THE INSTITUTE OF URBAN AND REGIONAL RESEARCH

ANALYSIS OF HOUSING CHOICES OF THE ELDERLY

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ANALYSIS OF HOUSING CHOICES OF THE ELDERLY

Introduction

In October 1979, the Administration on Aging (AoA) of the Department of Health, Education and Welfare provided the Institute of Urban and Regional Research at The University of Iowa with a research grant to investigate factors influencing the housing choices of the elderly.* As part of that research project, a national sample of the elderly U.S. population (aged 55 and over) was surveyed to determine their housing preferences and tradeoffs. This report focuses upon the design, analysis and results of the housing tradeoff research.

The intent of the tradeoff and choice research performed in this project was to develop parallel and complementary analyses and models of elderly housing tradeoffs, preferences and choices. The result of this research is improved knowledge of the factors influeincing housing choices of the elderly, leading to better public decisions on housing policies and programs for the elderly.

The parallel approaches utilized in Iowa's study were based upon theory and methods developed in economics and psychology. They are, respectively, multinomial discrete choice analysis developed in econometrics (McFadden, 1974; Hensher and Johnson, 1981) and Functional Measurement or Information Integration Theory (Anderson, 1974, 1979; Louviere, 1978, 1981) developed in psychology. This report describes the design and presents an analysis of the

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*Note: Grant No. 90-AR-2118, co-principal investigators Drs. Jordan Louviere and Lloyd Turner. Report edited by Dr. John W. Fuller.

Information Integration or tradeoff portion of the national survey of the U.S. elderly.*

Information Integration Theory or Functional Measurement

The following section provides a brief introduction to the approach used in this research project to model the choice behavior of the elderly population. Appendix A contains a detailed technical description of this approach (termed information integration theory or functional measurement).

The elderly evaluate alternative housing opportunities and choose from among their opportunities that which best satisfy their needs and preferences, subject to personal and household constraints. Information integration theory suggests that individuals proceed to make choices by evaluating a number of separate items of information, or "attributes" of housing alternatives. Essentially, the elderly trade off levels of the attributes of one alternative againg levels of the attributes of other alternatives. Information integration theory is a sound, analytically tractable approach to determining trade-off functions, which proceeds in this study by the following steps: (1) specifying the attributes that the elderly take into account in evaluating housing alternatives; (2) assigning levels to the attributes and placing those attributes in a combinatorial experiment in order to develop tradeoff data**;

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*Note: The analysis presented in this report relies critically on the survey, designed by Dr. Turner, and the data that were obtained under his supervision and with the assistance of Chilton Research Services. The author accepts that survey design and the data produced as input; strengths and limitations of the survey are referred to later in this report. Discrete choice analysis results are presented in a companion report, produced by Cambridge Systematics, Inc. Characteristics and limitations of the survey data are covered in Lloyd Turner et al., Housing Policies for the Community Resident Elderly, The Graduate School of Social Work and Social Research, Bryn Mawr College, December 1981.

**Note: The Iowa study used three levels of four housing attributes, or 81 possible mobility and residential situation tradeoffs.

(3) using the alternatives to survey respondents who evaluate each attribute, compare among alternatives and respond to an entire bundle of attributes. The next section describes the process and results of performing tradeoff surveys.

Aggregate Analyses of Tradeoff Data

Mobility Tradeoffs surveys used in this study are shown in Appendix A. (These surveys obtained information on interregional migration trdeoffs of the elderly.) In order to fully interpret the regression results to follow, we first illustrate the statistical findings through tables of means of the conditional (or Main) and joint (or Interaction) effects of the attributes.*

It is important to consider both Main and Interaction Effects because Main Effects can give a misleading picture of a true relationship if interactions are present. In particular, many research results are based upon consideration of only Main Effects--what will happen on the average if one changes the levels of a particular attribute. These results are especially attractive for policy if true because they imply that one can change the levels of an attribute, ceteris paribus, and anticipate the "correct" results. If, however, interactions between the attribute in question exist one cannot usually make such "correct" predictions without considering the simultaneous effect(s) of other attributes. For example, as will be noted in the results, the response to cost of living can be described as follows: as the cost of

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*A conditional effect is usually referred to as a "Main Effect"--it represents the relationship between the response and the levels of a single attribute, holding all other attributes constant. This is illustrated by calculating the marginal means (the mean response to a particular level of a particular attribute). A joint effect is usually referred to as an "Interaction Effect"--it represents the relationship between the response variable and the levels of one attribute, taking the levels of one or more additional attributes into account.

living increases in potential mobility-choice locations, the attraction of such places as potential movement choices decreases. One therefore might be tempted to entertain various strategies to enhance the attractiveness of higher cost of living destinations if it was felt it was in the national interest to do so. However, the statistical results indicate that cost of living interacts with type of community; hence, the policy would have potentially different effects for different types of communities, having the least effect in the centers of large cities.

Main Effects of Mobility Tradeoffs

These results are contained in Table A. The results suggest the following conclusions regarding effects on movement attraction:

- Small towns/rural areas are much more attractive than cities or suburbs of cities. Suburbs of cities are more attractive than centers of cities.

- As the major costs of living (housing, utilities, food and taxes) increase, the attraction of moving to a place decreases, approximately linearly.

- States/climatic areas in the southwest U.S. are slightly preferred to those in the southeast U.S. Both are more attractive than Northern states/climates.

- Having relatives living in nearby communities is slightly (very) less attractive on average than having them in the same community. Both are considerably more attractive for moving than having relatives nowhere nearby.

Because the experimental design employed permits one to control the standard errors of each attribute, it is possible to compare the average "conditional" (holding all else constant) effects of the four attributes because all have identical standard errors. This permits one to assess which attribute(s) will have the largest (smallest) effects within the ranges of levels examined. This assessment can be accomplished by examining the range in the marginal means: this range is directly related to the amount of

TABLE A: MARGINAL (CONDITIONAL) MEANS FOR MOBILITY TRADEOFFS SURVEY

Attributes	Levels	Marginal means	Range
Adjusted for Surveys			
Type of community	Center	-.34	
	Suburb	.02	.65
	Small Town	.31	
Proportion of income spent on costs of living	40%	.36	
	60%	.01	.74
	80%	-.38	
States/locations/ climate	Northern	-.14	
	Southwestern	.09	.23
	Southeastern	.04	
Location of close relatives	Nowhere Near	-.21	
	Nearby	.11	.32
	Same Town	.09	
Unadjusted (Raw Data Means)			
Type of community	Center	1.54	
	Suburb	1.90	.65
	Small Town	2.19	
Proportion of income spent on costs of living	40%	2.24	
	60%	1.89	.74
	80%	1.50	
States/locations/ climate	Northern	1.74	
	Southwestern	1.98	.24
	Southeastern	1.91	
Location of close relatives	Nowhere Near	1.67	
	Nearby	1.99	.32
	Same Town	1.97	

variance contributed by each attribute; hence, it is a measure of its effect relative to the other attributes and only within the levels examined. The results indicate the following:

- Cost of living has the largest effect over the range of levels examined.
- Type of community has the second largest effect of the attributes manipulated.
- Both of the preceding attributes have very much larger average effects than the remaining attributes (about twice as large on average).
- The location of close relatives has the third largest effect on average.
- Climate has the smallest effect on average.

These results must be interpreted cautiously because they belie considerable individual differences. Climate, in particular, was shown to have a similar average effect in a study of elderly migration preferences at The University of Iowa, funded by the U.S. NIA. Yet, at the individual level climate had the single most important influence on responses (Rushton, et al., 1979, 1980). This occurs because individuals have very different preferences for climatic/state types; hence, the average merely reflects the aggregate result of the distribution of these preferences in the population. We shall re-examine this issue in the disaggregate section.

Interaction Effects of Mobility Tradeoffs

The results of the analysis of interactions among the attributes is contained in Table B. The statistical treatment of these effects by means of multiple linear regression is contained in a following section (Main Effects of Residential Situation Tradeoffs, page 16). The mobility data reveal no reliable interaction effects: interactions were examined for three adjustments--the raw response data (no adjustment), Rating of Present Residential Situation, and Rating of the Treatment Combination Common to All Survey

TABLE B: INTERACTION MEANS FOR MOBILITY TRADEOFFS STUDY

Type of Community	Cost of Living		
	.4	.6	.8
Center -1	-.21	-.24	-.56
Suburb 0	.50	-.08	-.36
Small Town +1	.80	.34	-.22

Cost of Living	Climate		
	North. -1	S. West 0	S. East +1
40%	.19	.49	.40
60%	-.03	.10	-.05
80%	-.58	-.32	-.24

Type of Community	Climate		
	North. -1	S. West 0	S. East +1
Center -1	-.48	-.28	-.26
Suburb 0	-.21	.23	.04
Small Town +1	.27	.33	.33

Cost of Living	Location of Relatives		
	Does not -1	Nearby 0	Same +1
40%	.03	.40	.66
60%	-.19	.32	-.10
80%	-.46	-.38	-.29

Type of Community	Location of Relatives		
	Does not -1	Nearby 0	Same +1
Center -1	-.42	-.42	-.18
Suburb 0	-.16	.31	-.09
Small Town +1	-.05	.44	.53

Climate or States	Location of Relatives		
	Does not -1	Nearby 0	Same +1
Northern -1	-.54	.10	.24
S. West 0	.08	.19	.01
S. East 0	-.17	.05	.24

Sets (base adjustment). Nonetheless, the tables presented in Table B indicate some potentially important trends:

- There is a systematic trend evident for responses to type of community and costs of living. In particular, there is a trend for the effect of cost of living to increase systematically with the levels of community type ordered by preference (city center, suburb, small town). These slopes are respectively, -0.875, -2.150, -2.550. If "true," this implies that cost of living is less important if the location is the center of a city, and more important if the location is a small town or rural area (ceteris paribus).

- There is similar evidence for the responses for type of community and location of relatives as indicated above. That is, the effect of relatives' location is most for small towns and rural areas and least for centers of cities.

With regard to the above, it is important to note that we are relying purely upon visual evidence because the statistical results suggest that these effects are not reliable. However, previous experience with thousands of such data tables leads us to remark that the statistical results are predicated upon sets of assumptions that may not be fully satisfied. Although every attempt was made to insure satisfaction of these assumptions, satisfaction rarely can be ever truly known. In such cases our opinion is that the data must speak for themselves: we suggest these interaction tables speak for themselves.* Thus, if the effects observed in the tables are "correct," policies to affect broad national choices of location will likely differ in their effects by type of community for the two attributes in question--cost of living and location of relatives.

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*A complicating problem is that the experimental design is technically a "repeated measures" experiment. Such a design requires careful treatment to determine the "correct" error terms for each effect. Because each respondent was involved in a different block (1/5 of survey), such analysis is complicated and there is disagreement regarding its treatment. We chose to average over respondents to remove effects "within" and "between" respondents. This requires assumptions that may not be satisfied. We "correct" for this problem in the disaggregate analyses, but we cannot examine interactions therein.

Regression Analysis Results for Mobility Tradeoffs

The purpose of regression analyses of the response data is twofold: 1) to provide a statistical treatment of the relationship between the attributes and the attractiveness responses; and 2) to develop a predictive model for the response data which will forecast responses to combinations not observed in the surveys and which lie within the range of the attribute levels studied. This latter purpose is useful for policy assessment in that it is rarely the case that a particular combination of levels of the attributes used in the survey corresponds exactly to a particular policy or the translation of a particular policy. The predictive model permits one to extrapolate. This is particularly true for cost of living. The regression results are presented in two parts: Table C contains just the main effects, or the model developed by ignoring interactions; Table D contains the complete model containing all main and interaction effects which can be reliably estimated. This latter table also contains the results for both weighted and unweighted regressions and for adjustments due to responses to present residence and the common treatment combination or base alternative.

