A scientific method of measuring the effectiveness of local government

A SCIENTIFIC METHOD OF MEASURING THE EFFECTIVENESS OF LOCAL GOVERNMENT

by

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ABSTRACT

A major problem facing the political process in a community is accurately determining the preferences of citizens concerning how much money they would like local government to spend and, given that quantity as a budgetary constraint, what percentage of that amount should be allocated to each category of public 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. 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. An operational procedure (a bidding game) will be developed to determine preferences of citizens for publicly provided goods and services. This operational procedure was employed in a survey. The data thus obtained is statistically analyzed.

CHAPTER I

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 study is the development of an operational procedure to determine preferences of citizens for publicly provided goods and services. This operational procedure (a bidding game -- defined in Chapter II) 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.

Development of a prototypical game board and the rules of play are the subject of Chapter III. Data sources for the development of the budget will first be identified. A histogram will be created in which each category on the horizontal axis will represent a specific program area within the budget and an index on the vertical axis will indicate

the percent of the budget that is assigned to each budget category. Next, the budget will be translated from a percentage distribution histogram to a bidding game -- game board. Finally, the procedure of play will be delineated.

Chapter II contains a description of the experimental results. A survey was conducted employing the bidding game developed earlier. Data obtained from this survey were statistically analyzed.

A summary of the results and the implications of this study are presented in Chapter IV. Essentially, the results confirm our belief that the bidding game technique shows promise and that additional work should be done in the subject area.

CHAPTER II

THE BIDDING GAME CONCEPT

Introduction

This chapter contains a description of some of the theoretical considerations that are relevant to the design of a bidding game. The first section of the chapter contains a simplified mathematical model of local government in a democratic society. This model is used to describe the probable outcome of election in a perfect democracy in terms of who is elected. Within the conceptual framework of the model, a candidate wins an election because he represents the quantitative mix of public goods and services closest to what the voting public desires.

The first section of this chapter demonstrates that the outcome of an election can be thought of as a numerical expression of voter's tastes and preferences, and meaningful information can be derived by applying techniques of numerical analysis to the mathematical mode of local government. This chapter's second section contains suggestions for statistical analysis which may be applied to this model of local government. The subject of the third and fourth sections of this chapter is the description of a priority evaluation model. A priority evaluation model is a j-dimensional abstraction of the model of local government that is the subject of the first section. The priority evaluation model is used as a point of departure for the development of the bidding game model in the last part of the chapter.

Background

The purpose of local government is to provide services and public facilities for citizens residing within its jurisdiction. These services and facilities include police and fire protection, general governmental services, library facilities, parks and recreation, capital improvements, public works, health and welfare, and education. Local government's function is to provide these services and facilities in the quantities that the residents want.

Providing these services and facilities costs money. The aggregate amount of money available for such expenditures can be influenced by the activities of government. Randall, Ives and Eastman (1974) have used bidding games to estimate the benefits of providing an inexhaustible nonmarket good such as abatement of aesthetic environmental damage in the Four Corners Region. Benefits in their study are based on respondents' willingness to pay increased sales taxes, higher electricity bills, or increased recreational user fees. However, for the purpose of simplifying the discussion at this point, the following assumption is made: only a fixed amount of funds are available for the expenditures of local government.

This financial constraint necessitates a trade-off between the several services and facilities that can be provided within a budget. The several services and facilities provided by local government can be thought of as a bundle of goods and services. Each citizen residing within a local governmental unit wants to receive a particular bundle from that government. From these individual bundles, a representative

bundle of goods and services preferred by citizens in general can be produced.

The effectiveness of local government is a measure of how close its bundle of goods and services is to the aggregate bundle of goods and services citizens actually want. This chapter will delineate a method for determining the effectiveness of local government.

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 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.

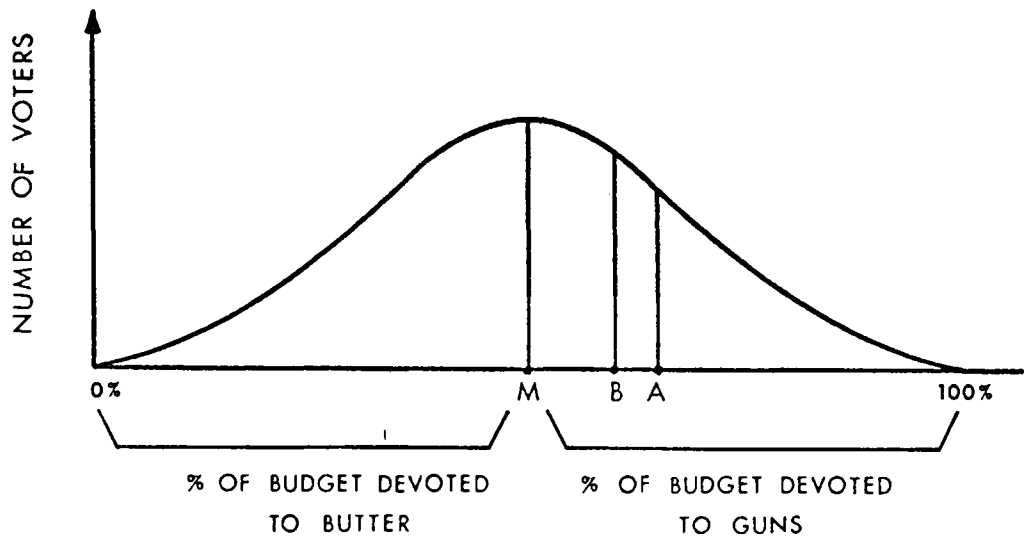

Figure 1. Distribution of the Preferred Portion of the Total Budget to be Allocated to Guns and Butter by Voting Public, Candidates A and B, and Median Budget M.

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. As a hypothetical example, candidate B may have lost the election because he reportedly became drunk at a nightclub and bit a young lady on the extreme upper thigh.

Mathematical Models of Policy Formation in a Democratic Society

A number of researchers have developed mathematical models of policy formation in a democratic society that are multidimensional extensions of the simple guns-and-butter example. These include the work of Davis and Hinich (1966, 1967), Plott (1967), Hoyer and Mayer (1974), and Riker and Ordeshook (1973). A typical model, described by Davis and Hinich (1967, pp. 15-17) is based on the following assumptions:

1. Policies can be measured by certain indices in multidimensional space.
2. The same indices measure any given policy for all voters.
3. Each voter has an opinion on all issues of policy.
4. The i^{th} voter's most desired policy i.e., preferred position, is represented by the vector
$X_i = [X_{i1}, X_{i2}, \cdots, X_{in}]'$
where X_{ik} represents the desired value of the index k for voter i.

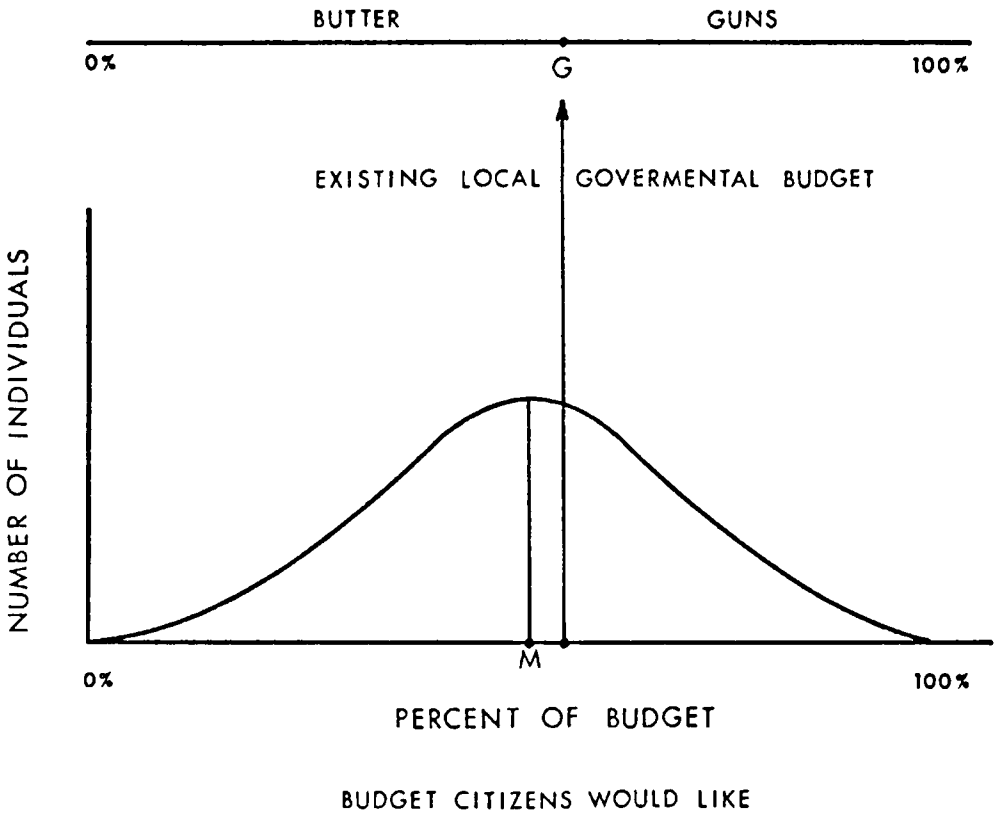

Figure 2. Comparison Between Existing Budget G and Preferred Budget M.

