for a decision maker. These Institutional costs are quite common in a variety of settings, but they have not received the attention lavished on other structural components of decision settings — such as agenda rules or jurisdictional claims.

Regarding decision costs as institutionally derived is appealing. Early models of decision settings with costs pointed to the importance of those costs when considering the array *of* possible institutional rules. Buchanan and Tullock (1962) spend a good deal of time establishing that a particular

decision rule minimizes decision costs with respect to the expected outcome of the decision. Their discussion focuses on which Institutional rules set a reasonable level of decision costs. While their discussion is fundamental, It does not cover the full range of such decision costs.

Aside from the seminal work by Buchanan and Tullock (1962) a few others have examined components of decision costs. Sloss (1973) introduces a general model of costs where every member in a majority rule process assures fixed costs to decision making. The costs to each decision are assumed captured by thick Indifference contours. Using such a notion of cost, Sloss details a set of equilibrium conditions comparable to those outlined by Plott (1967) for simple majority rule games. These equilibrium results provide valuable Insights into how extensive those costs must be in most decision settings.

Taking a different tack, Hoffman and Packel (1982) examine costs as discrete units associated with an agenda process. They treat costs as something tied to each step in the agenda process. Breaking an agenda into distinct units allows them to ask when the decision process will terminate. They rely on a stochastic concept which characterizes expectations over & variety of outcomes. This enables them to conclude that, In the face of costs, the decision process will halt before all possible alternatives are considered, Including a dominant outcome. The expectations, then, that decision makers hold over final choices is tempered by decision costs.

A different approach to the problem of costs is that taken by Denzau, Mackay and Weaver (1982). They construct a series of agenda access models that *vary* as to the cost of Introducing proposals to an agenda. Building on the general comparative static theories of agenda control outlined in the work of HcKelvey (1976; 1979), Plott and Levine (1977) and others, Denzau et al. model such processes using different costs of agenda access, instead of relying on fixed rules that award agenda control to subsets of individuals. In their models Individuals may face varying costs for proposal making. Agenda setters can be characterized as having Inexpensive access to the agenda, while others must pursue more costly avenues. Specifically, decision makers can be charged differential rates for placing a proposal on an agenda. Only those proposals that result in a net gain In payoff, given some imposed cost, will be made. As these costs are Included. Denzau et al, pinpoint a number of conditions under which a set of equilibrium alternatives arise.

5n our discussion we treat one specific case of institutionally derived decision costs. We focus on a setting where fixed costs are assessed on all Individuals at each stage of the agenda process. These "stage" costs are specific to forward moving agenda procedures commonly used in decision making arrangements (see Wilson, 1986b). In this particular Institutional setting, the agenda process begins from a fixed status quo. Any amendment is then paired for a vote with the status quo. The majority winner under this paired vote becomes (or remains) the status quo. Amendments can be Introduced at any time and the status quo can be changed many times. Decision costs are Introduced into this setting by assessing every decision maker a fee for winning amendments. That is, if an amendment defeats the status quo, then a fixed cost is charged to each decision maker.

It is seldom the case that transaction costs in the empirical world are frictionless. More usually there are real costs for changing a policy. In the case of a legislature costs are present at each step where alternatives are considered. Where a bill is considered in committee decision costs Include the costs borne by staff members In Investigating and analyzing alternatives and the costs borne by legislators in attending hearings *and* discussing markups. If the bill goes to the floor under some form of an

open rule, members bear costs for any amendments offered to the bill. These costs take the form of additional time spent In floor discussion and voting. It is not the case that only those present bear these costs, but everyone shares in them. This is because only a finite amount of time is available In any legislative session. Anything discussed on the floor takes time away from other legislation which could be discussed. Thus, even at this stage there are costs to considering amendments to legislation. While It Is the case that there is nothing in the empirical world which is isomorphic with the stage costs modeled here, this highly stylized form of costs captures one attribute of the costs to decision making. This in turn provides us a starting point with which to consider the effect of such costs on a decision setting.

Our approach in this paper utilizes some of the Intuition of the Denzau et al. approach combined with the setting Investigated by Hoffman and Packel. Furthermore we rely on Sloss' general findings in order to characterize our equilibrium results. Before beginning our discussion of these cost-induced equilibrium results, we provide several definitions.

Theoretical Concepts

In this section we build on a number of previous results showing that In the absence of costs the preference configuration necessary a sufficient to Insure that bome alternative is in equilibrium is very restrictive (see Plott, 1967; Slutsky. I979; Schofleld, 1985). As stage costs are added, however, equilibrium emerge under less restrictive conditions. Sloss (1973) characterizes this result under very general conditions. Here we establish this result in the context of covered and uncovered sets, relying heavily on theoretical results generated in Miller (1977, 1980) Snepsle and Weingast (1984) and McKelvey (1986).

Definitions and Assumptions:

Let $N = \{1,2,\ldots,n\}$ be the n-membered set of legislators charged with the task of selecting a single alternative, x, from a compact, convex policy space $X \subset R^m$. Each member, $i \in N$ has a binary preference relation defined over all $x \in X$ in relation to a member's ideal point x^i. When costs are present the set of alternatives preferred to any x by individual i is defined as $P^i(x) = \{x' \in X \mid \|x'-x^i\| < (1-\phi)\|x-x^i\|\}$ where ϕ is the cost associated with any change in the status quo (with $0 < \phi < 1$). In other words, x' is preferred to x if x', controlled for costs ϕ, lies closer to x^i in the issue space than does x. Where costs are equal to zero, this preference relation collapses to simple Type One preferences where $P^i(x) = \{x' \in X \mid \|x^i-x\| < \|x^i-x'\|\}$. We assume that an individual will only vote to support a change in the status quo if the move results in a strictly preferred alternative. In other words, indifference is resolved in favor of the status quo.

For simple majority rule we define a set of winning coalitions in N as S, where $S_j \in S$ if and only if $|S_j| \geq n/2$. An alternative, x', is socially-preferred if it is preferred by all members of any $S_j \in S$ or $x' \in P_j(x)$ where $P_j(x) = \bigcap_{i \in S_j} P^i(x)$. The set of socially preferred alternatives is defined as the win set of x or $W(x) = \bigcap_{S_j \in S} P_j(x)$. In order to be able to compare the equilibrium results of cost and no-cost decision settings, we distinguish between the no cost majority rule win set, simply $W(x^o) = \bigcup \{\text{Int}\}\|x^i-x^o\|$ and the cost majority rule win set, $W^c(x^o) = \bigcup \{\text{Int}\}(1-\phi)\|x^i-x^o\|$. These win sets are conceptually identical within the conditions of the institutional setting for which they are defined. However, the cost-induced win set is smaller than the majority rule win set by an amount relative to ϕ, the level of cost.

