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Rational expectations in elections: some experimental results based on a multidimensional model

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Democratic theory in general assumes that a well-informed citizenry is not only healthy but may in fact be essential for the "proper" functioning of electoral and representative institutions. Thus, journalists, political scientists, and other social commentators bemoan the fact that citizens are typically poorly informed about even the most mundane of political matters, including the names of the candidates for whom they vote as well as the policies espoused by those candidates. Most formal analyses of political processes, on the other hand, assume that people are perfectly informed (at least up to a well-defined probability distribution). Consequently, this research is subject to the criticism not only that it imperfectly models politics but also that it is incapable presently of explaining the ways in which democratic institutions transform individual preferences into public policy.

In several earlier papers we argue that perfect information is neither a prerequisite for democratic theory nor necessary as a theo-

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retical assumption in abstract models of election processes [1984a, 1984b]. Specifically, in those papers, by applying the fulfilled rational expectations perspective of economics to a simple 1-dimensional model of 2-candidate elections, we conclude both theoretically and experimentally that perfect information is not a necessary assumption for the validity of the median voter theorem. In a subsequent paper we extend these results to the case of multiple issues and generalized preferences (McKelvey and Ordeshook, 1984c). This essay reviews this extension for the case of Euclidian preferences and presents experimental results designed to assess the plausibility of our approach.

Briefly, Section 1 reviews the structure of our earlier 1-dimensional analysis and offers a modification of that structure which permits generalization to more than one dimension. Section 2 reviews our multidimensional election model as it applies to Euclidian voter preferences. Section 3 discusses our assumptions in more detail and, to better convey the role of these assumptions, illustrates one situation in which elections do not attain full information equilibria. Section 4 describes our experimental procedures and the results of three large-scale election experiments. Finally, Section 5 offers concluding remarks. The Appendix to this essay contains the instructions read to our experimental subjects and a quiz they were required to take after receiving the instructions.

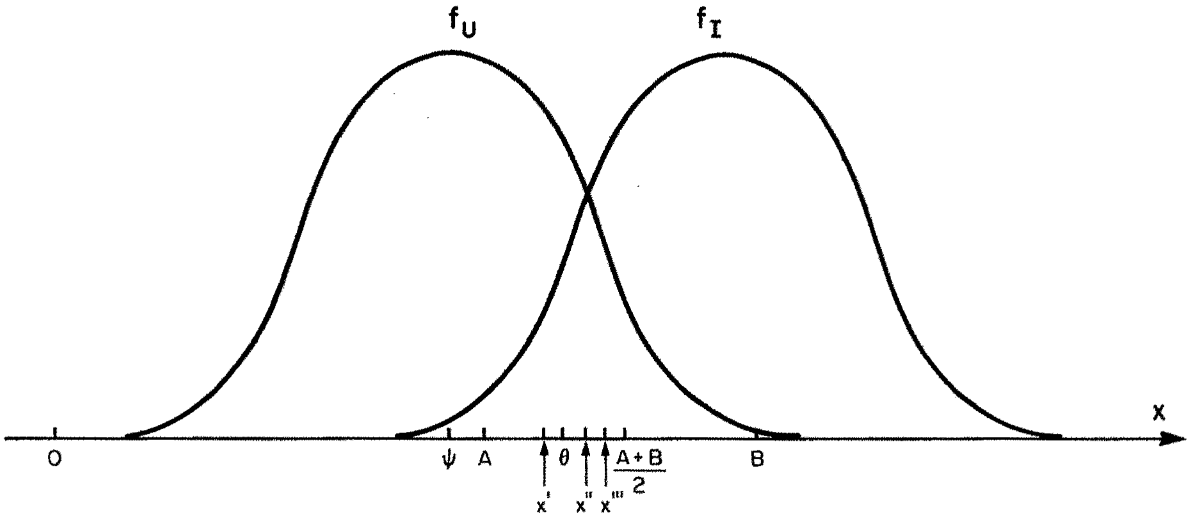
1. A 1-DIMENSIONAL MODEL

We begin with the usual Downsian representation of 1-dimensional elections in which voters possess well-defined symmetric single-peaked preferences on a particular issue, and candidates compete for electoral support by varying the position they espouse on that issue. Unlike the usual approach, however, we assume that voters are divided into two mutually exclusive types--informed and uninformed. Informed voters know the positions of the candidates and vote accordingly for the candidate closest to their issue preference. Uninformed voters do not know these positions, although they may have beliefs based upon certain (possibly erroneous) information. This essay focuses on voting behavior, but as we show elsewhere (McKelvey and Ordeshook, 1984b), the analysis can be extended into a full equilibrium analysis in which candidate behavior is also endogenous.

To understand how an uninformed voter can extract information relevant to his voting decision, suppose everyone except the voter in question possesses perfect information. Then, if each voter's preferences on the election issue can be represented by a *symmetric* and *single-peaked* function and if the candidates adopt positions at the points A and B, with A < B, then all voters to the left of the point (A + B)/2 will support candidate at A while all voters to the right of (A + B)/2 will support B. Thus, to cast an "informed" vote, voters need not know the exact positions of the candidates--rather, they need to know only the point that bisects the candidate positions.

While this information might seem at first glance no less difficult to obtain than exact candidate positions, consider the 1-dimensional model we offer elsewhere in which the information available to an uninformed voter is of three types: (1) interest-group endorsements; (2) polls; and (3) a knowledge of where he or she stands on the issue relative to other voters. First, we assume that, based on the endorsements of one or more interest groups in society, all voters know which candidate is to the left and which is to the right. Second, via a sequence of polls or straw votes, uninformed voters learn of the candidate preferences of other voters. These two pieces of information, when combined with the third, give an uninformed voter a basis for judging on which side of the bisecting point (A + B)/2 he lies and, hence, for which candidate he should vote. Moreover, this information is sufficient to yield a full information equilibrium as the unique equilibrium to the election game.

To see this more clearly, Figure 1 gives two distributions, f_I and f_U, that represent the preference distribution of informed and uninformed voters. Suppose two candidates, A and B, are at the points indicated and that all voters have symmetrical single-peaked preferences so that with full information all voters to the left of (A + B)/2 vote for A and all to the right of (A + B)/2 vote for B. An initial poll or voters, now, should reveal a random response by uninformed voters (hence, they split .50 - .50 between A and B) while the informed voters, voting correctly, split .30 - .70. Assuming for purposes of the example that informed and uninformed are in equal proportion, we observe an



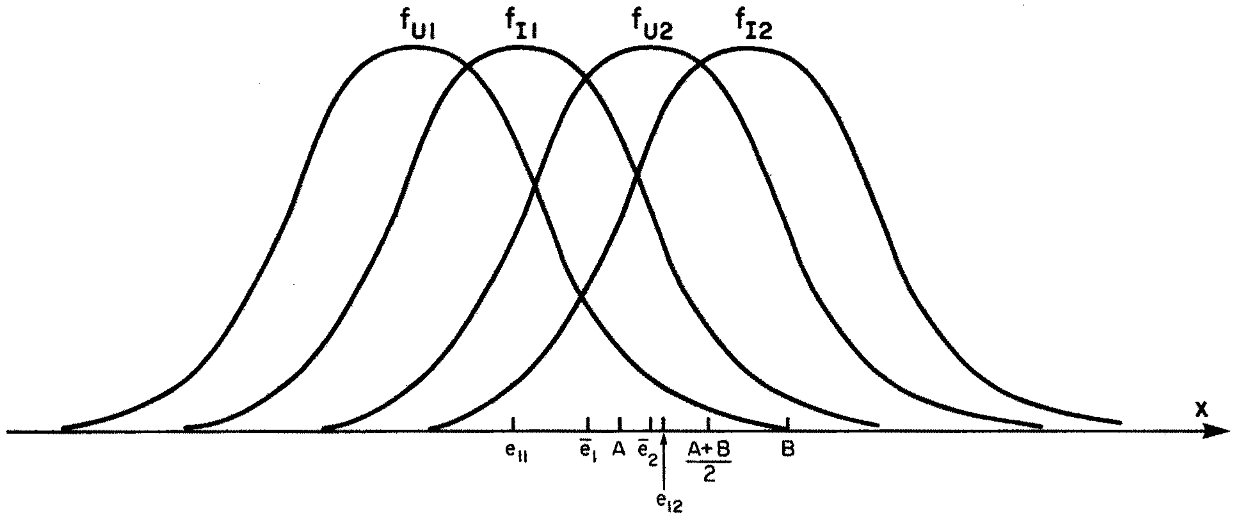
	1st POLL		2nd POLL		3rd POLL	
	A	B	A	B	A	B
INFORMED	30%	70%	30%	70%	30%	70%
UNINFORMED	50%	50%	70%	30%	80%	20%
OVERALL	40%	60%	50%	50%	55%	45%

FIGURE 1

overall straw poll of .40 for A and .60 for B. Now consider an uninformed voter at the point θ. This voter, while not knowing the positions of the candidates, is assumed to know his own position on the issue dimension relative to other voters--that 55% of the electorate most prefer policies to the right of him and 45% prefer policies to the left of him. If this uninformed voter supposes that all other voters are informed, and if he is aware that the interest group at point 0 has endorsed candidate A, he can now infer that the midpoint (A + B)/2 lies to the left of his ideal point. Thus, he infers incorrectly that B is closer to his ideal than is A. Conversely, an uninformed voter at the point ψ can infer correctly that A is closer to his ideal than is B. Overall, then, uninformed voters will, as a group, act as if x' is the midpoint between the candidates, where, in accordance with the initial poll, 40% of the electorate lies to the left of x' and 60% to the right. A second poll will produce a .70 - .30 split among uninformed voters which, when combined with the unchanging vote of informed voters, will produce a .50 - .50 split. This, induces some uninformed voters to update their inferences about (A + B)/2 (those with preferences between the 40 and 50 percentiles such as the voter θ), and induces a third poll that splits the uninformed voters at x'', yielding a poll of .55 - .45, and so on. And, as can be shown, this sequence of polls terminates--is in equilibrium--only when all voters choose as if they possess perfect information.