5. The j^{th} candidate or party adopts a position or platform represented by the vector
$\theta_j = [\theta_{j1}, \theta_{j2}, \ldots, \theta_{jn}]'$

6. The utility loss experienced by voter i when the government does not adopt his preferred set of policies is given by the loss function
$L_i(\theta) = (X_i-\theta)' A (X_i-\theta)$
where A is a symmetric, positive definite matrix of rank n which is common to all voters.

7. The preferred positions of all voters have been plotted into a multidimensional, normal, frequency distribution, $f_x(X)$ with mean and median vector $E(X) = \mu_X$.

Davis and Hinich (1966) prove that the median vector is the dominant strategy. 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 multidimensional distribution, whether or not it has the symmetric properties of the multivariate normal distribution.

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 priority evaluation technique emplified by the bidding game approach; 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

A priority evaluation model is a j-dimensional abstraction of the "guns and butter" model. The priority evaluation model has been described by Pendse and Wyckoff (1974, pp. 83-84) as follows:

Assumptions:

(a) Each individual prefers the environment that provides him and the community the most satisfaction.

(b) The different substandards[1] for the environmental factors are known.

(c) Each substandard provides some level of non-negative satisfaction.

(d) Each substandard is independent of the other(s) and can be traded for them.

(e) Allocation of a given budget among alternative situations is optimum when the individual cannot increase his satisfaction by further trade-offs.

Constraints:

(a) Only one standard (or situation) for each environmental variable can be chosen in the optimum allocation.

(b) The value of the optimum composite of variables cannot exceed the budget level.

Given the foregoning assumptions and constraints, the basic model can be stated as follows:

$$\text{Maximize} \quad \sum_{i=1}^{I} \sum_{j=1}^{J} X^{i}_{j} S^{i}_{j} \text{ subject to}$$

$$(1) \qquad \sum_{i=1}^{I} \sum_{j=1}^{J} X^{i}_{j} p^{i}_{j} \leq M$$

$$(2) \qquad \sum_{i=1}^{I} X^{i}_{j} = 1, \text{ for all } j = 1, \ldots, J$$

$$(3) \qquad X^{i}_{j} = 0, \text{ or } 1 \text{ for all } i \text{ and } j,$$

where X^{i}_{j} = the quantity of the i^{th} substandard of the j^{th} environmental variable, $i = 1, \ldots, I$, and $j = 1, \ldots, J$;

p^{i}_{j} = the price of the i^{th} substandard of the j^{th} environmental variable;

---

1. e.g., fire prevention programs, emergency rescue, and hook and lader trucks would be substandards of fire protection.

S^i_j = the amount of satisfaction from the i^{th} substandard of the j^{th} environmental variable; and

M = the maximum budget available to buy the different substandards.

A Simplified Example of the Priority Evaluation Technique

A simplified, hypothetical example of the priority evaluation technique, developed by Weisz (1975), is illustrated in Figure 3 on the following page. Assume that a participant in a survey is presented with the following problem: In Figure 3 each column j represents a j^{th} variable (i.e., the j^{th} program area). Each box within any given column represents the i^{th} substandard of the j^{th} environmental variable; for example, the third environmental variable representing additional public investment in augmenting the local groundwater supply with a supply of surface water contains two substandards -- i-1-the existing situation and i-2-public investment in the Central Arizona Project. The price p^i_j of the i^{th} substandard of the j^{th} environmental variable is indicated by the cost figure in the bottom of each box. S^i_j, the amount of satisfaction from the i^{th} substandard of the j^{th} environmental variable exists in the mind of each participant in this survey. Each participant is given a fixed government budget -- M = $1,500. With this budget, each respondent must buy $X^i_j = 1$, and only one, substandard i within each category j.

The alternatives and dollar amounts in this example are purely hypothetical. They are only used here to illustrate how a respondent can be confronted with a situation in which his, or her, utility must be maximized by deciding on a set of alternative goods and services subject to a fixed budget constraint.

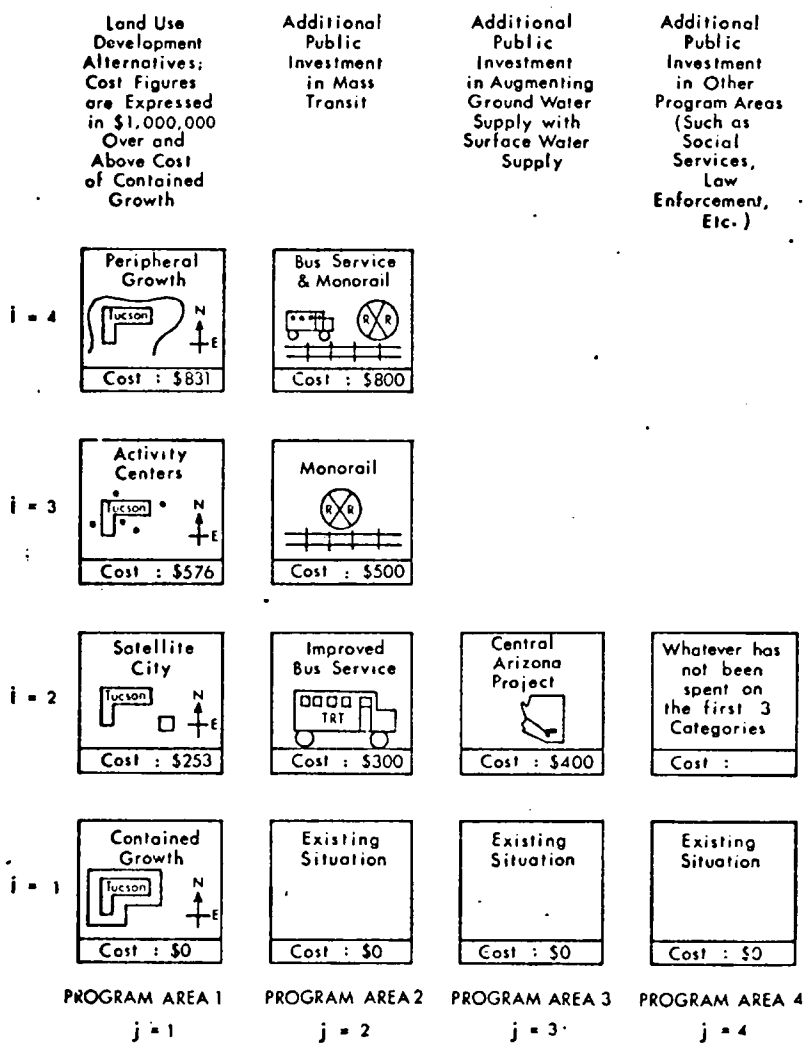

Figure 3. Simplified, Hypothetical Example of Priority Evaluation Technique.

The Bidding Game

The bidding game is a physical analogue (employing a game board) of the priority evaluation model. The bidding game begins with one-hundred poker chips representing one-hundred percent of the total local governmental budget assigned to the several public services and facilities as in the existing local government budget. The generalized form of the starting state of the game is illustrated in Figure 4. The analogy between the priority evaluation technique and the bidding game follows:

i = level of performance associated with service j, in mental picture of participant

j = service indicator for police, fire, etc.

