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Information Transfer and Aggregation in an Uninformed Committee: A Model for the Selection and Use of Biased Expert Advice

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SOCIAL SCIENCE WORKING PAPER 1394

(Revised January, 2015)

Information transfer and aggregation in an uninformed committee: A model for the selection and use of biased expert advice

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Abstract:
A committee of five uses majority rule for decisions on two public goods. Individual committee member preferences depend on a state of nature that is unknown to the committee members but the state of nature is known to two experts who have preferences about committee decisions. Experts have no vote on the committee but provide a recommendation to the committee at the opening of a meeting. Two experts are selected who have known, opposing biases -a dyadic mechanism. The results reveal that experts do not tell the truth but committee decisions are as if committee members know what the experts know. The information transfer occurs because committee members anticipate the biases and properly infer the information held by the experts.

JEL classification: C90; D71; D81
Keywords: cheap talk, committee experts, expert biases, experiments, majority rule, information aggregation, experimental economics, experimental political science

1. Introduction

The paper reports exploratory experiments focused on information aggregation within a committee organizational and experimental environment in which information aggregation is important and cheap talk is possible. The environment consists of conflicts that are prominent features of many models of political decisions. Committee organization and decision procedures are designed and tested as mechanisms to facilitate informed collective decisions. The experiments are exploratory in the sense of a merger of variables typically thought to be governed by two different sets of principles and the absence of an overriding theory to integrate the two. On the one hand, models of committee decisions typically rest on voting theory and cooperative game theory and do not extend themselves to cover strategic revelation of information. On the other hand, models of strategic revelation of information rest on non-cooperative game theory, which cannot explain the dynamic process of committee equilibration characteristic of majority rule voting groups. In the absence of an overriding model that integrates the two bodies of theory, the exploratory approach is attractive.

An organization is created in which a specific form of competition between experts with conflicting preferences is imposed for the purpose of information aggregation. The experiments ask if the organization successfully facilitates information transfer within a challenging

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environment. The environment is more complex than those where non-cooperative game theories of cheap talk can be successfully applied. Truth telling is not incentive compatible. The nature of the conflict is also more complex than typically studied in committee processes. The configuration of preferences is such that under full information majority rule equilibrium exists but committee members are not fully informed. Uncertainty about the consequences of options exists and the only sources of information are people with biases. Thus, there is no common source of information to guide a proposal and voting process. The questions posed by the experiments are the degree to which information transfer and aggregation might occur within the organization and if they are observed what might be the underlying principles at work that create them. The answers are: (i) the information transfer takes place with remarkable accuracy; and (ii) much of the behavior of experts and committee members is anticipated by the underlying models, but behavior suggests that a more complex equilibrium concept than simple Nash is required to capture the interaction between the experts and the committee.

The problem is centered on a committee or group that must make a collective decision in a classical Public Choice environment. The group must choose the levels of two public goods and the group is in conflict about the options. Individual preferences depend on a state of nature that if known, would influence the preferences of all participants but would not remove the conflict. The state of nature is known to a set of "experts" whose advice can be acquired by the committee.[2] Advice of experts is in the form of recommendations of actions to be taken by the committee as opposed to a report that identifies the state of nature or facts that can be verified. Thus, the environment is complicated by the fact that the description and identification of the state is not part of an expert assessment available to the committee, reflecting the possibility that the language to describe the state as viewed by experts need not be the same (described parametrically) as the language used by decision makers. Furthermore, the experts do not know the preferences of the decision makers except possibly as assessed thru repeated interactions, motions and votes. This fact is an important difference with models of information revelation where the expert strategically positions well-crafted messages concerning the state of nature in the light of known receiver preferences in order to induce the response preferred by the expert.

[2] Thus, the environment consists of multiple senders and multiple receivers whose vote determines the public good levels. The environment and challenges are different from those studied in a broad and important survey by Dewantripont and Tirole (1999) who study the search incentives of experts in the light of preferences of a single decision maker and the technologies available for verification of facts reported by experts. Some important differences and similarities with the literature on "cheap talk" are worth noting. Information transfer and the possibility of a fully revealing (Nash) equilibrium in the case of multiple senders of state information and a single receiver has been explored by Battaglini (2002) and the case of one sender and multiple receivers is studied by Battaglini and Makarov (forthcoming) and by Vespa and Wilson (2014). In such games, each agent has an independent influence on the outcome while in the majority rule environment studied here; a single vote has an influence only in the case of a majority of one. Other important structural differences exist between the experiment reported here and the previous works. The setting of Battaglini and Makorov (forthcoming) contains only two states of the world and two receivers each of whom takes a separate action. The message sent about the state could be public or private. By contrast, in the committee setting a large number of states exist, the receivers (the committee members) take only one action and all messages are public and are in the form of a recommended action as opposed to an identification of the state. Chakraborty and Harbaugh (2010) and Chung and Harbaugh (2014) explore the beliefs of a single decision maker as possibly influenced by a biased, multi-dimensional recommendation and in that context explore the role of transparency of biases following the questions posed by Dickhaut, McCabe and Mukherji (1995).

In summary, the recommendations are points in a two dimensional space as opposed to sets of points or natural language. The purpose is to make sure that the content of recommendation messages is common knowledge even though the information carried by the recommendations differs from voter to voter. In more complex messages spaces such as ordinary language, the assumption of common knowledge about the message content cannot be maintained.

The experts have their own preferences over the alternatives and thus, have incentives to influence the group. The lack of private goods prevents payment of experts based on information that might become available after the decision is made, so there is no way of structuring the institutional incentives of the experts to provide unbiased advice. At base, it is a problem of moral hazard exacerbated by the lack of commitment typical of cheap talk.

The focus of this paper is on one specific type of mechanism as a step toward the challenge to design mechanisms that facilitate the successful transfer and aggregation of information held by experts to groups who must make a decision. In a world of specialized information relevant for decisions of public goods, the problem is a familiar one. Possible examples include policy determining committees that depend on expert testimony for information. In a sense, it is similar to the problem of designing legal processes that facilitate the accurate transfer and aggregation of information to a jury when the information is held and perhaps only partially exposed by those who have a self-interest in influencing the decision. Furthermore, the "truth" may never be known.

The example mechanism studied here is “dyadic” in the sense that two experts are selected from those possible and will be called upon to offer proposed decisions and give advice to a committee. A group decision process for expert selection is not considered here, even though it is of considerable interest. Instead, the expert selection is imposed for testing purposes. The selection is guided by four conditions: (i) the experts know the state with certainty; (ii) the experts have known biases in the sense that for a given state the divergence of expert preferences from the preferences of the decision makers is transparent; (iii) with respect to their interest in committee decisions, the experts are in conflict- playing a game with its own properly configured Nash equilibrium; and (iv) the preferences of individual committee members are not known to the experts.

Thus, the dyadic mechanism depends on the selection of experts that have known biases relative to other preferences and have directly conflicting preferences. The competition between experts is designed to prevent them from colluding. The experimental issue is to determine if such a mechanism will facilitate a decision such that the uninformed voters choose as if they possessed the information about the state that is known only to the experts. The overall structure of the process has similarities with jury processes in which the experts with information about the state of nature, the defense and the prosecution, are involved in a zero sum game. However, the underlying preferences, conflicts, and models differ from those of jury decision problems[3] and are more closely related to the pioneering work of Battaglini (2002) who develops conditions under which a single decision maker will receive truthful recommendations from two decision makers.[4]

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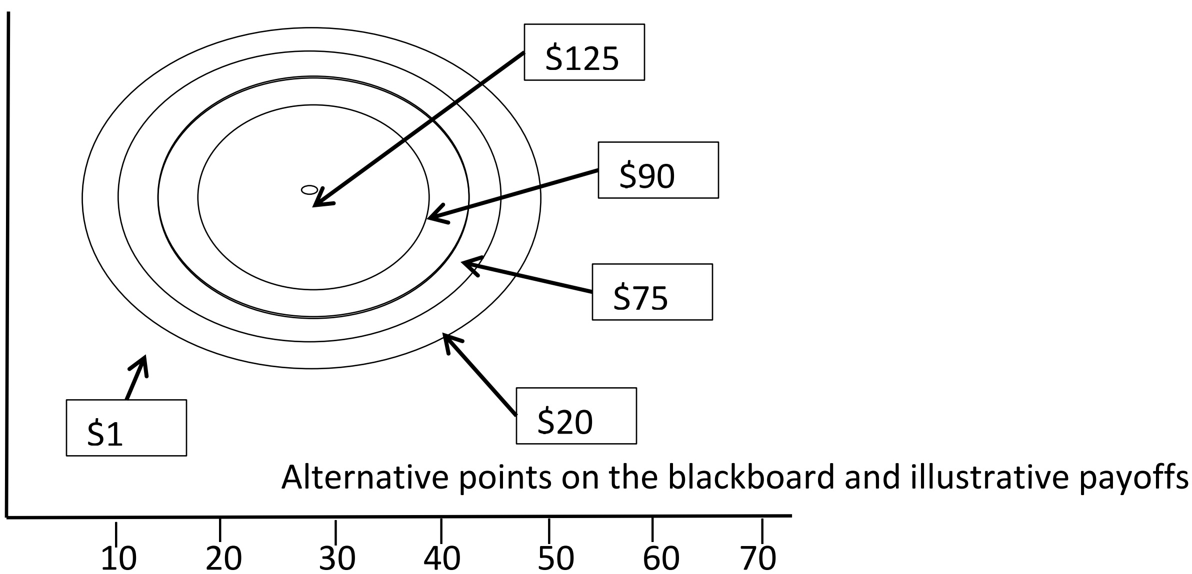
[3] See Palfrey (forthcoming) for an excellent review of experiments motivated by the Condorcet jury model.
[4] The preference and information structure developed by Battaglini is similar to the environment studied here. Following their own self-interest, the informed agents in Battaglini position their recommendations to a single

2. The Testing Environment

The experiments reflect two questions that are typically posed for testbed experiments used for studying mechanism designs[5]. Will the mechanism work under parameters where it is supposed to work? If it works, does it do so for understandable reasons? The first question asks for a proof of principle. The second question asks if the behavior is consistent with the theory that led to the design as opposed to some random event. Such design consistency is important for scalability.