Introducing costs also introduces the concept of a cost set. The cost

set for each individual is defined as $C^i(x)$, where $x' \in C^i(x)$ if $u^i(x') > u^i(x) > u^i(x'+c)$. In this case c represents the real valued stage costs assessed against each individual. For purposes of exposition and simplicity, we treat these costs as constant for all decision makers. Note that the set $C^i(x)$ contains all points that would be strictly preferred to the status quo in the absence of costs, but are no longer preferred as fixed costs equal to c are added. Consequently it is the case that for every $x' \in C^i(x)$, $x'\ P^i\ x$ but $x\ R^i_c\ x'$. We define the social cost set as the union of all the individual cost contours over all individuals, $C(x) = \bigcup_{i \in N} C^i(x)$. Finally, we define x as an equilibrium if $W(x) = \phi$ for the no-cost setting and $W^c(x^o) = \phi$ for the cost setting.

Stage Costs

Consider the case in which a voter faces real-valued costs in changing the status quo, $\phi \neq 0$. In this case only those moves that improve the members' utility by more than the costs of taking that move are preferred. An individual's preferred set, $P^i_c(x)$, is represented as those points contained in the indifference contour passing through the point $(1-\phi)\|x^i-x\|$ as shown for member i in Figure 1.

(Figure 1 about here)

The majority rule win set, W(x) is related to the cost-induced win set, $W^c(x)$, in the following way. Since $(1-\varepsilon)\|x^i-x\|$ is always less than $\|x^i-x\|$ for any $\phi > 0$, $P^i_c(x) \subset P^i(x)$. Thus, $W^c(x) \subseteq W(x)$ for all $x \in X$. Contrast the cost-induced Win set, $W^c(x)$ with the cost-free Win set, W(x), for the three-person, two-dimensional example in Figure 1. With no costs, W(x) consists of all points in the shaded petals about x. When costs are added into the analysis, the win set, $W^c(x)$, shrinks to incorporate a much smaller set of preferred alternatives, given by the cross-hatched area in

Figure 1. In fact, given the fixed level of costs and location of the alternative for the example, the only feasible agenda movement is toward players 2 and 3.

For games in which costs are nonzero, we can compare these cost-induced equilibrium results with the well-known pure majority rule results. First we demonstrate the following result:

Theorem One: Where $\phi \neq 0$, $x^o \in E$ if and only if $W(x^o) \subset C(x^o)$.

Proof: Let $x^o \notin E$. Then there exists an $x' \in W^c(x^o)$. By supposition $x' \in C(x^o)$ and $x' \in W(x^o)$. $x' \in C(x^o)$ implies by definition of $C(x^o)$ and $W(x^o)$ that $x' \in C^i(x^o)$ for some $i \in S_j$ for every $S_j \subset S$ where $x' \in P_j(x^o)$. But, then $x' \notin P^i{}_c(x^o)$ and $x' \notin P_{jc}(x^o)$ over all S_j implies $x' \notin \bigcap P_{jc}(x^o)$ which in turn implies $x' \notin W^c(x^o)$. Therefore $x^o \in E$.

Let $x^o \in E$. Assume $x' \in W(x^o)$ but $x' \notin C(x^o)$. Then since $x^o \in E$ $x' \notin W^c(x^o)$. By definition of $W^c(x^o)$, $x^o\ R_c\ x'$. Then either, x^o $P_c\ x'$ or $x' \in C(x^o)$ which would imply a contradiction. But, if $x^o \in P_c(x^o)$ then $x \notin W(x^o)$, also a contradiction. Thus $x^o \in E$ only if $W(x^o) \subset C(x^o)$. Q.E.D.

Whenever costs cover all majority preferred movements from a given status quo x^o, that status quo is an equilibrium. Costs, then, provide sufficient friction in the agenda process to prevent moves that otherwise would be taken. The question remains: under what conditions will stage costs cover majority preferred moves? To attack this question we outline a minimal set of cost conditions that induce an equilibrium. This allows us, for any given $x \in X$, to define the minimum cost necessary to ensure an equilibirum. We can also use these conditions to determine the full equilibrium set for various fixed costs. The point here is that for high

costs, several points will satisfy our equilibirum conditions, while for low costs no equilibrium may exist.

Taking the simple case where utility is linear and assuming circular indifference curves, we can relate the cost levels associated with equilibrium to distance in the space. The level of utility for any given i associated with the point $x \in X$ is set by the distance between x^i and x defined here as $h^i = \|x^i - x\|$. In order to establish equilibrium conditions at x, we first determine the largest part of the win set of x as measured by distance. This set is simply the largest petal of W(x) or $\max_{S_j \in S} P_j(x)$. Spatially we can identify this petal as the preferred set $P_j(x)$ of that minimum winning coalition, S_j, clustered most closely together in the space relative to x.[1]

We then find the contract locus for some $i, j \in S_j$ that bisects $P_j(x)$. The distance of that segment of the contract locus spanning $P_j(x)$ we call k(x). By definition $P_j(x)$ is the largest preferred set in W(x). Therefore, k(x) represents the maximum distance the cost contour must incorporate to assure $x \in E$. With linear preferences and equivalent costs ($c^1 = c^2 = \ldots = c^n$), to insure a cost-induced equilibrium it must be the case that the distance spanned by c^i and c^j (the cost intervals for those two members whose contract locus bisects $P_j(x)$) exceeds k(x). That is, at a minimum, if no feasible movements exist for these members, then the coalition fails. Since by definition $P_j(x)$ represents the largest set of feasible movements for any coalition, if costs cover this feasible set, then it covers all other $P_k(x)$. Since we have assumed that each c^i is equivalent and since $c^i + c^j > k(x)$ in order for the cost set to cover $P_j(x)$, a minimum cost is derived where $c = 1/2\ k(x)$. At this level of costs $W^c(x)$ is empty.