X^i_j = number of chips allocated to service j

M = total number of chips, equals 100% of budget

S^i_j = level of satisfaction, or utility, derived from level of performance i in service j

p^i_j = 1% for all budgeted i and j values = one chip.

When the bidding game is employed as an instrument within a community attitude survey, each participant plays his, or her, own version of the game. Although each individual is playing with the same game board, each individual plays the game with his, or her, unique utility function. Thus, one might expect the results of the constrained utility maximization problem to vary from one individual to the next. This fact can be recognized by modifying the notation utilized in the priority evaluation model to conform to the characteristics of the bidding game. For example, the general form of the bidding game is described in the following paragraph.

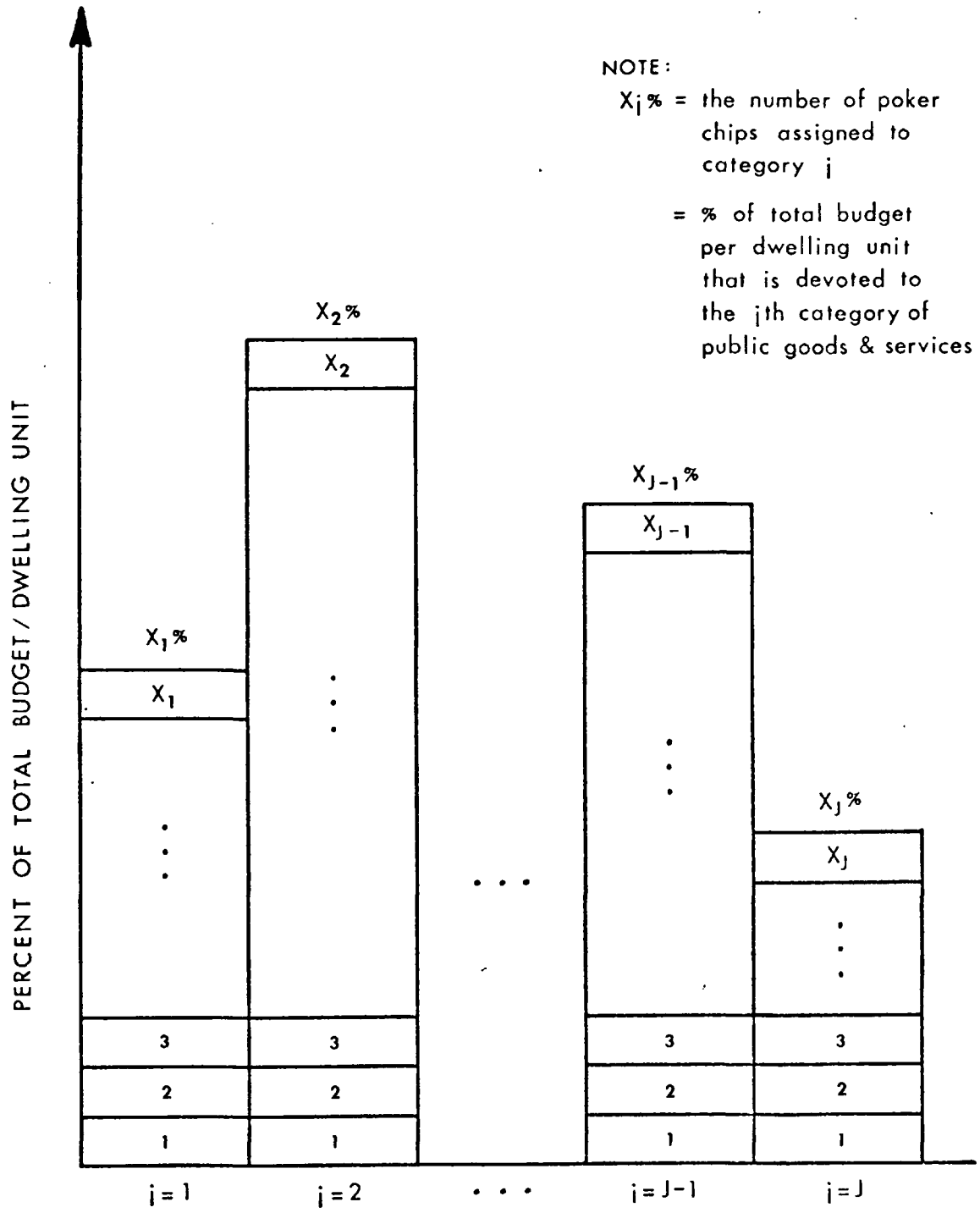

Figure 4. Generalized Form of Starting State of Bidding Game.

If R individuals take part in the survey, each respondent, r, where r = 1 . . . R, plays the following game:

$$\text{Maximize} \qquad \sum_{ij} \sum X^{i}_{jr} \, S^{i}_{jr}$$

subject to:

$$(1) \qquad \sum_{i=1}^{I} \sum_{j=1}^{J} X^{i}_{jr} \, P^{i}_{j} = M$$

$$(2) \qquad X^{i}_{jr} = 0, \text{ or } 1, \text{ for all } i \text{ and } j,$$

where X^{i}_{jr} = the number of chips allocated to budget category j by the r^{th} respondent,

S^{i}_{jr} = the utility that respondent, r, derives from level of performance i in category j and

where all other terms are defined as before.

In Chapter II, the theoretical foundation for the bidding game has been developed. Chapter III illustrates how the game was played when the first experimental tests were conducted.

CHAPTER III

THE GAME BOARD AND RULES OF PLAY

A generalized concept of a bidding game was developed in Chapter II. In this chapter the prototypical game board and rules of play are described. First, data sources for development of the budget are identified. Then, the budget is translated from a percentage distribution histogram to a poker chip, game board. Finally, the rules of play are explained.

The Local Government Budget

Tucson was selected as a representative local governmental unit for this study because it was readily at hand for survey purposes. Also, the Planning Division of the City of Tucson released a cost-revenue analysis for Tucson during January of 1974. This analysis was produced to identify the economic consequences of providing public services to residential, commercial, and industrial land uses. The cost-revenue estimates were based on the city and county budgets for fiscal year 1972-73. Educational costs and revenues were based on the Tucson District Number 1 budget for fiscal year 1972-73 (Planning Division, City of Tucson, 1974, pp. 23-24). Data from this study were used in the construction of a local government budget. There were two study areas used in the cost-revenue analysis. One of these areas, known as Villa Serenas, is in the neighborhood of Maguire Avenue and Sarnoff Drive on the east side of town.

The existing local government budget, given on a per dwelling unit basis, used for the purposes of this analysis is constructed from the Villas Serenas cost figures. These costs are expressed in dollars in Figures 5 and 6, and in percentages in Figure 7.

For the purpose of this study, the Tucson North townhouses located at 2875 North Tucson Boulevard was selected. Several individuals in the Planning Division of the City of Tucson have stated that the costs of publicly provided goods and services are the same on a per unit basis for both Villa Serenas and Tucson North due to the similar population density in each complex. In fact, when the Planning Division computes the cost of providing services to areas with similar densities, the same cost figures are used. Since the cost of providing services may be a function of more factors than the density factor, this may not be an appropriate assumption. For example, Villas Serenas and Tucson North are in different locations and the age distributions of the residents in the two subdivisions are also different. If location and age of residents affects the demand for and costs of providing services, the Planning Department's method of extrapolating cost figures from one subdivision to the next may not be valid. However, this assumption will also be used in this study.

Tucson North, a middle class townhouse complex, was chosen because Villas Serenas residents were in a guarded fortress type of environment that made interviewing very difficult, whereas Tucson North residents were less reluctant to be interviewed. Because all the dwelling units are of a single zoning type, only a single set of cost figures for publicly provided goods and services had to be developed for this neighborhood. This reduced the computational requirements of the experiment.

