A MODEL OF VOTING BEHAVIOR

FOR

REVEALING PUBLIC SECTOR DEMANDS

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FINANCE

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ABSTRACT

Two major political problems that face every community are:

(1) to determine how much money the local government should spend and, given that quantity as a budgetary constraint;

(2) what percentage of the budget should be allocated to each category of publicly provided goods and services.

A new type of survey instrument, the bidding game, can be used to address the second problem. Community attitudes are revealed by allowing each respondent to spend play money to construct his, or her, preferred budget. The outcomes of these games are utilized to construct a median budget. A mathematical model of political equilibrium suggests that a median budget will win a two way election with any other budget. Preliminary, quasi-experimental results support this hypothesis.

INTRODUCTION

The purpose of local governments is to provide social goods and services to the residents. Publicly provided goods and services generally have two features: costs of these commodities are paid for by individuals residing in the community, and decisions concerning the quantities to be supplied are determined collectively. A single decision must be made by a community composed of many individual citizens, each with differing tastes, varying amounts of wealth and conflicting interests. Quantities and costs must be determined in some manner.

A major problem facing the political process in a community is accurately determining the preferences of citizens concerning how much money they wish local government to spend and, given that quantity as a budgetary constraint, what percentage of that amount should be allocated to each category of publicly provided goods and services. The ultimate welfare could be achieved by the attainment of Pareto-optimal conditions. Determining such preferences is difficult due to the lack of market mechanisms for publicly provided goods and services.

Empirical studies of the demand for goods and services provided by collective decisions have generally examined the relationship between jurisdictional expenditures and various socioeconomic aspects of the constituent population. Typically, these studies depend on a simple

concept of political equilibrium in which the actions of a political jurisdiction reflect the preferences of the median voter, by estimating demand functions based on voting data. Both Barr and Davis (1966) as well as Bergstrom and Goodman (1973) used district voting records, Borcherding and Deacon (1972) employed state voting records, and Deacon and Shapiro (1975) utilized precinct voting records as a basis for attempting to estimate individual citizen's demand functions for publicly provided goods and services.

These empirical studies are greatly handicapped by the problems involved in obtaining voting records. Additionally, little may be revealed about individual preferences by suggested demand functions based on voting records. Finally, these studies are concerned with a single category of public spending emphasizing the private vs. public decision.

What is proposed in this paper is the development of an operational procedure to determine preferences of citizens for publicly provided goods and services. This procedure, a bidding game, will permit individual citizens to reallocate a fixed total budget among several categories of publicly provided goods and services, thus providing data on individual preferences rather than aggregated voting data. Another advantage of this operational procedure is that it forces the respondent to consider trade-offs between different categories of publicly provided goods and services.

The next section of this paper contains a survey of the literature that is used to introduce the reader to the bidding game concept. This is followed by a description of the game board and rules of play that were used in the first test of this procedure. A subsequent section summarizes the quasi-experimental results that were obtained from this study.

THE BIDDING GAME CONCEPT

Guns and Butter Example

Let us assume there is a government that spends money only on guns and butter. In any election, the sole issue is what percent of the budget should be spent on butter. The issue can be thought of as a continuum, representing the allocation of the available government budget between guns and butter (see Figure 1). In this figure, the horizontal axis is calibrated from zero to one-hundred percent of the available budget. The vertical axis indicates the number of voters that want each possible combination of guns and butter. If one candidate's policy were such that the total budget would be apportioned as at point A in Figure 1, his opponent's policy would only have to be further to the left (point B in Figure 1) in order to win the election. During the campaign each candidate tries to

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FIGURE 1 HERE

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find out what the majority of voters want, and then moves closer to the median M of the distribution. The winner of the election is the candidate whose policy was the nearest to the median on the day of the election. Since both candidates realize this, they would compete to get as close to M as possible.

The Potential for Statistical Analysis

This model of voting behavior should lend itself to statistical analysis. For example, G, the percent of the existing local budget devoted to butter could be compared with M, the median percent that citizens prefer (see Figure 2). If the above model of voting behavior is true, there should be no significant statistical difference between the two. If there is a significant difference, we may conclude that voters have not revealed their preferences for publicly provided goods and services.