To see this consider the five-person, two-dimensional example given on Figure 2. In this case $S_j = \{1,2,3\}$ represents the coalition whose preferred set is represented as the largest petal in $W(x)$. We can then identify the two players representing the boundaries of the coalition relative to x (in this case, 1 and 3). Their contract curve $|x^1x^3|$ bisects $P_{123}(x)$ at its widest point. The intersection of the winset and the relevant contract curve we have defined as $k(x)$. In this case $|k(x)|=[\|h^1-h^3\|-\|x^1-x^3\|]$ where $k(x)$ represents the greatest distance that $C(x)$ must cover in order to assure that all elements of the majority rule win set are contained within the cost contour. Let $[C^1(x) \bigcup C^3(x)] \bigcap |x^1x^3|$ represent the cost band covered by players 1 and 3 and define this amount as c^{13}. Then $x \in E$, if $k(x) \leq c^{13}$. If costs for both 1 and 3 are equal then $c^1=c^3$ and $c^1+c^3 \geq k(x)$ implies $c' \geq 1/2\ k(x)$.

(Figure 2 about here)

The method outlined here allows us to consider the effects of costs on majority rule equilibrium in two ways. In particular, we can establish the minimum level of cost given a specific preference configuration such that a cost equilibrium exists. That minimum will be a function of the symmetry of the preferences about any x since the petals of the win set expand. As the ideal points of all members of some minimum winning coalition cluster together relative to x, $k(x)$ grows larger. Similarly, once a set cost, $C(x)$, is established we can determine the full set of all points that satisfy equilibrium conditions, $c' \geq 1/2\ k(x)$.

The value of this approach is straightforward. From any point in the space and for any preference configuration, we can determine the level of costs that are necessary to produce a stable outcome. Institutional rules that impose high minimum costs are practically guaranteed to have a set of stable alternatives. On the other hand, low minimum costs provide no guarantee that equilibrium alternatives exist. By the same token different preference configurations can be judged in light of the levels of costs

needed to induce equilibrium. Preference configurations close to but not quite symmetric (as is the case in Figure 2) will require only small costs to insure that an equilibrium exists. Less symmetric arrangements will only result in stable outcomes if high costs are imposed.

To this point we have considered the effects of decision costs on settings in which no majority rule equilibrium exists. How might such costs affect a decision setting where preferences induce a majority rule equilibrium? The example in Figure 3 satisfies the sufficient conditions for a Plott equilibrium. Under simple majority rule, a status quo located at x^5 is invulnerable to any proposed change. When these restrictive patterns of preferences exist, the decision process is marked by an agenda leading to acceptance of x^5 as the social outcome. We can use the general results outlined here to understand exactly how costs affect this existing equilibrium set.

(Figure 3 about here)

For the special case of preference-induced equilibrium settings, the cost conditions sufficient to produce equilibrium can be stated as follows:

1. If $x \in C^i(x)$ for every $i \in N$ then $x \in E$.
2. If $c^k > \|x^k-x\|$, where k is the core member, then $x \in E$.

Minimally, the equilibrium set associated with a symmetric preference configuration consists of the set $C^k(x)$ (where k is the core member). In general it is the case that where costs are present the core expands.

Because of the central location of player 5, for any status quo not at x^5 the largest petal of the win set from x is equivalent to player 5's preferred set. The core member, player 5 in this example, plays a pivotal role in movements close to the core point. We define the cost set about the core player, $C^5(x)$, in which cost is represented by c^5 -- the distance from the core member's ideal point x^5 to the boundary of the cost set. For any

$x \in C^5(x)$, the costs exceed any gain in utility that could be achieved and, thus, no move away from x is supported by the core player. In most preference configurations, an x located within any player's cost set does not imply stability. Without knowledge of all other possible winning coalitions this condition does not guarantee that majority-preferred moves will not be made. However, where the preference configuration meets equilibrium symmetry conditions, the core member's role in winning coalitions is pivotal for those moves near to his ideal point. If costs exceed the distance to the status quo there exists no direction of movement preferred by the core player. Given the symmetry of members' preferences, if the preferred-to set of the core member is empty, no movement away from x is supported by a necessary majority. Thus, x is in equilibrium.

Our results in this section demonstrate that in the presence of costs a set of equilibrium alternatives may exist. Building on this notion of existence, we have characterized the minimal level of costs necessary to induce an equilibrium. As well, for fixed costs we can easily determine whether an equilibrium exists, and if so, where it is located. We now use these results to generate a cost equilibrium for laboratory experiments designed to test that equilibrium concept.

Experimental Design

We conducted 11 experiments during the Spring, 1987. These experiments are modeled after those discussed in Fiorina and Plott (1978), Laing and Olmsted (1978), and McKelvey and Ordeshook (1984). They differ, however, in that participants did not engage in face-to-face communication. Instead, all committee interaction was over a network of micro-computers. The procedures used here are similar to those detailed in Wilson (1986a). However, several differences exist in these procedures and they warrant

elaboration.

Participants were recruited from advertisements in the Rice University student newspaper and posters placed around the campus. Only "naive" participants were allowed in the experiment — individuals who had not previously participated in decision making experiments. Participants self-selected the time at which they wished to participate, choosing from a variety of time slots. Since during the experiment player identities were randomized and kept anonymous, there is little danger that groups of players could successfully collude using pre-arranged coalition strategies.

Upon showing up for the experiment, individuals were seated at micro-computers which were physically separated from one another by partitions. They then went through a set of instructions designed to familiarize them with the experiment. At a number of points in the instructions they had to provide correct answers indicating they understood concepts before they could proceed.[2] The instructions usually lasted no more than 10 minutes. Upon completion of these instructions, individuals participated in a practice period. This period was identical to the other periods, expect that individuals were not paid for that outcome. Instead, participants were told that this period was for practice and they were urged to try all the options until they were familiar with the experiment. They were cautioned that once they completed the practice session, they would begin the experiment, and that at that point their earnings depended only on their choices.