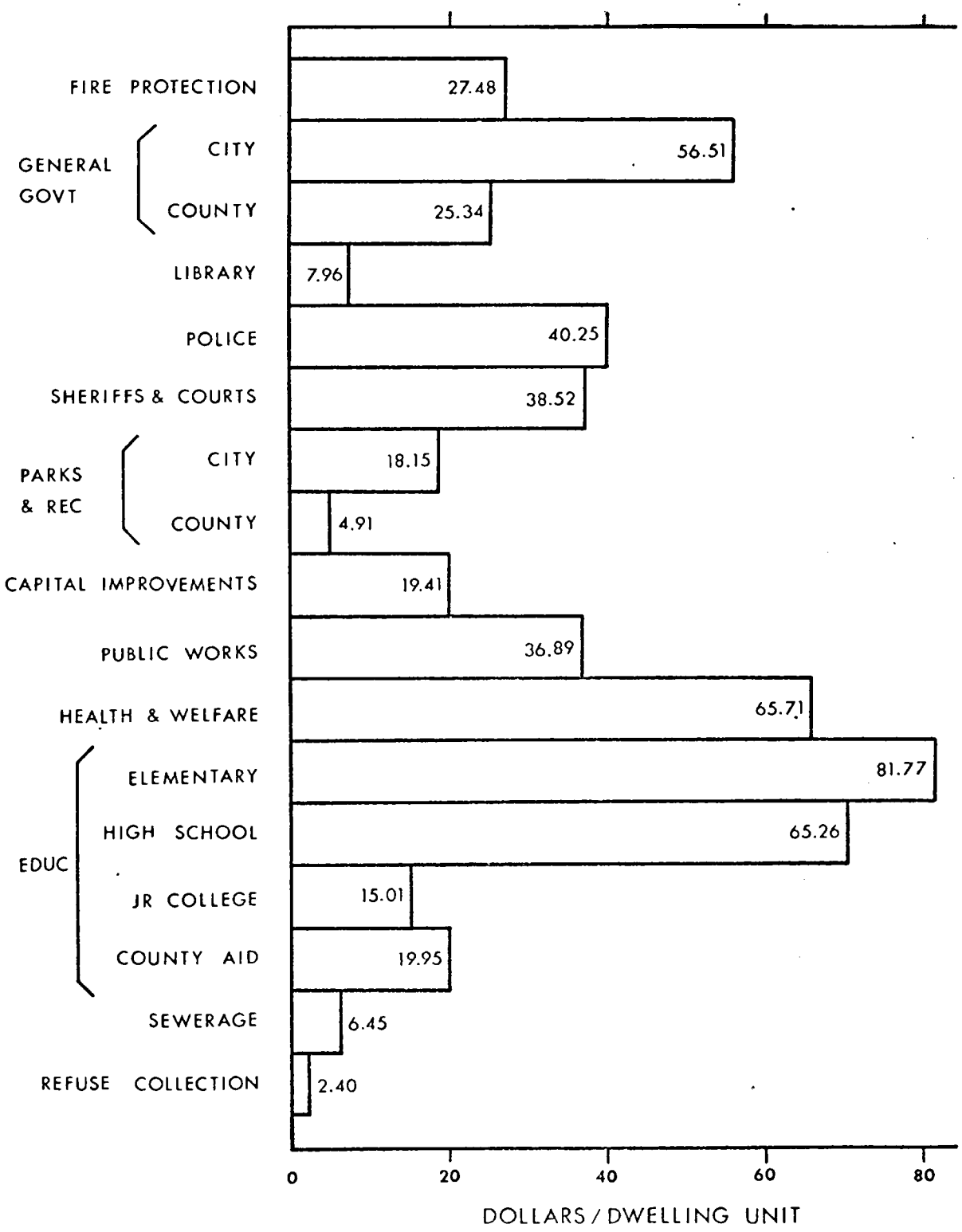

Figure 5. Existing Local Government Budget.

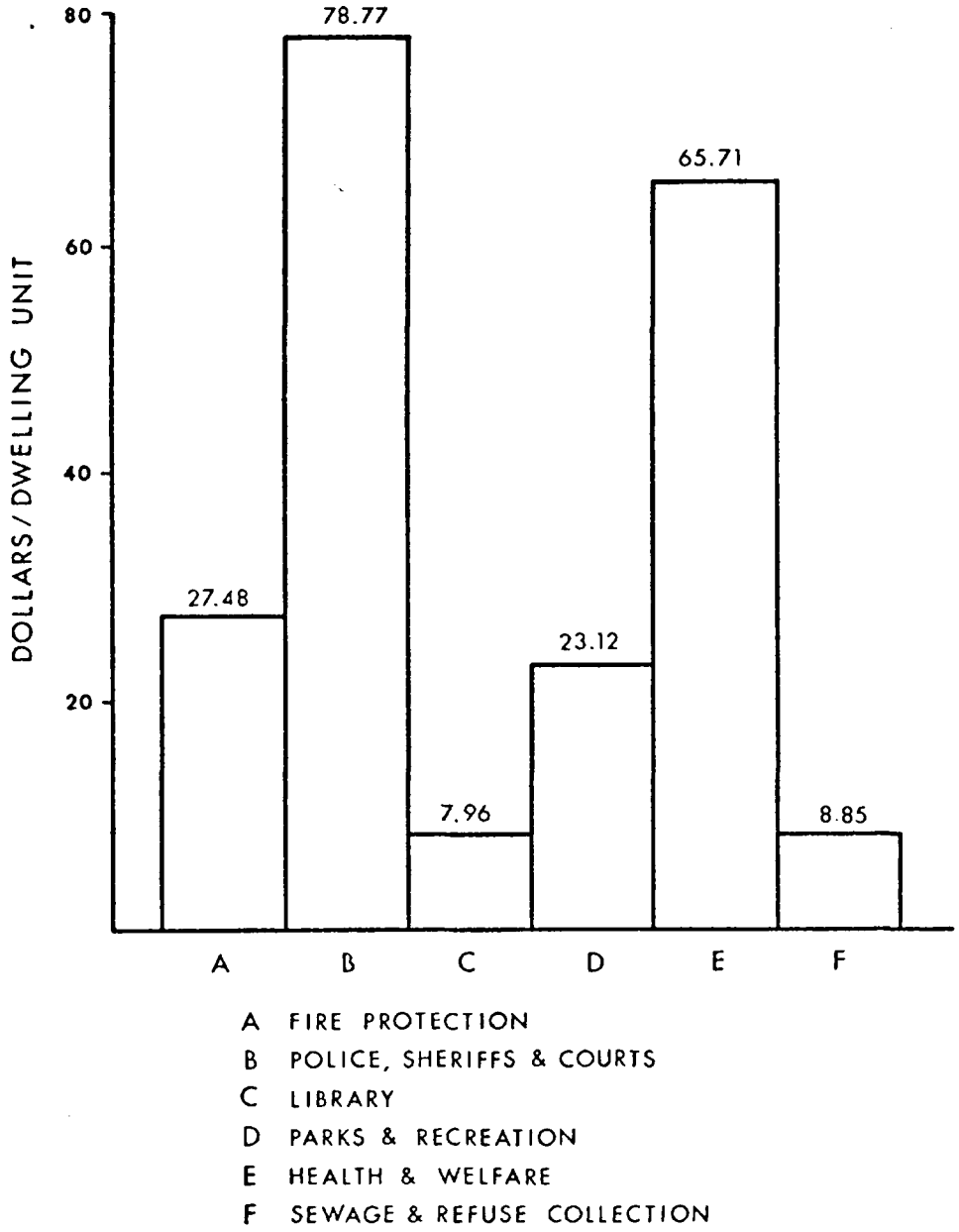

Figure 6. Conglomerate of Existing Local Government Budget.

Note: Figure 6 was created from Figure 5 by combining city and county figures for Parks and Recreation, Police and Sheriffs and Courts, Health and Welfare, and Sewerage and Refuse Collection.