The experimental environment includes parametric features that challenge the design while exposing the reliability of the behavioral principles studied by the design. The environment is not an attempt to capture the elements of any particular decision process found naturally occurring. While the experimental environment is a simple environment, it is nevertheless real, with real people facing real incentives and using a real and well-defined process. The simplicity should not be confused with any lack of reality. If the mechanism does not work in the simple environment or if the principles are not reliable, then there is little reason to suspect it would work in a more complex environment. If it does work in the simple environment, then experiments testing the reliability and robustness of the principles in more complex cases can be explored.

Preferences are induced using classical experimental public choice techniques for public goods. The space of alternatives is the two dimensional Euclidian plane with variables $x = (x_1, x_2)$, $x_1 \in [0,200]$, $x_2 \in [0, 150]$ that will be interpreted as the quantities of two public goods. Preferences are induced using U.S. currency. Figure 1 is a hypothetical example in which the indifference curves are circles representing the values in terms of the Euclidian distance from an optimal point as will be the case in the experiment.



decision maker so full revelation of the state occurs. In the environment studied here, full revelation of the state occurs but it is based on a different principle, It depends on known biases of the experts and it requires that more than one decision maker be informed.

[5] Plott, Charles R. (1994).

Figure 1: Committees Options and Induced Preferences

Seven agents indexed {1,2,3,4,5,A,B} will participate in a committee process in which one option will be chosen by majority rule. All participants will be paid the value of the incentive function evaluated at that alternative. Incentive functions are of the form $U^i(x, s)$ where $x = (x_1,x_2)$ and $s = (s_1, s_2)$, which is interpreted as a state of nature that take values $s_1 \in [0,50]$ and $s_2 \in [0,50]$ and is drawn from a uniform distribution.

The preferences reflect a property of geometrical symmetry. The change of state simply shifts the most preferred option of a decision maker. From a theoretical point of view, it is similar to the transformation of the origin of the commodity space used by Battaglini (2002). The point of maximum utility is moved but the shape of the indifference curves remains the same. Furthermore, all preferences are shifted in the same way. If the maximum of one person is shifted up and to the right, then the maximum of other preferences are shifted in the same way.

The first five agents are voters and agents A and B are "experts" in a sense to be described below. Induced preferences are all of the form $U^i(x,m^i(s)) = (x - m^i(s))\, I\, (x - m^i(s))'$ where $m^i(s)$ is voter i's most preferred alternative given the state s and I is the identity matrix. So utility functions reflect a Euclidian distance to an individual maximum and indifference curves are circular.

The state of nature operates to shift the preference of participants. For voting member in the experiment the shift is of the following forms.

$m^1(s) = (35,27) + (s_1,s_2)$
$m^2(s) = (30,47) + (s_1,s_2)$
$m^3(s) = (44,43) + (s_1,s_2)$
$m^4(s) = (67,84) + (s_1,s_2)$
$m^5(s) = (93,29) + (s_1,s_2)$

The state of nature influences the preferences of experts in the same way as it influences the preferences of the voters. As will be explained below, the maximum of each is 5 units removed from core in each dimension and in opposite directions.

$m^A(s) = (39,48) + (s_1,s_2)$
$m^B(s) = (49,38) + (s_1,s_2)$

Individual i knows $m^i(s)$ but does not know s until after all decisions are made. An individual voter knows nothing about the preferences of other voters. However, each voter i knows something about the underlying preferences of the experts. Specifically, the voters know the fundamental biases of each expert relative to his own preference. That is, voter i knows the vector of $bias(A,i) = m^A(s) - m^i(s)$ and also knows $bias(B,i) = m^B(s) - m^i(s)$. That is, while the voter does not know the vector s, the voter can make deductions about his/her optimum from information about the optimum of advisors A and B by just subtracting the bias. That is, for this environment, the key information elements for voter i are $\{m^i(s), m^A(s), m^B(s)\}$ and the observed choices of A and B. The experts are uninformed about all preferences except their own.

Preferences are configured around a "base" configuration in which s = (0,0). For the s = (0,0) case, the preference configuration is contained in Figure 2. The maximums for all agents are shown. The lines connecting the maximums represent the "contract curves" between pairs of agents. The set of Pareto Optimal alternatives are in the convex hull of the maximums. The majority rule equilibrium[6] (the core of a game in effectiveness form) is the maximum of voter 3. With five members, voting the maximum of voter 3 would win at least three of the five votes when placed against any other alternative. As can be seen, the equilibrium is in the intersection of the "cross" of the contract curves. The location of the optimal for expert A is always to the northwest of the optimal for committee member 3 and the location of the optimal for expert B is always to the southwest of committee member 3.

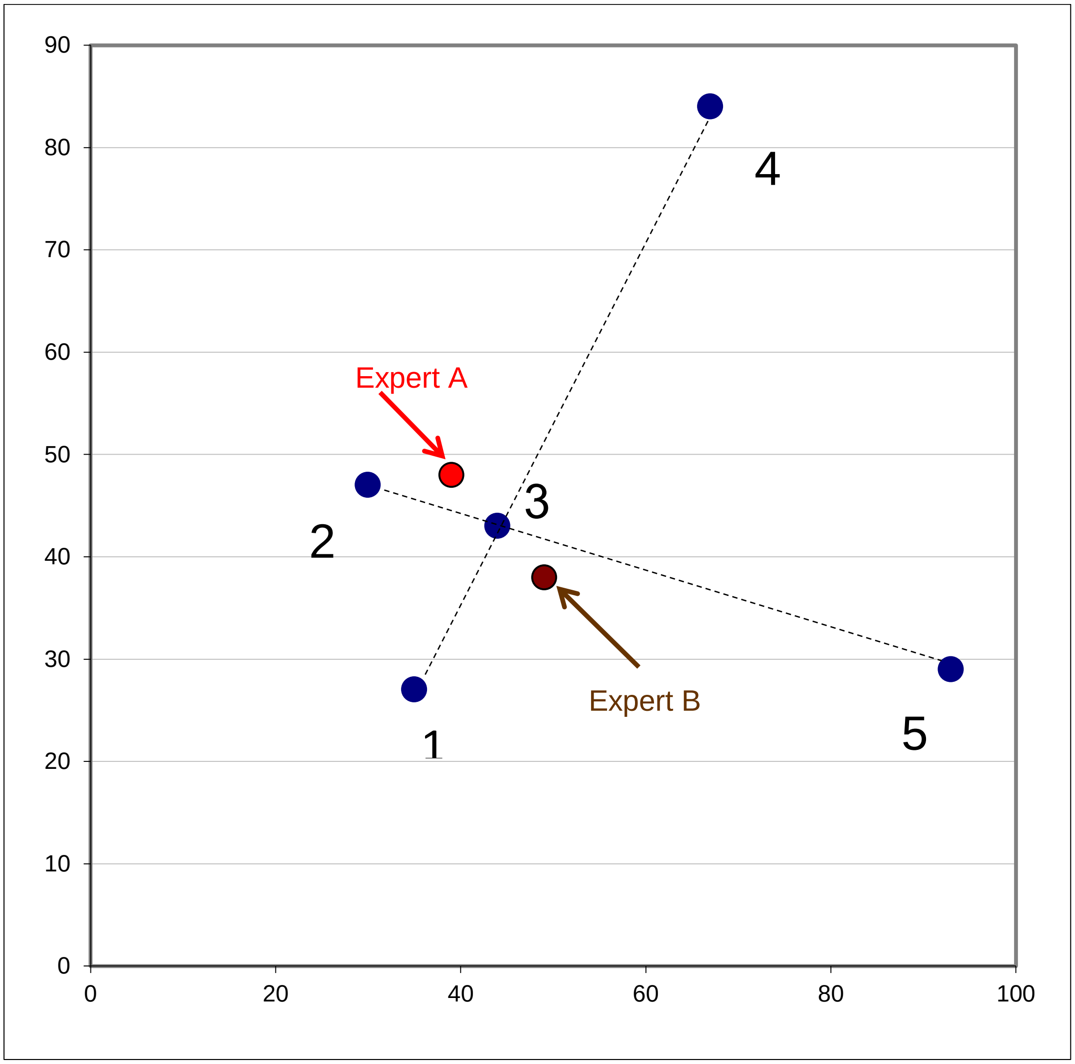


Figure 2: Base Parameters (signal is 0,0)

[6] Plott, Charles R. (1967).

The state s = (s_1, s_2) is drawn independently and uniformly from $[0,50]^2$. Figure 3 displays the location of preferences if s = (0,0), the base preferences. Notice that this particular configuration with the cross connecting voter maximums remains as s takes different values. As illustrated in Figure 3, a change in s simply changes the location of the cross. Figure 4 illustrates the locations of the preference maximums as s ranges over all of its possible values. Notice that the structure of parameters allows a committee member to put bounds on the possible locations of expert preferences as dictated by the domain of s. Both Figure 3 and Figure 4 provide a view of the location of preferences relative to each other and in relation to the entire range of the space of possibilities.