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FIGURE 2 HERE

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Mathematical Models of Policy Formation in a Democratic Society

A number of researchers have developed mathematical models of policy formation that are related to this simple guns-and-butter concept. One standard model of voting in the public choice literature is that of the "median voter." As shown in Bowen (1943) in a one-dimensional world, the median of the preferred budgets will be the equilibrium of a system of majority voting. This model assumes that all non-indifferent citizens vote and that voting is deterministic in that a citizen always votes for the more preferred budget level of those that are presented.

This result generalizes easily to multi-dimensional budgets if voter preferences are assumed to be separable (i.e., their ranking of each dimension is independent of the level of the other dimensions). Davis and Hinich (1966) prove that when the preferred positions of all voters are plotted into a multi-dimensional, normal frequency distribution the median vector is the dominant strategy; i.e., the candidate who chooses a policy vector nearest the median vector will win the election.

By definition the median vector is the vector that will minimize the sum of the absolute differences between itself and the vectors of the desired policies of all voters. If given two alternatives, every voter will select that alternative that is nearest to his, or her, own preferred vector, the median vector will be a dominant strategy; Hoyer and Mayer (1974) have shown that this result is true for any multi-dimensional distribution, whether or not it has the symmetric properties of

the multivariate normal distribution. However, Hinich (1976) has argued that the mean preferred point is a more useful measure of the equilibrium of a multi-dimensional majority voting process than the generalized mean. The individual level voting data that can be derived from the bidding game proposed in this paper will allow one to construct both mean and median budgets. These can be compared with each other as well as the existing budget as is illustrated in Figure 2.

Empirical Studies

There are two categories of empirical studies that are relevant to the problem of revealing preferences for publicly provided goods and services within a budgeting framework. In the first category, researchers assume that existing budgets are median budgets; given this assumption least squares analysis techniques are applied to these budgets. The second category of research is the priority evaluation technique which is exemplified by the bidding game; in this approach, respondents reveal preferences by spending play money on public goods and services subject to a utility maximization objective and a budget constraint. These two categories are described in the following paragraphs.

Least Squares Analysis

Empirical studies of demands for public goods and services have usually been based on some form of least squares analysis procedures.

For examples, Barr and Davis (1966), Borcherding and Deacon (1972), and Bergstrom and Goodman (1973) use some measure of the level of expenditure on public goods and services as the dependent variable and median levels of various population characteristics as the independent variables in ordinary least squares analyses to determine empirical relationships between public expenditures and population characteristics. Deacon and Shapiro (1975) have used the technique of conditional logit analysis to determine empirical relationships between categorical voting responses ("yes," "no," and "abstain") on a specific issue and population characteristics.

The Priority Evaluation Technique

The Priority Evaluator Technique (PET) has been described by Pendse and Wyckoff (1976), pp. 921-922) as follows:

> The PET methodology relies on an interview procedure in which an overlay showing selected environmental factors is shown to the respondents. Each factor is divided into subsituations depicting a range of possible quality. In this way, the respondent can evaluate a spectrum of possible or potential outcomes of certain policy measures, within his own judgment and experience. The respondent is asked to indicate his preference for the different situations. Each situation is then assigned a dollar value representing

> the cost of attaining or maintaining the quality of the factor portrayed in the illustration. A verbal description facilitates the weighing of benefits and costs of the existing and potential situations.
>
> The respondent is first asked to select the situation that most nearly approximates existing conditions. His responses are recorded by the interviewer. The respondent is then provided a token budget to "buy" desired situations, each "priced" as previously indicated. The rules prohibit exceeding the budget and/or buying limited situations only. He must have only one situation for a factor and must spend all of his budget. These constraints force him to trade-off different situations until he is indifferent to further trade-offs. The desired situations may differ from the identified existing situations, but the overlay constantly reminds the respondent of situations he has foregone or obtained in the process of allocating his budget among competitive situations. The final responses are recorded. This procedure is repeated for different budget levels.
>
> From the preferences revealed by the respondents, one can approximate a set of prices that correspond to the respondents' value structure. Also, using different budget levels, a series of points on the indifference curve between money and preference for particular situations are obtained for each respondent for each end factor.