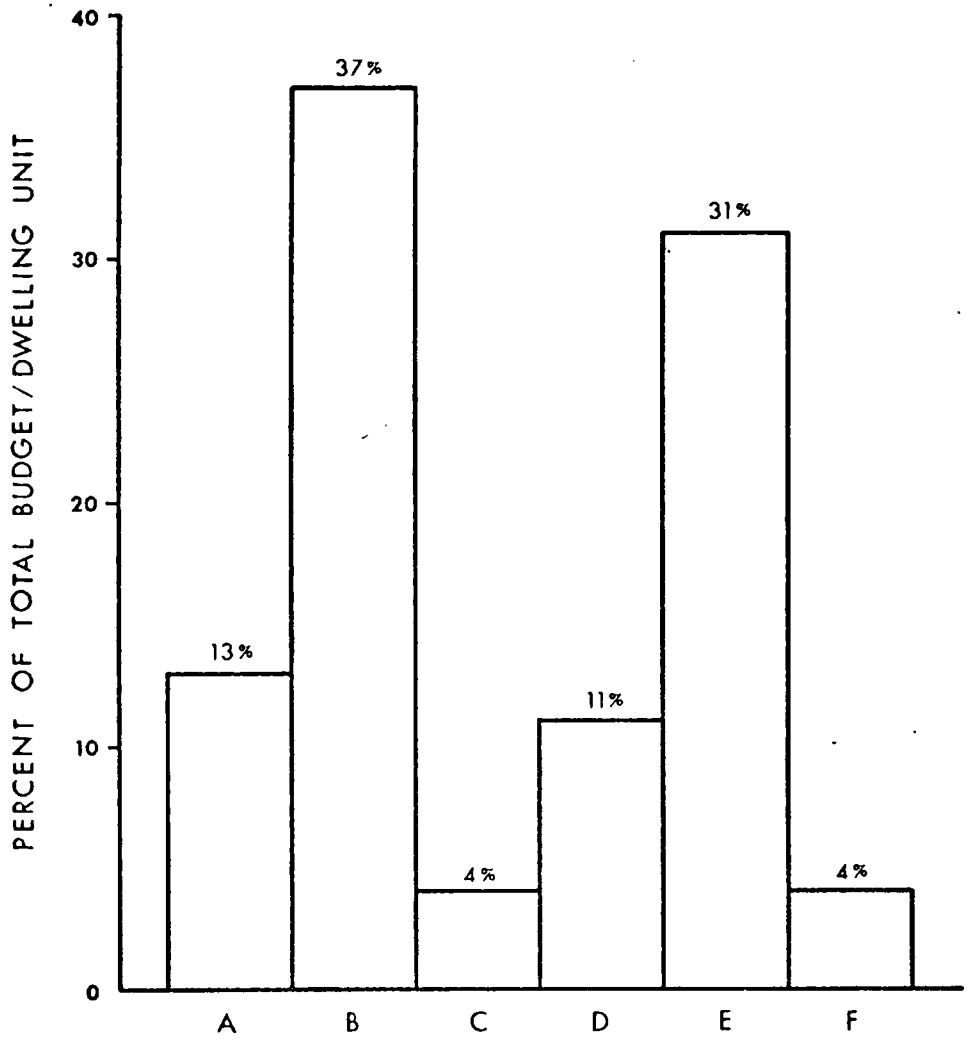

Figure 7. Starting State of Bidding Game.

The Game Board

The bidding game, as presented to the residents of Tucson North, consisted of a two-dimensional game board. A schematic diagram of the board is illustrated in Figure 8.

Its horizontal axis is divided into six categories of services that are provided to residents of the neighborhood by local government. These six categories represent the program areas listed in Figure 7. These categories were defined on a somewhat arbitrary basis. For example, for the purpose of simplifying the game during our initial study, both Health and Welfare programs are placed into one category although there would have been no conceptual difficulty in assigning each one of the program areas to a separate category on the game board. As another example, the General Government, Capital Improvements, Public Works, and Education categories were omitted for purposes of simplification. While such a gross level of aggregation may adversely affect the results of this experiment, the problem of determining the optimal level of detail (i.e., numbers and types of categories) to include in a bidding game will be left to other researchers in future studies.

One-hundred poker chips representing one-hundred percent of the total local government budget were assigned to the six categories, according to the percentage distribution described in Figure 7. The correspondence between Figures 7 and 8 is illustrated in Table 1.

Procedure for Administering the Game

The detailed procedure for administering the game is given in Appendix A which contains the "Subject's Consent Form." Briefly stated,

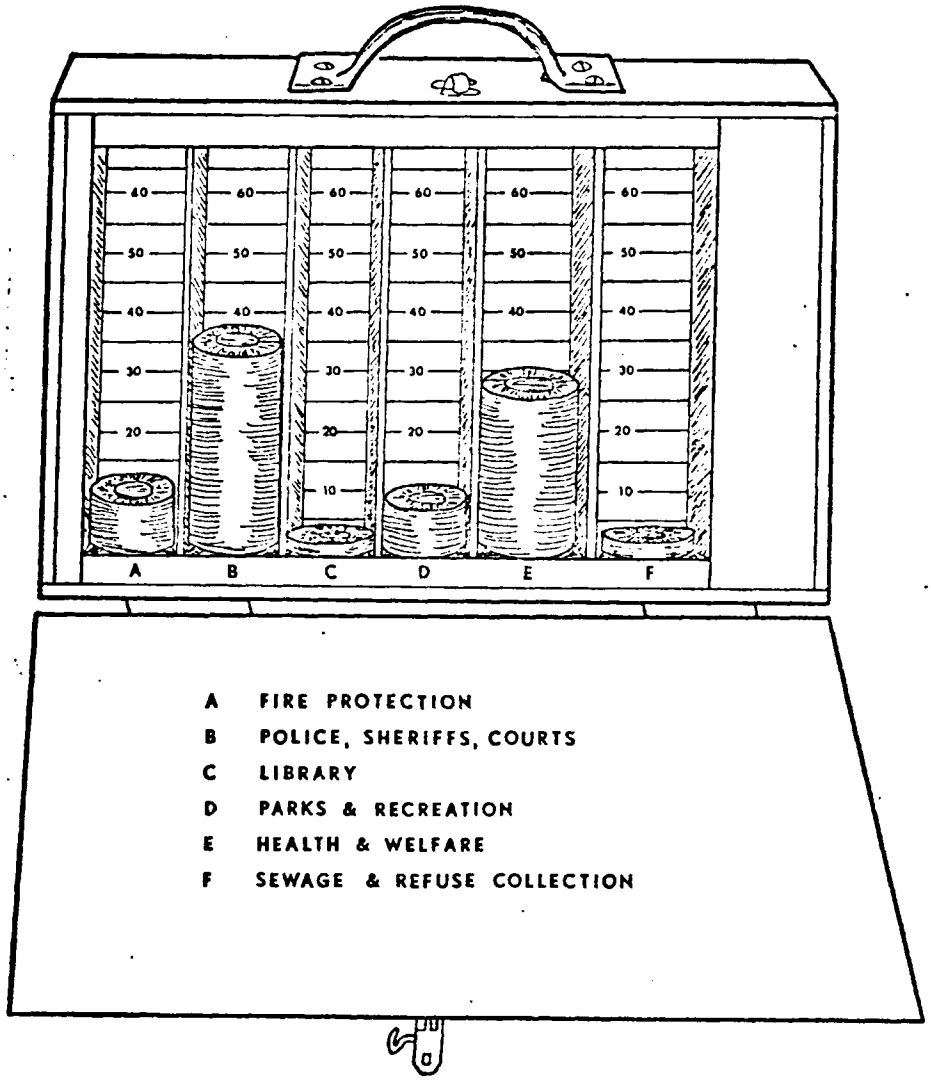

Figure 8. The Game Board.

Table 1. Programs, Percents, and Poker Chips.

Programs	Percent of Budget		Number of Chips
(1) Fire protection	13%	=	13 chips
(2) Police, sheriffs and courts	37%	=	37 chips
(3) Library	4%	=	4 chips
(4) Parks and recreation	11%	=	11 chips
(5) Health and welfare	31%	=	31 chips
(6) Sewage and garbage collection	4%	=	4 chips

each respondent was asked to reassign the poker chips on the game board so that the resulting distribution would correspond to a budget that would maximize that individual's utility. The answer sheet that was used to record each participant's response is illustrated in Appendix B.

When all the respondents were initially interviewed, an average (i.e., mean) preferred local government budget for this neighborhood was formulated. In the average budget, each program contained the average number of chips that were assigned to it by all participants in the survey.

A median preferred budget was also constructed. In the median budget, each program contained the median number of chips that were assigned to it by all participants in the survey.