With the exception of cost of living, which has natural units, all of the attributes were coded as orthogonal polynomials (see Appendix A) to maintain the independence properties of the experimental design. This makes the coefficients of these attributes difficult to directly interpret. However, all the information contained in these coefficients is contained in the marginal means in Table A. The purpose of the polynomial coding is simply to insure that independence is maintained in estimation and that the means observed are exactly reproduced. We can directly interpret the coefficient on cost of living: for each .01 increase in cost of living, there is a .01587 decrease in attractiveness on average. The arc elasticity for cost of living

TABLE C: AGGREGATE REGRESSION OF MOBILITY TRADEOFF RESPONSE DATA--MAIN EFFECTS ONLY

	Unweighted			Weighted		
	Coefficient	Std. Error	t-value	Coefficient	Std. error	t-value
Community Type	0.324	.029	11.08	0.279	.033	8.39
Community Type^2	-0.012	.017	-0.70	-0.002	.019	-0.12
Cost of Living	-1.852	.146	-12.65	-1.587	.163	-9.76
Cost of Living^2	-0.131	.423	-0.31	-0.211	.500	-0.42
States/Climate	0.089	.029	3.04	0.066	.032	2.05
States/Climate^2	-0.048	.017	-2.83	-0.032	.019	-1.67
Location of Relatives	0.149	.029	5.09	0.124	.032	3.86
Location of Relatives^2	-0.057	.017	-3.35	-0.049	.019	-2.54
Intercept	1.877			1.855		
R-Squared	.90			.88		
f-Value	42.20			32.00		

TABLE D: AGGREGATE REGRESSION RESULTS FOR COMPLETE MODEL FOR MOBILITY TRADEOFFS SURVEY

	Unweighted		Weighted		Weighted Pres-Ave		Weighted Last-Ave	
PARAMETERS	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Intercept	1.88		1.87		1.56		-0.682	
Community Type (CT)	0.31	.04	0.30	.04	-0.28	.09	-0.30	.05
Cost of Living (CL)	-0.36	.04	-0.37	.04	0.37	.09	0.37	.05
Climate/State (ST)	0.10	.04	0.10	.04	-0.13	.08	-0.10	.05
Relatives (R)	0.12	.04	0.13	.04	-0.14	.08	-0.13	.05
CT^2	-0.01	.02	-0.02	.02	0.01	.05	0.02	.03
CL^2	0.33	.58	0.26	.56	-0.06	1.24	-0.43	.71
ST^2	-0.04	.02	-0.04	.02	0.05	.05	0.04	.03
R^2	-0.05	.02	-0.05	.02	0.06	.05	0.05	.03
CT.CL	-0.14	.05	-0.14	.04	0.15	.10	0.135	.06
CT.ST	0.04	.04	0.03	.04	-0.04	.08	-0.03	.05
CT.R	-0.005	.05	-0.003	.04	-0.04	.10	-0.001	.06
$CT.CL^2$	0.33	.68	0.43	.66	-0.32	1.46	-0.45	.83
$CT.ST^2$	0.004	.02	0.01	.02	-0.01	.05	-0.02	.03
$CT.R^2$	-0.04	.03	-0.04	.03	0.04	.06	0.04	.03
CL.ST	-0.03	.05	-0.03	.04	0.04	.10	0.02	.06
CL.R	-0.03	.05	-0.04	.05	0.09	.11	0.05	.07
$CL.ST^2$	0.01	.03	0.03	.03	-0.05	.06	-0.02	.03
$CL.R^2$	0.005	.03	0.005	.03	-0.04	.06	-0.01	.04
ST.R	-0.03	.05	-0.04	.04	0.05	.09	0.05	.05
$ST.CT^2$	0.02	.02	0.01	.02	-0.002	.05	-0.01	.03
$ST.CL^2$	0.53	.68	0.46	.63	-0.52	1.40	-0.29	.80
$ST.R^2$	0.02	.03	0.01	.03	0.01	.06	-0.005	.03
$R.CT^2$	0.01	.03	0.01	.03	-0.01	.06	-0.02	.03
$R.CL^2$	-0.19	.79	-0.11	.70	0.16	1.55	0.09	.89
$R.ST^2$	-0.00	.03	-0.01	.03	0.03	.06	0.02	.03
$CT^2.CL^2$	-0.12	.39	-0.003	.38	-0.001	.84	0.10	.48
$CT^2.ST^2$	0.01	.01	0.02	.01	-0.02	.03	-0.02	.02
$CT^2.R^2$	0.003	.02	0.003	.02	-0.01	.04	-0.002	.02
$CL^2.ST^2$	0.06	.39	-0.09	.38	0.20	.84	0.125	.48
$CL^2.R^2$	0.34	.45	0.44	.46	-0.66	1.02	-0.45	.58
$ST^2.R^2$	0.01	.02	0.002	.01	0.0006	.03	-0.004	.02
$CL^2.CT^2$	0.01	.03	0.01	.03	-0.01	.06	-0.006	.04
$\overline{R}^2$	0.96	32,12	.97	32,12	.87	32,12	0.95	32,12

calculated by this method is approximately -2.6; hence, the response is very elastic with respect to cost of living. The interpretation of this elasticity is that each one percent rise in cost of living will result (on average) in a 2.6 percent drop in response.

As before, the complete regressions are not directly interpretable because of the orthogonal coding employed. In the case of the cost of living attribute, it too is orthogonally coded in these analyses in order to maintain independence of the interaction effects. Thus, the coefficient on cost of living is not the same as in the previous discussion. In this respect, the regression analysis is being employed as an analysis of variance. It should be noted that there are at most minor differences in coefficients as a result of the adjustments or contrasts examined. Thus, the previous results apparently do not depend upon the different surveys employed. Hence, except for intercepts, which will change as we change the adjustments, there are no reliable statistical differences in the result. Thus, our previous interpretation of the main and interaction effects is not affected by response scale transformation or survey type.

In summary, the results of the regression indicate a very low attraction of any of the places on average (the intercept equals the grand mean over all 45 alternative places in the 5 surveys). The mean response is 1.877 on a five-category scale, with 1 being lowest and 5 highest. Thus, the <u>average</u> response is only 21.93% of the maximum. The standard deviation of this mean is .467, which indicates that on average about 97% of the response means should be within (1.96 x .467 = $\pm$ .9153) units of the observed mean if the response means are normally distributed. That is, about 1.0 to about 2.8 or 3. The largest response mean is 3.07; the average response to present residence is 3.94. Hence, no places on average are as attractive as the average

present residence. This implies that there is very little likelihood of moving from present residence to a new location within the elderly population studied, assuming that the 4 attributes involved are the most (and only) relevant ones to influence the mobility decision. This hypothesis is specifically examined in the next section dealing with a "crude" choice analysis.

An Approximate Analysis of Choice Probabilities

In this section we develop a "crude" but reasonable approximation to defining the probability that the sample of individuals studied would choose a particular mobility alternative. The approximation entails calculating the relative frequency with which each of the 45 mobility scenarios were rated equal with or higher than the respondent's present residence (see survey form, Appendix B). The reasoning behind this approximation is that it is unlikely that respondents who rate their present residential and mobility situations higher than a particular alternative opportunity would choose that opportunity. Therefore, a "crude" choice analysis can be conducted by examining the way in which the relative frequencies vary as the attributes of the alternatives vary. These results should yield measures of the attractiveness of each of the 45 alternatives relative to the respondents' present residence.

In order to use the results to predict probabilities of choice one must draw upon recent theory and methods developed in psychology (Luce, 1959, 1977; Yellott, 1977), economics (McFadden, 1974; Hensher and Johnson, 1981) and marketing/statistics (Louviere and Woodworth, 1981). This theory basically states that the probability of choosing an alternative is defined relative to a set of alternatives from which the individual is considering selecting one. It suggests that the probability of choosing an alternative is equal to the ratio of how attractive the alternative is relative to the sum of the attractiveness of all other alternatives which the individual is considering.

In algebra this relationship may be stated as follows:

$$p(i|A, \forall j \epsilon A) = \frac{e^{Ui}}{\sum_{\forall j \epsilon A} e^{Uj}} \qquad (1)$$

where $p(i|A, \forall j \epsilon A)$ is the probability of choosing alternative i given a set A in which i and other alternatives (e.g., j) are being considered. This probability is defined over all the j members in A.

Ui, Uj are the utilities of i and j, respectively. They represent "how attractive" i and j are.

e is the base of the natural logarithms. It is a constant.

$\sum_{\forall j \epsilon A}$ is a sum taken over all the j alternatives in the consideration set A.

To implement the models for predicting choice behavior requires us to create choice sets (sets of alternatives for the individuals to "consider") and apply equation (1) to predict the choice probabilities. This is accomplished by noting that the probabilities in equation (1) are relative to a particular choice set, e.g., A. The denominator in each choice set is a constant, i.e.,

$$= \frac{e^{Ui}}{k_A} \qquad (2)$$

where e^{Ui} is as previously defined and k_A is the constant for choice set A. Taking logarithms of both sides yields:

$$\ln [p(i|A, \forall j \epsilon A)] = Ui - \ln(k_A) \qquad (3)$$

where all terms are obviously defined, except ln, which is the natural logarithm to the base e.

Next, define Ui to be a function of its attributes, which it must be:

Ui = f (community type, cost of living, climate, location of relatives)

where the function f is a regression type function. This defines the linear logit regression model. Hence, the probability of choosing a particular alternative relative to the present residence can be estimated by taking logarithms of the quantity, "Relative frequency with which i(=1, 2, . . ., 45) is rated greater than or equal to the present residence," and performing a weighted least-squares multiple regression using the levels of the attributes as independent variables. The term k_A will be captured in the intercept of the regression assuming the terms for choice sets to be small (although we test for this); hence, it need not be explicitly known. This procedure is employed to develop a separate regression analysis for the mobility tradeoff data.

The results of this analysis are given in Table E for the complete regression model. The estimated equation is significant beyond the .01 level and accounts for 96.2% of the variation in the logarithms of the choice proportions. These results indicate only two potentially significant interactions--the community types and cost effect and the cost and relatives effect. As before, we must interpret this cautiously because of the similar patterns in the raw data. Nonetheless, we can conclude that cost of living has the largest conditional effect, followed by community type. Apparently, location of relatives and region or climate have very minor effects on the aggregate choice surface approximation. In general, however, the conclusions essentially duplicate those derived from the aggregate response data.

TABLE E: WEIGHTED REGRESSION ANALYSIS OF CRUDE CHOICE PROBABILITY DATA FOR MOBILITY TRADEOFFS RESPONSE DATA

PARAMETER	Coefficient	Std Error	t-value
Intercept	-0.774		
Community Type (CT)	0.107	.022	4.78
Cost of Living (CL)	-0.139	.024	-5.75
Climate/State (ST)	0.020	.024	0.83
Location of Relatives (R)	0.060	.025	2.43
CT^2	-0.013	.012	-1.08
CL^2	-0.139	.330	-0.42
ST^2	-0.001	.015	-0.07
R^2	-0.019	.013	-1.43
CT.CL	-0.053	.027	-2.01
CT.ST	0.013	.024	0.53
CT.R	-0.031	.026	-1.19
$CT.CL^2$	0.215	.378	0.57
$CT.ST^2$	0.002	.014	0.14
$CT.R^2$	-0.014	.015	-0.96
CL.ST	0.008	.029	0.27
CL.R	0.018	.033	-0.55
$CL.ST^2$	0.009	.017	0.52
$CL.R^2$	-0.006	.018	-0.35
ST.R	0.001	.030	0.03
$ST.CT^2$	0.001	.013	0.10
$ST.CL^2$	0.234	.395	0.59
$ST.R^2$	0.002	.016	0.15
$R.CT^2$	0.007	.015	0.45
$R.CL^2$	0.094	.471	0.20
$R.ST^2$	-0.011	.017	-0.67
$CT^2.CL^2$	-0.083	.215	-0.39
$CT^2.ST^2$	0.003	.008	0.42
$CT^2.R^2$	0.008	.008	1.02
$CL^2.ST^2$	0.085	.230	0.37
$CL^2.R^2$	0.467	.234	2.00
$ST^2.R^2$	-0.007	.009	-0.72
$CL.CT^2$	0.021	.015	1.42
R-squared	0.96		
f-value	5.6(32,12)		

Main Effects of Residential Situation Tradeoffs

The "Main Effects" of residential situation tradeoffs are contained in Table F. The results suggest the following conclusions for the attractiveness of residential situations within larger places or regions:

- The elderly find larger multifamily unit complexes more attractive as residential situations than either complexes of 2-4 units size or single family residences; although complexes of size 2-4 are more attractive than single family units.