To extend this approach to more than one issue, we make two modifications in its underlying structure, which we illustrate now in the 1-dimensional context. First, we eliminate the interest group and substitute instead a second group of voters that consists also of informed and uninformed subpopulations. The two groups, then, might correspond to two socio-economic subgroups of the population that pollsters think are important, and hence for which poll results are broken down and published separately. Second, instead of supposing that voters know their relative positions on the issue, we assume that voters know the form of the distributions characterizing each group.

To see now how this information might be used by uninformed voters to formulate and refine their beliefs about (A + B)/2, consider Figure 2. In this figure we represent the distribution of the informed and uninformed subparts of two groups, 1 and 2, and, we suppose again that



	1st POLL A	1st POLL B	2nd POLL A	2nd POLL B
INFORMED 1	85%	15%	85%	15%
UNINFORMED 1	50%	50%	80%	20%
OVERALL 1	67.5%	32.5%	82.5%	17.5%
INFORMED 2	45%	55%	45%	55%
UNINFORMED 2	50%	50%	40%	60%
OVERALL 2	47.5%	52.5%	42.5%	57.5%

FIGURE 2

the candidates' true positions are at A and B. In the first poll, then, uninformed voters split .50 - .50 whereas the informed voters from group 1 vote .85 - .15 for A and B, respectively, while those in group 2 divide .45 - .55. Assuming as before that informed and uninformed are in equal proportion, this produces an overall poll of .675 - .325 in group 1 and .475 - .525 in group 2.

Given his knowledge of the form of each group's overall preference distributions, an uninformed voter can now infer that group 1 is voting as if e_{11} is the midpoint between the candidates that the voters in group 1 "see," while e_{12} is the midpoint Group 2 "sees." The uninformed voter knows, of course, that there is but one true midpoint but also knows that perhaps there are errors in the poll results, if not other uninformed voters. We assume, then, that each uninformed voter takes the poll results by group in conjunction with the knowledge of preference distributions and estimates a *best-fitting midpoint*. In our example, we assume that each uninformed voter estimates a best-fitting midpoint that minimizes the sum, over both groups, of the absolute difference between the observed poll and the poll that results from the assumed midpoint. In the figure, this results in a midpoint at $\bar{e}_1$. (In the next section we address the problems associated with nonuniqueness of $\bar{e}_1$.)

Assume now that uninformed voters, when polled a second time, base their responses on $\bar{e}_1$. This produces, in Figure 2, a poll in which the uninformed in group 1 divide .80 - .20 and a division in group 2 of .40 - .60. Overall, then, since informed voters do not change, the reported polls give A 82.5% of the vote in group 1 and 42.5% of the vote in group 2. These two poll results yield a best-fitting bisector at $\bar{e}_2$, which is closer to (A + B)/2 than is $\bar{e}_1$. Again, what we show in the next section is that if we satisfy certain assumptions about preferences and preference distributions, a unique equilibrium to this process exists--a unique poll that reproduces itself-- in which all voters choose as if they possess perfect information about the candidates' positions.

2. THE MULTIDIMENSIONAL EXTENSION FOR VOTERS

We begin with a set, N, of *voters* and a set $X \subseteq R^m$ of *outcomes* or policies over which each voter $\alpha \varepsilon N$ possesses a Euclidian utility function $u_\alpha : X \to R$. That is, for all $\alpha \varepsilon N$, $\exists$ $y_\alpha \varepsilon X$ such that $u_\alpha(x) = - || x - y_\alpha ||$, where y_α represents voter α's ideal point in X. We assume that N can possibly be an infinite set, which is a mathematically convenient way of modeling large numbers of voters. Next, we assume that N can be partitioned into two subgroups, I and U, representing *informed* and *uninformed* voters. Further, we can assume that t subpopulations, $N_1, N_2, \ldots, N_t$ of N, can be identified and that each voter is a member of one or more of these subpopulations. In addition to voters, we let $K = \{1,2\}$ be the set of candidates. And if $k \varepsilon K$ is the candidate under consideration, we let k denote his opponent.

We can now define an election game in which a voter's strategy is to choose one candidate or the other or to abstain, and a candidate's strategy consists of choosing a point in the set X. Notationally, let $b_\alpha \varepsilon K \cup \{0\} = B$ denote voter α's strategy or "ballot" (here $b_\alpha = 0$ denotes abstention) and $s_k \varepsilon X$ be candidate k's position. Then $s = (s_1, s_2) \varepsilon X^2$ denotes the vector of candidate strategies, $b = (b_1, \ldots) \varepsilon B^N$ denotes the vector (possibly infinite dimensional) of voter ballots, and (s,b) denotes the vector of strategies of all players.

Given (s,b) we can now compute a *poll outcome*. That is, for the electorate as a whole and for each of the t subgroups, we let

$$V_k(s,b) = \{\alpha \varepsilon N \| b_\alpha = K\}$$

$$v_k(s,b) = \mu(V_k(s,b))$$

$$p_{ik}(s,b) = \mu_i(V_k(s,b))$$

where μ is a measure on the measurable subsets of N such that $\mu(C)$ represents the "number of voters in C" and, for each subgroup $1 \le i \le t$, μ_i is the conditional probability measure induced on the subsets of N_i. That is, $\mu_i(C) = \mu_i(C \cap N_i)/\mu_i(N_i)$ is the "proportion of the voters in N_i who are in C." Thus,

$$p_i(s,b) = (p_{i0}(s,b), p_{i1}(s,b), p_{i2}(s,b))$$

denotes the poll in group 1--the proportion of voters in group 1 abstaining, voting for Candidate 1 and for Candidate 2, respectively. Further, we write

$$p(s,b) = (p_1(s,b), \ldots, p_t(s,b))$$

to represent the poll. Clearly, any poll is in the set Δ^t, where Δ is the unit simplex in R^3. We next define the *outcome function* as $k(s,b) =$ 1,2 or 0 depending on whether Candidate 1 or 2 wins or the election is a tie. The payoffs to the players in the election game now are $M_\alpha(s,b)$ for voters and $M_k(s,b)$ for candidates, where

$$M_\alpha(s,b) = u_\alpha(s_{k(s,b)})$$

and

$$M_k(s,b) = \begin{cases} 1 & \text{if } k(s,b) = k \\ -1 & \text{if } k(s,b) = \bar{k} \\ 0 & \text{otherwise} \end{cases}$$

Turning to the beliefs of the players in this election game, we let H denote the set of all hyperplanes in X and $h \in H$ be a particular element in H. Thus, any hyperplane $h \in H$ is identified by a vector $z \in R^n$ with $||z|| = 1$ and a scalar $c \in R$, and can be written $h = (z,c)$. Given $h = (z,c) \in H$, we write $h_0 = \{x \in X | x \cdot z = c\}$, $h_1 = \{x \cdot\in X | x \cdot z > c\}$, and $h_2 = \{x \in X | x \cdot z < c\}$ for the hyperplane and the corresponding positive and negative open half-spaces defined by it. Since we have assumed Euclidian preferences, a choice of strategies by the two candidates defines a bisecting hyperplane

$$h(s) = \left(\frac{s_1 - s_2}{||s_1 - s_2||}, \frac{||s_1|| - ||s_2||}{2||s_1 - s_2||}\right)$$

such that all voters with ideal points in h_k prefer candidate k, and all voters with ideal points in $h_{\bar{k}}$ prefer the opponent. Thus, h defines the "supporting coalitions," h_k, for each candidate, k. We also know, of course, that the candidate strategies giving rise to a particular h are not unique. Nevertheless, given a *belief* about h and knowledge of one's own policy preferences, each voter can establish a ranking over the candidates and can act, with his ballot, to maximize utility by choosing the candidate highest in this ranking.