In the experiment, participants were instructed that they were to collectively choose an alternative from a two-dimensional policy space. Alternatives were simply represented as Cartesian coordinates from orthogonal dimensions labelled X and Y. Each individual was assigned a specific point in this two-dimensional space as an ideal point and were given a preference function. In these experiments, member preferences were represented as circles, with utility linearly decreasing with distance from the member's ideal point. These Ideal points and associated utility functions are given in Table 1. The computer terminal displayed the alternative space, the member's ideal point and representative indifference curves, and the ideal points of alt other members (but not their utility functions). The current status quo, as well as all proposals currently on the floor were also represented on this alternative space. In addition, members had before them a menu from which they could select a number of actions. This screen Is displayed In figure 4.

<Table 1 about here>

<Figure 4 about here>

The choice *of* an outcome from the alternative space was controlled by strict forward moving agenda rules (see Wilson, 1986b). Participants could bring any proposal to the floor. However, no proposal was offered as an amendment to the status quo unless "seconded" by another member. This prevented a large number of "nuisance" votes from being counted and fit well with standard parliamentary procedure. A seconded amendment was then paired with the current status quo, with a majority vote for the amendment making it the status quo. Otherwise the status quo remained unchanged. From the menu, then, participants could choose to propose an alternative, second another alternative, or choose to adjourn the experiment. As with a vote to amend the status quo, a vote to adjourn required a majority. If a vote to adjourn was successful, the period was over and members were paid the value of the current status quo.

The process for proposing or seconding an alternative Is quite similar. Once one option or the other is selected, a member simply moves the cursor to a specific point on the alternative space. The input device *for* these

experiments was a "mouse," allowing for easy cursor control. To the right of the alternative space Is displayed the current location of the cursor and the valuation at that point. Thus each participant could quickly know the precise valuation for *every* alternative in the space. To make a proposal a member simply locates the cursor at some point and then clicks the mouse. This choice is then displayed and the member queried whether she wishes to send that proposal. To affirm this choice, the participant simply moves the cursor to a box indicating "OK" and clicks it. The proposal is then sent to a host machine which relays it to all other members on the network. To second another proposal a participant moves the cursor on top of the proposal to be seconded. If the proposal Is legitimate (a proposal sent by some other player), an impending vote is announced by the host machine once the participant signifies this is what she wishes to do. Finally, an adjournment motion is even simpler, since once It Is selected as an option the member needs only confirm that Is what she aimed to do and all other members are notified of an impending vote.

Proposals were sequentially ordered by the host machine and then displayed on the alternative space by that number end the letter of member who sent the proposal. The ideal points (but not the utility functions) of all members were displayed as was the current status quo. Once an amendment was made, each member was notified by the host machine. Also, the amendment itself was flashed to provide members a visual location of the amendment. With a motion to adjourn, members were simply notified that an adjournment vote was forthcoming. Voting took place following a thirty second interval designed to give participants enough time to consider the alternative space. Once a vote was called, no other motion to vote was entertained until after the vote took place. However, members could bring additional proposals to the floor during this 30 second interval. Participants voted from their terminals, checking a box for one alternative or the other. In the case of an amendment vote, members voted either for the amendment or the status quo. The coordinates of each proposal, as well as the member's valuation for each alternative, are given. In the case of an adjournment vote, members were given the option to vote to continue with the round or to quit. The value of the current status quo was prominently displayed. In either case, once a member voted, they were informed as to how they voted, and how much their vote was worth. They were then asked whether this was their intention and given an opportunity to change their mind. Once the voting was complete, everyone was informed as to the outcome. In the case of an amendment vote or an unsuccessful attempt to adjourn the round, participants continued the round. If a vote to adjourn was carried, members were Informed as to their earnings and the round was ended.

Aside from proposing alternatives and voting participants also had a number of "tools" available to them during the experiment. With a large number of alternatives on the floor, the screen could become quite cluttered. Members, had options to plot the last 10 alternatives or to plot all. As well, members could erase their representative indifference curves or replot them. Since,moving the cursor around the screen gave full information about the value of any point In the alternative space, participants had a ready store of information available.

Experiment Treatments.

Two treatments were used in these experiments. Each is identical, except for costs assessed with each agenda step. The first setting has no costs Imposed. In the second treatment members were assessed a cost of $1.50 for every successful amendment to the status quo. This treatment matches our "stage-cost" model of decision costs. All costs were cumulated over the

course of the experiment, and reflected as decreases in a member's utility function. As member's continued to accumulate costs in the experiment, these amounts were represented as a decrease in their valuation for other points in the alternative space. So, under a high cost treatment, a member's ideal point began as $16.00. After the first amendment this ideal point was worth (and displayed as) $14.50. This continued for every amendment. Values for a member that became negative (due to the transaction costs In these games) were arbitrarily set to $.00 — members could not lose money for participating in these experiments. Operationalizing these real-valued time costs as a function of the number of changes to the agenda directly stems from our model of stage costs developed above. Member's were fully informed as to all transaction costs Imposed during their experiment.

Hypotheses.

Working from our comparative static models discussed above we have strong predictions to make about our experimental results. In our experiments we use a configuration of preferences In which there is no preference-induced equilibrium. Costs are fixed and assessed against every individual. These costs are large enough to induce an equilibrium. Since the cost treatment has a clear equilibrium, while the no cost treatment lacks an equilibrium, our hypotheses are discussed in a comparative fashion. Our first, strong hypothesis, suggests."

> Strong Hypothesis: Experiments under a cost treatment will appear in the cost equilibrium (In the shaded area of Figure 5), while experiments under the no-cost treatment will not concentrate in this equilibrium set.

This hypothesis Is strong since It specifies that cost treatment outcomes will appear at the equilibrium, while no cost treatments will not. This equilibrium set for the cost treatments is based on the set of points covered by the union of cost sets for all coalitions. This set is reasonably sized and centrally located in the alternative space.[3] Since the no cost treatment experiment outcomes can theoretically wander anywhere in the alternative space, it is possible that a few outcomes might appear in the centrally located equilibrium set of the cost treatment. The point is. however, that very few of these outcomes will appear in that set.

<Figure 5 about here>

A weaker hypothesis can also be offered that points to the relative difficulty of amending the status quo when it moves Into the central pentagon of the pareto optimal set. The cost equilibrium set represents those points which are covered by the cost sets of all winning coalitions. Points which are only slightly removed from this set are almost completely dominated by the cost set. The further a point is front the equilibrium cost set, the larger the uncovered win set of that alternative. This means that It is easier to find a successful amendment to the status quo and hence It is more likely that naive participants can construct an agenda leading Into the equilibrium cost set. However, the closer the status quo is to the cost equilibrium for cost treatment experiments, the more difficult it is to find undominated alternatives. Consequently we might expect:

> Weak Hypothesis: Cost treatment outcomes will cluster around and in the cost equilibrium. In comparison with no-cost treatment outcomes, cost treatment outcomes will be more tightly clustered around the cost-equilibrium.