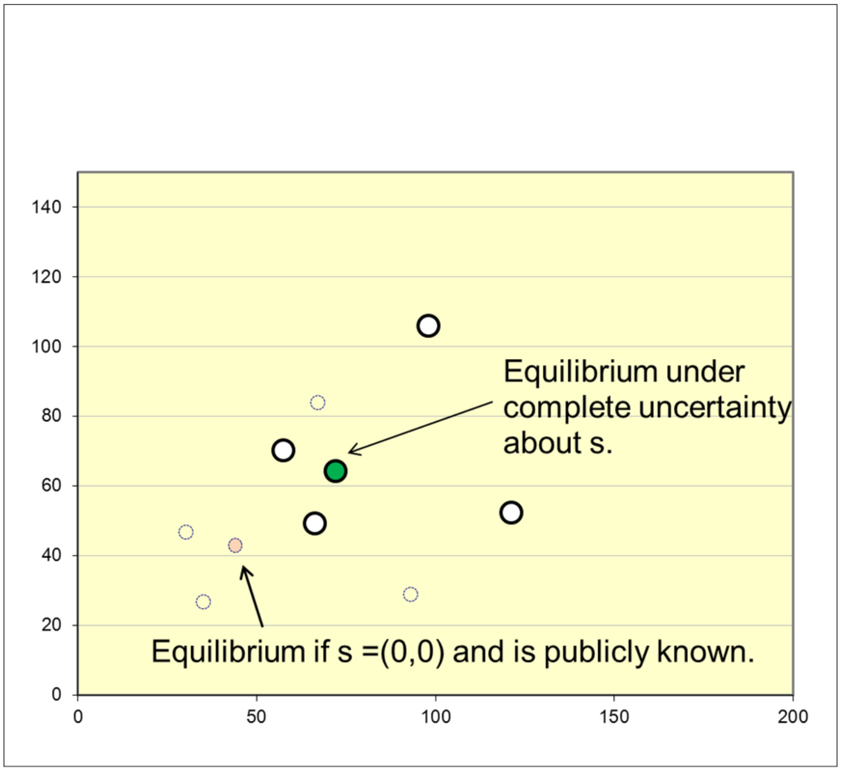


Figure 3: Expected value of optimums compared to base value options when s=(0,0)

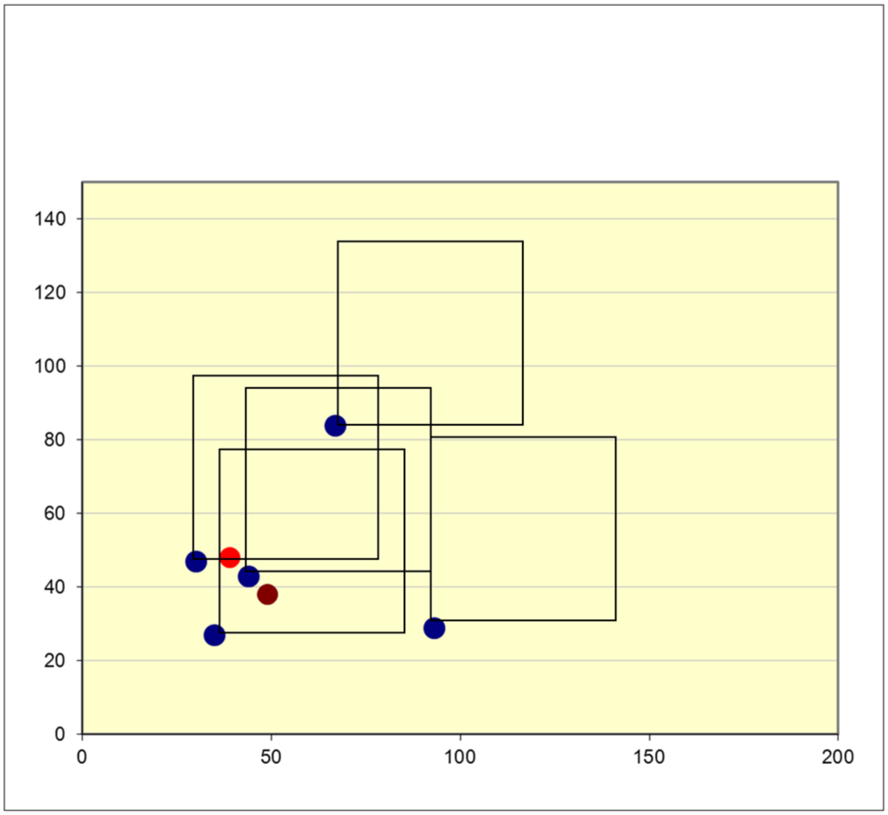


Figure 4: Base Parameters: individual optimum given state is base plus state which is taken from the rectangle [0,50],[0,50]

Fiorina and Plott (1978) discovered that the equilibrium point tends to be the outcome of spatially configured, majority rule committee processes that follow versions of Roberts Rules of Order. The Fiorina and Plott configuration is used because the equilibrium is a reliable model of a majority rule committee process under the conditions imposed here. That is, when the committee members operate with well-defined preferences (with certainty or uncertainty) the points near the majority rule equilibrium tend to emerge as the committee choice. This fact is a key feature for measuring the degree to which information is transferred and aggregated from the experts to the voting members of the committee. If the information is aggregated and transferred, then the information about the state held by the experts will also be held by the voters. If the voters know the state with certainty, the group choice will be the equilibrium that would exist if there was no uncertainty.

If s is completely unknown, then the expected maxim for each voter is the center of the respected support for probabilities of s. The equilibrium is shown on Figure 4 as at the intersection of the implied “cross”, which is the expected maximum for voter 3. That point is the equilibrium if individuals always choose among alternatives according to the expected utility given s is drawn from $[0,50]^2$ and if individuals have no additional information.

3. Why Should a Dyadic Mechanism Work?

The mechanism is dyadic, consisting of two experts (in the sense of knowing the state with certainty) who are known to have opposing preferences, known biases, and communicate with the committee through a formal process. Specifically, the two experts are chosen because their preferences are diametrically opposed relative to the equilibrium given any state of the world. The committee equilibrium given the state is on the “contract curve” or “Pareto Optimal alternatives” for the pair. From the majority rule equilibrium, given any state of the world, Expert A prefers to go "up" from the equilibrium and to the left, while B’s optimal is down and to the right. Biases are known relative to each individual voter’s preference in the sense that a voter can infer their own preferences and thus infer the state, if the optimum of either expert is known. Of course, it is this bias relative to the preferences of voting members that is the key to the selection of experts but unknown is how the expert recommendations will respond to the competition and what committee members might infer from the expert advice. The committee members know expert preferences but do not know what the expert knows and for that must rely on testimony.

The process of using decisions and known preferences as tools for “inverting decisions” and inferring- information known to an insider has a long history of use in market experiments with asymmetric information. It is a fundamental feature of rational expectations models and explains much market behavior (Plott and Sunder, 1982, 1988; Plott, 2000, Barner, Feri, and Plott, 2005). It is clearly evident in the information efficiency property of cascades where the existing high levels of information efficiency can be improved by voting institutions (Hung and Plott, 2001). The principle has been used in political science and voting experiments by McKelvey and Ordeshook (1984, 1985a, 1985b, 1990), Lupia (1994) and Dasgupta (2002). More recently, the property is used in parimutuel information aggregation mechanisms for the collection of information held in the form of intuitions among a dispersed population (Gillen, et.al. 2012).

Figure 5 illustrates the geometry through which the inference works. If proposals by the experts accurately suggest the location of the expert’s maximum then any voter can deduce the state. The expert knows the state and has an interest in persuading the committee to choose that state. The issue is whether or not the proposals and discussion reveal what the expert knows. In this context, the expert cannot tell what he or she knows. They can only make recommendations concerning what the committee decision might be.

The choice of experts from the many possible experts that could have been imposed in the experimental environments reflects two features. First, the experts must be in conflict relative to the (generalized) median committee member regardless of the state. Secondly, the individual committee members must be able to infer their own preferences for public good levels from the estimated preferences of the experts. That means what the underlying “triangularization” or “identification” dictated by the distances and angles must be possible. Of course, how committee members might estimate the preferences of the experts from what they recommend, or if it can be done at all are different matters. Of course, in the experimental environment there is a large set of possible experts that might not be available in naturally occurring situations.

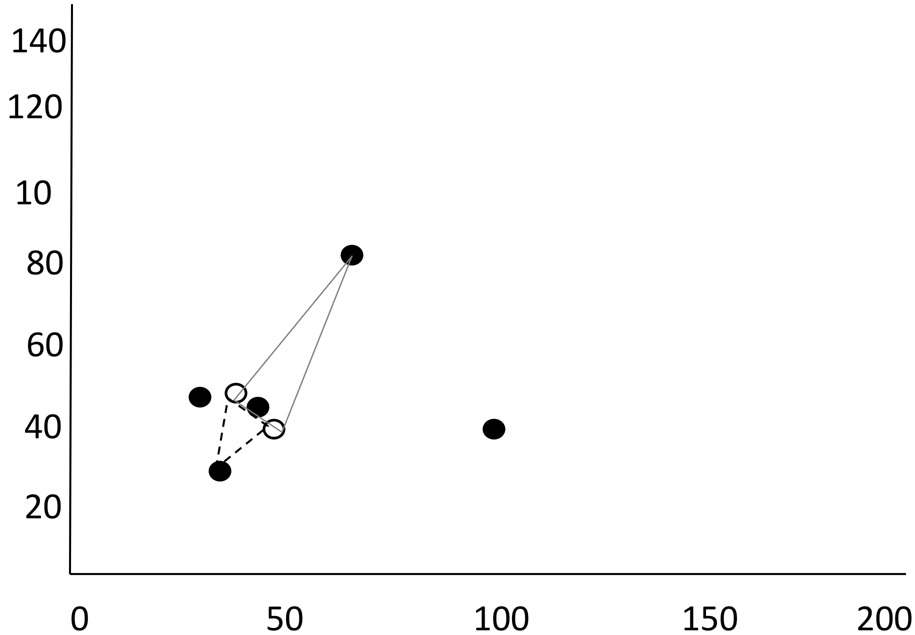


Figure 5: Voting members know the biases of experts relative to the state of nature and relative to own preferences

4. Procedures

The experts remain the same throughout an experiment consisting of several decisions. Experts do not know the preferences of voters or each other. Each expert (privately) prepares a recommended alternative to the voters based on own preferences and information about the state and whatever information held about preferences of voters and the other expert that has been accumulated through experience on previous rounds. Advice after initial recommendation appears to be important. Experiences show that convergence is a property of many processes. As will become evident, the data show that the capacity for recommendation adjustment is used by the experts. The experts do adjust but the exact role of the adjustments is not established. Adjustments of recommendations could be interpreted as “correcting opinions” that might have been drawn from previous recommendations or a refinement of a recommendation as a strategic response to the recommendation of the other expert.”

Procedures with regard to experts are as follow. Each expert is informed about the state and prepares a recommendation about the committee choice. Both recommendations are prepared and submitted in private and announced simultaneously. That is, a recommendation cannot be made conditional on what the other expert recommended. The language of the experts was confined to recommendations for the final committee decision as opposed to what the state might be or information received from the experimenter. Experts cannot vote and cannot make motions. However, experts can comment during the discussions and give ordinal recommendations, e.g. move up.