We assume, then, that each voter has a belief $\tilde{h}^{\alpha} \in H$ about the bisecting hyperplane h. We let $\tilde{h} = (\tilde{h}^{1}, \ldots)$ be the vector of voter beliefs. But, on what basis do uninformed votes establish beliefs about h? Suppose $\tilde{h}^{\alpha}$ is a particular belief by voter α about the separating hyperplane between the candidates. This hyperplane, in conjunction with a knowledge of how preferences are distributed within each subpopulation $1 \le i \le t$, gives rise to a *predicted poll* by voter α among each group, which we denote

$$\hat{p}_i(\tilde{h}^{\alpha}) = (\hat{p}_{i0}(\tilde{h}^{\alpha}), \hat{p}_{i1}(\tilde{h}^{\alpha}), \hat{p}_{i2}(\tilde{h}^{\alpha}))$$

where $\hat{p}_{ik}(\tilde{h}^{\alpha}) = \mu_i(\tilde{h}^{\alpha}{}_k)$. We write $\hat{p}(\tilde{h}^{\alpha}) = (\hat{p}_1(\tilde{h}^{\alpha}), \ldots, \hat{p}_t(\tilde{h}^{\alpha}))$, and, for any $p \in \Delta^t$,

$$||p - \hat{p}(\tilde{h}^{\alpha})|| = \sum_{i=1}^{t} |p - \hat{p}_i(\tilde{h}^{\alpha})|$$

Then for any $p \in \Delta^t$, we define $H(p) \subseteq H$ to be the set of hyperplanes in H which generate polls that are "closest to" the poll p, i.e.,

$$H(p) = \{h \in H |\ h \text{ minimizes } ||p - \hat{p}(h)||\}$$

<u>Definition 1:</u> *A voter equilibrium, conditional on* $s \in X^2$ is a pair $(b, \tilde{h}) \in B^N \times H^N$ such that for all $\alpha \in N$, $k \in K$

i. If $y_{\alpha} \in \tilde{h}_k{}^{\alpha}$, $b_{\alpha} = k$.

ii. if $\alpha \in I$, $\tilde{h}^{\alpha} = h(s)$

if $\alpha \in U$, $\tilde{h}^{\alpha} \in H(p(s,b))$

In this definition, condition i states that given his belief about the hyperplane separating the candidates, voter α votes for the candidate on the same side of the hyperplane as is his ideal point. This corresponds to the behavior he would adopt if he is maximizing expected utility subject to his beliefs. Condition ii for informed voters states that the belief is identical to the true bisecting hyperplane. For an uninformed voter, on the other hand, this condition requires that he choose $\tilde{h}^\alpha$ to make his predicted poll correspond as closely as possible to the observed poll. In effect, each uninformed voter believes that few other voters are making errors.

Definition 2: A voter equilibrium $(b,\tilde{h})$ conditional on $s \in X \times X$ *extracts all available information* if, for all $\alpha \in N$, $k \in K$,

$$y_\alpha \in h(s) \Rightarrow b_\alpha = k$$

Thus, a voter equilibrium extracts all available information if all voters vote for the candidates they would prefer if they knew the specific strategies of the candidates.

Next, we define, for any $C \subseteq N$, and $s \in \underline{S}$, the poll $\hat{p}^C(h)$, with components $\hat{p}^C_{ik}(h) = \mu_i(\hat{h}_k \cap C)/\mu_i(\hat{C})$. Clearly $\hat{p}(h) = \hat{p}^N(h)$. The poll $\hat{p}^C(h)$ can be thought of as the predicted poll among the members of C, if all voters voted correctly.

Definition 3: A poll $p \in \Delta^t$ is *consistent for* $C \subseteq N$ if there exists an h $\in$ H such that $p = \hat{p}^C(h)$. The poll is *consistent* if it is consistent for N.

A poll is consistent for C, therefore, if the poll results restricted to C could have been generated by a pair of candidate positions with all voters in C voting as if they had perfect information. For our results, we need an assumption on consistent polls which requires that each consistent poll be generated by a unique $s \in X^2$. This condition is generally met if the number of subpopulations, t, is at least one more than the number of dimensions and if all the distributions are continuous and invertible.

Assumption 1: If p is consistent for C = N, I or U, and $h,h' \in H$

satisfy $p = \hat{p}^C(h) = \hat{p}^C(h')$, then $h = h'$.

Now, given any fixed candidate positions s, we can define the correspondence $T : \Delta^t \to \Delta^t$ by setting

$$T(p) = \text{Co}\ \{p' \in \Delta^t |\ \text{for some } h' \in H(p),$$

$$p_i' = \mu_i(I)\ \hat{p}_i^I(h) + \mu_i(U)\ \hat{p}_i^U(h')\}.$$

Thus, T(p) is the set of polls that could result when all voters vote optimally according to their beliefs, generated by $\tilde{h}$, and their beliefs are consistent with the information p. It follows easily that any voter equilibrium must be a fixed point for the above correspondence, i.e., if $(b,\tilde{h})$ is an equilibrium with respect to $\underline{s}$, then if $p = p(s,b)$, we must have

$$p \in T(p)$$

We can now state a lemma that is close to the result we seek (see McKelvey and Ordeshook, 1984c for a proof). This result also implies as a special case our result of (1984b), discussed in Section 1. Namely, in the 1-dimensional model, with one group plus endorsement, as long as the distributions of voter ideal points are invertible, all equilibria extract full information. This is immediate from the following lemma since, in this case, all polls are consistent.

<u>Lemma 1</u>: Given fixed strategies, $s \in X^2$, with $s_k \neq s_{\bar{k}}$, there exists a voter equilibrium that extracts all information. Further, under Assumption 4.1, any voter equilibrium, $(b,\tilde{h})$ based on s for which p(b,s) is consistent, extracts all information.

For our central result, we introduce a stronger assumption on the distribution of voter ideal points.

<u>Assumption 2</u>: (Identical Distributions). For all $h \in H$,

$$\hat{p}^I(h) = \hat{p}^U(h) = \hat{p}(h)$$

Thus, this assumption requires that in all directions the cumulative density functions of the ideal points for the informed and uninformed voters in each group must be identical, and they must agree with the cumulative density functions of the ideal points of that entire group.

Theorem 1: If Assumptions 1 and 2 are met, and if $\mu_i(U) < \frac{1}{2}$ for all $1 \leq i \leq t$, then for any fixed candidate strategies $s \in X^2$ with $s_k \neq s_{\bar{k}}$, if $(b,\tilde{h})$ is a voter equilibrium, it extracts all information. (See McKelvey and Ordeshook, 1984c, for proof.)

3. A COMMENT ON ASSUMPTIONS

The preceding section presents several implicit assumptions that simplify notation, but are unnecessary for the functioning of the model, and at least one assumption that, if weakened, must be done so carefully.

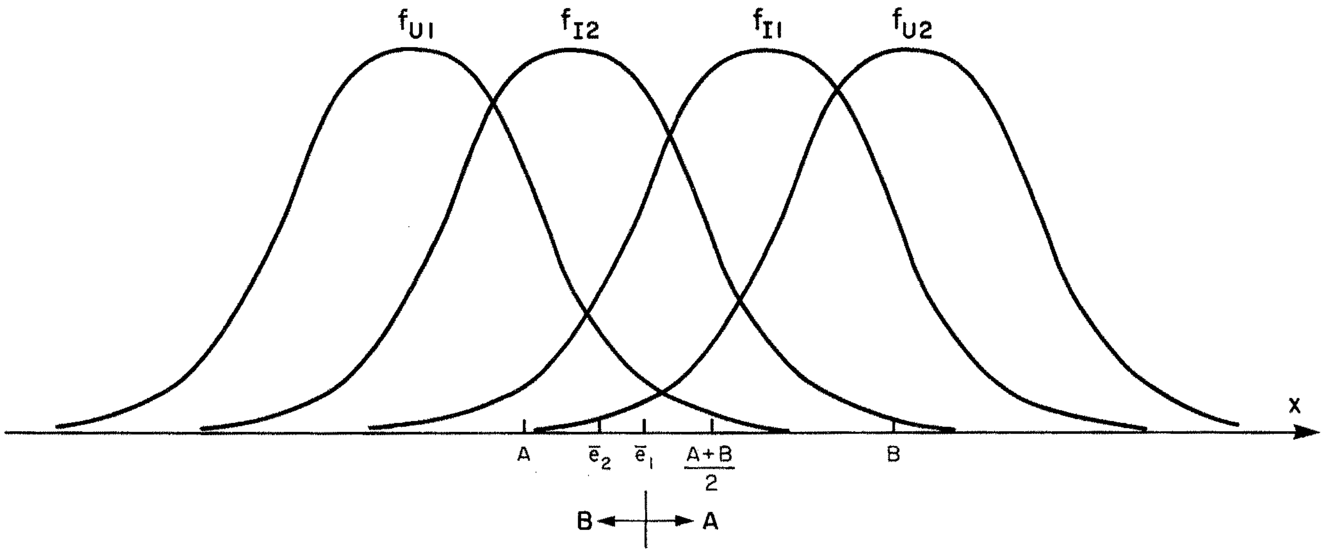
First, implicitly we assume that all uninformed voters know the distribution of preferences of *all* t subpopulations. In fact, if there are m issues the uninformed voter needs only to know the distributions of $m + 1 \leq t$ subpopulations. Hence, while our formal development supposes that uninformed voters know "nearly as much" as candidates, they can in fact know considerably less.

This possibility, moreover, renders more palatable the explicit assumption that uninformed voters are outnumbered by informed voters. Rather, we need to suppose that the informed outnumber the uninformed for those subpopulations used to formulate the belief $\tilde{h}$. In effect, we are assuming that the uninformed cue off of "smarter" groups in the electorate or that the "opinion elites" in society are informed.