This hypothesis provides a weaker prediction than the first, but is nonetheless consistent with the theoretical thrust of our stage-cost equilibrium model presented above. Empirically, this weak hypothesis suggests that the variance around the equilibrium of the cost treatment outcomes will be less than the variance of the no-cost treatments outcomes around that same equilibrium set.

Results

Results from our experiments are plotted on Figure 6 and a listing of outcomes is provided in Table 2. These results are disappointing, since only three of eight cost outcomes appear in the cost equilibrium. On the other hand two of seven no-cost outcomes are in the cost equilibrium. Clearly these results do not corroborate our strong hypothesis differentiating cost and no-cost outcomes. By the same token these results fall to provide any corroborating evidence for our weak hypothesis that cost outcomes will be more tightly clustered around the cost equilibrium. Visually this appears to be the case and this is supported by a simple nonparametric test of the rank order differences of distances of each type of outcome from the central point In the cost equilibrium set (these distances are calculated from $[(x-150)^2+(y-l64)^2)^{1/2})$. The null hypothesis that the rank ordered distances of the no cost treatment are less than or equal to the ordered distances of the cost treatments cannot be rejected at the .05 level (x^2=.75, df=l, p=.39). The simple point, then, Is that these results tell us little about the effect of the costs on collective choice mechanisms.

While these non-findings are distressing, it is apparent something is happening in these experiments. The process of building an agenda is quite different between the cost and no-cost treatments. On average far fewer proposals are made in experiments with costs (13.1 versus 22.3 proposals). This means far fewer alternatives are considered, since only proposals on the floor can be put up against the status quo. In a similar vein, when faced with costs members voted only half as often (an average of 5.0 votes versus 9.9 votes for no-cost experiments). This illustrates *a* behavioral effect induced by these costs — participants act cautiously and hurriedly in the cost experiments.

Participants are cautious in that they do not vote very often, avoiding rather large costs assessed for successful amendments. In fact, In the cost experiments an average of only 1.13 amendments were successfully passed, while in the no-cost experiments the average was 3.0. The cost experiments ranged from a minimum of zero amendments passing to a maximum of two. By contrast the range for the no-cost experiments as a minimum of one and a maximum of eight amendment changes. Under each treatment, then, very different set of alternatives were explored. While cautious, members also hurried through these experiments, spending almost half as much time in the cost experiments as in the no cost experiments before adjourning (and average of 216 seconds for the former and 399 seconds for the latter).[4] Two points are notable here. First, when confronted with costs, participants very quickly exited from the experiment — spending less than four minutes in proposal making (time was halted during voting). Obviously these costs represented a significant deterrent to extended decision making. The second point is that in neither treatment did participants spend a great deal of time in the decision process — on average less than seven minutes in *the* no-cost experiments. This compares with an average amount of time spent in decision making of almost fifteen minutes in similar experiments conducted by the second author (see Wilson. 1982). In short, there is some behavioral evidence that these stage costs matter. However, these behavioral differences do not translate into differences In collective outcomes.

Alternative Explanations

It would be simple to write off these results as evidence that the equilibrium set identified here is tetentive, but not attractive. However, this would be ignoring a variety of competing explanations which *are* subject

to further test. First, the results reported in this paper are Initial results from a newly developed committee laboratory setting. While this setting is modeled on another computer-controlled laboratory setting, the differences noted here between the amount of time participants spent in these different experimental settings is worrisome. It may be that the ease with which participants propose alternatives and call votes makes these experiments *very* different from previous committee experiments. Consequently the experimental setting needs further investigation, with comparisons to results from other committee games. The newness of this experimental setting raises an interesting, plausible explanation for these puzzling results.

Rather than simply blaming the experimental mechanism, It may be that what is driving these results is some combination of rather hefty decision costs and member's expectations about their outcome for the experiment. For many members It may be that the risk of Incurring additional costs for amending is sufficiently high that it is best to adjourn quickly. While members have full information as to the location of other member's ideal points, they are not *very* adept at predicting the votes of others. This uncertainty as to the outcome of an amendment vote, especially where even those voting against the amendment share In the decision costs of a successful amendment, may be enough to drive members out of the game before the agenda stumbles into the equilibrium set. If this is the case, then these decision makers have to be cast as quite risk averse, exiting the game well before they should In anticipation of *very* low payoffs.

A third possible alternative explanation Is that there are period effects in these experiments. Members participated In three periods In these experiments — the first for practice, while the remaining two periods constituted different treatments. Participants never repeated a treatment.

The problem here is that payments were accumulated across periods and paid at the conclusion of the experiment. It may be that participants sought to "average" their earnings across these periods by choosing a "satisficing" rather than maximizing strategy. In fact the average earnings in these experiments were relatively high (|7.85) given that the total amount of time spent In the Instructions and experiment was around 45 minutes. In the face of risk and high costs. It is possible that participant are driven to quickly adjourn their decision making.

New Directions for Research

Obviously these alternative explanations are highly speculative. However, they cannot be Ignored. Moreover, each points to new directions for research. Rather than quickly abandoning a plausible theoretical model that might have some explanatory power in the empirical world, we will heed our usual call for further experimental research. At least four types of experiments are called for in order to explore these rival explanations. First, we will want to explore Issues connected with the problem of participants choosing "satisficing" strategies. In one sense this may be done by starting participants with a bankroll and removing the floor in these cost experiments (i.e.. allowing preferences to go negative). One problem, perhaps endemic to many Incentive compatible experiments. Is that participants begin an experiment with no money. Whatever they earn Is more than they had before they began the experiment. Staking participants to money before they begin gives them a stake in the game — not only can they gain, but they can lose money. Although settings where members are given a bankroll and when they are not are theoretically Identical. observationally we may find something akin to a "preference-reversal" phenomenon where satisficing becomes a reasonable strategy in one setting

and not In another.

A second experimental thrust will be to move toward single period games. This approach too will aim at the problem of satisficing or some related problem associated with multiple period games. Already we have some weak evidence that this may be Important for differentiating outcomes in preference-induced equilibrium games.