Others who have employed this type of a technique (see Randall, Ives and Eastman, 1974) also have been concerned with developing price-quantity relationships. In contrast with earlier researchers, our approach casts the results of playing a bidding game similar to the PET within the context of the mathematical models of political equilibrium that were described, earlier.

THE GAME BOARD AND RULES OF PLAY

Our bidding game begins with a distribution of poker chips representing an allocation of the total local government budget among six categories of publicly provided goods and services [see Figure 3]. One hundred poker chips, each representing one percent of the total local government budget, were intially assigned to the six categories, according to the percentage distribution shown in Table 1 [see Table A1 in the Appendix for source]. The city of Tucson was chosen as an area to study as data were readily available. The residents of a townhouse development were chosen as the subjects and interviewed using a board to hold and separate the poker chips.

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FIGURE 3 HERE

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TABLE 1 HERE

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Briefly, the procedure for administering the game was to ask each respondent to reassign the poker chips so that the resulting distribution would correspond to a budget that he would most prefer. This "bid" was then recorded by the interviewer [see Appendix Table A2 for these bids]. The results indicate that the initial distribution (existing budget) was most preferred by only two respondents. In other words, only six percent of the respondents were completely satisfied with the current allocation of local budgetary resources to publicly provided goods and services.

In contrast to the satisfied two, other participants changed the distribution of poker chips. For example, Table 2 gives the results of play for one individual who is identified as respondent 1 in the Appendix Table A2. As the last column in Table 2 indicates, respondent 1 withdrew 12 poker chips from health and welfare programs and assigned two of the 12 chips to "fire protection" and ten of the 12 chips to "parks and recreation."

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TABLE 2 HERE

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EVALUATION OF RESULTS

Statistical Analyses

Due to the limited resources that were available for this study, only a very small group of respondents from a larger townhouse population were selected to play the bidding game. Because a large, scientifically selected, random sample from the Tucson metropolitan area was not obtained, the players who participated in this study cannot be said to represent a larger political entity. Nevertheless, to illustrate how the results of this experiment could have been analyzed if a more ambititious community attitude survey had been undertaken, we pretended that this was not the case. This assumption allowed us to apply some traditional statistical procedures to analyze the final scores of the games.

Before any further use of the data is made, it is important to determine if it is actually different from the existing budget. In other words, is the pattern of bids significantly different from the status quo, as shown in Table 1? This question will be answered from the overall bids using a multivariate t-test and for each category with a univariate t-test.

Overall Responses

For the multivariate t-test (or Hotelling test), the null hypothesis states that there is no difference between the distribution of percentages allocated to all categories within the individual budgets and the distribution of percentages allocated to all categories within the existing budget, i.e.,

$$H_o : \mu - \mu_i = 0, \text{ for all } i,$$

where μ = the existing budget, and μ_i = the bid of individual i.

A multivariate t-test is based on the assumption that the vectors are multivariate normally and independently distributed. It was assumed that the data were distributed as a lognormal distribution. To correct for this and for the linear dependence caused by the fact that for each respondent the sum of the bids across categories is 1, the data were normalized with respect to category 6 and transformed into logs:

$$y_r^j = \ln x_r^j - \ln x_r^6, \; j = 1, \ldots, 5; \; r = 1, \ldots, 32,$$

where y_r^j = normally distributed relative bid of individual r for category j, and x_r^j = the bid of individual r for category j.

The result of the multivariate analysis in testing for equality of mean vectors was an F-ratio equal to 10.18, with degrees of freedom of 5 and 27, which rejects the null hypothesis at a significance level above 99 percent. This indicates that there is a difference between the existing budget and the bids generated by those who play the game.