The analysis, however, can be extended yet further. For example, let there be two issues and $t > 2$ subgroups. Additionally, let only 3 subgroups, say 1, 2, and 3 satisfy the assumption that they contain more informed than uninformed. Finally, let groups 4, 5 and 6 cue off of these first three groups, let groups 7, 8, and 9 cue off of groups 4, 5, and 6, etc. In this hierarchical arrangement, of course, information will be transmitted from one set of groups to the other so that, if all of our other assumptions are satisfied, the full information equilibrium is the unique equilibrium.

A more crucial explicit assumption, however, is that the informed and uninformed are identically distributed within each subpopulation. While it may be possible to weaken this assumption, the following example in Figure 3 reveals that we must impose a structure on the distributions. Specifically, in this figure note that the informed mean of group 1 lies between the uninformed and informed means of group 2 and that the order of the means for informed and uninformed is reversed between the two groups. Assuming now that the candidates are at A and B, the first poll produces a .475 - .525 division in group 1 and a .65 - .35 division in group 2. The best-fit bisector then is $\bar{e}_1$. However, this best fit incorrectly identifies the relative positions of the two candidates and indicates that B is to the left of A. This is because, while the mean preference of group 1 is to the right of the mean of group 2, the informed voters, who drive the initial poll, have means that are ordered just the opposite. In the second poll, then, the majority of uninformed voters in group 1 erroneously vote for B, while almost all uninformed voters in the second group erroneously vote for A. This, in turn, produces a second best-fit bisector at $\bar{e}_2$, which is farther still from the true bisector and which still reverses the polarity of the candidates. The eventual equilibrium to this situation thus fails to induce voting in accord with perfect information.

Some weakening of the assumption of identical distributions between informed and uninformed nevertheless appears plausible. For instance, the example in Figure 2 converges to a full information equilibrium even though the assumption is not satisfied. For another example consider Figure 4 which denotes the mean preferences of the informed and uninformed parts of three subpopulations and which is particularly interesting because it approximates the context of the experiments we describe in the next section. Note in particular that the means of the uninformed are different in each group from the means of the informed. Next, we assume that the distribution of preferences within each subpopulation is given by the bivariate log normal distribution. Assuming finally that h^* corresponds to the true bisecting hyperplane between the two candidates, the sequence of hyperplanes h^1 through h^4 corresponds to



	1st POLL		2nd POLL	
	A	B	A	B
INFORMED 1	45%	55%	45%	55%
UNINFORMED 1	50%	50%	20%	80%
OVERALL 1	47.5%	52.5%	32.5%	67.5%
INFORMED 2	80%	20%	80%	20%
UNINFORMED 2	50%	50%	90%	10%
OVERALL 2	65%	35%	85%	15%

FIGURE 3

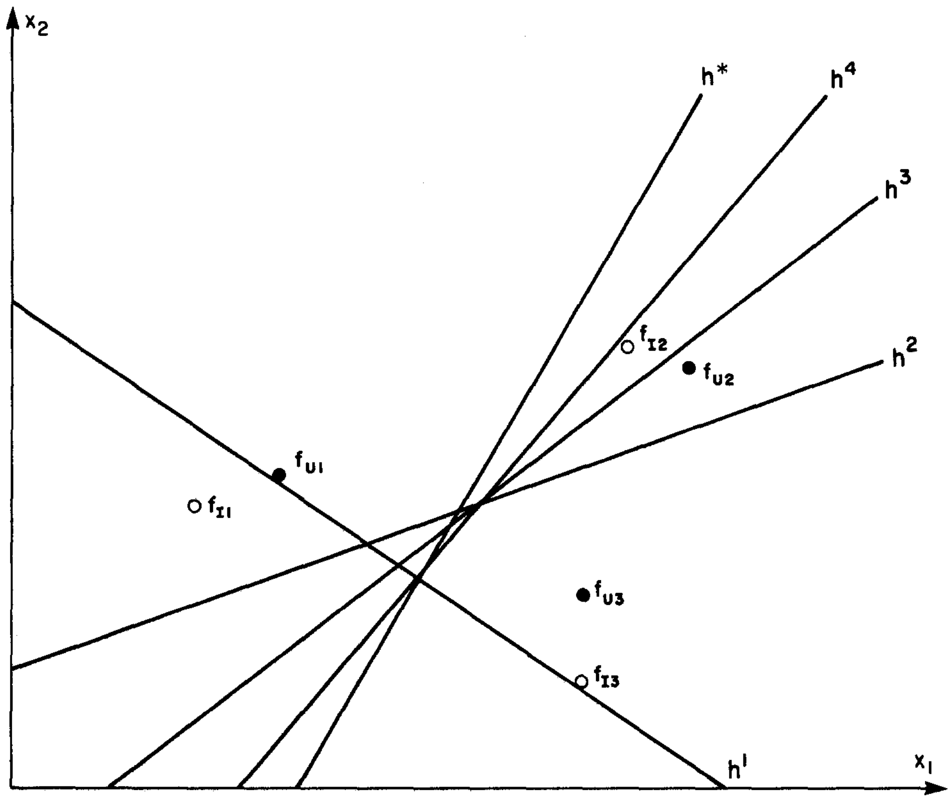


FIGURE 4 SEQUENCE OF BEST FITTING BISECTING LINES

the sequence of the best-fitting bisectors, beginning at h^1, in which informed voters vote correctly and uninformed voters are initialized to vote exactly opposite the way they should under full information. In each successive poll, uninformed voters in period t vote according to h^{t-1}, leading to a new poll $p^{t+1} \in T(p^t)$. That this sequence converges to h^* despite this extreme initial condition generating h^1 and despite the fact that the distributions of the informed and uninformed do not coincide gives us hope for a generalized analysis which would relax Assumption 2.

4. EXPERIMENTS

The preceding theoretical developments show that the assumption of perfect information is unnecessary for the attainment of an election equilibrium at the median voter's ideal point. We can appreciate, however, skepticism over the question of whether real voters in real elections can make the appropriate inferences from polls and act accordingly. In this section we examine experimental results that, while not confirming the empirical validity of our model, at least give us confidence that the model provides a plausible scenario of how people could use the information available to them in an election.

We report specifically on three experiments designed to match the theoretical conditions of our model as closely as possible. The first uses 71 undergraduates from California Institute of Technology. The subjects of the second experiment, 55 in all, are principally masters students at Carnegie-Mellon University's Graduate School of Industrial Administration. The third experiment uses 91 undergraduates, also from Carnegie-Mellon University. While we do not contend that this sample is representative of voters in any election, we would argue that if little or no support is found for the model using this pool under controlled experimental conditions, then it is unlikely that our model possesses much empirical value.

Experimental design

Each experiment is conducted in a large classroom or auditorium. After the instructions are read (see Appendix A for text), a brief quiz is handed out to all subjects (see Appendix B). The quizzes are then collected and individual consultations are given to subjects who have not completed the quiz correctly. Generally, the reading of the instructions and administration of the quiz takes from 45 minutes to an hour. Two subjects are then selected (from volunteers) to act as candidates; the remaining subjects are assigned voter numbers and given their worksheets and a sheet of graph paper (see Appendix C for samples). The graph paper identifies for each subject his or her ideal point and, via a series of concentric circles (indifference curves) about this ideal point, the rate (linear) at which the subject's payoff declines as points farther from the ideal are selected. The worksheet tells the subject whether he or she is an informed or uninformed voter and, for purposes of tabulating poll results, which of *three* groups the subject is a member of. The subjects are then given the mean location of the ideal points of each group and are asked to plot each of those means on their graph paper.

Each experiment consists of several periods. The number of periods is dictated by an approximate three-and-a-half-hour time limit. The California Institute of Technology experiment (CIT1) consists of 6 periods, the first Carnegie-Mellon experiment (CMU1) consists of 9 periods, and the second Carnegie-Mellon experiment (CMU2) consists of 7 periods. After the two candidates select their positions at the beginning of each period, the positions are coded and announced to all subjects. Only candidates and informed voters, however, possess the information to decode the positions. Voters must then vote three times in each period. The first two votes are to be interpreted as polls, while the third represents the actual election and determines which candidate wins the election in that period. After each vote the results are tabulated and announced by group. That is, for each group, subjects are told what percent, of those indicating a preference, voted for candidate A and what percent voted for B. They are also told what percent within each group abstained (abstention is not permitted in the third and final vote). After the final vote in a period, the winning candidate and the actual vote margin are announced. The candidates can then adjust their positions, and the experiment proceeds to the next period. We note here that uninformed voters do not learn of the candidate's positions in any period until the entire experiment is terminated. Only informed voters and the two candidates know the sequence of candidate positions. Hence, the uninformed voters cannot use the outcome of one period to infer candidate positions in subsequent periods.

At the termination of the experiment, the sequence of candidate positions is announced to all subjects so that they may compute their payoffs. The subjects are paid in cash and, for voters, the payoffs range between $15 and $45 with an average of approximately $25 per subject. Candidates are paid on the basis of the elections they won, with the payoffs varying between $15 and $70 per subject.

The induced preferences

The distribution of voter ideal points used in the experiments is shown in Figure 5. This figure corresponds to the preferences in the largest experiment (experiment CMU2), which had 89 voters. Experiment CIT1 was run with voters 1 through 69 and experiment CMU1 with voters 1 through 53. The voters were each assigned to one of three groups, as indicated in the figure, according to the region they were in. Also, each voter was either informed or uninformed. The informed voters are denoted with a point and the uninformed with an "x."