A third approach Involves adding a smaller cost treatment, here we will halve the stage costs — assessing members $.75 for each successful amendment. At this cost an equilibrium set exists, though It Is substantially smaller. This will serve two purposes. First, it will enable us to more easily differentiate cost and no-cost outcomes. If the former converge on the equilibrium, while the latter remain scattered as they were In these experiments. Second, these costs may be less formidable *for* participants, with the consequence that they remain In the experiment longer and explore a larger number of alternatives. In any case, these lower decision costs can be directly compared with the higher cost treatment.

Our final research strategy will be to Incorporate these decision costs into settings with a preference-induced equilibrium. This will allow us to investigate to what extent the new experimental apparatus used here replicates other committee-like results and whether decision costs perturb outcomes from that equilibrium.

In summary, the results reported here are less perplexing than incomplete. A variety of rival explanations for these outcomes Must be explored before questioning the Intuitive appeal of our theoretical results. As with an new measurement tool, this experimental apparatus oust still be fine tuned before Its results can be used.

Conclusion

In this paper we formulate a cost-induced equilibrium concept. This equilibrium Is generated from transaction costs connected with a sequential agenda process. Our claim is that most collective choice Institutions carry with them decision costs. If these transaction costs are very large, they are sufficient to produce stable collective choices. One of our findings Illustrates that the size of these costs can be rather minimal and still produce a set of equilibrium outcomes. From a theoretical standpoint this leads us to conclude that cost-induced equilibrium are common in the empirical world.

We attempt to provide an empirical test of a cost-induced equilibrium using a laboratory experimental setting. Our results are disappointing. however, the experiments reported here are derived from pre-tests of a micro-computer network. At this point It is unclear whether the experimental design is producing independent effects or whether our results are valid. Given the variety of behavioral differences we observe, we doubt that the latter is the case. We suggest a number of additional experiments to more fully explore these results. In the meantime we are left with our puzzling empirical results and a call for further experimental research.

Endnotea

1. Such a method can be found in Sloss's (1973) work on decision costs. She identifies the level of costs relative to the set of spherical cones spanning any S_i. Smallest costs are Identified relative to that coalition whose preferred to set is spanned by the smallest spherical cone (i.e.—that coalition with the smallest angle). If cost is sufficient to cover preferred movements into this coalition's cone, by definition it will satisfy conditions for other more dispersed coalitions.

2. A copy of the Instructions is available upon request from the second author.

3. Obviously the cost-Induced equilibrium set Is sensitive to the structure of each individual's utility function and the location of members' Ideal points. Given the ideal points and linear preferences used In this experiment, the equilibrium set includes the points in the shaded area In Figure 5. As ft turns out, the cost equilibrium set for this experiment disappears when amendment costs drop below $.60.

4. All of the differences highlighted above are statistically significant below the .05 level using a Kruskal-Wa11is nonparametric rank order test. The only exception is the test for difference in the amount of time spent In the experiment. Here the statistical parameters are x^2=3.43 and p=.064.

Bibliography

Buchanan, James and Gordon Tullock (1962) The Calculus of Consent Arm Arbor: University of Michigan Press.

Cohen, Linda (1979) "Cyclic Sets In Multidimensional Voting Models" Journal of Economic Theory V. 20 (February), 1-12.

Denzau, Arthur, Robert Mackay and Carolyn Weaver (1982) "Agenda Cost, Institutional Inertia, and the Possibility of Majority Rule Equilibrium" A paper presented at the Annual Meeting of the public Choice Society, March 5-7, San Antonio, Texas.

Fiorina, Morris and Charles Plott (1978) "Committee Decision Under Majority Rules An Experimental Study." American Political Science Review. 72(2 (June), 575-598.

Hoffman, Elizabeth and Edward Packel (1982) "A Stochastic Model of Committee Voting With Exogenous Costs: Theory and Experiments" Behavioral Science V. 27: 1 (January), 43-56.

Laing, James D. and Scott Olmsted (1978) "An Experimental and Game Theoretic Study of Committees" In Peter C. Ordeshook (ed). Game Theory and Political Science. New York: New York University Press.

McKelvey, Richard (1976) "Intransitivities in Multidimensional Voting Models and Some Implications for Agenda Control" Journal of Economic Theory V. 12 (June), 472-484.

McKelvey, Richard (1979) "General Conditions for Global Instransitivities In Formal Voting Models" Econometrica V. 47, 1085-1111.

McKelvey, Richard (1986) "Covering, Dominance, and Institution Free Properties of Social Choice" American Journal of Political Science V. 30 (May), 283-314.

McKelvey, Richard and Peter Ordeshook (1984) "An Experimental Study of the Effect of Procedural Rules on Committee Behavior" Journal of Politics V. 46 (February), 182-205.

McKelvey, Richard, Peter Ordeshook, and Mark Winer (1978) "The Competitive Solution for n-person Games Without Transferable Utility, with an Application to Committee Games" African Political Science Review V. 72s 3 (September), 599-615.

Miller, Nicholas R. (1977) "Graph-Theoretical Approaches to the Theory of Voting" *American* Journal of Political Science 21:4 (November), 769-603.

Miller, Nicholas R. (1980) "A New Solution Set for Tournaments and Majority Voting: Further Graph-Theoretical Approaches to the Theory of Voting." American Journal of Political Science 24:1 (February), 68-96.

Plott, Charles (1967) "A Notion of Equilibrium and Its Possibility Under Majority Rule" American Economic Review. V. 57 (September), 787-806.

Plott, Charles and Michael Levine (1978) "A Model of Agenda Influence on Committee Decisions" American Economic Review. V. 68 (March), 146-160.

Schofleld, Norman (1978) "Instability of Simple Dynamic Games" Review of Economic Studies. V. 45:3 (October), 575-594.

Shepsle, Kenneth A. (1979) "Institutional Arrangements and Equilibrium In Multidimensional Voting Models" American Journal of Political Science 23:1 (February), 27-59.

Shepsle, Kenneth A. and Barry Welngast (1984) "Political Solutions to Market Problems" American Political Science Review V. 78 (June), 417-434.

Shepsle, Kenneth A. and Barry Welngast (1984) "Uncovered Sets and Sophisticated Voting with Implications for Agenda Institutions" American Journal of Political Science 28:1 (February), 49-75.