- The elderly find ownership of their dwelling unit much more attractive than either renting same or living in the home of a relative. It is clear, in fact, that living in the home of a relative is very unattractive.

- On average, the elderly in our sample prefer to live in middle income neighborhoods compared with upper and lower income areas. They find upper income areas more attractive than lower income neighborhoods.

- On average, the elderly in our sample find homes requiring 30% of their income for housing and utilities more attractive than those requiring 15% or 45%. Income outlay of 15% is more attractive than 45%, but the differences are not great. We suspect that some respondents interpreted the housing outlay as an indicator of quality as well as cost. The price/quality illusion, of course, is a well-known and reliable effect in marketing studies similar to these.

As noted under mobility tradeoffs, the experimental design selected permits one to assess differences in relative effects among the attributes. By considering the ranges of the four attributes, we can draw the following inferences:

- Individual living arrangements (own, rent, live with relative) has the greatest single influence on the attractiveness of residential situations.

- The number of dwelling units has the second largest effect on attractiveness responses; it has about 3/4 the impact as living arrangement.

- Income level of neighborhood has about 1/2 as great an influence on average as does living arrangement.

- Cost of housing and utilities has a very minor influence on judgments of attractiveness, only being about 1/6 as great as that of living arrangements.

TABLE F: MARGINAL (CONDITIONAL) MEANS FOR RESIDENTIAL SITUATION TRADEOFFS SURVEY

	Adjusted for Surveys		
Attributes	Levels	Marginal Means	Range
Type of Dwelling Unit	Single 2-4 > 5	-.27 -.09 .36	.63
Living Arrangement	w/relative Rent Own	-.46 .05 .41	.87
Proportion of Income for Housing and Utilities	15% 30% 45%	-.19 .23 -.03	.42
Income Level of Neighborhood	Low Medium High	.03 .06 -.09	.15
	Unadjusted (Raw Data Means)		
Attributes	Levels	Marginal Means	Range
Type of Dwelling Unit	Single 2-4 > 5	1.60 1.78 2.23	.63
Living Arrangement	w/relative Rent Own	1.41 1.92 2.28	.87
Proportion of Income for Housing and Utilities	15% 30% 45%	1.67 2.10 1.84	.43
Income Level of Neighborhood	Low Medium High	1.90 1.93 1.77	.16

These findings suggest that (ceteris paribus) policies designed to influence costs will have less effect than others based on the remaining attributes. This should be interpreted cautiously, however, because this average finding could mask considerable individual differences. The dwelling unit finding is, however, of potentially great relevance because it so clearly indicates the attraction of multi-family housing. Given the state of the U.S. housing industry at the time of this writing, there are implications for the future distribution of types of facilities in these data relevant to policy makers in both elderly affairs and housing. The income level of neighborhood finding suggests broad policy implications for the location of housing in communities, suggesting that there is an important difference in attractiveness depending upon neighborhood type. As we shall see under Interaction Effects (in the next section), the implication is that more multifamily housing in middle and upper income areas would have a potentially large influence on residential attractiveness.

As noted previously, one must interpret these aggregate effects cautiously because there is the possibility of great individual differences. We shall return to this in the analysis of the disaggregate data. We remark at this point, however, that it is important to note that the results only pertain to attractiveness responses--not choices. This report is confined to the former, and although it is possible to simulate the latter from the available data, such an analysis is beyond the scope of this study.

The next section considers the existence of interaction effects among the attributes. If such effects exist, and the statistical results suggest that they do, one has to temper the conclusions of this section in light of these effects.

Interaction Effects of Residential Situation Tradeoffs

The results of the analysis of the interaction effects in the residential situation tradeoffs study are contained in Table G. The statistical results based upon multiple linear regression analysis is discussed in the next section. The residential situation response data reveal a number of significant interactions. These interactions may be interpreted as follows:

- The type of living arrangement (own, rent, live with relatives) interacts with every other attribute. It is suggested, therefore, that the particular type of living arrangement colors the response to the remaining attributes on average. Specifically,

  A. Ownership has a dramatic effect on the responses. In all cases, if the situation involves ownership, the response to levels of the other attributes is greatly exaggerated. In all cases, the interaction tables show a systematic trend for the range in the means to increase, from situations in which living with a relative is involved, to those in which renting is involved, through ownership. This effect is typical of multiplicative or cutpoint decision processes and suggests that living arrangement acts as a weighting factor for all other attributes: the slope or effect of the second attribute systematically changes as living arrangement differs. When the arrangement is living with a relative, other attributes have little influence; if renting is the arrangement, the attribute levels have more influence; if the arrangement is owning, the attributes have the most influence.

- Other interactions indicate that the effect is fairly precisely estimated, but relatively smaller in influence. The following appear to be notable influences from Table D:

  A. The effect of middle income neighborhoods differs within different levels of type of dwelling unit (single vs. multifamily housing). In particular, the preference ordering is for large multifamily complexes in middle income neighborhoods, followed by the same in high income neighborhoods. However, the third preference is for 2-4 unit complexes in high income neighborhoods, then 2-4 unit complexes in middle income areas. Whether this is sampling fluctuation or a reliable effect cannot be determined. If "real" it could reflect perceptions of safety and security as well as desirability of housing and neighborhood.

  B. There is a fairly dramatic preference reversal evident in the data for cost of housing and income level of neighborhood: middle income neighborhoods are more attractive on the average at every level of cost, but the data suggest that at 15% level of cost the areas are about equally attractive. Respondents definitely do not want an expensive place in a low income neighborhood and do not find medium cost (30%) places attractive in either high or low income

TABLE G: INTERACTION MEANS FOR RESIDENTIAL SITUATION TRADEOFFS STUDY

Type of Dwelling Unit	Living Arrangement		
	With relative -1	Rent 0	Own +1
Single -1	-.57	-.07	-.15
2-4 0	-.44	-.07	.23
> 5 +1	-.24	.29	1.15

Living Arrangement	Costs		
	15% -1	30% 0	45% +1
With relative -1	-.46	-.42	-.50
Rent 0	.11	.07	-.03
Own +1	.45	.53	.25

Type of Dwelling Unit	Cost of Housing		
	15% -1	30% 0	45% +1
Single -1	-.19	-.23	-.38
2-4 0	-.09	.03	-.23
> 5 +1	.37	.38	.32

Living Arrangement	Neighborhood Income		
	Low -1	Med 0	High +1
With Relative -1	-.48	-.42	-.47
Rent 0	-.09	.08	.16
Own +1	-.01	1.02	.22

Type of Dwelling Unit	Neighborhood Income		
	Low -1	Med 0	High +1
Single -1	-.38	-.05	-.37
2-4 0	-.18	-.13	.03
> 5 +1	-.04	.87	.25

Cost of Housing	Neighborhood Income		
	Low -1	Med 0	High +1
.15	.03	.06	.01
.30	-.12	.46	-.16
.45	-.50	.16	.07

neighborhoods. Expensive homes (45%) are okay in middle income and in upper income areas. This finding has implications for the distribution of types of housing by neighborhood.

These interaction effects, of course, are aggregate in nature. They can mask considerable individual differences. The designs employed make it impossible to assess these interactions at the individual level. Future work should be directed towards their definition for individuals because the distribution of these effects in the population is what matters in assessing the consequences of policy. At the present we can only remark that they are likely to exist and, depending upon their configuration for a particular individual, one cannot anticipate the likely consequences of policy change without understanding them.

Regression Analysis Results for Residential Situation Tradeoffs

The regression analysis of the residential situation data has two purposes: 1) it serves as a statistical test for the form of the main and interaction effects discussed earlier, and 2) it provides a predictive device for interpolating to levels not observed in the experiment. The results are contained in Tables H and I; the corresponding tables of means are contained in Tables D and E. Table H contains the regression results for the main effects alone, while Table I contains the results for the complete model. Results indicate that estimating a single coefficient for cost of housing and utilities would be very misleading because attraction increases from 15% of income outlay to 30% of income outlay, then falls dramatically to a low at 45% outlay. In all likelihood this reflects a price/quality illusion: respondents felt that price (or income outlay) was a good indicator of quality of home because no other information in that regard was supplied. Thus, a single measure of elasticity would be most misleading.

TABLE H: AGGREGATE REGRESSION OF RESIDENTIAL SITUATION
TRADEOFF RESPONSE DATA--MAIN EFFECTS ONLY

	UNWEIGHTED			WEIGHTED		
Attribute	Coefficient	Std. Error	t-value	Coefficient	Std. Error	t-value
Dwelling Unit	0.312	0.048	6.56	0.264	0.046	5.69
Dwelling Unit^2	0.047	0.027	1.70	0.043	0.027	1.61
Living Arrangement	0.435	0.048	9.14	0.367	0.045	8.16
Living Arrangement^2	-0.024	0.027	-0.89	-0.036	0.029	-1.24
Cost of Housing	-0.416	0.317	-1.31	-0.144	0.299	-0.48
Cost of Housing^2	-1.338	1.220	-1.10	-0.541	1.156	-0.47
Neighborhood Income	0.084	0.048	1.76	0.091	0.044	2.09
Neighborhood Income^2	-0.113	0.027	-4.13	-0.083	0.028	-3.00
Intercept	1.868			1.834		
R-Squared	.81			.78		
F-Value	19.166			15.717		