The preference configuration is designed so that in all three experiments, there is a core for the informed voters and also a core for the population as a whole. The informed core in all cases is at the point I = (40,40), whereas the total core is at T = (60,50). Thus, if uninformed voters end by voting randomly, we would expect candidates to converge to I, whereas if they end by extracting all information, we would expect candidates to converge to T.

The theoretical model we review in the previous section is concerned solely with voters. Since we are concerned ultimately, however, with how democratic institutions function with incomplete information, the strategies adopted by the candidates are of interest as well. We look at these data separately, first considering voters and then candidates.

Voters

If the theory were to predict accurately the behavior of all voters, then we would expect Theorem 1 to apply, and all voters would extract

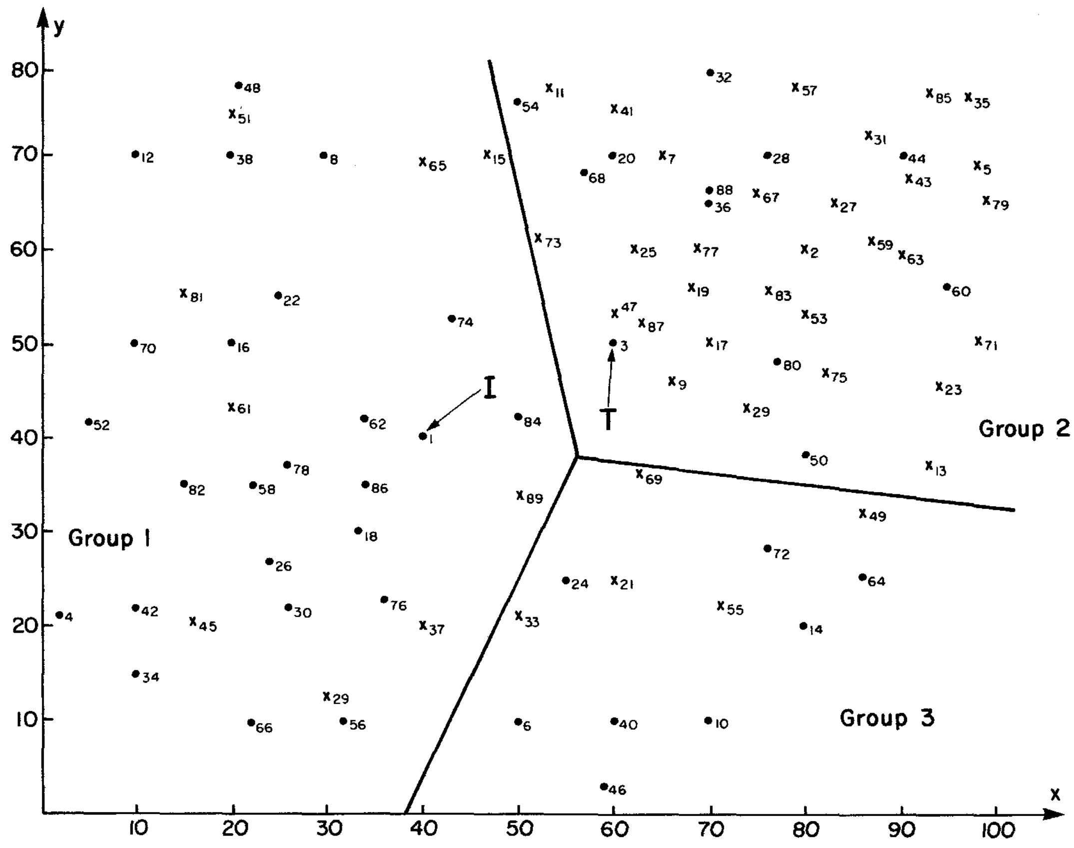


FIGURE 5 DISTRIBUTION OF VOTER IDEAL POINTS FOR EXPERIMENTS CIT1, CMU1, CMU2

Table 1

Successes and Errors under the Full Information Model
(final votes only)

Informed Voters

	Correct		Errors	
CIT1	98.1&	(206)	1.9%	(4)
CMU1	89.7	(218)	10.3	(25)
CMU2	92.8	(292)	7.2	(23)
Total	93.4%	(716)	6.6%	(52)

Uninformed Voters

	Correct		Errors	
CIT1	82.4%	(168)	17.6%	(36)
CMU1	77.4	(181)	22.6	(53)
CMU2	82.8	(255)	17.2	(53)
Total	81.1%	(604)	18.9%	(142)

all available information about candidate positions and finish by voting as if they had complete information. Thus, the uninformed voters should be indistinguishable in their voting behavior from the informed voters, and we should have, for all $\alpha \varepsilon N$,

$$y_\alpha \varepsilon h(s) \Rightarrow b_\alpha = k \tag{4.1}$$

(See Definition 2.) We call this model the "Full Information" model.

Table 1 shows the number of successes and errors in each of the three experiments for both the informed and uninformed voters. We look at the final election in each period only, when all voters are required to vote. As we see from this table, in experiments CIT1 and CMU2, the uninformed voters vote correctly about 82% of the time, while in the CMU1 experiment the percentage is 77%. This averages to about 81% correct voting by the uninformed voters. This compares to an average of about 93% correct voting among the informed voters.

Clearly, the uninformed voters do not vote randomly. The proportion of correct votes is significantly greater than 50% at the .01 level or below in all three experiments. The 81% correct voting is impressive given the small amount of information the uninformed voters have available. (We emphasize that given our procedures, uninformed voters never learn the exact positions of the candidates until the termination of the experiment.)

While the uninformed voters do quite well, it is clear that they are not able to vote as consistently correct as the informed voters. Their error rate is significantly higher than that of their informed counterparts in every experiment. So the "Full Information" model does not give the whole story.

There are two reasons why the "Full Information" model is not completely successful in explaining our data. The first is that the full-information equilibrium is what should be expected after a large number of polls, whereas we have only two polls prior to the final vote in each period. As illustrated in Table 2, the percentage of correct votes increases from 58% in the first vote to 79% in the second and 81% in the final vote, so the uninformed voters also seem to "learn" the correct vote as they obtain more poll information, as is predicted by the theory. It is impossible to tell how well the uninformed voters might have done if more polls had been taken prior to the final vote. The explanation for the 58% correct voting in the first vote (which is significantly greater than 50% at $p = .048$), may be that after the initial period, those uninformed voters who vote in the first poll support candidates who they inferred adopted favorable positions in the previous election. There is enough stability in candidate positions to make this type of behavior yield correct votes more frequently than 50% of the time. (In the first period, over all three experiments, only 48% of those expressing a preference in the first poll ($n = 25$) voted correctly.)

The second, and perhaps more important reason that the "Full Information" model is not completely successful is due to a "compounding of errors." If we look at the voting decision from the point of view of any one uninformed voter, the only information he had in the final vote is that from the previous poll. If other voters have made errors in the previous polls, then the inferences that a given voter makes about the candidate positions would also be wrong. We cannot expect the voter to extract more information than has been given him. Thus, for any given

Table 2

Successes and Errors Under the Full Information Model by Poll

	Uninformed Voters					
	Correct		Errors		Total % Voting	
Poll #1	57.7%	(75)	62.3	(55)	17.2	(130)
Poll #2	78.5	(365)	21.5	(100)	62.3	(465)
Final Votes	81.1	(604)	18.9	(142)	100.0	(748)

voter, a better test of whether he obeys the model is whether or not he votes correctly *given the information available to him*. For any $\gamma \varepsilon U$, if b^t is the vector of ballots at poll t, and s* is the vector of candidate positions in the period, we should have

$$y_\alpha \varepsilon \tilde{h}_k^\alpha \Rightarrow b_\alpha^t = k \qquad (4.2)$$

where $\tilde{h}^\alpha \varepsilon H(p^*)$, with $p^* = p(s^*,b^{t-1})$. (See Definition 1.) We call this the "Dynamic Model." To test this possibility, we use the results of the second poll, assume a lognormal distribution of preferences for each group, with appropriate mean and variance, and estimate a best-fitting bisector for the candidates. Using this bisector against the true bisector we can then identify which voters are choosing correctly, given the information contained in the second poll. These results are reported in Table 3.

This table reveals a significant improvement in the performance of the uninformed voters. (Using a sign test for matched pairs on the total sample, 54 of 74 differences are in the correct direction, which is significant at level p = .00004.) And while this performance is still considerably lower than that of the informed subjects, it does give strong evidence of information content in the votes of the uninformed voter.

A closer look at the data also reveals which uninformed voters are

Table 3

Successes and Errors Under the Dynamic Model
final votes only, with voters using poll results from second poll

Uninformed Voters

	Correct		Errors	
CIT1	84.3%	(172)	15.7	(32)
CMU1	83.3	(195)	16.7	(39)
CMU2	88.0	(271)	12.0	(37)
Total	85.5	(638)	14.5	(108)

the source of error. Specifically, the errors are not distributed uniformly across all voters but are concentrated in a few subjects who never learn what is going on in the experiment and in those subjects who are closest to the true bisecting line and, hence, have the most difficult inferences to make. Table 4 shows, for example, that in the CIT1 experiment uninformed voters who voted correctly were, on average, 20 units from the bisector dividing the candidates, whereas uninformed voters who voted incorrectly were, on average, closer by half to this bisector; furthermore 21% (7 of 34) of the uninformed voters account for half of all errors.