The initial respondents were revisited. Each respondent was shown two budgets, i.e., the existing budget and the median budget and asked to indicate which budget he, or she, preferred. Respondents were not told which budget was the existing one and which was the median. Each participant's preference was recorded on the answer sheet illustrated in Appendix B.

The Tucson North community attitude survey data was examined thoroughly using a variety of statistical tests. The empirical results of this analysis are the subject of the next chapter.

CHAPTER IV

EXPERIMENTAL RESULTS AND ANALYSES

This chapter presents a description of the results of the survey and a discussion of the statistical analyses that were conducted with the data obtained from the questionnaire. Tucson North consists of 67 townhouses. Each of these townhouses were visited. Thirty-two voting age residents were willing to play the game.

Ranking procedures are often used in community attitude surveys in order to reveal preferences for the goods and services that are supplied by local government. The bidding game technique advocated in this study is undoubtedly a more costly approach to revealing preferences than is the ranking technique, however, the bidding game probably provides better information than the traditional ranking procedures. To illustrate and compare the differences in results that could have been obtained if the respondents in this study were asked to rank alternatives, a set of ranked budgets were derived from the original set of bidding game budgets. Statistical tests were conducted on both sets of data.

Poker Chip Responses

For All Participants

The starting state of the game was given by the game board, as pictured in Figure 8, in the preceding chapter, with poker chips assigned to each of six budget categories according to the existing distribution

of funds in the local government budget. Each participant was asked to reallocate the chips so that the resulting distribution maximized his, or her, utility.

Table 2 indicates the number of poker chips X^{i}_{jr} that were allocated to each budget category j by each respondent r. The results indicate that the existing budget maximizes the utility of only two respondents -- participants 5 and 28. In other words, only 6% of the respondents are completely satisfied with the current allocation of budgetary resources to publicly provided goods and services.

For One Individual

In contrast to these two individuals, other participants changed the distribution of chips on the game board. For example, Table 3 gives the results of play for one individual who is identified as respondent r=1 in Table 2. As the last column in Table 3 indicates, respondent 1 withdrew 12 poker chips from health and welfare programs and assigned 2 of the 12 chips to "fire protection" and 10 of the 12 chips to "parks and recreation."

Responses by Rank

For All Participants

The six categories in each individual budget were ranked on the basis of the percentage of the total budget assigned to each category. A rank of 1, 2, 3, 4, 5, or 6 was assigned to each category with 1 being assigned to the category that had the smallest and 6 being assigned to the category that had the largest share of the budget. In the event of

Table 2. Number of Chips (X^i_{jr}) 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

Table 3. One Individual's Results of Play.

Budget		Distribution of Funds within Budget		
Category	Description	Existing	Individual	Individual Existing
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	Refuse collection	4%	4%	0

ties, the average rank was used. Table 4 contains the results of translating each respondent's Table 2 poker chip budget into a list of ranked categories.

Table 5 depicts the results of a similar ranking procedure that was applied to the existing government budget. A comparison of Tables 4 and 5 indicates that the ranking assigned to the existing budget corresponds to the rankings assigned to the individual budgets in only four cases -- i.e., for respondents 4, 5, 20, and 28. In other words, only 12% of the respondents would rank their budget categories in the same order that the categories are currently ranked.

While the budgets associated with 12% of the respondents have the same rank order as the existing budget, the preceding analysis of Table 2 indicated that only 6% of the respondents are completely satisfied with the current allocation of budgetary resources to the goods and services provided by local government. These empirical results appear to suggest that the bidding game results are a more sensitive index of revealed preferences than are the results of traditional ranking procedures.

For One Individual

In contrast to the four respondents whose rankings agreed with the existing rankings, the game outcomes of other participants resulted in a different set of rankings. Table 6 gives the results of play for the individual who is identified as respondent r=1 in Tables 2 and 4.

Table 4. Rank Assigned to Each Category by Respondent r.

Respondent r	Category j					
	j=1	j=2	j=3	j=4	j=5	j=6
1	3.0	6.0	1.5	5.0	4.0	1.5
2	3.0	6.0	2.0	4.0	5.0	1.0
3	4.0	6.0	1.0	3.0	5.0	2.0
4	4.0	6.0	1.5	3.0	5.0	1.5
5	4.0	6.0	1.5	3.0	5.0	1.5
6	3.0	6.0	2.0	4.0	5.0	1.0
7	3.0	6.0	2.0	4.0	5.0	1.0
8	4.0	6.0	2.0	5.0	3.0	1.0
9	3.0	6.0	2.0	4.0	5.0	1.0
10	3.0	5.0	2.0	4.0	6.0	1.0
11	5.0	6.0	1.0	3.0	4.0	2.0
12	2.0	6.0	3.0	4.0	1.0	5.0
13	2.0	5.5	3.0	4.0	5.5	1.0
14	4.5	6.0	1.5	4.5	3.0	1.5
15	4.0	6.0	1.0	3.0	5.0	2.0
16	3.0	6.0	2.0	4.0	5.0	1.0
17	3.0	5.0	1.0	4.0	6.0	2.0
18	4.0	6.0	2.0	5.0	3.0	1.0
19	4.0	6.0	2.0	3.0	5.0	1.0
20	4.0	6.0	1.5	3.0	5.0	1.5
21	3.5	6.0	1.0	3.5	5.0	2.0
22	4.0	6.0	2.0	3.0	5.0	1.0
23	4.0	6.0	2.0	3.0	5.0	1.0
24	4.0	6.0	1.0	3.0	5.0	2.0
25	4.0	6.0	1.0	3.0	5.0	2.0
26	4.0	6.0	1.0	3.0	5.0	2.0
27	3.0	5.0	2.0	4.0	6.0	1.0
28	4.0	6.0	1.5	3.0	5.0	1.5
29	3.0	6.0	1.5	4.0	5.0	1.5
30	3.0	6.0	2.0	4.0	5.0	1.0
31	3.0	6.0	2.0	4.0	5.0	1.0
32	3.0	6.0	1.5	4.0	5.0	1.5

Table 5. Ranks Assigned to Existing Budget.

Category	Ranking
1	4.0
2	6.0
3	1.5
4	3.0
5	5.0
6	1.5

Table 6. One Individual's Ranking of Categories.

Budget		Ranking of Categories within Budget		
Category	Description	Existing	Individual	Change in Rank
1	Fire protection	4.0	3.0	-1
2	Police, sheriffs and courts	6.0	6.0	0
3	Library	1.5	1.5	0
4	Parks and recreation	3.0	5.0	+2
5	Health and welfare	5.0	4.0	-1
6	Refuse collection	1.5	1.5	0

Comparison of Individual Poker Chip Responses and Responses by Rank

Whereas Table 3 indicated that respondent 1 withdrew 12 chips from category 5 and increased the number of chips in categories 1 and 4, Table 6 indicates that category 4 increases in rank while categories 1 and 5 decrease in rank. Therefore, the implication of Table 6 are different from those of Table 3.

The 100 poker chips used to develop the Table 3 results give a precise estimate of a relevant concept -- the relative level of funding that is desired for each budget category; the 6 ranks assigned to the 6 budget categories in Table 6 give a rough, inconsistent, and perhaps inaccurate estimate of the same precise concept.

Multivariate T-Test

In this study, a multivatiate t-test described in Finn (1974) is used to determine if there is a statistical difference between the existing budget and the budgets generated by those who played the game. 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. For example,

$$H_o: \mu - \mu^* = 0$$

where μ = the existing budget (as a mean vector)

μ^* = the individual budgets (as a mean vector).

A multivariate t-test is based on the assumption that the vectors are multivariate normally and independently distributed. In order to satisfy this assumption the original 32 budgets were transformed according

to the following procedure: for each respondent, r, where r=1 . . . R, substitute the natural log of the quotient, $(X^i_{jr} - X^i_{6r})$ for X^i_{jr} in each category j where j = 1 . . . 5. Table 7 illustrates the transformation of the first respondent's budget from its original form to its natural log normalized form. Category 6 is not explicitly used in the multivariate t-test since its result is a linear combination of the first five categories. Since any one category is a lienar combination of the other five, the result of the multivariate t-test does not depend on which one of the six categories is used as the denominator.