TABLE I: AGGREGATE REGRESSION RESULTS FOR COMPLETE MODEL
FOR RESIDENTIAL SITUATION TRADEOFFS SURVEY

	Weighted		Unweighted		Weighted Pres - Ave		Weighted Last - Ave	
PARAMETERS	coef	SE	coef	SE	coef	SE	coef	SE
INTERCEPT	1.87		1.87		1.62		-.67	
Dwelling Unit (D)	0.31	0.03	0.32	0.03	-0.30	0.05	-0.31	0.04
Living Arrgmt (L)	0.42	0.03	0.42	0.03	-0.43	0.05	-0.43	0.03
Cost (C)	-0.60	0.22	-0.63	0.22	0.60	0.31	0.61	0.22
Income (I)	0.08	0.03	0.08	0.03	-0.09	0.05	-0.08	0.03
Dwelling Unit^2 (D^2)	0.04	0.02	0.04	0.02	-0.04	0.03	-0.04	0.02
Living Arrgmt^2 (L^2)	-0.03	0.02	-0.03	0.02	0.03	0.03	0.03	0.02
Cost^2 (C^2)	-1.92	0.86	-1.93	0.85	1.78	1.20	1.95	0.87
Income^2 (I^2)	-0.10	0.02	-0.10	0.02	0.10	0.03	0.10	0.02
D•L	0.20	0.04	0.20	0.04	-0.19	0.05	-0.20	0.04
D•C	0.04	0.22	-0.02	0.22	-0.13	0.31	-0.03	0.23
D•I	-0.001	0.04	0.003	0.04	-0.004	0.05	0.02	0.04
D•L^2	0.02	0.02	0.02	0.02	-0.03	0.03	-0.02	0.02
D•C^2	-2.44	0.81	-2.98	0.85	2.85	1.13	2.14	0.82
D•I^2	-0.03	0.02	-0.04	0.02	0.03	0.03	0.03	0.02
L•C	-0.53	0.24	-0.51	0.26	0.46	0.34	0.56	0.25
L•I	0.04	0.04	0.03	0.05	-0.05	0.05	-0.04	0.04
L•D^2	0.05	0.02	0.06	0.02	-0.05	0.03	-0.05	0.02
L•C^2	-1.08	0.94	-1.55	0.99	0.89	1.31	1.09	0.95
L•I^2	-0.06	0.03	-0.06	0.03	0.06	0.04	0.06	0.03
C•I	0.29	0.24	0.27	0.26	-0.22	0.34	-0.27	0.25
C•D^2	-0.22	0.12	-0.20	0.13	0.23	0.17	0.18	0.12
C•L^2	0.27	0.15	0.25	0.15	-0.33	0.21	-0.26	0.16
C•I^2	0.03	0.15	0.06	0.15	0.04	0.21	-0.06	0.15
I•D^2	0.00	0.02	0.001	0.02	-0.003	0.03	0.001	0.02
I•L^2	-0.01	0.03	0.002	0.03	0.01	0.04	0.005	0.03
I•C^2	0.58	0.91	1.19	0.99	-0.58	1.27	-0.29	-0.93
D•L^2	0.01	0.01	0.01	0.01	-0.01	0.02	-0.01	0.01
D•C^2	0.27	0.50	0.24	0.49	-0.25	0.69	-0.30	0.50
D^2•I^2	-0.02	0.01	-0.02	0.01	0.02	0.02	0.01	0.01
L^2•C^2	0.33	0.60	0.07	0.57	-0.45	0.83	-0.25	0.61
L^2•I^2	0.01	0.02	0.02	0.02	-0.01	0.02	-0.01	0.02
C^2•I^2	0.33	0.58	0.71	0.58	-0.19	0.81	-0.28	0.59
R^2	0.98	(32,12)	0.98	(32,12)	0.96	(32,12)	0.98	(32,12)

Let us calculate the elasticity from 15% to 30% and then from 30% to 45% to make the point: the elasticity of the response from 15% to 30% is =.0235; i.e., cost makes almost no difference. The elasticity from 30% to 45% is -.2162, again very inelastic but in the negative direction. Apparently, outlay of income on housing and utilities makes very little difference to attractiveness. This finding would indicate that, on the average, housing subsidies would have little effect on individuals' attractiveness judgments, relative to the other attributes.

As with mobility tradeoffs data, the regression analysis is not directly interpretable because orthogonal polynomial coding was used to insure independence of the effects of interest. In this sense it is analagous to an analysis of variance. The statistical results confirm the results in Table I: the interaction effects are consistent across the adjustments, revealing little to no significant survey effects, and they clearly indicate the impact of living arrangement. It is fair to say that this variable not only has the greatest single impact on responses, but because of its involvement in interactions, its effect must be considered to be even greater. Hence, policies designed to promote ownership of dwelling units for the elderly would have substantial positive impact on attractiveness.

An examination of the mean response to all 45 residential situation options reveals that it is substantially lower than the mean response to present residence (1.868 vs. 4.046). Thus, the average response to any residential situation option is only 21.7% of the maximum response (5) and only 28.5% of the observed mean for present residence. This clearly implies that, on average, there are very low probabilities of switching from present residence. An examination of the 45 residential option means reveals that only two exceeded 3.0 and none exceeded the present residence mean: 1) a mean

of 3.77 for a residential situation described by a) 5 or more dwelling units in complex, b) owned by respondent, c) costing 30% of income for housing and utilities, and d) located in a middle income neighborhood; and 2) a mean of 3.24 for a residential situation described by a) 5 or more dwelling units in a complex, b) owned by respondent, c) costing 15% of income for housing and utilities, and d) located in a middle income neighborhood. This is an implied arc elasticity for housing cost of -.23, again very low and inelastic. Contrast this result with that of a change from ownership to living with a relative for the second option above--a drop from a mean of 3.24 to 1.61, or a 50% decline in response.

The next section discusses the results of a "crude" approximation to developing choice probabilities as described for the mobility tradeoffs data.

An Approximate Analysis of Choice Probabilities

Following the logic developed for the log-linear regression approach to assessing choice probabilities, we estimated a complete regression equation from the residential situation frequency counts. That is, we tabulated the relative frequency with which each residential option was rated equal to or greater than the respondent's rating for their present residence. These data are our crude estimates of the empirical probabilities. The regression results are listed in Table J for the complete model. The regression equation is significant beyond the .01 level and accounts for 95.3% of the variation in the logarithms of the relative frequency data. Results suggest no significant interactions, but again this finding should be interpreted cautiously in light of previous findings.

As before, living arrangement and type of dwelling unit emerge as the major influences on the crude choice frequencies. Income level of the neighborhood is much less influential and proportion of income required for

TABLE J: WEIGHTED REGRESSION ANALYSIS OF CRUDE CHOICE PROBABIILITY DATA FOR RESIDENTIAL SITUATION TRADEOFF STUDY

PARAMETER	Coefficient	Std Error	t-Value
Dwelling Unit Type (DU)	0.139	.027	5.15
Living Arrangement (LA)	0.177	.029	6.19
Cost of Housing (CH)	-0.397	.194	-2.05
Neighborhood Income (NI)	0.046	.029	1.61
DU^2	0.014	.016	0.86
LA^2	-0.028	.016	-1.79
CH^2	-0.472	.748	-0.63
NI^2	-0.042	.016	-2.67
DU.LA	0.041	.033	1.24
DU.CH	0.037	.185	0.20
DU.NI	-0.041	.032	-1.30
$DU.LA^2$	0.000	.018	0.01
$DU.CH^2$	-1.009	.674	-1.50
$DU.NI^2$	-0.019	.017	-1.10
LA.CH	-0.179	.230	-0.78
LA.NI	0.017	.040	0.43
$LA.DU^2$	0.019	.019	1.00
$LA.CH^2$	-0.699	.882	-0.79
$LA.NI^2$	-0.022	.021	-1.07
CH.NI	0.139	.234	0.59
$CH.DU^2$	-0.077	.112	-0.69
$CH.LA^2$	0.124	.126	0.98
$CH.NI^2$	0.074	.120	0.62
$NI.DU^2$	0.012	.018	0.65
$NI.LA^2$	0.012	.021	0.56
$NI.CH^2$	0.141	.889	0.16
$DU^2.LA^2$	0.002	.010	0.18
$DU^2.CH^2$	-0.122	.417	-0.29
$DU^2.NI^2$	0.004	.010	0.37
$LA^2.CH^2$	0.524	.472	1.11
$LA^2.NI^2$	0.013	.012	1.07
$CH^2.NI^2$	0.283	.454	0.62
INTERCEPT	-0.804		
R-squared	0.95		
F-Value	7.675(32,12)		

housing and utilities is the least significant factor. These results largely parallel those performed on the aggregate ratings response data and therefore will not be pursued further.

Disaggregate Analyses of Tradeoff Data

We examined the distribution of tradeoff values in the respondent sample and explored the hypothesis that individual differences in tradeoff values are systematically associated with differences in individual characteristics. For example, we might be interested in testing the hypothesis that individuals' sensitivity to cost of housing and utilities is systematically associated with (inter alia) differences in income levels. Alternatively, we might be interested in whether differences in attractiveness of center city locations are systematically associated with differences in (inter alia) current resident locations. These analyses are pursued in the next section; illustrative materials are contained in the Appendix Figures.

Distributions of Tradeoff Values for the Mobility and Residential Situation Surveys

The empirical distributions of the regression coefficients which represent the levels of the attributes of the two tradeoff surveys are given in Appendix Figure 1, along with some supporting statistics regarding each. We briefly discuss the surveys in turn and then proceed to analyze these distributions in a following section.

Mobility Tradeoff Coefficients

The Overall Average or Grand Mean for each respondent for the set of nine alternatives that were rated measures the attractiveness of the alternatives, assuming all attributes are at their mean. Appendix Figure 1(a) displays this relationship. One can see at a glance that there are very few

respondents with high grand means. This indicates that on average the respondents find very few alternatives attractive. The mean of the grand mean is 1.75, only slightly above the low end of the response scale.

The coefficient for center of a large city appears slightly skewed to the right in Appendix Figure 1(b), although the mean is close to the middle of the distribution. This indicates that respondents were reasonably normally distributed vis-a-vis the attractiveness of centers of large cities: a few like them a lot, most are in the middle, and a few really dislike such locations.

The coefficient for Suburban Locations is more or less normally distributed (Appendix Figure 1(c)) with a lower mean than that for center city locations and a smaller range. This indicates that on average individuals like suburban locations slightly less than central city locations, but the distributions are otherwise similar: e.g., their variances are very close.

The coefficient for Southeastern Location is plotted in Appendix Figure 1(d). This graph indicates that most individuals are clustered about the lower two-thirds of the scale. The mean is -.34 and the variance is similar to that of the locational attribute levels.

By way of contrast, the coefficient for Southwestern locations is plotted in Appendix Figure 1(e), which indicates a slightly higher distribution: a mean of -.22. The variance is similar to that of the southeastern coefficients. Thus, southwestern locations are slightly preferred in that there is a higher concentration in the upper part of the distribution.

The cost of living parameter is centered closely about zero (mean equals .16) as indicated in Appendix Figure 1(f). This distribution appears to be normal in shape, which suggests that there are individuals who actually find

expensive locations attractive: probably the price/quality illusion is at work in this regard.

The distribution of the coefficient for having relatives living in the same community is illustrated in Appendix Figure 1(g). This distribution is skewed to the left, with most individuals being in the upper third. The mean is -.30 and the variance is similar to that of the non-cost attributes.

By contrast, the distribution of the coefficient for having relatives living in a nearby community is symmetrically distributed about zero (mean equals -.05). This distribution is plotted in Appendix Figure 1(h). There is a slight tendency for individuals to find having relatives living nearby more attractive than having them in the same community.

Residential Situation Tradeoff Coefficients

The overall ratings average for the nine residential situation alternatives is distributed according to the graph in Appendix Figure 2(a). This figure is skewed more to the right than that for the mobility tradeoffs, but the means and variances are about the same for the two distributions. The graph indicates that few people on average find any of the alternatives very attractive.

The coefficient for single family dwelling unit situation is distributed empirically according to the graph in Appendix Figure 2(b). There is a slight tendency to be skewed to the left and the majority are in the positive end of the distribution.

In contrast, the coefficient for multifamily dwelling units of size 2-4 units is slightly (very) more positive than that for single family units, with a smaller variance. The majority of the respondents are clustered closely around the mean (Appendix Figure 2(c)).

The coefficient for the ownership option has an empirical distribution illustrated in Appendix Figure 2(d). This distribution is skewed to the left, with the majority of respondents in the upper third.

The mean for the rental option coefficient is identical to that for ownership. The distributions look similar as illustrated in Appendix Figure 2(e). However, the variance is higher for this distribution, indicating somewhat more agreement about the attractiveness of ownership compared with renting.

The Cost of Housing coefficient is slightly skewed to the left, although the distribution is clustered about -.19. This is illustrated in Appendix Figure 2(f). As with cost of living, the response to housing costs indicates a number of respondents with positive values which suggests that some respondents like more expensive homes.