That uninformed voters vote randomly, however, is not a particularly compelling null hypothesis against which to compare the predictions of our model. Consider instead two simple behavioral heuristics: the first heuristic requires voters to vote with the majority preference of their group, the second specifies that they should vote with the majority preference of the group whose mean preference is closest to their ideal point. Table 5 shows the number of successes and errors for these hypotheses among uninformed voters in the three experiments and reveals that, with the data of Table 3 in mind, there is little to distinguish between either null hypothesis and the hypothesis that voters use their information to estimate a bisecting line.

Table 4

Experiment	Average Distance from Bisector for Uninformed Voters Voting Correctly	Incorrectly	# of Uninformed Voters	% of Errors They Account For
CIT	20	9	7 of 34 (21%)	50%
CMU1	24	16	5 of 26 (19%)	43%
CMU2	21	12	6 of 44 (14%)	45%

More disturbing still is the fact that these two heuristics are not unreasonable ones to follow. Specifically, if all uninformed voters simply voted with their group, then, given the candidates' true positions, these voters would have voted correctly 80% of the time in the CIT1 experiments, and 78% and 84% of the time in each of the two respective CMU experiments. Similarly, voting with one's closest group would have produced correct voting rates of 80%, 80%, and 86%. All of these numbers compare favorably with the observed rates reported in Table 1.

Can we, then, distinguish between the hypothesis of the model and the two null hypotheses? In order to address this question, we ran a probit analysis using the individual vote in the final election as the dependent variable, and with three independent variables, one corresponding to each of the three models. Specifically, we let i represent a particular voter in a particular period and experiment. (So $1 \le i \le 746$.) Then

$$Y_i = \begin{bmatrix} 1 \text{ if } i \text{ votes for candidate } 1 \\ 0 \text{ if } i \text{ votes for candidate } 2 \end{bmatrix}$$

X_{1i} = Distance from i's ideal point to best-fitting hyperplane from poll 2. (Positive if on side closer to candidate 1, negative if on side closer to candidate 2.)

X_{2i} = Percent vote for candidate 1 in poll 2 among group of which i is a member.

X_{3i} = Percent vote for candidate 1 in poll 2 among group whose mean is closest to i's ideal point.

Table 5

Success Rate of Two Null Hypotheses

	% Voting With Their Group		% Voting With Closest Group	
CIT1	84.5%	(173)	82.8	(169)
CMU1	84.6	(198)	85.5	(200)
CMU2	87.3	(269)	89.0	(274)
Total	85.8	(640)	86.2	(643)

The results of the probit analysis are given in Table 6. We see that the results of the three models reverse themselves from the ranking in terms of the percent of votes predicted correctly. Thus, both in terms of the log likelihood function (LL) and the goodness of fit (R^2), the dynamic model by itself does better than either of the group models by itself. This seems to be, for the dynamic model, because errors are concentrated near the dividing hyperplane, and this model does quite well in predicting those that are far from the hyperplane. For the group models, on the other hand, errors are more evenly distributed among the cases when the group splits nearly 50-50 and among those cases when the group goes overwhelmingly for one candidate. The differences among the three models are slight, however. When all three models are estimated in one equation, we see that all three models have significant independent effects, with the coefficient of the dynamic model being the strongest. Overall, then, the results support the conclusion that a good proportion of the voters behave according to the models of this paper, although other more intuitive rules also play a role.

Table 6

Probit Results*

	Dynamic Model	Voting with One's Group	Voting with Closest Group	Combined
α	-.088	-1.79	-1.70	-1.08
	(-1.44)	(-17.4)	(-17.6)	(-7.18)
X_1	.053			.0294
	(15.81)			(6.50)
X_2		.034		.0134
		(17.35)		(3.43)
X_3			.036	.0080
			(17.26)	(1.96)
LL	-285	-290	-292	-256
-2 log L	392.4	383.4	378.6	450.3
R^2	.606	.530	.524	.613
% Correct	.858	.858	.862	.864

*entries in parentheses are z-statistics

Candidates

Our prediction about the behavior of candidates is that it should converge to the multivariate median of the entire electorate. Since our experiments focus on voting, they are less robust with respect to hypotheses about candidate behavior. The voter ideal points were constructed in each experiment so that an overall majority-rule equilibrium exists at the point T = (60,50)--a core if all voters possess perfect information. Moreover, *informed* voters are distributed in both experiments so that the majority-rule equilibrium is I = (40,40) if all uninformed voters vote randomly or if the candidates otherwise ignore these voters.

While our experiments yield observations on the choices of 102 uninformed voters, they provide observations on only 6 candidates. Moreover, in experiment CMU1, one candidate incorrectly plotted the mean position of group 3 by reversing the x and y coordinates. This naturally caused the subject to become totally confused in attempting to interpret the poll outcomes in light of the known positions of both candidates. Consequently, the data from this experiment are of little value in assessing the performance of the candidates. The remaining two experiments are encouraging but hardly conclusive, owing to the small sample size.

Figures 6, 7, and 8 now graph the candidate trajectories for our experiments, where A_i and B_i denote the position adopted by candidates A and B in period i. And, as these figures show, three of the six candidates chose, in general, positions considerably closer to T than to I. Moreover, a modest argument can be made that these three candidates are converging, albeit erratically, towards the overall majority-rule equilibrium.

From experiments conducted in different information contexts than those considered here (McKelvey and Ordeshook, 1984a,b), we make the conjecture that 6 to 8 periods are too few to adequately evaluate the hypothesis of convergence. Even in a full-information setting, convergence often takes longer than this number of periods. Nevertheless, these outcomes encourage the conjecture that, in the long run, the information given subjects herein may be sufficient for them to approach an overall majority-rule equilibrium point as their election strategy.