Univariate t-tests (for Categories 1 through 5)

Five univariate t-tests also were conducted--one test for each one of the first five budget categories. Essentially, each of these tests determines if the transformed values for a specific category in the individual bids is significantly different from the value for the corresponding category in the existing budget. The results of this analysis are displayed in Table 3. If there is no significant difference between the bids for a specific category and the corresponding category in the existing budget, then the probability of obtaining a t-value from the univariate t-test whose absolute value is as large or larger than the one actually obtained is given by the last column in the table. There is a significant difference if the value in the last column is .05 or less. As Table 3 indicates, the probability for Categories 1 and 3 is close to .5 indicating that there is no significant difference in these categories. However, the probabilities associated with the t-values for Categories 2, 4, and 5 are low indicating a significant difference in these categories. In other words, the participants were relatively satisfied with the existing budget shares of libraries and fire protection but were interested in increasing the share of parks and recreation at the expense of police and health and welfare spending.

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TABLE 3 HERE

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Although the bids are statistically significantly different from the existing budget, we must ask whether this difference would make a difference in resource allocation. In a scheme of popular voting, we wish to know whether they are politically significant. This is examined in the next section.

A COMPARISON OF EXISTING MEAN AND MEDIAN BUDGETS

A mean and a median budget were created as alternatives to the existing budget allocation of resources among functions. These are illustrated in Table 4. These budgets were then used in ballots for hypothetical elections. The residents of the townhouse complex were revisited and presented with a ballot containing the median of the preferred budgets as well as the existing budget. They were then asked to indicate which budget was preferred. They were not told which was the existing budget nor how either was chosen.

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TABLE 4 HERE

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TABLE 5 HERE

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As Table 5 shows, 19 of the 30 preferred the median budget while only 11 preferred the existing. This result supports the hypothesis that, in a two-way race, a median budget will always do at least as well as any other budget. When the mean budget was paired with the existing budget, the vote was 16 to 14 against the mean. Thus, the existing budget can defeat the mean but is itself defeated by the median budget. While factors such as abstention in an actual election have not really been considered, this result does not support Hinich's argument against the median voter models.

CONCLUSIONS

This research should be viewed as a preliminary test of a potentially valuable research method allowing one to utilize the results of bidding games to reveal preferences for publicly provided goods and services. Such a method bypasses the usual problem with voting data which is caused by the secret ballot and can yield even more data concerning each individual than merely how people vote in a single election.

The successful results derived from testing the game justify the need for additional work in this area. Several suggestions follow as examples of what could be done in future studies.

In future studies, the bidding game could be applied on a community wide basis instead of using it in just one subdivision as was

the case in this study. This could be facilitated by using mail questionnaires.

In future studies, more refined statistical analysis techniques could be applied to the outcomes of the bidding games. As examples--cluster analysis techniques could be used to develop relationships between budgets generated and the socioeconomic characteristics of respondents; discriminant analysis techniques could be used to determine which categories within budgets are most influential in determining how an individual will vote in an election between a median budget and another budget.

More refined and meaningful budgets could be developed and applied in future studies. In this study, the budgets are divided into categories according to how funds are allocated to departments and divisions within government. In future studies, the budgets could be expressed in terms of program areas. If this were done, the funds for the fire department's mobile cardiac unit would appear in the health and welfare category instead of in the fire protection category (as it did in this study). Similarly, the funds spent on the park guards would be put in the same category as police, sheriffs, and courts funds instead of the parks and recreation category (as it did in this study).

The results of this experiment might have been biased by the fact that the game began with the allocation of poker chips corresponding to the existing distribution of funds in the local government budget. Alternative starting states of the game could be utilized in future studies.