The coefficient for High Income Neighborhood has an empirical distribution as illustrated in Appendix Figure 2(g). The distribution is skewed to the left, although there is a definite cluster about zero.

In contrast, the coefficient for Middle Income Neighborhood (Appendix Figure 2(h)) is also skewed left, but the distribution has more respondents in the lower half than does the Upper Income Neighborhood option. The means of the two distributions are similar, being respectively -.16 and -.12 for high and middle income neighborhoods.

Joint Distributions of Coefficients: Pair-Wise Associations of Coefficients

In order to get some idea of the joint distribution of the tradeoff coefficients we examined the pair-wise correlations among the attribute coefficients. We noted in the previous section that the marginal distributions were approximately normal for most coefficients. We examined the pair-

same community have lower overall ratings in the residential survey and tend to be more attracted to 2-4 family units and renting. Finally, respondents attracted to having relatives live in nearby communities tend to also be attracted to single family or 2-4 family units. They tend to be less attracted to owning, more cost sensitive, and less attracted to high income neighborhoods.

Analyses of Individual Differences in Tradeoff Values Associated With Individual Characteristics

In all cases the hypothesis that variation in individual tradeoff values is systematically associated with measures of individual differences in current housing, socioeconomic measures and other tradeoff values was tested using multiple linear regression. In particular, each tradeoff coefficient for each attribute for each individual was treated as a vector of observations on a dependent variable. Measures of personal situational, social, economic and related personal characteristics, as well as other tradeoff coefficients, were treated as independent variables. The results of the multiple regression analyses are descriptive of individual difference effects systematically related to tradeoff differences in the sample. The results, therefore, permit one to assess whether there are reliable differences in tradeoffs as a function of various possible cross classifications of individuals. The sections to follow simply provide a verbal description of the results. Because there is such a great amount of material, we present only a summary in this report.

Analysis of Mobility Tradeoff Values

There are eight coefficients that can be uniquely estimated from each respondent's mobility ratings: 1) The respondent's overall mean response (the grand mean), which can be forced to be the intercept term with orthogonal coding. It can be interpreted as the average attractiveness of any of the nine

mobility options put to the respondent. 2) The coefficient or attractiveness value of "center of a large city." Higher values mean higher attractiveness relative to "suburb" or "small town/rural location." 3) The coefficient or attractiveness value of "suburb of a large city." The higher the value, the more attractive relative to "center" or "small town/rural area." No coefficient can be found for "small town/rural area" because it serves as a base. 4) The coefficient for "Southwestern State" or its attractiveness value. Higher values imply greater attractiveness for "Southwestern State" relative to "Southeastern" or "Northern State." 5) The coefficient or attractiveness value for "Southeastern" relative to "Southwestern" or "Northern." The higher the value or coefficient for "Southeastern State," the more attractive is the Southeast relative to other regions. 6) The cost of living coefficient. This is the slope for costs of living for each individual. The more negative the slope, the more sensitive the individual is to costs of living (ceteris paribus). 7) The coefficient for "close relative lives in same community." This measures the attractiveness of proximity to close relatives vis-a-vis them living "nearby" or "not nearby." Higher values imply that presence in "same community" is more attractive. 8) The coefficient for "close relative lives in nearby community." This measures the relative attractiveness of "nearby" vis-a-vis "same community" or "does not live in a or near community." The higher the value, the more attractive is the level "nearby." The coefficient for "does not live in same or nearby community" cannot be estimated because it is the base. We examine the statistical results for each of these in turn in Appendix D.

Analysis of Residential Situation Tradeoff Coefficients

There are eight coefficients that can be uniquely estimated from each respondent's residential situation ratings: 1) The respondent's overall

average rating for the nine residential options (the grand mean). This measures the relative attractiveness of any of the nine options. 2) The coefficient for a single family dwelling unit. Higher values imply that the respondent found single family units more attractive relative to other dwelling situations. 3) The coefficient for a 2-4 unit multifamily complex. Higher values imply that the respondent found 2-4 unit facilities more attractive relative to other options. 4) The coefficient for owning a place of residence. Higher values imply that the respondent found ownership attractive relative to the other possibilities--renting or living in the home of a relative. 5) The coefficient for renting a residence. Higher values imply that the respondent found renting attractive relative to owning or living with a relative. 6) The coefficient for cost of housing and utilities. More negative values imply that the respondent is increasingly sensitive to costs. 7) The coefficient for living in a higher income neighborhood. Higher values imply that the respondent found higher income neighborhoods attractive relative to middle income or lower income neighborhoods. 8) The coefficient for living in a middle income neighborhood. Higher values imply that the respondent found middle income neighborhoods attractive relative to higher and lower income neighborhoods.

No unique coefficients can be found for five or more dwelling unit residence complexes, living with a relative, or living in a low income neighborhood. This is because these coefficients are measured relative to a base--the intercept of the respondent's regression equation. All of these excluded coefficients have the intercept as a common origin. For this reason the intercept of the regression intercept is not of interest: it technically represents the score for a 5+ dwelling unit complex, in which the respondent lives with a relative for free in a lower income neighborhood. The

subsections of Appendix E describe the results of relating each respondent's coefficient for a particular level of a particular attribute to personal and situational characteristics of individuals and to the coefficients of the respondent from the mobility tradeoff survey.

Conclusions and Implications of the Research

Caveats

This study has demonstrated that it is possible to measure and model tradeoffs in mobility and housing for respondents aged 55 and over. Similarly, the research demonstrates that one can draw important inferences regarding relationships among tradeoff values and regarding individual differences. It is important to note that these results are very tentative and should be viewed as suggestive of future research possibilities rather than providing actionable results for implementation. In particular, the inferences drawn suffer from some very important limitations:

- The relationship between non-completion and non-response to the tradeoff surveys and other factors is unknown.

- The considerable amount of missing data precluded analysis involving more than a limited number of individual difference variables. Hence, selection for analysis was based on availability of relatively complete records rather than on hypothesis testing considerations.

- The tradeoff studies should have been based on preinterviews to isolate attributes influential to the joint choice of moving, geographical area and type of residence. Instead, attributes were selected on the basis of literature findings. It should be borne in mind that past findings based on aggregated mobility data are likely useless for understanding individuals' behavior.

- Because the mobility and residential tradeoff surveys were treated as separate judgment tasks, it is very difficult to draw inferences regarding joint tradeoff processes. Future work should deal directly with these interlinked choice and tradeoff processes.

- Although the tradeoff surveys are based upon controlled treatment combinations drawn from a factorial design, it is not possible to test for non-additivities at the individual respondent level. Future work should correct for this in order to detect these potentially important policy reaction parameters.

- Although the surveys are derived from a controlled experiment such that we know a priori which parameters are potentially estimable, the individual differences data are not controlled. Thus, inferences about individual differences are much less precise than inferences about tradeoff coefficients. Further, the presence of multicollinearity makes inferences very difficult. Future work should explore different sampling procedures to reduce collinearity if possible.

- Future work should deliberately be designed to enable the correspondence of the tradeoff models with actual mobility and residential choice behavior to be assessed. Evidence strongly suggests that tradeoff models predict real behavior in the real world; however, the study must be designed to permit validity tests. It is difficult to see how the present study could be validated except in the following manner (and this would be a very weak test): one would need to use the 1980 Census Tapes to aggregate the movements of individuals aged 55 and over into a series of cross-classifications which correspond to the levels of the four mobility attributes. That is, one must aggregate moves by urban, suburban, rural location; Southeast, Southwest, or Northern region; costs of living; and location of close relatives. The tradeoff equations can be used then to forecast the proportion of the sample expected to choose each of these cross-classes. In the case of the residential situation tradeoffs, one would have to similarly aggregate housing data for individuals aged 55 and over, given that they moved after age 55. The data would have to be cross-classified by type of housing unit; ownership, rental, etc.; cost of housing; and tradeoff equations can then be used to forecast the expected proportion of individuals living in the cross-classes.

Major Results

The major implications of the research are the consistent associations between coefficients of tradeoff equations. Because they are more reliable, we concentrate on the aggregate results of the tradeoffs:

- On average, individuals over 55 in age prefer small towns or rural areas to suburbs or centers of large cities.

- On average, individuals prefer Southwestern locations to Southeastern or Northern locations.

- On average, individuals prefer having relatives living nearby to having them in the same town or nowhere near.

- Costs of living have significant and influential effects on the attractiveness of mobility alternatives.

- On average, individuals over 55 in age prefer larger multi-unit housing complexes to smaller complexes and to single family housing.

- On average, respondents prefer owning to renting or living in the home of a relative.

- On average, respondents prefer to live in middle income neighborhoods compared with upper income or lower income areas.

- On average, respondents prefer to spend 30% of their income on housing compared with 15% or 45%.

- There are some important aggregate interactions which influence the attractiveness of mobility or residential situation alternatives:

  - If the cost of living is high, the type of urban/suburban/rural locations matters little, although small towns or rural areas are still preferred.

  - Type of region/climate matters little if the respondent can live in a small town or rural area. If respondents have to live in a suburban location, they overwhelmingly prefer Southwestern regions and are very negative towards Northern locations. If they have to live in the center of a large city, they prefer to be in the Southeast and are very negative towards the North.

  - Respondents prefer to live in small towns or rural areas with close relatives in the same community, although having relatives in a nearby community is also attractive. Next most attractive are suburban locations with close relatives in nearby communities. Center city locations are very unattractive unless close relatives live there as well; however, this latter situation is still fairly unattractive.

  - For low and moderate costs of living, respondents prefer the Southwest, although at high costs of living, they prefer Southeastern locations.

  - At low costs of living, respondents prefer to have close relatives in the same community; at moderate costs of living, they prefer to have close relatives living nearby.

  - Respondents prefer to have close relatives living in the same community if the location is the North or the Southeast. If the location is the Southwest, they prefer relatives living nearby.

  - If respondents have to live with a relative, then the size of the housing complex makes little difference unless it is large. In all cases larger complexes are more attractive than smaller. Single family units are relatively unattractive, particularly if they are owned.

  - Respondents prefer housing costs of 30% unless the housing is rental accommodation, in which case they prefer lower costs.

- Respondents prefer large housing complexes in middle income areas by a wide margin, but they also find these complexes attractive in high income areas. Two-to-four unit complexes are most attractive if in high income areas, and single homes are most attractive in middle income areas.

- Larger housing complexes are attractive almost regardless of costs; 2-4 unit complexes are most attractive at 30% of income; single family units are most attractive at 15% of income.

- Living with a relative is very unattractive regardless of the income of the neighborhood. Renting is most attractive if the neighborhood is upper income in level. Owning is most attractive if the neighborhood is middle income. The owning option in a middle income area is preferred by a very wide margin over all other alternatives.

- If housing costs are 15%, income level of the neighborhood matters little. If costs are 30% of income, respondents definitely prefer to live in a middle income area. At housing costs 45% of income, respondents still prefer middle income areas, but also find upper income areas relatively attractive. Respondents definitely don't want to be spending 45% of their income and living in a low income area.

These results indicate that one cannot assume that mobility and residential tradeoffs are compensatory: good levels of one attribute do not necessarily make up for bad levels of a second attribute. Rather, the attractiveness surface is fairly complex and should be the object of considerable further research. One cannot stress too highly the importance of being able to understand interaction effects. Understanding these interactions is vital for the proper assessment of the effects of policies. Most of the interactions uncovered, in fact, suggest that many policies would have complicated effects that would depend upon one or more other attribute levels. Anticipating the effects of policies, therefore, requires complete understanding of the response surface to avoid mistakes.

Additionally, finding significant and systematic individual differences has important implications for future research and policy assessment. Specifically, finding individual differences implies that not only can

policies have differential effects across attribute levels, they also have differential effects among segments of the population. Future research should be carefully designed to maximize the chance of finding these individual difference effects because of their potential import for policy understanding and for understanding differential impacts on individuals. This research project should be seen as an initial effort to explore the possibilities for understanding tradeoffs and their implications.