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Table 1: Experimental Conditions and Summary Results of Committee Decisions

Information condition	Calibration	Full Information	Limited information		
Experts: existence and performance feedback to voters	Condition 1: y state public x state known to experts	Condition 2: All voters are experts	Condition 3: No experts (no information about states)	Condition 4: Experts with no voter feedback about advice accuracy	Condition 5: Experts with complete voter feedback about advice accuracy
number of experiments	4	1	1	8	7
total decisions (periods)	80	7	7	62	72
Model	x state public	Fully informed voter model	No voter information model	Fully informed voter model	Fully informed voter model
error eq-mean (SD)	0.36 (11.4)	1.1 (.5)	1.3 (.5)	6.9 (.6)	9.5 (.7)
Model		No voter information model	Fully informed voter model	No voter information model	No voter information model
error eq – mean (SD)	-3.14 (20.25)	16.4 (.2)	17.9 (2.8)	14.6 (.9)	13.4 (.8)
number of decisions closer to full information model				On average 10 units closer and 82% of decisions are closer to the full information model.	On average 7 units closer and 64% of decisions are closer to the full information model.

Committees followed a modified Roberts Rules of Order. The system starts with a motion on the floor (a status quo), which can be changed by amendment and votes. One proposed amendment is made at a time and voted up or down. If an amendment passes, the amended motion becomes the new motion on the floor, which can be amended. If the amendment fails, the floor remains open for additional motions. The system stops if the question is called and the motion on the floor receives a majority vote of three voters. All payoffs are determined by the winning alternative.

5. Experimental Design

The experimental design is represented in Table 1. Five information conditions were studied. The underlying preferences were the same in all conditions except in condition 1 in which the preferences were placed slightly differently from the other four conditions. In all cases, the state was revealed to the experts and all procedures were followed as outlined in the sections above. Condition 1 can be viewed as an initial test in the special case of one dimension of uncertainty. In condition 1, the s_1 state was given to the experts and the s_2 state (the height on the vertical) was revealed publically. The state was randomly determined so the known value of the y dimension differed for each committee decision. The resulting committee problem was "single dimensional" because all uncertainty was confined to the x dimension (the horizontal dimension), even though the committee had to choose both dimensions. Nevertheless, since the indifference curves are circles, the classical "single peaked preference condition" was always satisfied and thus, the fully informed core/equilibrium always existed at the most preferred alternative of the median voter along the known y axis.

Since the structure of the parameters used for Condition 1 experiments are different from those of the other experiments, the data from those experiments are not included and analyzed with the other experiments. However, a quick summary of the experiments will facilitate an understanding of the Table. These experiments were conducted in a two dimensional space with a random date but one dimension of the state was public information. So, from the point of view of the theory there was only one dimensions of uncertainty, the x dimension, which was known to the experts but not the voters. Two models are compared. One holds that the outcome will be as if both dimensions are known with certainty, because the level of the x dimension will become known from the recommendations of the experts. The other model holds that the recommendations of the experts will be regarded as cheap talk. No information will be produced through the expert recommendations and the choice will be as if the voters regarded the x dimension as completely random. The measures from both models are listed. The error for the model based on information aggregation and the standard deviation of the error are both lower than the error of the model based on no information aggregation. In both cases, the errors are low and the standard deviations are relatively high, so the predictions of neither cannot be rejected as error free. However, the data demonstrate that the standard deviations of the alternative model are much higher.

Condition 2 is a replication of the Fiorina and Plott experiments in which the state is publically known. The committee faced no uncertainty and thus, no independent expert advice existed. All voters were experts. It is baseline against which we measure the degree of information aggregation and transfer. If all information in other conditions is transferred, then the voters should act as if they had complete information and thus the results should mirror the results of Condition 2.

Condition 3 plays is a second baseline in the determination of whether or not information aggregation takes place. It is the case of complete uncertainty other than the public information about the distribution (independent uniform distributions with the same support) from which the state was drawn. No experts existed and the committees operated under complete uncertainty except for the common priors. Under the expected utility hypothesis, the equilibrium/core existed due to the symmetry of the environment. For all committee decisions, the core/equilibrium is the point (69,68) regardless of the underlying state. The assumption that this will be the outcome in the absence of information is a key step in determining if information aggregation took place under other conditions.

Conditions 4 and 5 are variations of the asymmetric information environment in which the voters have no private information about the state and the experts are perfectly informed. The difference is the feedback given voters about the state and thus the accuracy of the expert recommendations. The purpose is to explore the sensitivity of the results to the possibility of reputational influences by the experts. The variables are similar to the nature of information used in retrospective voting models and experiments such as Collier, et al (1987) and McKelvey and Ordeshook (1990a).

In Condition 4, voters were given no feedback about the state until all decisions were made and the experiment ended. Thus, experts had no obvious incentive to produce accurate recommendations and were free to recommend whatever might influence the committee to choose the most preferred option of the expert. Thus, a viable model would have the recommendations only existing as cheap talk that would be exaggerated to the maximum and thus, ignored by the voters.

In Condition 5, voters were told the state after each decision. Thus, the voters could observe the historical accuracy of the experts and from that information the voters could constrict reputations of the experts. A natural conjecture is that the experts would exaggerate less if the accuracy of their recommendations were to be revealed to the voters, and that the information possessed by the experts would be aggregated and transferred to the voters.

6. Results

The first result provides both a baseline for analysis and a replication and generalization of previous results. The result focuses on the cases where the state is known to all committee members so information acquisition or transfer plays no role in the model. The Table contains error rates for a model that assumes information will be perfectly aggregated and also contains a model that assumes no information will be aggregated. The question is which is more accurate. Notice the grid is 200 x 150 so the units are “small” relative to the grid. The size of error must be interpreted in the _light of the fact that “larger” errors are actually “small” relative to the grid. The variances are so small all models would be rejected as statistically accurate. Conclusions reflect average model error divided by standard deviation of the data.

The first result is conveyed by Figures 6 and 7. Shown there are the displacements of final decisions minus the predicted equilibrium. Figure 6 includes the committee decisions made by fully informed voters. Figure 7 contains the decisions and the equilibrium for the uninformed voter decisions. As can be seen, the final decisions are close to the equilibrium with a slight bias to the right in the case of fully informed committee decisions in Figure 6. In the case of Figure 7, the completely uniformed voters, the final decisions are represented by the circles and tend to be exactly the same and almost exactly on the equilibrium. These results are similar to the results of Fiorina and Plott (1978).

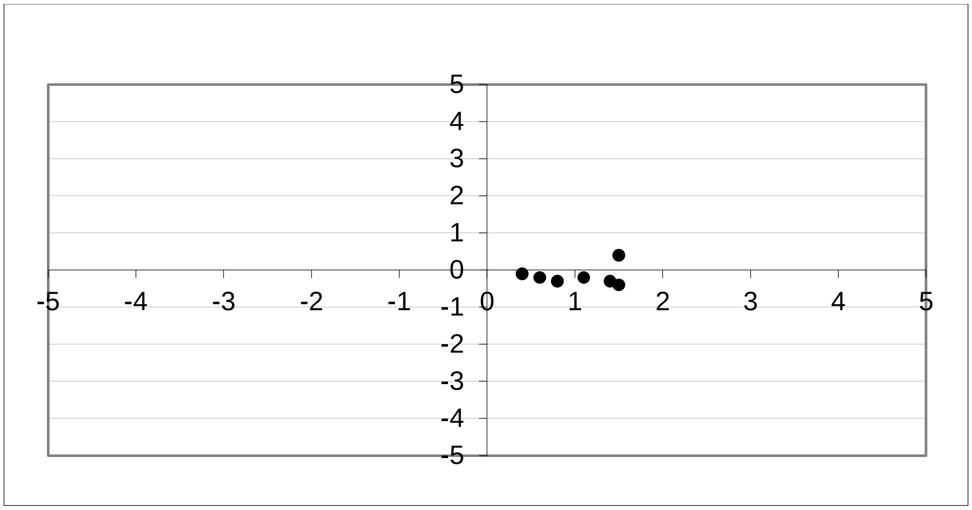

Figure 6: Full State Information for Voters (Decision Minus Equilibrium): Condition 2

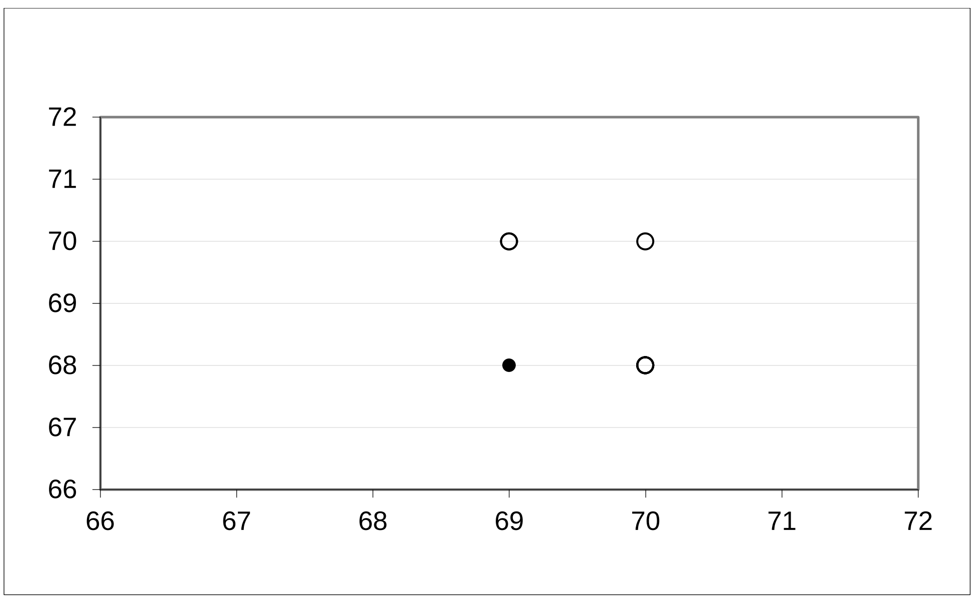

Figure 7: No State Information for Voters (Committee Decisions and Uninformed Equilibrium): Condition 3

Result 1: Equilibration principles are observed in operation. (i) Equilibration is observed under conditions of complete voter information about the state, i.e. Condition 2. (ii) Equilibration is observed under conditions of no voter information about the state (other than background randomness), i.e., Condition 3.