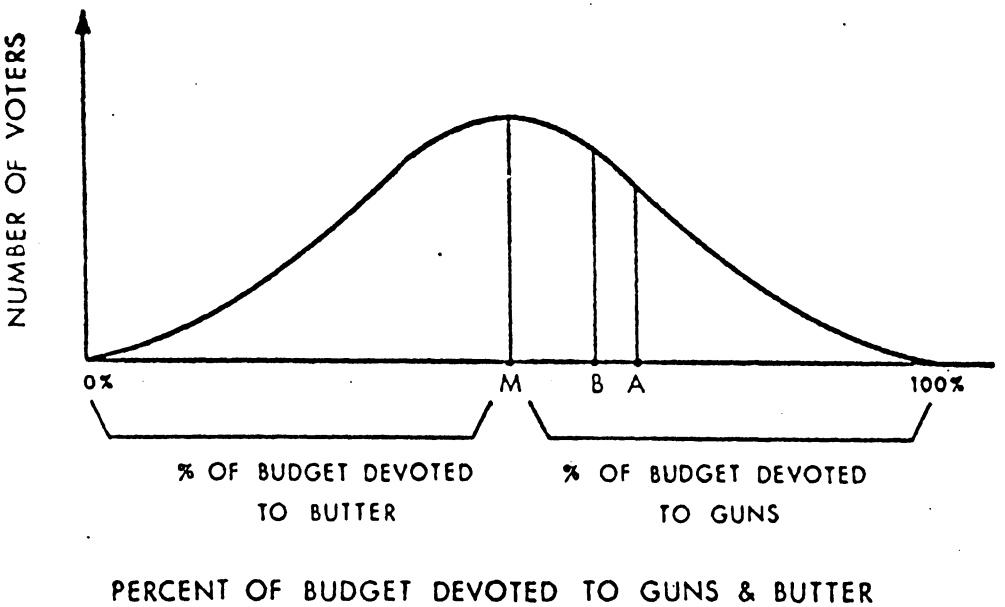
In this study, the following assumption has been made: only a finite amount of funds are available for the expenditures of local government. In future studies, the bidding game should be modified so that each participant can be allowed to shift some of the budget back into private consumption (and vice versa) at a known exchange rate (tax share).

FIGURES

Figure 1. Distribution of the Preferred Portion of the Total Budget to be Allocated to Guns and Butter by Voting Public, Candidates A and B, and Median Budget.

Figure 2. Comparison Between Existing Budget G and Preferred Budget M.

Figure 3. The Game Board.



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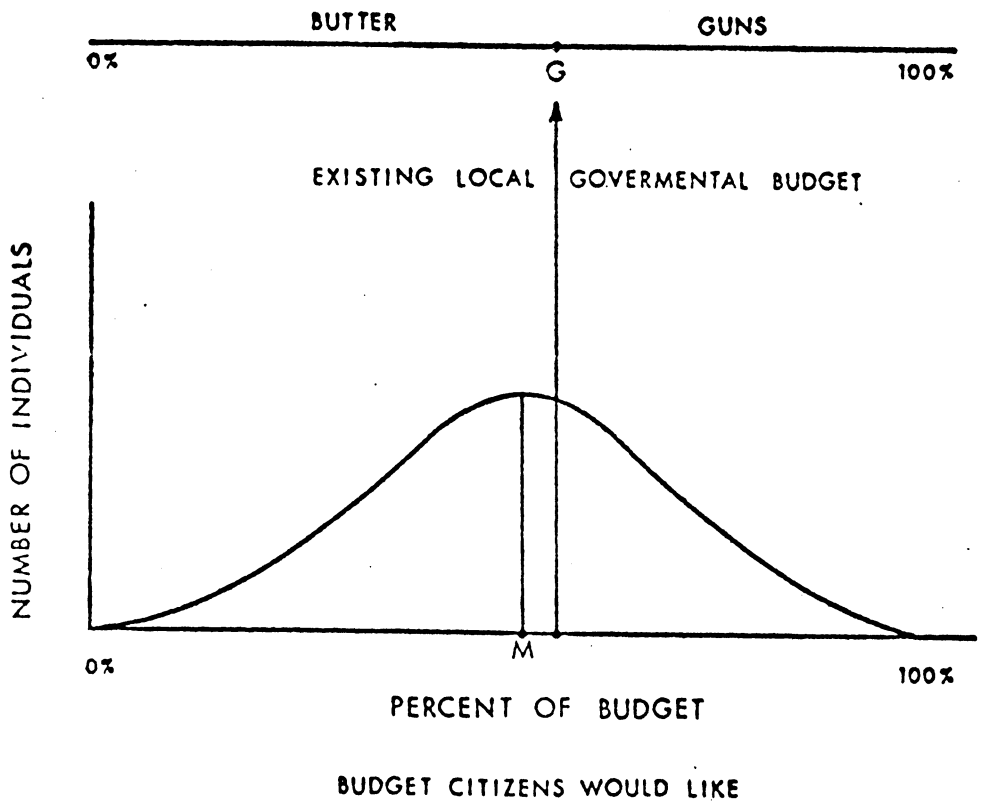