REFERENCES CITED AND REFERENCES USEFUL FOR FURTHER READING

Anderson, N. H. Algebraic rules in psychological measurement. American Scientist, 1979, 67, 555-563.

Anderson, N. H. Information integration theory: A brief survey. In D. H. Krantz, R. C. Atkinson, R. D. Luce, and P. Suppes (Eds.), Contemporary developments in mathematical psychology (Vol. 2). San Francisco: Freeman, 1974.

Anderson, N. H. and Shanteau, J. Weak inference with linear models. Psychological Bulletin, 1977, 84, 1155-1170.

Barron, F. H. Empirical validation of elicited utilities for prediction and decision making. Decision Sciences, 1980, 11(3), 411-424.

Batsell, R. R. Consumer resource allocation models at the individual level. Journal of Consumer Research, 1980, 7, 78-87 Bettman, J. R. An Information Processing Theory of Consumer Choice, Reading, Mass.: Addison-Wesley Publishing Co., Advances in Marketing Series, 1979.

Birnbaum, M. H. The devil rides again: Correlation as an index of fit. Psychological Bulletin, 1973, 79, 239-242.

Birnbaum, M. H. The nonadditivity of personality impressions. Journal of Experimental Psychology, 1974, 102, 543-561.

Cochran, W. G. and Cox, G. M. Experimental Design, New York: John Wiley, 1957.

Dawes, R. M. A case study of graduate admissions: Application of three principles of human decision making. American Psychologist, 1971, 26, 180-188.

Dawes, R. M. and Corrigan, B. Linear models in decision making. Psychological Bulletin, 1974, 81, 95-106.

Eberts, P. M. and Koeppel, K. W. P. The trade-off model: Empirical and structural findings. NYDOT Preliminary Research Report No. 123, State Campus, Albany, 1977.

Green, P. E. and Wind, Y. Multiattribute Decisions in Marketing: A Measurement Approach. Hinsdale, Il: Dryden, 1973.

Green, P.E. On the design of choice experiments involving multifactor alternatives. Journal of Consumer Research, 1974, 1, 61-68.

Guilford, J. P. Psychometric methods (2nd ed.). New York: McGraw-Hill, 1954.

Hahn, G. J. and Shapiro, S. S. A catalog and computer program for the design and analysis of orthogonal symmetric and asymmetric fractional factorial experiments. Technical Report No. 66-C-165, G. E. Research and Development Center, Schenectady, N. Y., 1966.

Hensher, D. A. and Johnson, L. Applied Discrete Choice Modeling, London: Croom-Helm, 1981.

Hensher, D. A. and MacLeod, P. B. Towards an integrated approach to the identification and evaluation of the transport determinants of travel choices. Transportation Research, 1977, 11, 77-93.

Johnson, R. M. Tradeoff analysis of consumer values. Journal of Marketing Research, 1974, 11, 121-127.

Keeney, R. L. and Raifja, H. Decisions with Multiple Objectives: Preferences and Value Tradeoffs. New York: John Wiley and Sons, 1976.

Krantz, D. H., Luce, R. D. Suppes, P., and Tversky, A. Foundations of Measurement. Vol. 1. Additive and polynomial representations. New York: Academic Press, 1971.

Krantz, D. H. and Tversky, A. Conjoint-measurement analysis of composition rules in psychology. Psychological Review, 1971, 78. 151-169.

Lerman, S. R. and Louviere, J. J. On the use of direct utility assessment to identify functional form in utility and destination choice models. Transportation Research Record 673, 1978, 78-86.

Levin, I. P. Comparing different models and response transformations in an information integration task. Bulletin of the Psychonomic Society, 1976, 7, 78-80.

Levin, I. P. and Louveire, J. J. Psychological contributions to travel demand modeling. In I. Altman, P. B. Everett, and J. F. Wohlurill (Eds.), Human behavior and the environment: Current theory and research (Vol. 5). Pergamon Press, in press.

Louviere, J. J. Applications of principles of experimental design to the modeling and prediction of judgment and choice: A functional measurement approach. Proceedings, Seminar in the Measurement of Social Values in Road Research, Australian Road Research Board, Melbourne, Vic, Australia, May, 1980(b).

Louviere, J. J.; Beavers, L. L.; Norman, K. L.; Stetzer, F. Theory, methodology, and findings in mode choice behavior. Working Paper No. 11, The Institute of Urban and Regional Research, The University of Iowa, Iowa City, July, 1973.

Louviere, J. J. Psychological measurement of travel attributes. In D. A. Hensher and M. Q. Dalvi (Eds.) Determinants of Travel Choice. London: Farnborough Tealsfield (Saxon House Studies), 1978.

Louviere, J. J. Some considerations in the design and analysis of experiments to model and predict consumer choice behavior. Unpublished Seminar Paper, Australian Graduate School of Management, Kensington, NSW, April, 1980(a).

Louviere, J. J. Specification of the form of the utility expression for tradeoffs in choice behavior. In Hensher, D. A. and Johnson, L. Applied Discrete Choice Modeling. London: Croom-Helm, 1981.

Louviere, J. J. and Meyer, K. J. A composite attitude-behavior model of traveller decision making. Transportation Research, in press, 1981.

Marks, L. E. Sensory Processes, New York: Academic Press, 1974.

McClelland, G. H. A psychological and measurement theory approach to fertility decision making. Center for Research on Judgment and Policy, Report No. 219, Institute of Behavioral Science, University of Colorado, Boulder, June, 1979.

McFadden, D. The measurement of urban travel demand. Journal of Public Economics, 1974, 303-328.

Rushton, G. Analysis of spatial behavior by revealed space preference. Annals, Association of American Geographers, 1969, 59, 391-400.

Shinn, A. M. Measuring the utility of housing: Demonstrating a methodological approach. Social Science Quarterly, 1971, 52, 88-102.

Slovic, P., and Lichtenstein, S. Comparison of Bayesian and regression approaches to the study of information processing in judgment. Organizational Behavior and Human Performance, 1971, 6, 649-744.

Srinivasan, V.,; Flachsbart, P. G.; Dajani, J. S.; and Hartley, R.G. Forecasting the effectiveness of work-trip gasoline conservation policies through conjoint analysis. Research Paper No. 535, Graduate School of Business, Stanford University, February, 1980.

Stevens, S. S. Issues in psychophysical measurement. Psychological Review, 1971, 78, 426-450.

Stevens, S. S. Problems and methods of psychophysics. Psychological Bulletin, 1957, 55, 77-196.

Timmermans, H. T. Unidimensional conjoint measurement models and consumer spatial decision-making processes: A comparative analysis. Unpublished Manuscipt, Dept. of Architecture, Building and Planning, University of Technology, Eindhoven, The Netherlands, summer, 1980.

Wainer, H. Estimating coefficients in linear models: It don't make no nevermind. Psychological Bulletin, 1976, 83, 213-217.

Wilkie, W. L. and Pessemier, E. A. Issues in marketing's use of multiple-attribute attitude models. Journal of Marketing Research, 1973, 10, 428-441.

Winer, B. J. Statistical principles in experimental design (2nd ed.). New York: McGraw-Hill, 1971.

Yellot, J. I. The relationship between Luce's choice axioms, Thurstone's theory of comparative judgment, and the double exponential distribution. Journal of Mathematical Psychology, 1977, 15, 109-144.

APPENDICES

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APPENDIX A
INFORMATION INTEGRATION THEORY OR FUNCTIONAL MEASUREMENT

As used in this context, the term functional measurement describes an approach to modeling individual judgment and choice behavior which is characterized by two aspects. First, functional measurement is based on an explicit theory of how people reach decisions. Second, it uses laboratory-like experimental measurement methods to estimate models rather than relying on observations of people's revealed preferences.

Functional Measurement is based on theoretical and empirical research in mathematical psychology and related fields, where there is extensive support for the following assumptions:

$$x_{ki} = f(X_{ki}) \tag{1}$$

$$U_i = g(x_{1i}, x_{2i}, \ldots, x_{ki}) \tag{2}$$

$$B_i = h(U_i) \tag{3}$$

where:

X_{ki} are k physically measurable attributes of the i^{th} alternative under study;

x_{ki} are the values of X_{ki} as perceived by individuals;

U_i is some level of response (such as numerical judgments, rankings, or choices) which is observed in an experimental context for the i^{th} alternative (for the purpose of this report, we shall refer to this response as the utility of the i^{th} alternative);

U_i is the vector $(U_i, \ldots, U_I)$;

B_i is an actual choice or behavior directed towards alternative i in a nonexperimental or real world situation;

i is the number of available alternatives (i = 1, 2, . . . , I);

k is the number of variables (k = 1, 2, . . . , K); and

f, g, h are all functions.

In many cases, the X_{ki}'s may include factors for which the corresponding x_{ki}'s are difficult to measure or not well understood. For example, personal fears for safety may affect a person's choice of residential location, but its physical referents are not well known. Such factors are treated in this theory below as distinct, qualitative variables and are part of the x_{ki}'s.

As developed above, this theory allows for responses, perceptions, and behavior over any set of discrete alternatives, indexed as i = 1, . . . , I. For example, one might be interested in type of housing choice behavior, in which there are different factors influencing the desirability of single family units, duplexes, multifamily units, etc. In many situations, however, the behavior of interest is continuous and involves only one alternative. In these instances, the theory often can be reduced to the case I = 1, and the i subscript can be deleted. However, because in this case study we are concerned with people's choices among discrete alternatives, we will retain the full notation except as noted.

Each of these assumptions is restated more formally below, and the case of additive and multiplicative utilities is explored in detail.

Assumption 1

For any observed choice behavior there exists a set of independent factors which are functionally connected to its occurrence on a particular occasion or the relative frequency of its occurrence over some time period or spatial cross-section of interest. Each factor may be either quantitative or qualitative in nature. We shall denote the set of J quantitative factors by $S_i = (S_{1i}, S_{2i}, \ldots, S_{Ji})$ and the set of L qualitative factors by $Q_i = (Q_{1i}, Q_{2i}, \ldots, Q_{Li})$; $J + L = K$. The entire vector X_{ki} is simply S_i and Q_i.

Assumption 2

Associated with each quantitative and qualitative factor is a corresponding perceptual value or magnitude of belief which may be obtained by one of several psychological measurement procedures. This is formally represented in Equation (1) above.

Assumption 3

In an experimental context we observe a response to a combination of (S_{1i}, S_{2i}, . . ., S_{Ji}, Q_{1i}, . . . Q_{Li}) on a psychological measurement scale. We assume that this response measure is related to the utility of the experimental factors according to some algebraic combination rule. This is expressed in Equation (2). The vector of responses (U_i) is connected to some observed choice behavior by means of some algebraic function. Hence, if we agree to call the observed behavior of interest B_i, we can write:

$B_i = h(U_i)$. Then by substitution,

$$B_i = h(U_i) \tag{3a}$$
$$= h(g(x_{ki}))$$
$$= h(g(f(S_i, Q_i))).$$

This is too general a formulation for modeling purposes; in a practical application, it is necessary to make explicit assumptions about f, g, and h and deduce their consequences. The results lead to a general paradigm for the analysis of choice behavior which has growing empirical support. (See Levin, 1976; Levin and Louviere, 1981; and Lerman and Louviere, 1979).