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. Since the tabular value of F, with these degrees of freedom and an α level of 0.05, is 2.27, the null hypothesis is rejected. This indicates that there is a difference between the existing budget and the average budget generated by those who played the game.

Univariate T-Tests

For Categories 1 Through 5

Five univariate t-tests have been 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 budgets is significantly different from the value for the corresponding category in the existing budget. The results of this analysis are displayed in Table 8. If there is no significant difference between the mean of the transformed values for a specific category in the individual budgets and the corresponding category in the existing

Table 7. Original Budget and Normalized Budget for Respondent r=1.

Budget		Type of Budget	
Category	Description	Original Percent	Normalized Log
1	Fire protection	15	1.3218
2	Police, sheriffs and courts	37	2.2246
3	Library	4	0.0000
4	Parks and recreation	21	1.6582
5	Health and welfare	19	1.5581
6	Refuse collection	4	a

a. Category 6 is not used in the multivariate t-test since the natural log $(X^i_{jr} - X^i_{6r})$ transformation places the Category 6 information into each of the other five categories.

Table 8. Result of Univariate T-Tests.

Budget Category	Budget Description	T-Statistic |t|	Probability of obtaining t-value |t| > t
1	Fire protection	.7623[a]	0.4517
2	Police, Sheriffs and courts	2.2804[b]	0.0297
3	Library	.1628[a]	0.5445
4	Parks and recreation	2.6372[b]	0.0130
5	Health and welfare	3.2150[b]	0.0031
6	Refuse collection		not determined

a. Not significant at the $\alpha = .05$ level for a two-tailed test.

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

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. We say that there is a significant difference if the value in the last column is .05 or less. As Table 8 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 comparabively low indicating that there is a significant difference in these categories.

For Category 6

Because the original Category 6 values are used to derive the natural log transformed values for the first five categories, a separate univariate t-test on Category 6 was not conducted. Nevertheless, it is possible to determine, in an intuitive manner, how closely the individual Category 6 allocations compare with the existing Category 6 allocation. Table 9 contains the informatin that is useful for conducting this analysis.

In Table 9, there is a large difference between the existing percentages and the geometric means for Categories 2, 4, and 5. In Table 8, there is an indication that in each one of these same categories the individual allocations are significantly different from the existing allocations.

In Table 9, there is a small difference between the existing percentages and the geometric means for Categories 1 and 3. In Table 8, there is an indication that in each one of these same categories the

Table 9. Comparison of Existing Percentages Versus Individual Geometric Means.

Budget		Percent Assigned by Category	
Category	Description	In Existing Budget	According to Geometric Mean of Individual Budgets
1	Fire protection	13.0	13.9
2	Police, sheriffs and courts	37.0	34.4
3	Library	4.0	4.7
4	Parks and recreation	11.0	14.8
5	Health and welfare	31.0	24.3
6	Refuse collection	4.0	4.5

individual allocations are not significantly different from the existing allocations.

Category 6 behaves more like Categories 1 and 3 than like Categories 2, 4, and 5 in Table 9. Therefore, the assumption can be made that the Category 6 allocations in the individual budgets are not significantly different from the Category 6 allocation in the existing budget.

Spearman Rank Correlation Coefficient

Just as the multivariate t-test can be used to determine if there is a difference between the existing budget and the budgets generated by those who played the game, the Spearman rank correlation coefficient can be used to determine if there is a difference between the average rankings assigned to the existing budget, and the ranks derived from the budgets of those who played the game. This statistic, sometimes called rho, can be computed from the data contained in Table 10. In Table 10, the second column contains the average rank assigned to each category by those who participated in the survey; the original set of ranks is given in Table 4. The third column in Table 10 contains the ranks assigned to each category within the existing budget; this information is taken from Table 5.

In Table 10, the largest differences between average ranks and existing ranks occurs in Categories 1 and 4. The order of the ranks assigned to these two categories in the average budget is the inverse of the order assigned to these two categories in the existing budget. These two categories are reversed in the two ranking schemes. The only other difference is in Categories 3 and 6. Both Categories 3 and 6 in the

Table 10. Data Used for Spearman Rank Correlation Coefficient.

Category	Average Ranking by Respondents	Ranking of the Existing Budget
1	3	4.0
2	6	6.0
3	2	1.5
4	4	3.0
5	5	5.0
6	1	1.5

ranking of the existing budget were ranked 1.5. While in the average ranking by respondents, Category 3 was given the rank of 2 and Category 6 was given the rank of 1, these discrepancies do not appear to constitute a major difference between the average ranking of the six categories by the respondents and the ranking of these categories in the existing budget. This conclusion is confirmed by an examination of the Spearman correlation coefficient, rho.

The correlation between the average ranking by respondents and the ranking of the existing budget results in a value of rho equal to .93. This value of the Spearman measure of association is significant at the .05 significance level (see Table P in Siegel, 1956, p. 284).

Comparison of Results of Multivariate T-Test and Spearman Test

In order to illustrate the differences between the type of information that can be derived from the bidding game and the type that can be derived from traditional ranking procedures, the poker chip budgets were transformed into a set of ranked budgets. Whereas the multivariate t-test indicates that there is a significant difference between the existing budget and the individual budgets, the Spearman test indicates that there is a high degree of correlation between the two types of budgets. This evidence suggests that the bidding game technique may provide a more precise measure of participants' preferences than does the traditional ranking approach that is used on community attitude surveys. This is not a fair comparison between the two methods of revealing preferences, because in this study respondents were asked to reveal preferences by assigning poker chips to budget categories; they were not asked to rank

categories according to the order of magnitude of funding level desired. A more valid comparison could be made in future studies if respondents both played the bidding game and ranked alternatives.

Creation of a Median Budget

The ultimate test in a democracy such as ours is the plurality test; i.e., the winner of an election is the person, or proposition, with the largest number of votes. A basic hypothesis in this study is that a median budget will be favored over any other budget in an election.

In order to test this hypothesis, a median budget was derived from the data in Table 2, i.e., the numbers of poker chips that were allocated to each of the six budget categories by each of the participants in this experiment.

The method of calculating the median budget in this experiment can be illustrated by examining Table 11. Table 11 contains the same data as Table 2 with the following two exceptions. Whereas Table 2 contains the responses of the 32 individuals who initially participated in this study, Table 11 only contains the responses of 30 of the original group that could be located for the purposes of completing the experiment. In Table 2 the numbers in each budget category are arranged in the order that respondents were interviewed; in Table 11 these numbers are arranged in order of increasing magnitude.

The symbol "Md.j" appears once in each column in Table 11. This symbol is used to denote the location of the median number, Md., of poker chips that were allocated to budget category j. The median has been defined by Perlman (n.d.) as follows: "When the data is arranged in order

Table 11. Data Ranked by Order of Magnitude.

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

NOTE: Md.j = the median for category j; e.g.,
Md.1=13, Md.2=36.5, Md.3=5, Md.4=14.5, Md.5=27.5, Md.6=4

Md.1=13, Md.2≃37, Md.3=5, Md.4≃15, Md.5≃27, Md.6=4

of magnitude, the middle item (half above, half below) is the median (Md.). If the number of items is even, the median is the average of the two middle items."

Perlman's method of computing the median has a potential limitation that can be illustrated by the data in Table 12. In this simplified example, each one of the three respondents has 100 poker chips that are allocated to three budget categories. If the poker chips in the simplified example are rearranged so that they are ranked by order of magnitude, as in Table 13, the median budget can be computed according to Perlman's definitions. The result, illustrated in Table 13, is that the median budget has 95 poker chips.

This problem did not occur with the data that resulted from playing the game at Tucson North. In other words, our empirical results yielded a median budget with 100 poker chips. Nevertheless, a better definition of a median budget may be needed in future studies.

The Plurality Test

In the final test of the bidding game, the residents of Tucson North were revisited and presented with the two budgets illustrated in Table 14 -- the median of the preferred budgets and the existing budget. They were not told which was the existing budget and which was the median budget. Each resident was asked to indicate which budget he, or she, preferred.

Of the 30 respondents interviewed, 19 preferred the median budget while only 11 preferred the existing budget. This result supports the

Table 12. Simplified Budgets Used to Illustrate Median Computation Problem.