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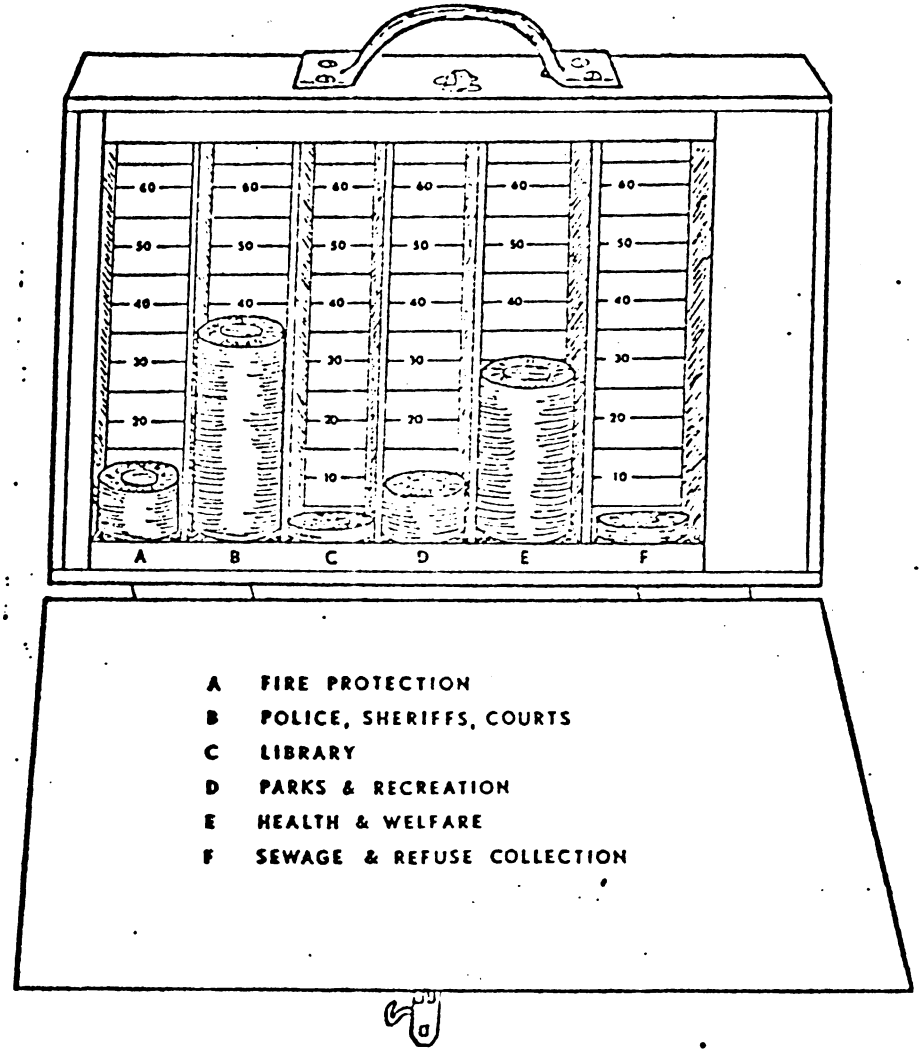

Figure 3. The Game Board.

Table 1. Programs and Existing Budget*

Programs	Percent of existing budget
1) Fire protection	13
2) Police, sheriffs, and courts	37
3) Library	4
4) Parks and recreation	11
5) Health and welfare	31
6) Waste disposal	4

*See Table A1 in Appendix for source.