Support. Table 1 contains the deviation of the data from the model equilibrium. Statement (i) is addressed by experiments under Condition 2, fully informed voters, where the mean error is 1.1 units with a standard deviation of .5. While equilibration cannot be rejected the small standard deviation makes it appear close. Statement (ii) is addressed by Condition 3 and the error of 1.3 and standard deviation of .5. The equilibration is clear. Any alternative model that suggests that decisions were not sensitive to induced preferences or that decisions converge to some point other than the equilibrium would produce a large error. For example, a model which asserts that the committee decisions would converge to the no information equilibrium when the committee is fully informed produces and error of 16.4.

The second result reveals that the design does what it is supposed to do. The dyadic mechanism facilitates information aggregation and transfer. Figure 8, Figure 9, and Figure 10 contain the difference between the final committee decisions and the equilibria for Conditions 1, 4, and 5 respectively. The aggregations are not perfect in the sense that the decisions are not made as if voters had private information about the state but decisions are close in a statistical sense and far from the behavior that would be observed if no aggregations at all took place.

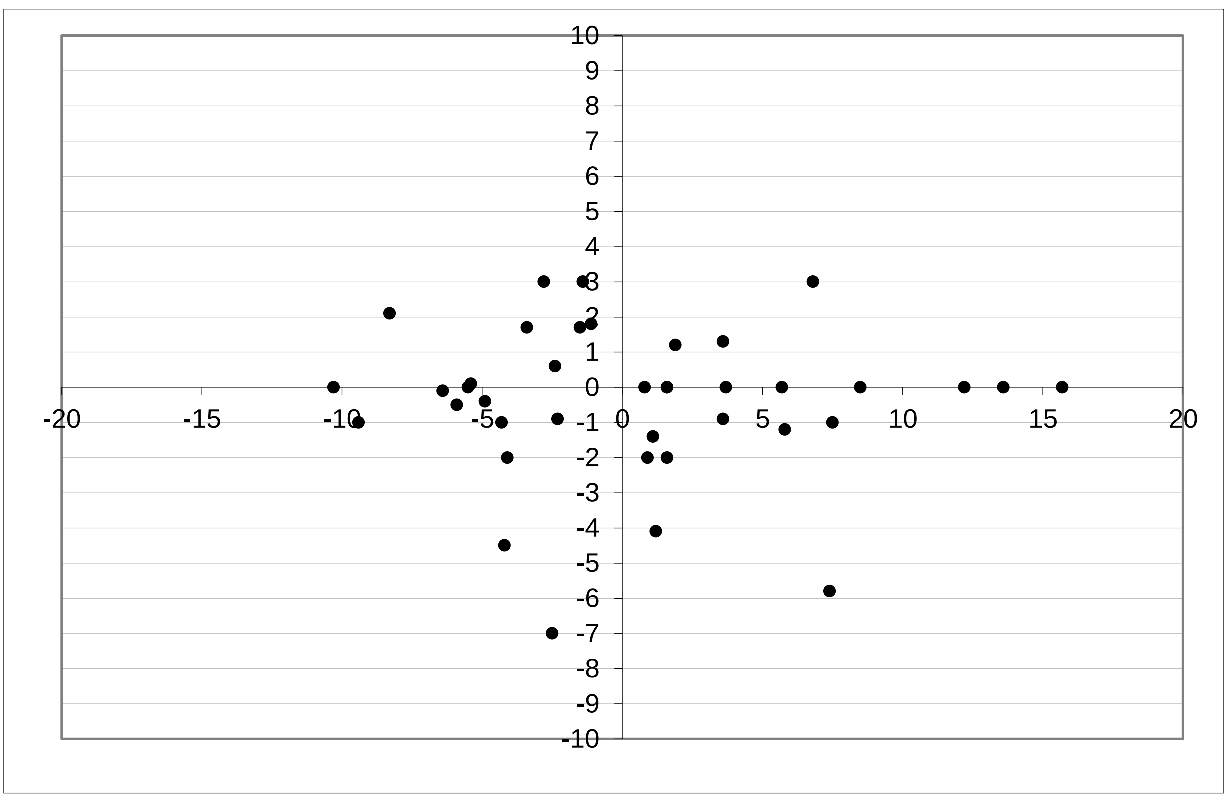

Figure 8: Y State Known to Voters But X State Known Only to Experts (Committee Decision Minus Equilibrium): Condition 1

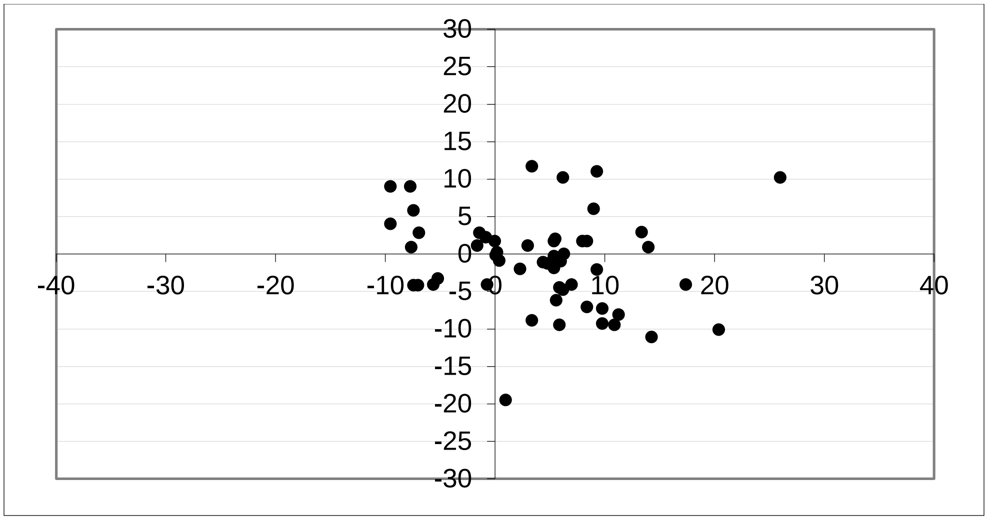

Figure 9: No Voters Feedback About Expert Advice (Committee Decision minus Fully Informed Equilibrium): Condition 4

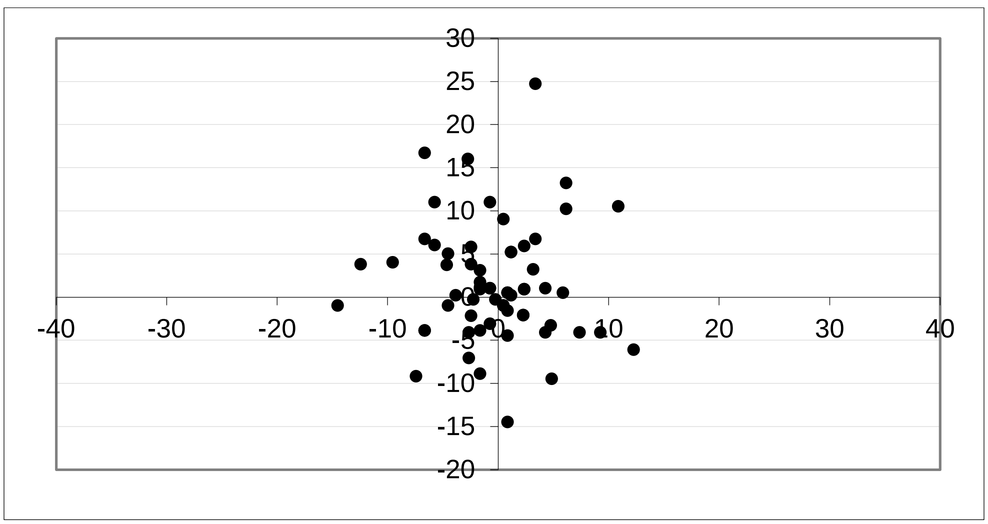

Figure 10: Full Voter Feedback About Expert Advice (Committee Decision minus Fully Informed Equilibrium): Condition 5

Result 2: Under the dyadic process, information is revealed and incorporated into decisions. (i) Under Condition 1 in which the y axis of the state was known publically the decisions are statistically indistinguishable from the equilibrium. (ii) Under Condition 4 and Condition 5 the decisions are substantially closer to the full information equilibrium than that case where no information is available. (iii) Decisions get slightly closer to the equilibrium when information about the state is available and can be used to judge the quality of past expert advice.

Support. Appropriate statistics are in Table 1. (i) The hypothesis that committee decisions under Condition 1 are centered on the equilibria cannot be rejected. The mean error is 5.12 and the SD is 3.7. (ii) The hypothesis that committee decisions are centered on the equilibria can be rejected for both Condition 4 (error 6.9 and SD .6) and Condition 5 (error 9.5 and SD .7). However, under both Conditions the decisions are closer to the full information equilibrium than to the uninformed equilibrium (a factor of 2 in the case of Condition 4 and a factor of approximately 1.5 in the case of Condition 5) and the percentages of decisions closer to equilibrium are 82 and 64. (iii) The hypothesis that the distance from the fully informed equilibrium is the same for Condition 4 and Condition 5 can be rejected.

Of particular interest is the behavior of the experts. The behavior of voters and the fact that decisions reflect considerable information aggregation motivate an investigation. Figures 11 and 12 contain the individual expert recommendations relative to the equilibrium. Figure 11 contains the data for Condition 4 where no feedback about the state took place. Figure 12 contains the expert recommendations for the periods in which voters were told the actual state after each decision thus creating a possibility of reputation formation. The figures also contain the location of each expert's preferred alternative relative to the equilibrium as a large dot. Expert A is always up and to the left of the equilibrium and expert B is always down and to the right of the equilibrium.