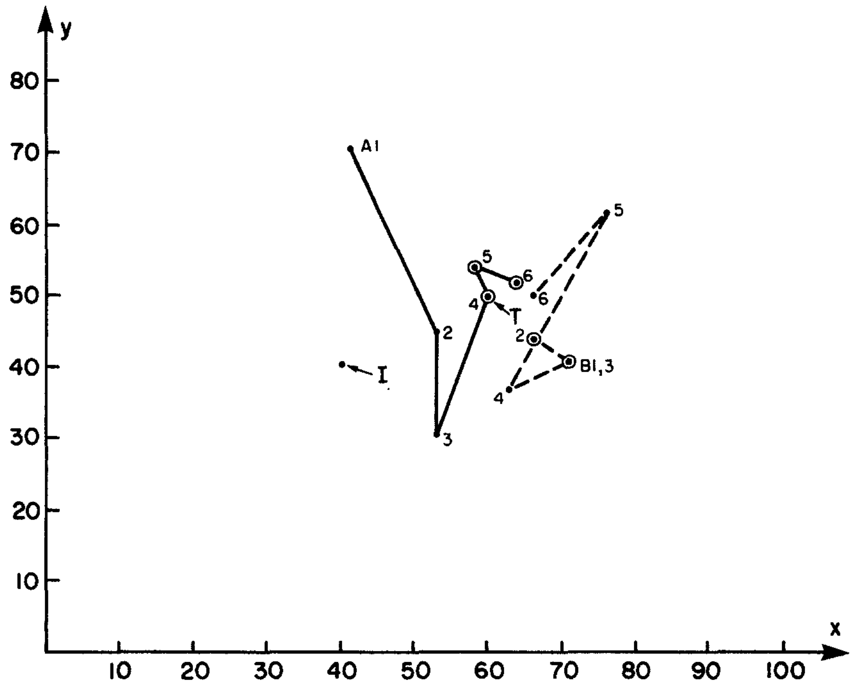


FIGURE 6 CANDIDATE TRAJECTORIES, CIT1

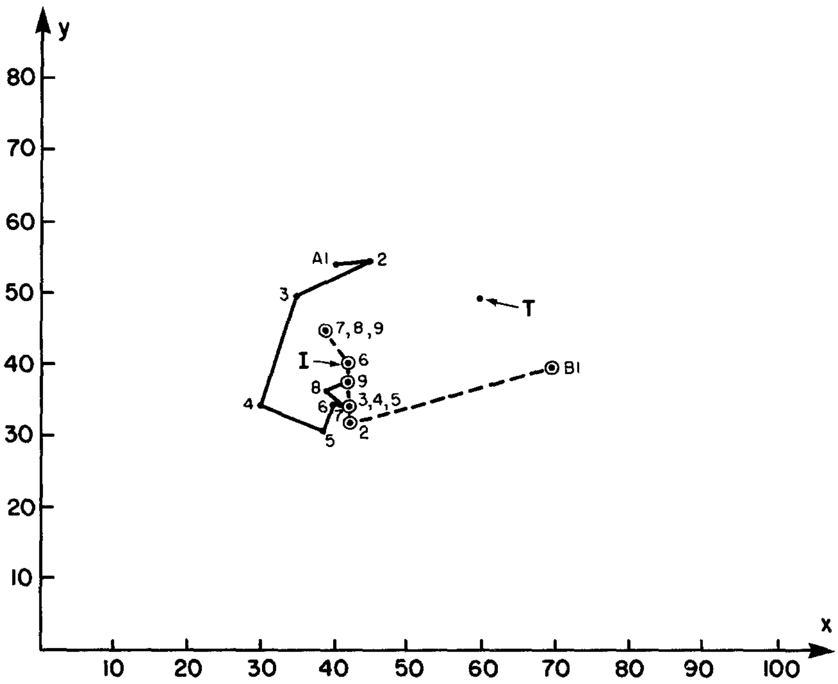


FIGURE 7 CANDIDATE TRAJECTORIES, CMU1

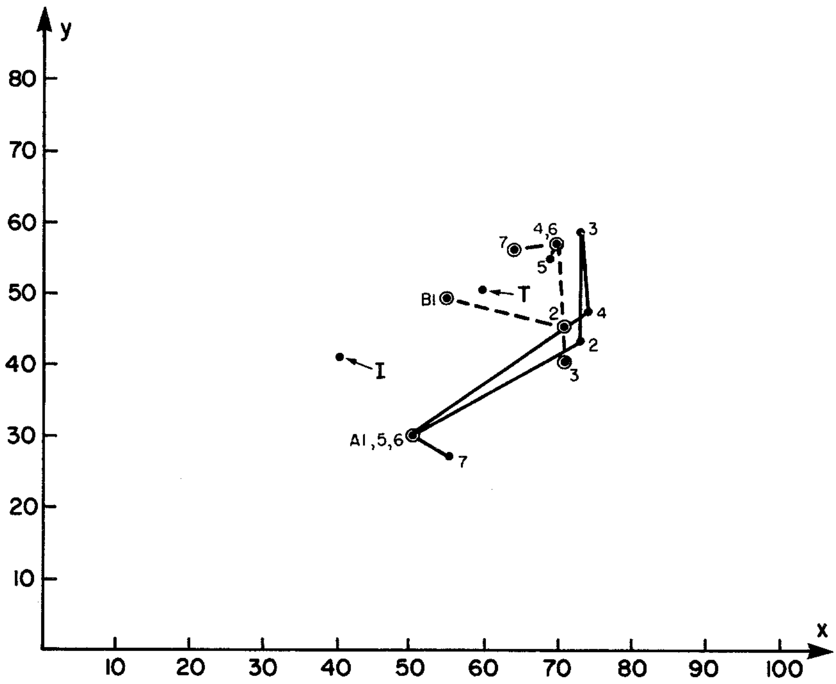


FIGURE 8 CANDIDATE TRAJECTORIES, CMU2

5. CONCLUSIONS

While our experimental results do not show convincingly the superiority of our model over alternative hypotheses, these results do not reject the rational expectations approach to handling incomplete information in elections. This is not to say, of course, that our model provides the most appropriate treatment of incomplete information since it relies primarily on one source of information--polls. Certainly, other data exist--such as the historical record of the parties, primary election outcomes, and the coalitions observed at nominating conventions--which voters might use for information on their choices. What we hope our analysis has begun, however, is a more rigorous study of how citizens can interpret such data and the role played by the various media in supplying these data.

Admittedly, the model presented here endows uninformed voters with substantial computational abilities, since even the brightest subjects in our experiments found their tasks challenging. The question arises, then, as to whether we can expect average citizens -- and, in particular, "uninformed" citizens -- to be capable of using polls in the way assumed by our model. Our experiments show only that our model is feasible, not that it describes actual voting behavior. Such questions can be answered only by examining actual election data. Our model, nevertheless, serves as a counter-example to the oft-repeated presumption that our democratic institutions can function "properly" only to the extent that citizens are informed on public issues and the positions of election candidates on those issues. That we do not find citizens conforming or even approximating this normative ideal should not be interpreted to mean that our institutions cannot function as designed.

APPENDIX A

INSTRUCTIONS

2-Issue Rational Expectations With Polls

This experiment is a study of voting in two-candidate elections. As subjects in the experiment, you will each be paid for your participation in the experiment on the basis of the decisions you make. If you are careful, and make good decisions, you can make a substantial amount of money.

In this experiment, there are two candidates, labeled A and B, and the rest of you are voters. The purpose of this experiment is to test certain ideas about how voters and candidates make decisions in elections and, in particular, how they make decisions when their information is imperfect or incomplete. The experiment will consist of a number of elections or periods. In each election the candidates will adopt positions in a two-dimensional policy space. Two successive polls will then be taken in which voters can indicate which candidate they prefer, and the outcome of each poll will be announced. After the second poll, voters will vote for the candidate of their choice, and the outcome of this vote will determine the winning candidate for that election. Candidates will then be permitted to adopt new positions, and the process will repeat itself. Voters are paid for their participation on the basis of their payoff function--to be described in more detail shortly--and candidates are paid for their participation on the basis of how many elections they win.

Before describing the experiment in detail, let me describe the policy space and the payoff function of the voters.

At the beginning of the experiment, voters will be given a chart similar to the sample chart in front of you. This chart depicts the policy space and a sample payoff function for a voter. Candidates will be given a similar chart. However, the candidate chart will only contain the policy space, and will not have *any* voter payoff functions. The policy space is a two-dimensional grid, where the horizontal axis represents the first issue--issue x--and the vertical axis represents the second issue, issue y. During the experiment, in each period, candidates will select positions in this grid or policy space. At the end of each period, each voter will be paid for his or her participation in that period on the basis of his payoff function and the position of the winning candidate. As the sample indicates, a voter's payoff function is described by a series of concentric circles, where circles of smaller radius correspond to higher payoffs. The center of these circles is the voters "ideal point," or point of maximum payoff. The numbers on each circle indicate the voter's payoff for points *on* that circle. Payoffs associated with points between two circles are computed by interpolating between the payoffs associated with those circles. Referring to the sample, if the winning candidate were at the position 53x, 37y, then this sample voter's payoff would be approximately $1.70, since this candidate's position is approximately midway between the voter's $1.60 and $1.80 contours.

In the actual experiment, the payoff charts for each of the voters will be different from the sample chart. Further, the payoff functions for different voters may also be different. Each voter will have a payoff function with an ideal point at some point in the policy grid, and his payoff will decrease with the distance we move away from this ideal point in any direction, as in the example in the sample chart. Thus, *all* voters' indifference contours are circles and, thus, all voters prefer the candidate that is closest to their ideal point. However, different voters' ideal points may be at different points in the grid. One important rule in the experiment is that the information on your payoff chart is *private* information. None of the other voters or candidates should know the information on your chart. At no time should you show, talk about, or in any other way reveal any information about your payoff chart to the other subjects. Further, at no time during the experiment are you to have *any* communications with any of the other subjects except those explicitly provided for in the rules.

Are there any questions about the payoff chart? If not, I will proceed to a description of the experiment itself.

The experiment itself is divided into a number of periods or elections. Each period will consist of a sequence of two polls followed by an election. At the beginning of each period, the two candidates, A and B, will each adopt policy positions. These positions will hold throughout that period, and the candidates will not be permitted to modify or change these positions until the next period. The positions adopted by the two candidates *will not be made public*. Rather, you, as voters will selectively be provided with information about the candidate positions. Before the first poll, some of the voters will be informed as to the actual positions of the candidates, while the remaining voters will not be told this information.

After the candidates have adopted their positions, and the voters have been given their information, we will then take a poll of all voters. You may think of this as a Gallup Poll. Voters will be asked to indicate the candidate they *would* vote for, if the election were held now, by filling in their ballot cards and handing them in. On these ballot cards you will be asked to record the election and poll #, your preference for candidate A or B or whether you wish to abstain, your voter identification number, and your group number which will be discussed shortly. We emphasize that abstention is an option only in the polls and that all voters must vote for A or B in each final election. All voting will be done as a secret ballot. The vote will be tallied and announced. After two such polls, we will proceed to the final vote. In this final vote no one is permitted to abstain. Everyone must vote for candidate A or B. These votes will also be cast in secret on the cards provided, and the experimenter will then tally the vote. We will then announce the vote totals and the winning candidate and then proceed to the next period.

In order to selectively give information *only* to some voters, the following procedure will be used. Before each poll, the experimenter will write, on the blackboard, *coded* information about the position of each of the candidates on each issue. You will note on the record sheet (which is the second sheet in the sample packet you have been given) that for each period, and each poll, there is an entry for a *code* for each candidate. If this entry is filled in, you are an *informed* voter in that period and that poll. If it is not, you are uninformed. If you are an informed voter, you may obtain the correct position for the candidate from the coded information on the board. To do so, you just add the code to the coded information on the blackboard. Thus, in the example, if the coded position of candidate A on the board was 106x, 157y, then the correct position of candidate A in the first election is 48x, 34y. Thus, if you are an informed voter, you'll be able to obtain the exact positions adopted by the candidates.

It should be emphasized that all voters will get the *correct* information if they are informed. Further, if you are informed for two successive polls in the same period, then using your code, you will get the *same* information in each period. So it is really only necessary for you to compute the candidate positions once. It is important to emphasize that there is no attempt in this experiment to mislead voters as to the position of the candidates. To emphasize this point, we invite any interested voter, after the experiment, to compare his decoded position with the actual position of the candidates. If there is any discrepancy, you will be awarded a $10 bonus.