The critical component of this theory for the purposes of developing appropriate functional forms for travel demand models is the specification of $U_i = g(x_{1i}, x_{2i}, . . . , x_{ki})$. Analysis of variance or multiple linear regression provides a straightforward means of implementing the theory and

diagnosing and/or testing alternative functional forms. In almost all cases, however, analysis of variance will be easier to apply than regression; hence, it is to be preferred. In this report, we will consider examples of the linear and multiplicative cases as alternative algebraic forms. There are two key conditions involved in the application of analysis of variance for testing functional form which must be satisfied:

(1) the pattern of the statistical significance (or nonsignificance) of the utility responses to various combinations of the independent variables must be of a specific nature so as to permit inference (diagnosis) or testing of model form; and

(2) corresponding graphical evidence must support the inference or test.

Consider the hypothesis that individuals in an experiment to evaluate housing alternatives will trade off income level of neighborhood and cost of housing independently of one another. That is, they combine the effects of these two variables additively. This hypothesis may be tested directly by an analysis of variance. For clarity we suppress the subscript "i" and write:

$$U_{mn} = U^1_m + U^2_n + \varepsilon_{mn} \qquad (4)$$

where:

U^1_m are the utility values assigned to the m^{th} level of the first factor (say, income level of neighborhood) in a factorial experimental plan;

U^2_n are the utility values assigned to the n^{th} level of the second factor (say, cost of housing);

U_{mn} is the overall utility assigned by individuals to combinations of levels of factors 1 and 2; and

ε_{mn} is a random error term with zero mean.

The test for independence of the two effects (neighborhood and cost) corresponds to the test of the significance of the interaction "effect" of $U^1_m \cdot U^2_n$. In an analysis of variance, this is a global test for any and all

interaction effects between neighborhood and cost. If the interaction is not significant (i.e., the hypothesis that U^1_m and U^2_n combine additively cannot be rejected), then the additive form may be accepted; if the interaction is significant, it signals that some form other than a simple additive combination is appropriate. This test is accompanied by a graphical plot of the interaction. If the hypothesis of additivity is correct, the data should plot as a series of parallel lines when plotted against either U^1_m or U^2_n values on the abscissa. To see why, assume the additive form to be correct, and consider the effect of subtracting level 1 from level 2 of the first factor. This yields:

$$U_{2n} - U_{1n} = (U^1_2 + U^2_n) - (U^1_1 + U^2_n) + (\varepsilon_{2n} - \varepsilon_{1n}) \qquad (5)$$
$$= U^1_2 - U^1_1 + (\varepsilon_{2n} - \varepsilon_{1n})$$

where U^1_1 and U^1_2 are the utility values assigned to levels 1 and 2 of factor one, respectively. Thus, the difference between the points when U^2_n takes on any value is always a constant $U^1_2 - U^1_1$ (except for disturbances); hence, the graph should yield a series of parallel lines.

Note that this is true regardless of the forms we assume for the marginal relationships (i.e., $U^1_m = f_1(X_m)$ and $U^2_n = f_2(Z_n)$). It can be demonstrated that a measure of the average effect or utility (the so-called marginal utilities) of each of the two variables is given by their marginal means. We now demonstrate that this is true for <u>any</u> multi-linear utility model, confirming thereby that it holds for any more restricted form such as simple addition or multiplication.

If the data were obtained from a factorial design in which factor one is the row factor (subscripted m) and factor two is the column factor (subscripted n), we may write the most general multi-linear form as follows:

$$U_{mn} = k_0 + k_1 U^1{}_m + k_2 U^2{}_n + k_3 U^1{}_m \cdot U^2{}_n + \varepsilon_{mn} \quad (6)$$

where all terms are as defined previously and the k's are scaling constants. Additional factors simply add additional one-, two-, three-, and higher-way cross-product terms. Now, if we average the factorial data over the second subscript n (i.e., the column factor), we would have:

$$U_{m.} = k_0 + k_1 U^1{}_m + k_2 \overline{U}^2{}_n + k_3 U^1{}_m \cdot \overline{U}^2{}_n + \varepsilon_m \quad (7)$$

where $\overline{U}^2{}_n$ is the average over the column factor. Thus, Equation (6) reduces to:

$$U_{m.} = K_0 + K_1 U^1{}_m + \varepsilon_m \quad (8)$$

where the K's are collected terms. Equation (8) demonstrates that the marginal row means (in general, the marginal means for any subscript), are equal to the marginal utilities up to a linear transformation. Hence, they are "as good" as any other estimate measured on an interval scale. Equation (8) is important because it demonstrates that an estimate of the marginal utility for any factor may be obtained by manipulating that factor as part of a factorial or fractional factorial design so long as any multi-linear utility function can be assumed to have generated the data.

Returning to the reduced strictly additive form, it may also be demonstrated that these marginal means relate to the overall utility value of cell m,n as follows:

$$U_{mn} = U_{m.} + U_{.n} - U_{..} + \varepsilon_{mn} \quad (9)$$

where $U_{..}$ is the grand average utility (mean). Similarly, for a strictly multiplicative form, it may be demonstrated that the following is true:

$$U_{mn} = k + [(U_{m.} - k)\ (U_{.m} - k)/(U_{..} - k)] + \varepsilon_{mn} \qquad (10)$$

where all terms are as defined in Equation (9), except for k which is a scaling constant which represents the arbitrary zero point on the utility scale.

Now, on the assumption that Equation (8) is true, we may write the following expressions by assigning levels of cost to the rows and levels of neighborhood to the columns:

$$U_{m.} = f_1(\text{cost}_{\ m}) \text{ and} \qquad (11)$$

$$U_{.n} = f_2(\text{neighborhood}_{\ n}), \qquad (12)$$

because the only source of variation in $U_{m.}$ and $U_{.n}$ is that due to the levels of cost and neighborhood and error. Thus,

$$U_{mn} = f_1(\text{cost}_{\ m}) + f_2(\text{neighborhood}_{\ n}) - U_{..} + \varepsilon_{mn} \qquad (13)$$

if the two factors combine additively, or

$$U_{mn} = k + [f_1(\text{cost}_m) - k] \cdot [f_2(\text{neighborhood}_{\ n}) - k] / (U_{..} - k) + \varepsilon_{mn} \qquad (14)$$

if the factors combine multiplicatively.

Following our previous logic, Equation (14) is testable statistically and graphically. In particular, Equation (14) requires that all interaction effects be statistically significantly different from zero and that the graph of the interaction must consist of a series of diverging lines. An exact statistical test may be obtained by using the marginal means as the independent values, estimating k (usually done by iterative methods) and performing the following linear regression:

$$\ln(U_{mn} - k) = \ln(U_{m.} - k) + \ln(U_{.n} - k) - \ln(U_{..} - k) \qquad (15)$$

If Equation (14) is true, the coefficients of the cost and neighborhood terms should not be significantly different from 1.0.

Thus, we have demonstrated that an algebraic and statistical theory to diagnose and test <u>any</u> multi-linear utility form exists. In order to derive a model in the units of the original variables (e.g., income level, summer temperature, dollars), it is necessary first to diagnose the overall form of Equation (6), and then to make assumptions about the functions in Equations (13) and (14) (or a more general form given by Equation (6), if appropriate).

<u>Applications Considerations for Functional Measurement</u>

Most existing theory in human judgment behavior posits that individuals respond "as if" they use simple algebraic rules in order to make judgments or tradeoffs. Although such an hypothesis may sound restrictive and even presumptuous, given the complexity possible in human behavior, research has consistently found humans to use simplifying strategies (see, e.g., Slovic and Lichtenstein, 1971; Bettman, 1979; Slovic, Fischoff, and Lichtenstein, 1977). If individuals do employ simplifying strategies to evaluate and choose among alternatives as research suggests they do, then it is possible to propose several simple algebraic models which can represent such strategies.

In fact we can propose one simple form to represent Equation (2), the overall utility function, which has broad application to a variety of tradeoffs of interest to mobility and housing choice. This simple form is referred to as the Multilinear Utility Function (see Anderson, 1974; Keeney and Raiffa, 1976). It may be written as follows for three attributes:

$$V_{im} = k_0 + k_1\, v(x_{i1m}) + k_2\, v(x_{i2m}) + k_3\, v(x_{i3m}) \qquad (16)$$

$$+ k_4\, v(x_{i1m})\, v(x_{i2m}) + k_5\, v(x_{i1m})\, v(x_{i3m}) + k_6\, v(x_{i2m})\, v(x_{i3m})$$

$$+ k_7\, v(x_{i1m})\, v(x_{i2m})\, v(x_{i3m}),$$

where V_{im} is the overall utility assigned to the i^{th} alternative for the m^{th} behavior; and $v(x_{ikm})$s are the separate utilities of the k(=1,2,3) attributes of interest; k's are scaling constants.

Equation (16) involves single terms, two-way cross-product terms, and a three-way cross product. By extension, any number of attributes may be included in an expanded Equation (16) by incorporating the necessary two, three, four, etc.-way cross-product terms. Equation (16) may be interpreted as follows: k_0 is a scaling constant necessary to define an arbitrary origin; k_1, k_2, and k_3 are scaling constants which apply to the "main effects" of the utilities of the attributes. If k_4 through k_7 are non-zero, this requires us to modify the "main effects" by considering the possibility that the overall utility is not simply an additive combination of marginal utilities; rather, the overall utility depends upon the levels of utility of both or all three (in this example) of the attributes in consort. Hence, strictly speaking, the utility of the levels of, say attribute one, change systematically in connection with variation in the levels of attribute two. As an example, it may be the case that the difference in the utilities of 30% vs. 45% of your income spent on housing may be quite different at various types of urban/suburban/rural locations. One might suppose, for example, that the utility of 30% of income being required would not be much greater than that of 45% of income being spent if the respondent didn't like urban locations; while the difference would be relatively larger if the respondent liked such locations. This latter example requires us to consider cross-product terms. If the utility

difference between 30% and 45% was approximately a constant, regardless of the location, we would not require a cross-product term. This latter condition implies that the contribution of one attribute's utility to overall utility is independent of the levels of a second attribute; hence, the joint contributions would be additive.

Equation (16), therefore, is sufficiently general to enable one to model a wide range of individual tradeoff rules. These include the following: a) strictly additive rules--this requires that coefficients k_4 through k_7 equal zero; b) strictly multiplicative rules--this requires that either all coefficients be non-zero, or only coefficients k_0 and k_7 be non-zero; c) conjunctive, disjunctive and other non-compensatory rules--these demand various cross-product terms of various signs. In general, therefore, almost all tradeoff rules under serious research consideration can be approximated by this equation type. For good reviews of various "rules" proposed, see Slovic and Lichtenstein (1971); Wilkie and Pessemier (1973); Louviere (1978).

We would like to concern ourselves with the development of Equation (16) (or approximations to it) as a matter of practical interest. There are several methods that could be proposed for application to this problem; however, of the available methods, only one has an error theory to enable one to decide which coefficients in Equation (16) are non-zero. The remaining methods either use rules-of-thumb, lack an error analysis, or assume a simpler form of Equation (16) to be true. Because we strongly believe that the identification of Equation (16) is important and because the approach offers other advantages as well, we strongly favor the Functional Measurement approach.

Functional Measurement is a theory about the way in which data must behave in order to be represented by some algebraic, polynomial,

multiattribute expression. It has an error theory which can be applied simply, and it utilizes categorical ratings scales as well as ordinal scales. However, decades of research into its use in a wide variety of applications have repeatedly demonstrated the advantages of utilizing the numerical information contained in continuous, categorical ratings scales.

These advantages include the following: a) most polynomial representations of interest can be diagnosed and tested by means of multiple linear regression or analysis of variance, which serve as the error theory; b) it is possible to develop tests of models even in fairly large problems by relying on theory concerning the fractional or optimal design of experiments, which permit tests to be made over groups of respondents; c) important measures of individual differences can be derived such as the grand mean of the respondent's data, or the slope parameters for each attribute, or the elasticities for each attribute; d) it is possible to relate these individual differences to market segmentation measures of interest, such as home ownership, income, age, etc.