Respondent	Budget Category			Total Number of Chips Allocated by Respondent
	j=1	j=2	j=3	
1	10	10	80	100
2	30	40	30	100
3	35	30	35	100

Table 13. Simplified Budgets Ranked by Order of Magnitude.

Rank	Budget Category j		
	j=1	j=2	j=3
1	10	10	30
2	30←Md.1	30←Md.2	35←Md.3
3	35	40	80
Total Number of Chips in Median Budget =	Md.1 +	Md.2 +	Md.3
=	30 +	30 +	35 = 95

Table 14. The Median and Existing Budgets.

Budget Category	Budget Description	Percentage Allocations Median	Percentage Allocations Existing
1	Fire protection	13.0	13.0
2	Police, sheriffs and courts	37.0	37.0
3	Library	5.0	4.0
4	Parks and recreation	14.0	11.0
5	Health and welfare	27.0	31.0
6	Refuse collection	4.0	4.0

hypothesis that, in a two-way race, a median budget will do at least as well as any other budget.

CHAPTER V

CONCLUSION

Summary of Results

The following ideas were expressed at the start of this thesis:

(1) There is a need for a better system of public participation in the planning, programming and budgeting of public goods and services. Traditional community attitude surveys are inadequate for this purpose.

(2) A bidding game may counter some of the drawbacks of the traditional community attitude survey.

(3) A mathematical model of local government forms the basis of the bidding game. The numerical output of such a model lends itself to statistical analyses, and can be used to compare the existing government budget with the one that voters would prefer.

(4) In a democracy such as ours, the winner of an election is the person, or proposition, with the largest number of votes. In a two-way race, a median budget will always do as well as any other budget. Where this is not the case, the voters have not been adequately represented by their elected officials in terms of the one man, one (dollar) vote principle.

(5) A bidding game is a physical analogue of the mathematical model of government. The game begins with one-hundred poker chips representing one-hundred percent of the local government budget allocated to each budget category as in the existing local government budget. Each

player reassigns the poker chips on the game board so that the resulting distribution will maximize that individual's utility.

(6) The bidding game was tested in the Tucson North subdivision in Tucson. Thirty-two individuals played the game and the results conformed to our expectations.

(7) Only a small percentage of the respondents were completely satisfied with the existing budget. Most participants changed the distribution of chips on the game board.

(8) A multivariate t-test indicates that there is a significant difference between the existing budget and the budgets generated by those who played the game.

(9) Univeriate t-tests indicate that there is a significant difference in the allocation of funds within some budget categories when these categories are considered one at a time.

(10) Comparisons between parametric statistical tests conducted on the original poker chip budgets and non-parametric tests conducted on a traditional rank ordered version of the same budgets indicate the following:

(a) the poker chip budgets give a precise estimate of a relevant concept -- the level of funding that is desired for each budget category;

(b) ranked budgets give a rough, inconsistent, and perhaps, inaccurate estimate of the same precise concept.

(11) When given the cohice in a test run, the participating residents of Tucson North preferred the median budget (which they had created through playing the bidding game) over the existing budget.

Future Work

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

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, the bidding game could be used as an adjunct to the traditional type of questionnaire that is used in community attitude surveys.

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 among 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 participants can be allowed to change the level of the budget.

APPENDIX A

SUBJECT'S CONSENT FORM

Summary of Project Procedures and Demands in Lay Language (See DHEW Guide)	TITLE: A Preliminary Experiment to Test a New Technique for Citizen Involvement in a Local Government's Budgeting Process	NUMBER

Hello, my name is _____. I promise you that I am not selling anything. I am cooperating with Dr. Reuben N. Weisz of the Department of Agricultural Economics at The University of Arizona in Tucson. We are interviewing a group of residents in your neighborhood to test a new survey technique that is called a "bidding game."

The University of Arizona research guidelines require all survey participants to be fully aware of what their participation in a survey will entail. To meet these requirements, I would appreciate it if you would read this consent form. If, after reading the consent form, you agree to participate in the survey please indicate this by signing your name at the bottom of this page. If you agree to participate in this study, you are under no obligation to complete the study. You may withdraw at any time.

If you decide to participate in this survey, it will require that you volunteer about 15 minutes of your time without pay to answer a few interesting questions.

The bidding game is different from the typical questionnaire that has written, multiple choice questions and answers. The game is played on the two-dimensional game board that is in front of you.

The horizontal axis of the game board is divided into six categories of services that are provided to residents of this neighborhood by your local government. The six categories represent the following program areas:

1. fire protection;
2. police, sheriffs and courts;
3. library;
4. parks and recreation;
5. health and welfare; and
6. sewerage and garbage collection.

The vertical axis of the game board is calibrated in such a way that the smallest unit of measure is equal to the width of one of these poker chips. Each poker chip represents 1% of the local government's budget.

The City of Tucson Planning Department last year published the results of a study (Cost-Revenue Analysis by Land-Use Zone). Of the total amount of money that the local government spends on all of the programs that are displayed on the game board, the following percentages are spent on each program area in this neighborhood:

1.	fire protection	13%
2.	police, sheriffs and courts	37%
3.	library	4%
4.	parks and recreation	11%
5.	health and welfare	31%
6.	sewerage and garbage collection	4%

The number of poker chips in each game board category is equal to the percent of the budget that is spent on that program area. For example, since 13% of local government spending on services provided to residents of this neighborhood is spent on fire protection, 13 poker chips have been placed in the fire protection category, etc.

Each person who plays the bidding game will be asked to reallocate the poker chips according to the way that he, or she, would like to see local government money being distributed among the six program areas in this neighborhood. The resulting percentage distribution of the budget will be recorded in the following blank spaces:

1.	fire protection	_____%
2.	police, sheriffs and courts	_____%
3.	library	_____%
4.	parks and recreation	_____%
5.	health and welfare	_____%
6.	sewerage and garbage collection	_____%

The blank spaces appear on the answer sheet in front of you.

After the initial interviews in this neighborhood are completed, an "average preferred budget" for this neighborhood will be developed. The percent of the local government budget that is assigned to a specific program area in the "average preferred budget" will be the average number of poker chips that were assigned to that specific program area by all survey respondents in the neighborhood. At that point in time we will return to this neighborhood to ask each bidding game player one final question which is described in the following paragraph.

We are interested in determining whether the majority of bidding game players prefer the existing local government budget or the average preferred budget. The results of this question will give us that

information. The existing local government budget and the average preferred budget are illustrated on the card being held by the interviewer. Please indicate which budget you like the most by putting the letter "X" beside the budget of your choice.

A. Existing local government budget for this neighborhood ___
B. Average preferred government budget for this neighborhood ___

The answer to this question will also be recorded on the Answer Sheet that is in front of you.

The results of this study will be used to determine the value of putting more research time and effort into perfecting the bidding game technique as an instrument to be used in future community attitude surveys. The results of this particular survey will not be used to influence local policymakers in their budget decisions.

All information will remain strictly confidential. Your anonymity will be protected by removal and destruction of the information below the dotted line on the answer sheet; this will occur immediately before asking you the second question.

I am willing to answer any questions that may arise regarding the procedure. In addition, you should feel free to call Dr. Reuben N. Weisz at his University phone number, 884-3228, if any questions arise.

The nature and demands and the risks and benefits of the project have been explained to me; I understand what my participation involves. Furthermore, I understand that I am free to ask questions at any time and that I may withdraw from the project at any time.
Subject's Signature _____ Date _____

I have carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge the subject signing this consent form understands clearly the nature, demands, benefits and risks involved in participating in this study. A medical problem or language or educational barrier has not precluded a clear understanding of his/her involvement in this project.
Investigator's Signature _____ Date _____

APPENDIX B

ANSWER SHEET

I. Question I.

1. fire protection _____%
2. police, sheriffs and courts _____%
3. library _____%
4. parks and recreation _____%
5. health and welfare _____%
6. sewerage and garbage collection _____%

II. Question II.

A. Existing local government budget for this neighborhood _____

B. Average preferred local government budget for this neighborhood _____

- -

RESPONDENT'S NAME:_____

RESPONDENT'S ADDRESS:_____

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