Sloss, Judith (1973) "Stable Outcome In Majority Rule Voting Games." Public Choice V. 15, pp. 19-48.

Wilson, Rick K. (1982) "Institutional Effects on Committee Behaviors A Game Theory Experiment" Unpublished PhD. Dissertation, Indiana University.

Wilson, Rick K. (1986a) "Results on the Condorcet Winners A Committee Experiment on Time Constraints" Simulation and *Games 17:* 217-243.

Wilson, Rick K. (1986b) "Forward and Backward Voting Agenda Procedures. Committee Experiments on Structurally-Induced Equilibrium" Journal of Politics V. 48 (May), 390-409.

Table 1

Member Ideal Points and Utility Functions for Experiments

Member	Ideal Point (X^i)	No-Cost Maximum (M)	Cost Maximum (M)
1	(22,214)	$13.00	$16.00
2	(171,190)	$13.00	$16.00
3	(279,180)	$13.00	$16.00
4	(225, 43)	$13.00	$16.00
5	(43, 75)	$13.00	$16.00

The initial status quo in all experiments was (280,280).

A member's utility at any point X is given by:

$$U_i(X) = \$.07 * (M - (\|X^i - X\|))$$

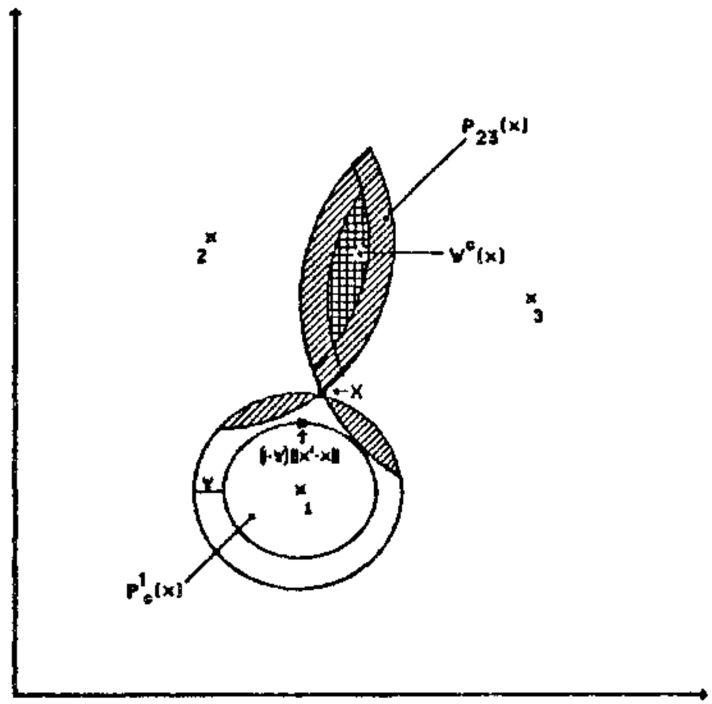
Table 2

Experiment Outcomes by Treatment

Experiment	Period	Outcome	Treatment
MB02	2	(139,182)	COST
MB03	3	(76,188)	COST
MB06	3	(158,172)	COST
MB07	2	(186,140)	COST
MB08	3	(280,280)	COST
MB09	2	(182,136)	COST
MB10	2	(144,179)	COST
MB11	2	(155,109)	COST
MB01	2	(164,223)	NO COST
MB02	3	(137,128)	NO COST
MB04	2	(197,165)	NO COST
MB05	3	(191,169)	NO COST
MB07	3	(134,188)	NO COST
MB09	3	(112,142)	NO COST
MB11	3	(130,125)	NO COST