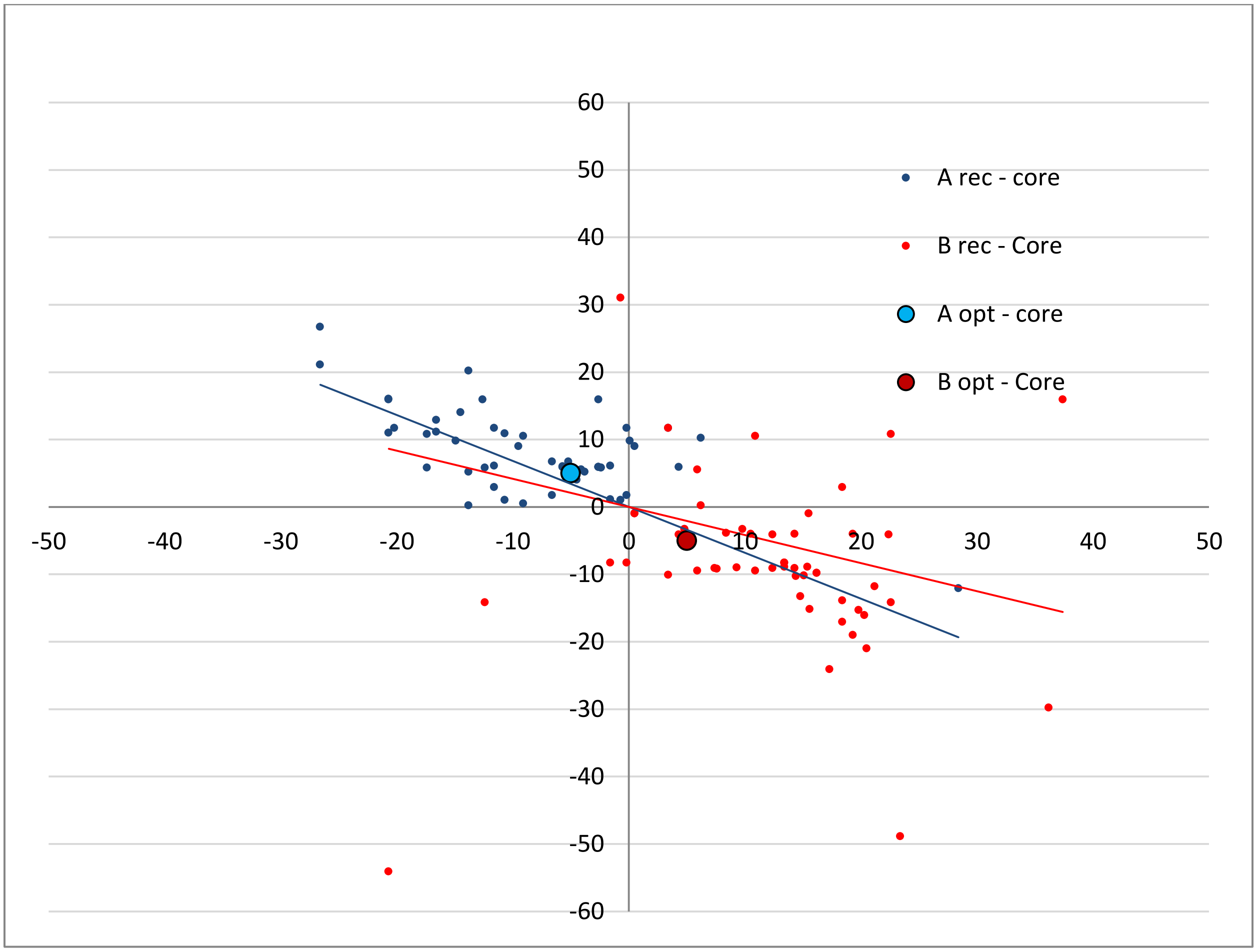

Figure 11: Expert Advice Minus Perfectly Informed Equilibrium: No Feedback to Voter: Condition 4

The lines are the regression of A recommendation and B recommendation respectively, with the intercepts constrained to (0,0)

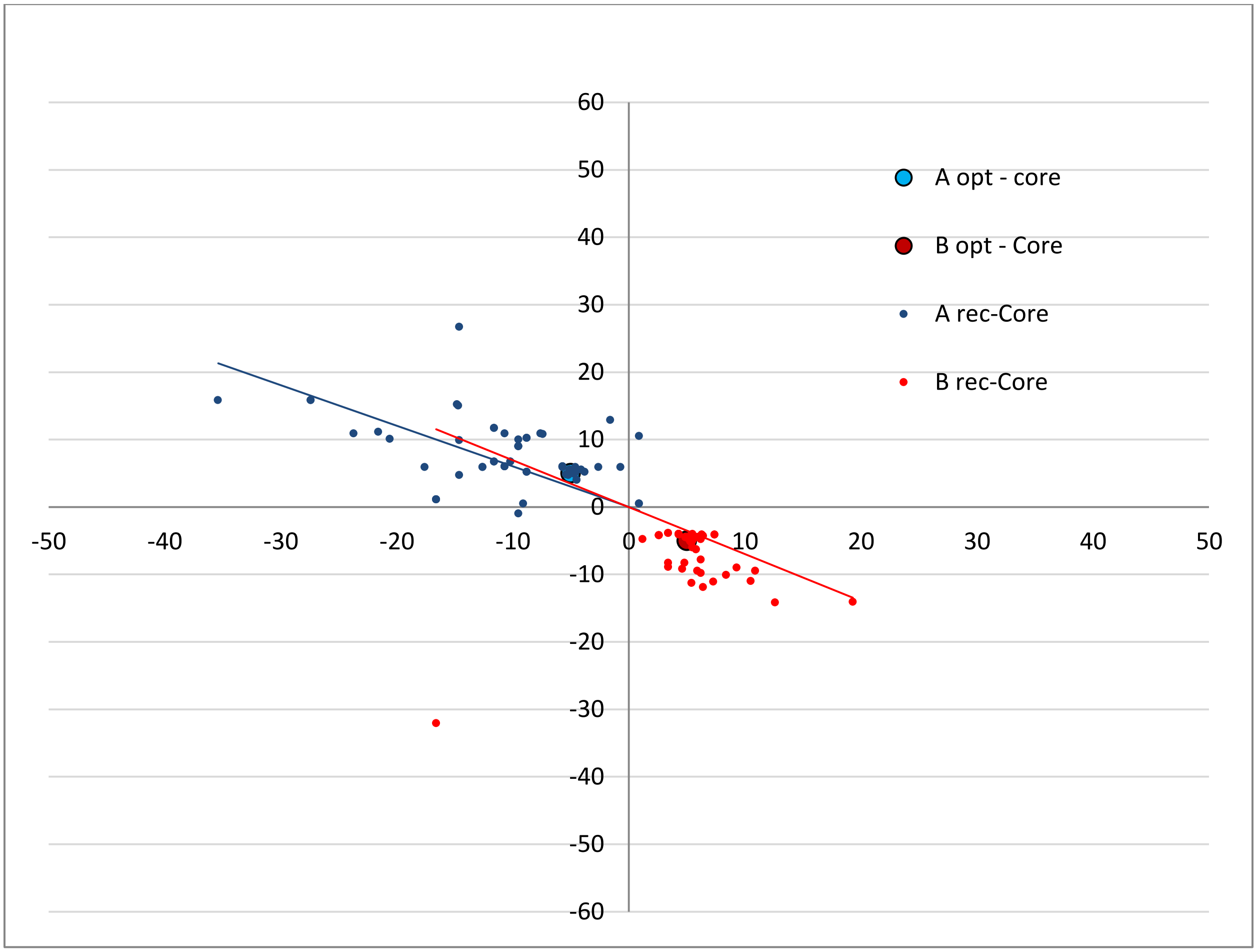

Figure 12: Expert Advice Minus Perfectly Informed Equilibrium: Feedback: Condition 5

The lines are the regression of A recommendation and B recommendation respectively, with the intercepts constrained to (0,0)

Result 3: Experts behave strategically. (i) Experts do not propose their most preferred option. (ii) Experts act as if they are attempting to pull the average of the expert advice to become centered on their most preferred option. (iii) Experts do not propose the most extreme possible in the direction that they want the final decision relative to the state.

Support. Figure 12 illustrates recommendations relative to equilibrium and expert ideal point. Statement (i) and (ii) follow from the fact that expert recommendations tend to be further from the equilibrium than their own optimal alternative. The regressions also support the conclusions by indicating that relative to the equilibrium the tendency for proposals is to be on the line that runs through the expert optimal. Result (iii) follows from the fact that the proposals are not at the border of the probability support for the state.

The average of pairs of expert recommendations in relation to the equilibrium provides insights about the process through which information becomes revealed by the dyadic mechanism. Figures 13 and 14 compare the average of pairs of recommendations to the location of the perfectly informed equilibrium. Basically, on average, the average of a pair of expert recommendations is not distinguishable from the perfectly informed equilibrium and suggests that recommendation biases and the strategic behavior of experts have sufficient structure to permit a reliable inference about the state location. As was established by Result 3, the experts exaggerate but they do not exaggerate "too much" and they are not arbitrary or purely random. Figure 13 contains data from the no feedback condition 4, and Figure 14 contains the recommendations from the decisions in which the quality of the expert advice will become known, the full feedback condition 5. The figures indicate that the variance under full feedback conditions (mean 4.11, SD 3.40) is smaller than under no feedback conditions (mean 8.12, SD 5.82). When the experts know that the accuracy of their recommendation will be known, the variance of their recommendations is reduced and more accurate but the difference between these patterns of recommendations is not statistically significant. Those facts are summarized by the following result.