Table 2. One Individual's Bid

Budget		Distribution of funds within budget		
Category	Description	Existing	Individual bid	Individual -Existing
		Percent		
1	Fire protection	13	15	+ 2
2	Police, sheriffs, and courts	37	37	0
3	Library	4	4	0
4	Parks and recreation	11	21	+10
5	Health and welfare	31	19	-12
6	Waste disposal	4	4	0

Table 3. Result of Univariate t-tests

Budget Category	Budget Description	t-Statistic t	Probability of obtaining t-value t > t
1	Fire protection	.7623	0.4517
2	Police, sheriffs, and courts	2.2804*	0.0297
3	Library	.1628	0.5445
4	Parks and recreation	2.6372*	0.0130
5	Health and welfare	3.2150*	0.0031
6	Waste disposal		not determined

*Significant at the $\alpha = .05$ level for a two-tailed test.

Table 4. The Mean, Median, and Existing Budgets

Budget		Percentage Allocations		
Category	Description	Median	Existing	Mean
		Percent		
1	Fire protection	13	13	14
2	Police, sheriffs, and courts	37	37	35
3	Library	5	4	6
4	Parks and recreation	14	11	15
5	Health and welfare	27	31	25
6	Waste disposal	4	4	5

Table 5. Re-Interview Test Votes

Election	Votes		
	Existing*	Mean*	Median*
Mean vs. existing	16	14	
Median vs. existing	11		19

*Table 4, above, describes the three alternative budgets.

DATA APPENDIX

A townhouse complex in Tucson, Arizona, was chosen for the initial use of the survey method. Some 32 residents of the Tucson North subdivision played the bidding game. The initial state of the game reflected the existing local government budget, presented in Table A1. Each respondent was then asked whether he preferred some reallocation of the budget percentages (see Table 1). If so, he then rearranged a set of 100 poker chips (each representing 1 percent of the local government budget) until satisfied with the result. The final disposition is referred to in the body as his "bid," and the complete set of bids is shown in Table A2. This is the raw data from which our statistical analyses and voting results are derived.

Table A1. Existing Local Government Budget*

Category	Aggregation group	Dollars/ dwelling unit	Percent of total budget**
Fire protection	Fire (1)	$ 27.48	
General government --city	____+	$ 56.51	
General government --county	____	$ 25.34	
Library	Library (3)	$ 7.96	
Police	Police (2)	$ 40.25	
Sheriffs and courts	Police (2)	$ 38.52	
Parks & recreation --city	Parks (4)	$ 18.15	
Parks & recreation -- county	Parks (4)	$ 4.91	
Capital improvements	____	$ 19.41	
Public works	____	$ 36.89	
Health and welfare	Health (5)	$ 65.71	
Sewerage	Waste disposal (6)	$ 6.45	
Garbage collection	Waste disposal (6)	$ 2.40	

*Source: Cost-Revenue Analysis by Land Use Zone, Planning Division, Tucson, 1974.

+A dash indicates this category was not used in the analysis.

**See Table 1 for percentages.

Table A2. Number of Chips Allocated to Category j by Respondent r.

Respondent r	Category j					
	j=1	j=2	j=3	j=4	j=5	j=6
1	15	37	4	21	19	4
2	12	37	8	13	26	4
3	17	33	2	16	28	4
4	13	37	4	12	30	4
5	13	37	4	11	31	4
6	13	36	5	15	27	4
7	12	34	6	13	30	5
8	17	33	10	20	16	4
9	13	27	9	19	25	8
10	13	27	6	19	31	4
11	18	42	5	14	15	6
12	13	26	14	16	9	22
13	11	25	15	19	25	5
14	20	24	10	20	16	10
15	13	39	2	12	30	4
16	14	36	5	20	21	4
17	12	23	2	22	38	3
18	17	42	6	21	10	4
19	13	37	5	11	30	4
20	13	36	4	12	31	4
21	13	37	2	13	31	4
22	13	42	6	12	23	4
23	15	37	5	13	26	4
24	15	39	2	13	27	4
25	15	40	2	12	28	3
26	15	41	2	10	28	4
27	13	31	5	15	32	4
28	13	37	4	11	31	4
29	13	32	4	16	31	4
30	13	34	10	14	25	4
31	13	38	6	15	23	5
32	15	40	4	16	21	4

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