Figure 1

Example of $W(x)$ and $W^c(x)$ in Two Dimensions



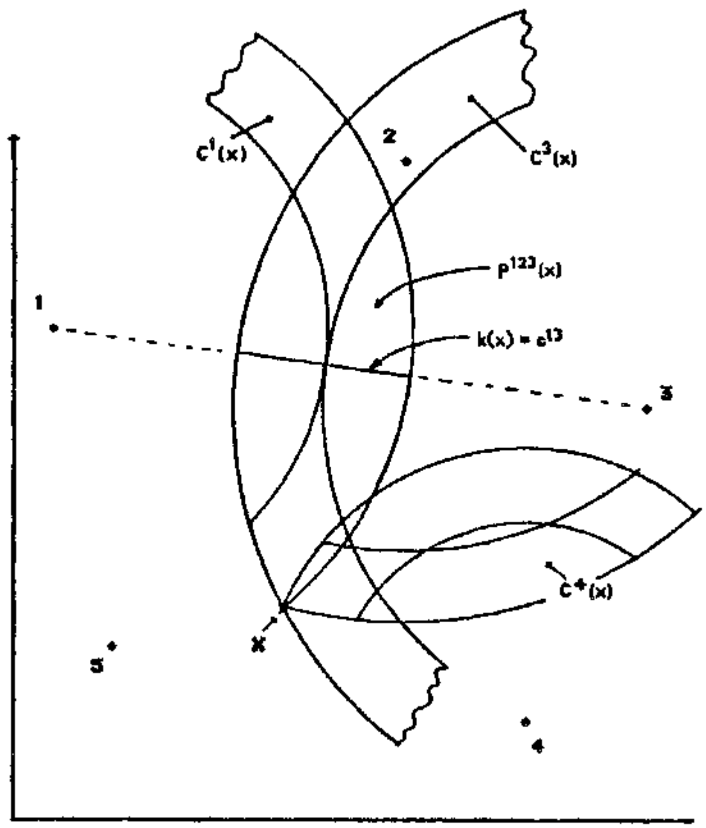
x = Member Ideal Points

▨ = Elements of $W(x)$

▦ = Elements of $W^c(x)$

Figure 2

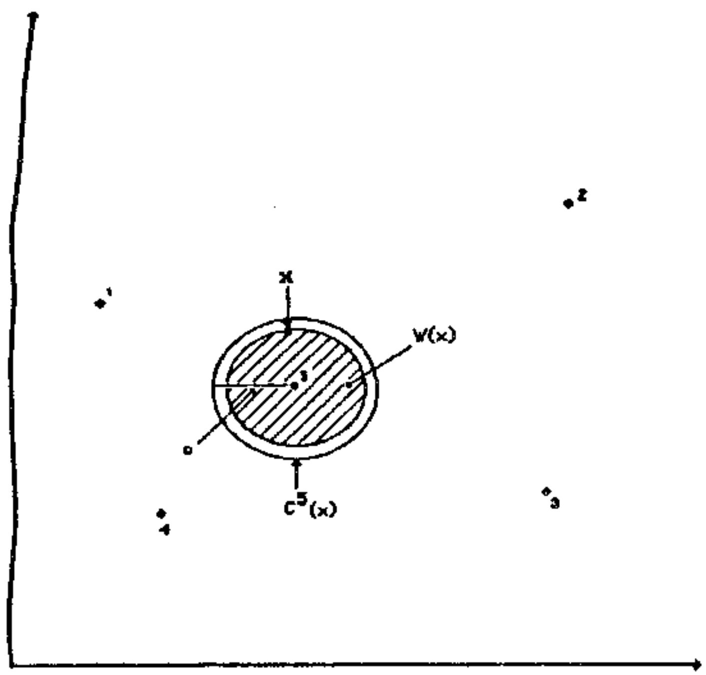
Five Person Example Illustrating Minimum Cost Condition



• = Member Ideal Points

Figure 3

Preference-Induced Equilibrium and Cost Set



◆ = Member Ideal Points

▨ = Majority Preferred Set (without costs)

Figure 4

Sample Main Screen for Experiment

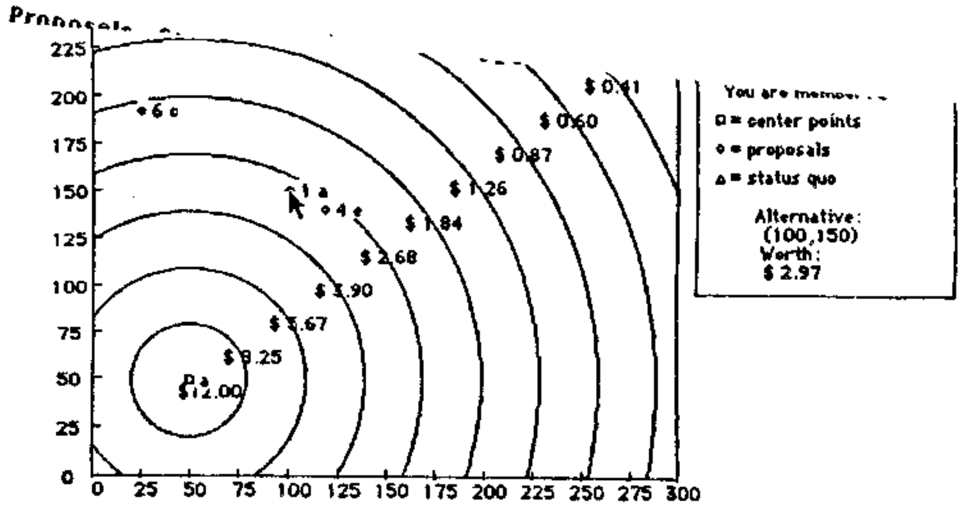
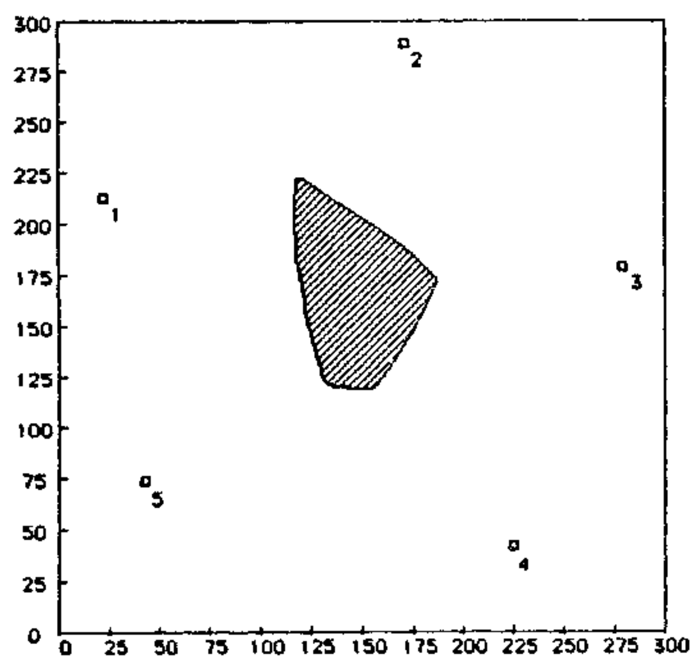


Figure 5

Equilibrium Set for Experiment with Stage Costs of $1.50

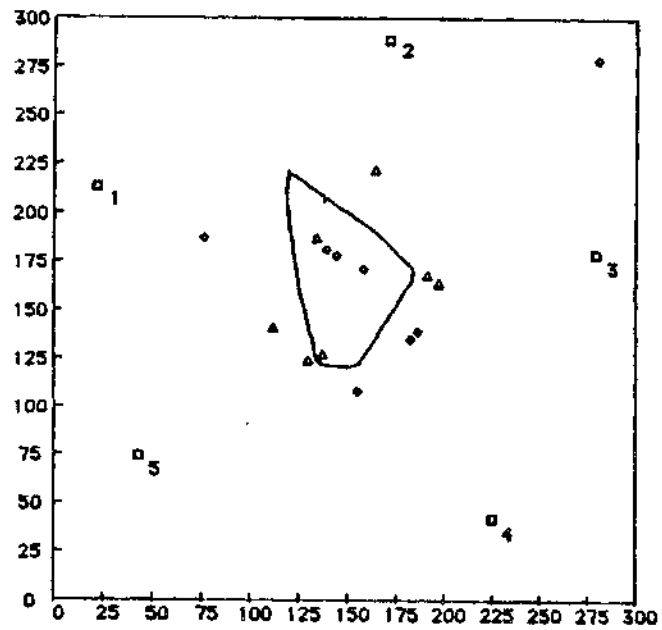


□ = Ideal points of players

▨ = Equilibrium set

Figure 6

Outcomes Under Cost and No Cost Experiment Treatments



□ = Member's Ideal Points

◆ = Cost Treatment Outcomes

△ = No Cost Treatment Outcomes