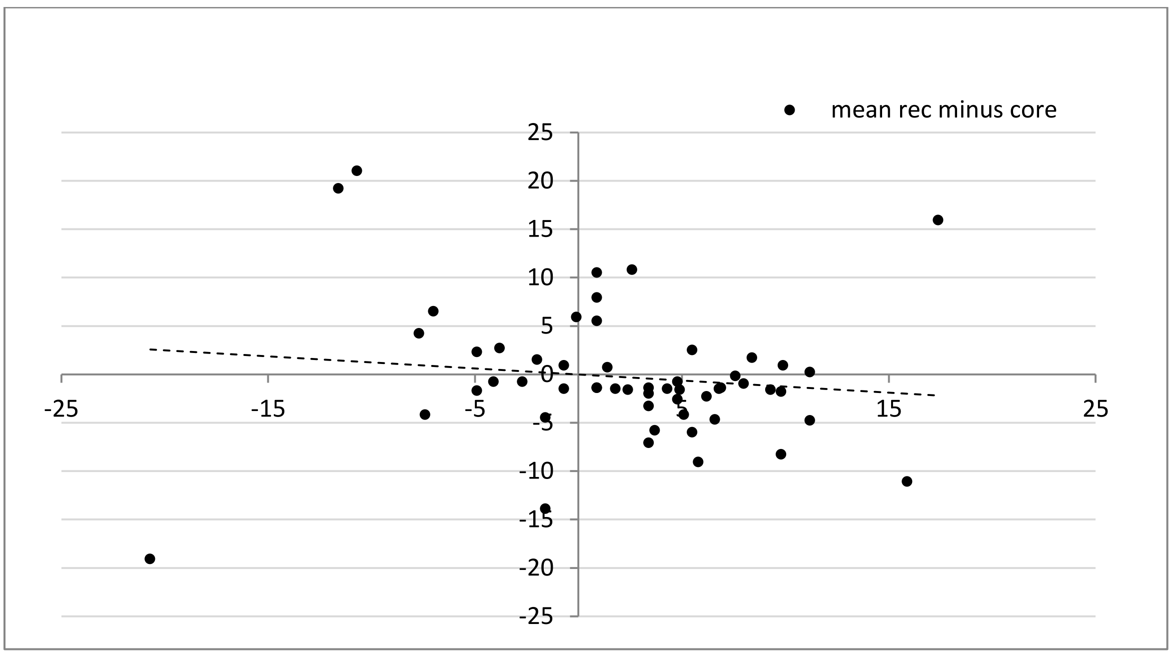

Figure 13: Mean Difference (Expert Advice Minus Perfectly Informed Equilibrium) No Feedback: Condition 4

The line is an unconstrained regression.

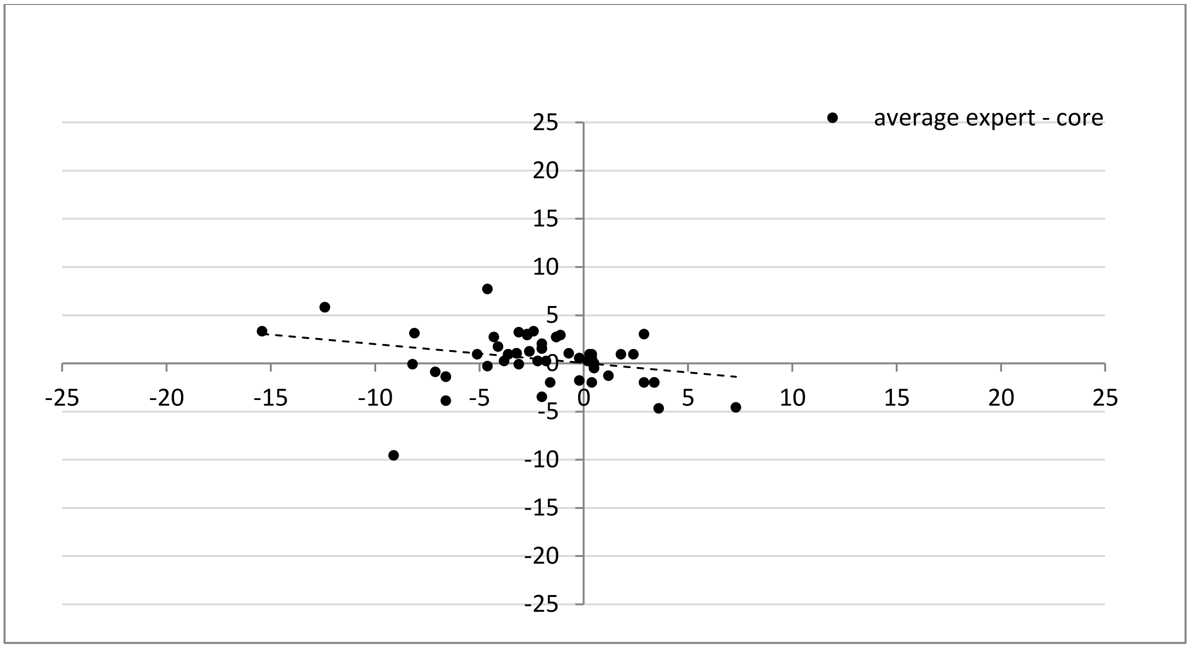

Figure 14: Mean Difference (Expert Advice Minus Perfectly Informed Equilibrium) Full Feedback: Condition 5

The line is an unconstrained regression

Result 4: An analysis of the pairs of expert recommendation leads to two conclusions. (i) The average recommendation of pairs of experts is not distinguishable from the perfectly informed equilibrium. (ii) The average recommendation from the pair of experts under the feedback conditions 5 tends to be closer to the perfectly informed equilibrium and tends to have less variability than the average of recommendations under the no feedback condition 4.

Support: Under the no feedback conditions 4, the mean distance of the average expert recommendation is 8.12 and the standard deviation is 5.82. The mean distance and the standard deviation for committee decisions under the full feedback conditions 5 are 4.11 and 5.40, respectively. Result (i) is supported by the fact that the hypothesis that the average of the pair of recommendations equals the equilibrium under both conditions cannot be rejected. While the distributions of averages tend to be centered on the perfectly informed equilibrium, they are not the same. Result (ii) follows from the fact that the hypothesis of equality of means can be rejected. The average of recommendations from experts with unknown accuracy is further from the perfectly informed equilibrium and has greater variance than experts whose accuracy will become known.

Observation 1: Result 4 (i) suggests the need for a more refined equilibrium concept than Nash is needed to capture the decisions regarding expert recommendations.

Given the recommendations of the other expert and given the tendency of the committee to accept the mean of recommendations as a signal of the state of nature, both experts have an incentive to give more exaggerated advice. Given what the other does, and other things being equal, either expert can pull the mean of the advice and, the committee decision closer to the expert's ideal point by giving more exaggerated (extreme) advice. Unless the advice is placed at the edge of the state space, the advice could always be more extreme and thus, has a potential for drawing the mean closer to the expert's ideal. For some reason, increasing the exaggeration of advice does not appear productive to the experts. One conjecture is that the equilibrium advice satisfies a more refined equilibrium concept in which the expert anticipates rejection should the advice move too closely to the extremes.[7] How that might work is not obvious since neither expert knows the preferences of the other; and neither expert knows the preferences of any of the committee members. They only know that committee members have some qualitative information about their bias.

Overall, the process has the appearance of two interacting equilibria. Conditional on the equilibrium of the revelation game of experts the committee converges to its equilibrium. The revelation game seems to have an equilibrium – state invertability property. One equilibrium is dictated by the behavior of the experts and another dictated by the behavior of the committee. Of course, these processes are interacting simultaneously so how the dynamics might behave or how the two equilibria might be approached separately is a matter for theoretical exploration.

7. Summary of Conclusions

The first of two basic questions posed for a process design is whether or not it does what it is supposed to do. The dyadic process was designed to facilitate the transfer information from experts to an uninformed committee whose decision the experts wish to influence. Basically, it is designed to remove the power of those who have privately held information that could otherwise be used to influence the outcome of group deliberations. The dyadic process involves choosing two experts with opposing interests and whose preferences (biases) are known to the committee members. The experts recommend an action to be taken by the committee using a formal protocol. Precautions are taken to prevent expert collusion while letting experts adjust their recommendations in the light of deliberations. The competition between experts appears to be a key to removing the power they might otherwise have over the group decision. The result is that the committee decisions are near those that would be made if all committee members were experts or if the experts truthfully revealed the state. Basically, the dyadic procedure is successful but not perfect.

The second question is whether or not the mechanism performed for understandable reasons. Are the principles and insights that lead to the design supported by behavior observed in the experiment or was success simply an accident of some sort? Support exists for aspects of theory. In particular, the rational expectations principles that lead to the design have some support in the data. As a group, committee members correctly anticipate the behavior of experts and in turn, experts respond to the possibility that that excessively exaggerated advice can result in a reduction of their influence. The interpretation is that voters observe the outcome of a game of influence among "insiders" (the experts) and from the equilibrium or from the observations of the dynamics of the game the voters find themselves able to infer the underlying information

[7] If the state is informally distributed a boundary of the support is not a credible recommendation. Thus, if the state has a uniformed distribution limits exist to credible recommendations in any particular direction. An experimental design used by Vespa and Wilson (2014) represents the state space as a Clifford toris in order to control for the boundaries when the state is produced by a uniform distribution. Such a construction permits extreme recommendations by experts without recognition that they are unlikely because of proximity to the boundary of the outcome space.

held by the insiders. The interpretation suggests a possible role of information revealing equilibration from two interdependent processes.

While the intuition of the information transfer and aggregation process is supported by the data, the result stands more as a discovery than a demonstration of mechanism reliability. The intuition itself is not supported by a complete theory and the robustness of the result is not explored. In the absence of a deeper theory, it is not clear how experiments that explore robustness should proceed. Questions are easy to pose. The differences in the recommendations of experts appear to be important for triangulation on the state of nature by committee members. That individuals can discount biases is known (Chung and Harbaugh, 2014) but how that takes place in the context of an equilibrating process, is not known. Is the information transfer to a single committee member facilitated by the voting patterns of other committee members or by the comments of the experts during committee deliberations? The communication protocols are known to be important as are the rules for collective decision (Hoffman and Plott, 1983) (Goeree and Yariv, 2011) in addition to the influence of parliamentary procedures themselves. How the information transfers of the system might adjust as a result of changes in the configuration of committee preferences is an open question. What happens if the equilibrium does not exist? Suppose different decision rules are in place, such as a veto player in which the equilibrium exists but the symmetry of the majority rule equilibrium is not present. How will the system behave if the experts have an incentive for implicit collusion? Is the key to the intuition about competition among experts captured by the fact that the committee equilibrium under certainty conditions is in the Pareto optimal set of the experts? If the Pareto set among experts is an appropriate indicator of competition among experts, then would improved success follow from the addition of experts as long as the majority rule equilibrium (or even the core) is in the Pareto set of the experts? If left a committee is left to its own devices, how would it choose experts? While this paper reports some key results, many questions about the robustness of the results exist and all invite more precise theory.