Note that for each period there are three possibilities in terms of the information you might receive. You may be an informed voter throughout the period (i.e., for both polls and the final vote), you may be uninformed for the entire period, or you may become informed part way through. On the sample record sheet, these possibilities are represented in periods 1, 3, and 2, respectively.

At this point the task of the uninformed voters might seem an impossible one. However, if you are an uninformed for the entire period you can make use of some additional information to assist you in your decisions. Specifically, each of you, as voters, will be a member of one of three groups--denoted as groups 1, 2, and 3--which you may think of as voters with similar but not necessarily identical ideal points. Your group number appears at the lower right corner of your payoff chart, as illustrated on the sample. (In your actual chart, this will be filled in.)

After each poll, the poll results will be announced, broken down by group. That is, among those voters indicating a preference, you will be told what proportion of voters from each group voted for each candidate [refer to sample]. Note, from the sample, that you are also told what proportion abstained from each group. While none of you will be told the complete distribution of ideal points of voters within each group, or who and how many voters there are in each group, you will be told, as the sample payoff chart indicates, the mean position of the ideal points of each group. Candidates will also be given this information. You can use this information and the fact that it is in the interest of the informed voters to vote sincerely, to formulate your guess about the locations of the candidates and hence to determine your preference for one candidate over the other.

To recapitulate, then, the sequence of events will be as follows. Candidates adopt positions, the experimenter will write the coded positions on the board for the first poll, and the first poll will be taken and announced by group. The experimenter will write the coded positions for the second poll, and the second poll will be taken and announced by group. Then the coded positions for the final election will be written, and the final election will take place. We then proceed to the next period.

After a predetermined number of periods, the experiment will end. At this point, the positions of the winning candidates in each election will be announced, and voters will be paid the sum of their payoffs for the position of the winning candidate in each election. (Note that in each election all voters are paid for the position of the winning candidate, regardless of whether or not they voted for that candidate.) The candidate payoffs are as follows: Each candidate will receive $5 for an election they win and noting for each election lost.

APPENDIX B

QUIZ

For the following questions, imagine that you are a voter with payoff function as on the attached sheet and that you have just completed the second poll in a given period. You were uninformed for the first two polls, and the poll results for the first two polls are given in the table.

1. As an uninformed voter in the first two polls, you were not told the positions of the candidates during these polls. If you assume that most other voters besides yourself were informed in the first two polls, and were voting for the candidate they preferred, which of the possible pairs of candidate positions are consistent with the results of the first two polls?

	consistent	inconsistent
(a) A = (65,45), B = (50,30)	_________	_________
(b) A = (50,30), B = (65,45)	_________	_________
(c) A = (40,40), B = (30,50)	_________	_________

2. Now, you are given the following coded information before the final vote.

A: (143,148)
B: (216,195)

Fill in the entries in the table to determine the position of each candidate, and then mark the position of each candidate on the payoff chart.

3. If you were to vote for candidate B, what would be your payoff in this period if

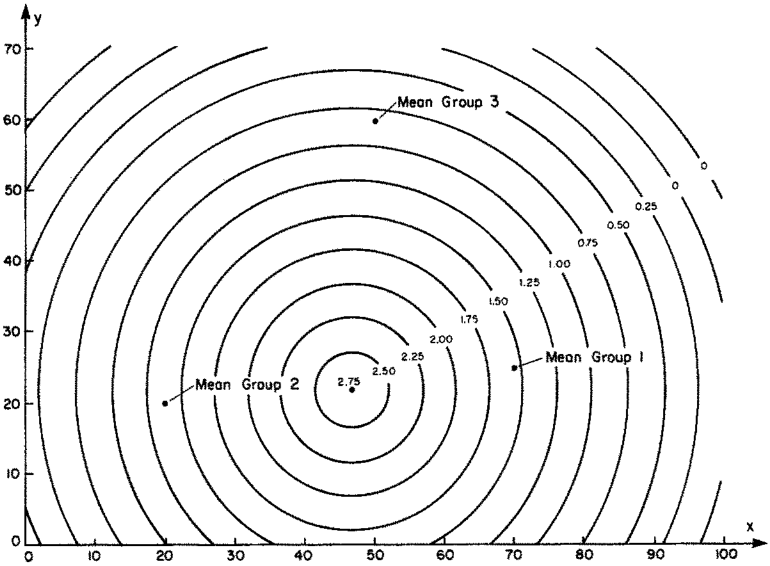
(a) candidate A were to win the election? __________

(b) candidate B were to win the election? __________

4. If all voters were informed in the final election, and all voted in their own best interest, how would voters with ideal points at each of the following point vote? (Check one entry for each row.)

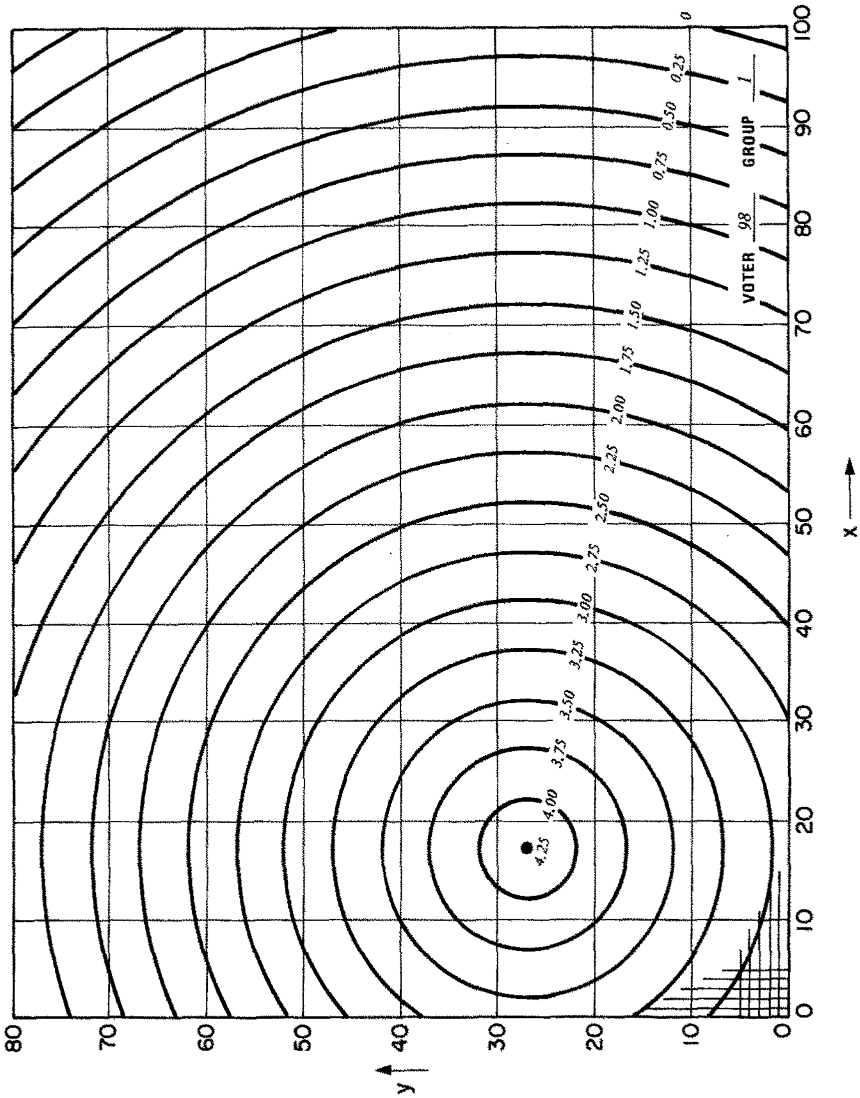
	Ideal Point	A B	Some A Some B
(a)	(30,10)	___________	______
(b)	(80,40)	___________	______
(c)	(40,50)	___________	______

CHART



		POLL 1					POLL 2					FINAL ELECTION				
		CANDIDATE					CANDIDATE					CANDIDATE				
		A		B			A		B			A		B		
PERIOD		x	y	x	y		x	y	x	y		x	y	x	y	
1	INFORMATION															
	CODE											−93	−113	−156	−150	FINAL VOTE
	POSITION															A ____
	GROUP 1 OUTCOME	46%		54%		8%	50%		50%		2%					B ____ WINNER ____
	GROUP2 OUTCOME	90%		10%		9%	95%		5%		4%					POSITION ____ YOUR PAYOFF ____
	GROUP 3 OUTCOME	40%		60%		15%	30%		70%		3%					

APPENDIX C SAMPLE PAYOFF CHART



REFERENCES

McKelvey, R.D. and Ordeshook, P.C.

(1984a) Sequential Elections with Limited Information, California Institute of Technology Working Paper 530.

———— (1984b) Elections with Limited Information: A Fulfilled Expectations Model Using Contemporaneous and Poll and Endorsement Data as Information Sources, *Journal of Economic Theory*, forthcoming.

———— (1984c) Elections with Limited Information: A Multidimensional Model, California Institute of Technology Working Paper 529.