Acknowledgements

The financial support of the Caltech Laboratory for Experimental Economics and Political Science is gratefully acknowledged. The paper benefited from the comments of Rick Harbaugh and Alexander Hirsch and the insights of Meghana Bhatt, who as a student in a Caltech experimental economics class, conducted initial pilot experiments. The research and paper also benefited from the participants attending a conference on behavioral and experimental economics held at the University of California Santa Barbara in February 2006.

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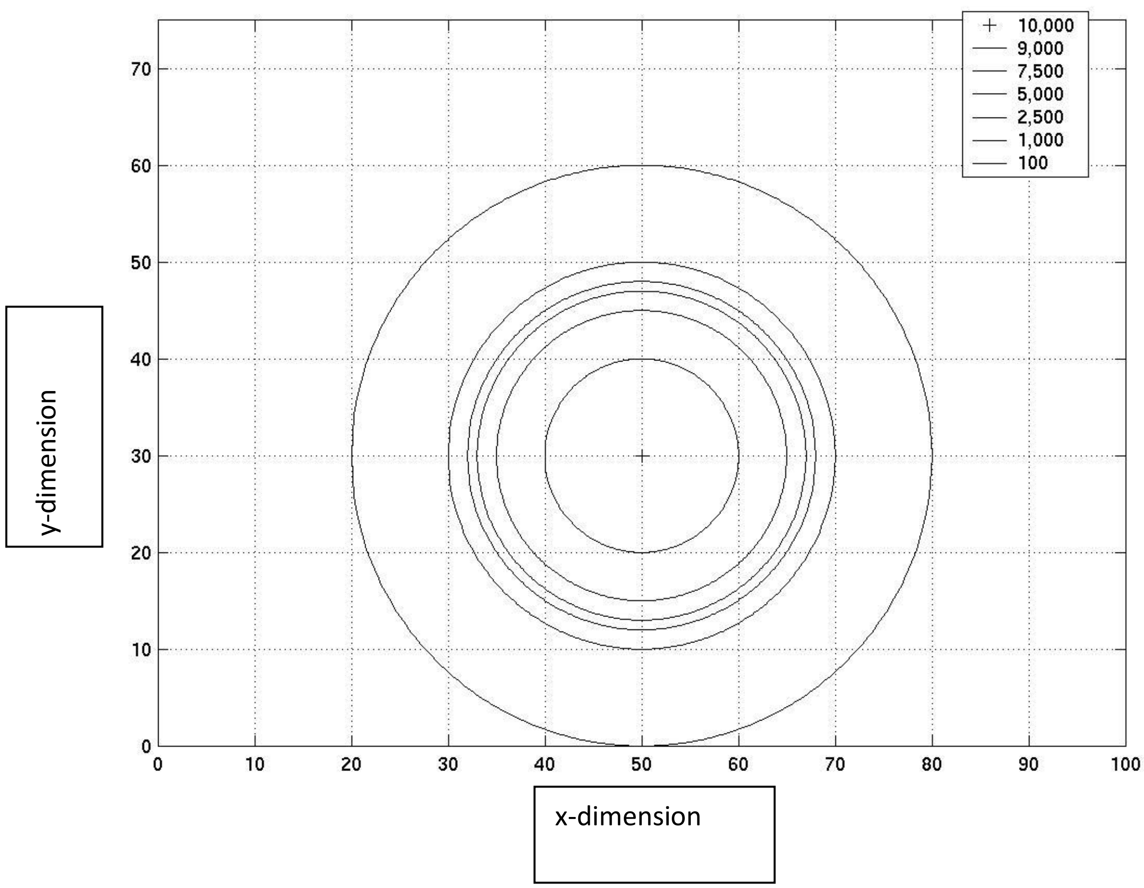
Appendix A

Instructions

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

Instructions to Committee Members. The alternatives are represented by points on the grid you've been given (these will also be drawn on the blackboard). The committee will adopt as the committee decision one and only one point. *Your* compensation depends on the particular point chosen by the committee (see attached payoff chart). Your payoff will be the value of the point (x, y). For example, suppose your payoff chart is that given in Figure 1 and that the committee's final choice of alternative is the point (x,y) = (30,30). Your compensation in this event would be 1,000. If the policy of the committee is (45,30) your compensation would be computed as follows:



The point (45,30) is halfway between the point worth 10,000 and the curve worth 9,000, i.e., about 9,500. There is a key in the upper right corner of the chart which gives the values of the curves. The point in the middle of the circles is your peak point and worth the most to you. The curves are decreasing in value as you move away from this point.

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

Parliamentary Rules. The process begins with an existing motion (200,150) on the floor. You are free to propose *amendments* to this motion. Suppose, for example, (170,50) is the motion on the floor and you want the group to consider the point (140,125). Simply raise your hand and when you are recognized by the chair, say "I move to amend the motion to (140,125)." The group will then proceed to vote on the amendment. If the amendment passes by a majority vote, the point (140,125) is the new motion on the floor and is subject, itself, to amendments. If the amendment fails, the motion (170,50) remains on the floor and is subject to further amendment. Thus, amendments simply change the motion on the floor. You may pass as many amendments as you wish.

At any time during the consideration of an amendment or the motion on the floor, a *motion to end debate* is in order. If the motion to end debate fails, the amendment process continues. If it passes, the motion currently on the floor goes through.

To sum up, the existing motion on the floor is (200,150). You are free to amend this motion as you wish. The meeting will not end until a majority consents to end debate and accept some motion. Your compensation will be determined by the motion on the floor finally adopted by the majority.

Your Payoff: In this experiment your payoff chart will depend on two values. One of these, S_y, will be announced at the beginning of each period to everyone in the committee. The other, $\mathbf{S_x}$, will be unknown to you. You have been given a grid with a 50x50 unit square drawn on it. To generate your payoff chart in the case that $S_y = 0$, and $X = 0$, you should place the transparency on the grid so that the point corresponding to you payoff peak is on the bottom-left corner of the square. For other values of $\mathbf{S_x}$ and S_y, for example 5 and 10, you should slide the transparency to the right along the horizontal line 5 units and then up 10 units. If you have any questions on how to generate your payoff chart, raise your hand and the experimenter will demonstrate how to do this.

You will not know the value of S_x merely that it is some number between 0 and 50 and that all these values are equally likely. Furthermore, the value of S_x in one period is unrelated to its value in any other period.

INFORMATION

In addition to the other committee members, there will be two informed parties. They will know with certainty the value of S_x every period. They will have no voting rights and have other limitations on what they can do or say as will be described below. For each of the informed parties, you will be told the relative position of their payoff peak to yours. For example, if your payoff peak is at (50, 30) as in the example above, you may be told that informed party A's peak is above you and to the left, so unlike the other committee members, you know something about their preferences. Their payoffs depend on the chosen point the same way yours does. They will be allowed to take part in all committee discussions, but only committee members will be able to vote.

Instructions to "Informed" parties. You will be given the variable S_x at the beginning of each round. Your payoffs will be partially known to the entire committee and are calculated in the same way as the committee members. You are not allowed to vote on amendments and you cannot reveal the value of S_x, but you are allowed to propose amendments and take part in any other discussions in committee.

Are there any questions?

We would like you to answer the questions on the attached page. These should help you understand the instructions.

Test

1. For S_x = 20, $\mathbf{S_y}$ = *5* at **_____________** I would make the most possible money.

2. Suppose (200,150) is the motion on the floor and an amendment to move to point (199,149) passes (fails), then the new motion on the floor is**_____,____** (**_____**,**_____**) ?

3. True or false: S_x is more likely to fall between 20 and 30 that

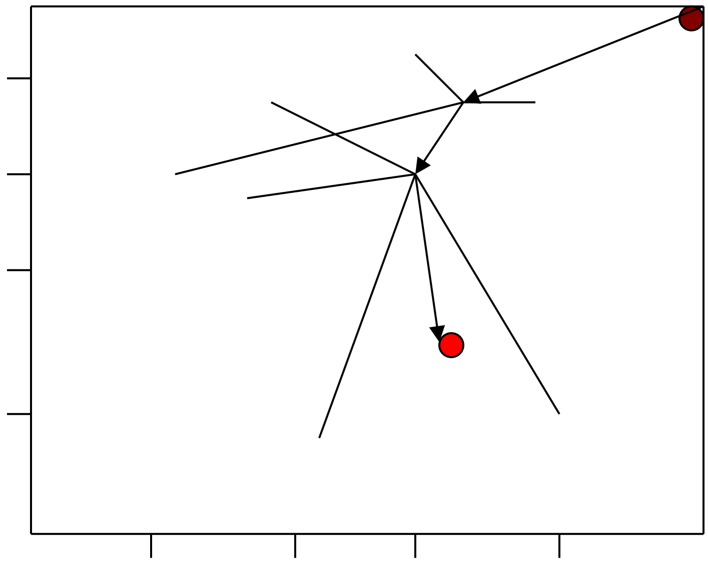
Appendix B

COMMITTEE INSIDERS LAB PROCEDURES

Motions and proposals are listed on the board and graphed on the board.

THE GRAPH

The graph follows the real time action. The motion on the floor is always a point. Arrows leading to it are the history. Failed amendments are also shown. When data become too messy then old data are removed.



THE FORMAL MOTION LISTING

The experimenter maintains a table on the board with the following information.

	Floor motion	Proposed amendment: move to	Amendment proposer	Discussion	second and Voting For	
	(200,150)					
		(20,30)	Suggestion A			
		(100,100)	Suggestion B			
		(100,100)	1	A (up, right) B (down, right)	1,2	failed
		(50,50)	6		1,4,6,3	passed
	(50,50)					
		(75,85)	4		1,4	failed

THE PROCEDURE

The experimenter is the chair. Motion on floor is (200, 150)
Call for suggestions from the informed. Suggestions listed on table and drawn on figure. “A suggests that the motion be moved from (200, 150) down by 130 and to the left by 170 to here.”

Call for motions. #1 says “I propose to amend to (100,100)” . #2 I second. Discussion? The informed can give directions (Up and left, down and right, etc.) All in favor? #1 and #2 vote for and #3,4,5 do not. Motion failed. The motion on the floor remains (200,250).