Functional Measurement (FM) seeks to develop a quantitative expression or model of a single individual's or some group's relative values such as the attractiveness of or the likelihood of use of a set of multiattribute alternatives. FM, therefore, develops a model of the process by which attributes are combined by an individual or group to assign a value to a bundle or collection of attributes. Because any alternative such as a housing option can be expressed as a combination (or bundle) of levels of different relevant attributes, the responses of individuals to alternatives can be expressed as values for the attributes (and their levels) of the alternatives. Interest centers on the shape (functional form) of each separate attribute function and the manner by which the individual combines the separate

preferences (or values) for the attributes into an overall value for the alternative(s).

Technically, it is necessary to describe both the conditional and joint value functions. A conditional function refers to the shape or behavior of an individual's responses to a single attribute, while all other attributes are held constant. For example, if housing cost, type of dwelling unit, location, and tenure are primary attributes which determine choice (or rejection) of housing options, then the conditional response (or value) for cost would be the shape of the response curve for various levels of cost, while the remaining attributes are held constant. Each attribute has a conditional value function. The shapes of these conditional functions are unique to individuals; however, one can approximate any individual's curve by a polynomial expansion such as:

$$L(A_k) = \beta_{0k} + \beta_{1k}A_k + \beta_{2k}A_k^2 \qquad (17)$$

where: $L(A_k)$ is the conditional choice likelihood response function of attribute A_k;

β_{0k}, β_{1k}, β_{2k} are individual value coefficients;

A_k is attribute k;

A_k^2 is attribute k squared.

In practice, polynomial expansions of degree two (squared, as in the example above) are generally sufficient. Although this modeling strategy has the power to determine unique shapes of conditional response curves for individuals, one can also hypothesize that individuals with similarly shaped curves may have similar interpersonal situations and characteristics. The shapes of these curves are determined by the coefficient β_{1k} and β_{2k} in the example above. Thus, if these coefficients can be estimated for each individual, then it is possible to test for differences in these coefficients among individuals

as a function of differences in interpersonal characteristics.

A joint value (or response) function represents the manner in which the separate conditional values of the different attributes are combined to produce an overall value for the bundle (i.e., as noted above, the value or response for an alternative). For example, it is assumed in most housing demand models that the joint function is:

$$V_i = \beta_0' + \beta_1' v(A_1) + \beta_2' v(A_2) + \ldots + \beta_k' v(A_k) \qquad (18)$$

where V_i is the value assigned to alternative i (bundle or combination i);

$v(A_k)$ represents the conditional responses to attribute k;

$\beta_0' , \ldots \beta_k'$ are constants.

In particular, most housing demand models assume that:

$$v(A_k) = \beta_{0k} + \beta_{1k} A_k^* \qquad (19)$$

That is, the conditional value function is assumed to be linear; the joint value function also usually is assumed to be linear and additive in the β's.

Note that almost all potential function forms or specifications of interest can be transformed to a linear additive form; hence, the assumption of a jointly additive value specification is not unduly restrictive. For example, if one proposes an alternative form, say multiplication, which often emerges from an analysis of individual responses to alternatives, this can be written as:

$$V_i = \alpha_0 + \alpha_1 \prod_k v(A_k), \qquad (20)$$

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*Note that in a jointly multiplicative function, any constants on the $v(A_k)$ would "wash out" by common multiplication to some constant such as β_1.

where

V_i is the overall value or utility of the i^{th} alternative;

$v(A_k)$ is the conditional value response to attribute k;

Π is the product over all k conditional values; and

α_0 and α_1 are constants.

Now, if one substitutes the relationship between the levels of an attribute and the conditional values for these levels [Equation (17)] into Equation (20), restricting it to degree two, this yields:

$$V_i = \alpha_0 + \alpha_1 \prod_k (\beta_{0_k} + \beta_{1_k} A_k + \beta_{2_k} A_k^2) \qquad (21)$$

where all terms are as defined in Equations (17) and (20). Equation (21) states that, if expanded by cross-multiplication, the multiplicative form is actually a jointly additive expression involving single terms (conditional values), e.g., expressions in A_1, A_2, . . . A_i alone; and cross-product terms, i.e., expressions in $A_1 \times A_2 \times A_3$, etc. The single terms are commonly referred to as "main effects" because they represent the "main" contribution of each attribute, independent of other attributes, to the overall utility response or value; the latter terms are commonly referred to as "interactions" because they represent any effects that two or more attributes have in combination above and beyond the sum of their main effects. For example, if one considers how individuals' responses change as one jointly changes costs and locations, the strictly linear additive form of Equation (18) states that no matter what the level of costs (A_1), a unit change in location (A_2) will make a unit change β_2' in the response value, if A_1 is costs and A_2 is location. By contrast, in Equations (20 or 21) the contribution of location to V_i differs for different levels of costs.

In general, one would like to be able to estimate Equation (16) for single individuals. In practice, however, it is rarely possible to do so

because this requires an individual to make a very large number of responses or value judgments in most cases. Suppose one wishes to assess a person's value function for combinations (or bundles) of costs, locations, tenure types, and dwelling types. One would begin by assigning J levels to costs, K levels to locations, L levels to tenure types and M levels to dwelling types. There would, therefore, be (J x K x L x M) total bundles needed to completely specify all joint and conditional functions. It would also be desirable to obtain a second (J x K x L x M) or replication set of judgments to yield sufficient variation for an error analysis. For example, if J = K = L = M = 4, there are 4^4 possible bundles, or 256 total judgments, even without a replication set which would add another 256.

Such a large number of judgments is clearly impractical in applied work. As a result, a number of ways to reduce the total number of judgments required have been developed, which are explored in the section entitled, "Fractional Factorial Sampling Plans." It is sufficient to note that all of these methods for reducing the number of bundles required for judgment result in a loss of some information regarding joint functions. Thus, any reduction in the total number of combinations means that one must make assumptions about the joint functions that cannot be observed. This is, however, not a serious restriction, just as the earlier assumptions of linear and additive values were not restrictive. If one has an approximation to the conditional value functions, one can then substitute in Equations (18) or (20) and test the joint result against the observed judgment data. That specification which fits best across all individuals is accepted as the "best" representation.*

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*Although it is possible that different individuals have different joint specifications, one usually assumes that all individuals share the group form. In fact, previous work has demonstrated this to be a reasonable assumption.

Factorial Sampling Plans

Modeling individuals' responses to multiattribute alternatives involves selecting bundles (combinations) of attributes for individuals to evaluate. In a similar manner, the observations of choice employed in housing demand or housing choice data sets consist of bundles of attributes; i.e., combinations of observations of attributes at different levels. Because of the nature of the real world, the vectors of attributes are almost always correlated. For example, in travel demand analysis, auto and transit travel time, auto cost, and transit fare are almost certainly related to distance and will be strongly correlated for most trips. Moreover, in many cases only a subset of the possible alternatives is available to individuals, also limiting the inferences that can be made. Thus, the sampling plans discussed in this section are extensions of traditional data collection efforts which improve alternative and attribute bundles over those available in actual data.

It is theoretically possible, although not practical in most instances, for these sampling plans to guarantee independence of all attributes and to permit estimation of a large number of joint effects of these attributes. Such a possibility would be realized by conducting one or more of a number of possible controlled experiments. As stated previously, a factorial experiment consisting of all combinations of all variables is required in order to be able to estimate all possible main effects and interactions. The approach to using this kind of plan is to present individuals with such sets of alternatives and have them express some response of interest, such as preference or likelihood of use. This permits one to simulate the same experiment, as if it had been run in the real world. The term for this kind of sampling design, or experimental design, is a factorial design. It is

called a factorial design because all combinations of all levels of all attributes are employed.

It should be clear that as one increases the number of attributes or the number of levels, or both, the total number of possible combinations grows rapidly. Two examples of this problem might be five attributes at three levels which is 3^5 or 243 combinations, or an asymmetrical design such as a $4 \times 3 \times 2^7$, or 1536 combinations. (Designs in which all attributes are at the same number of levels are termed symmetric; all others are asymmetric.) As a result of this property of factorial designs, one will usually want to use considerably less than all possible combinations, given any set of attributes and their levels of interest. This requires that one understands the methods available for reducing the number of combinations required; these are termed "fractional factorial designs."

Fractional Factorial Sampling Designs

If one is interested in estimating value functions as described earlier, the following questions must be answered before any design can be selected (see Green, 1974):

a. What type of information does one require for modeling purposes:

   i) main effects only
   ii) main effects plus selected interaction effects
   iii) all main and interaction effects

b. What is the nature of the levels of each attribute?

   i) all attributes have equal numbers of levels
   ii) different attributes have different levels

c. How many attributes does the researcher want to vary in any single set of combinations?

   i) all attributes
   ii) some subset of attributes

Question (a) essentially determines the complexity of the information one can obtain from the individual: (i) yields the least information, essentially equivalent to providing information about the conditional response values only; (ii) yields more information than (i), in that it permits one to examine selected joint value terms; (iii) provides complete information, but is rarely practical. Question (b) concerns whether one can employ a symmetric or asymmetric fractional design. Although it is easier to obtain symmetric designs in available sources, a catalog produced by Hahn and Shaprio (1966) covers a very wide range of both types of designs and should ordinarily suffice. Question (c) is included only because some researchers have advocated using designs that present less than all attributes at a time. In particular, one type of design in which attributes are varied two at a time (called tradeoff analyses) has been frequently employed (e.g., see Eberts and Koeppel, 1977; Bruggeman, Rubin, and Griffith, 1976).

Questions (a) and (b) are considered relevant to the design of a typical FM or value assessment study. It is impossible to provide a general rule for the selection of fractional designs and it is recommended that the interested researcher examine some basic texts, such as Winer (1973) or Cochran and Cox (1957). An excellent cookbook to guide selection of plans for almost <u>any</u> specific real problem is provided by Hahn and Shapiro (1966).

It is frequently desirable to develop designs which provide that all main effects and two-way interactions can be estimated independently of one another and all other interaction effects. To illustrate this idea, consider a 3 x 3 x 3 sampling plan. The levels are labeled 1, 2, and 3. The full design is given in Table A-1 for hypothetical attributes A, B, and C. If one wishes to fractionate this design so that one can infer the main effects of A, B, and C, one needs to know which terms or effects are correlated with which others.

Table A-1

Full Factorial Coding Example

A	B	C	A	B	C	A	B	C
1	1	1	2	1	1	3	1	1
1	1	2	2	1	2	3	1	2
1	1	3	2	1	3	3	1	3
1	2	1	2	2	1	3	2	1
1	2	2	2	2	2	3	2	2
1	2	3	2	2	3	3	2	3
1	3	1	2	3	1	3	3	1
1	3	2	2	3	2	3	3	2
1	3	3	2	3	3	3	3	3

For example, if one wants to estimate the main effects independently of one another, it is obviously desirable that all main effects be uncorrelated with each other. So, one would want to choose a fractional sampling plan that guaranteed this independence. Likewise, if one suspected that there would be significant interaction effects, one would want to try to minimize correlations with these effects as well. As a rule of thumb, less and less variation is accounted for by interactions after main effects have been accounted for, even if the interactions are significant. It is usually the case, in fact, that two-way (e.g., A x B) interactions account for less variance than main effects, but more than three-way interactions (e.g., A x B x C). Hence, one usually wants to collapse across as many interaction effects as possible that are three-way or larger. In fact, one tries to minimize correlations with two-way effects because these could be large and affect interpretation of results.

To understand how one selects such a fraction, it is instructive to return to a multiple linear regression format. For the design in Table A-1, the following regression equation may be specified:

$$V_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^2 + \beta_3 B_i + \beta_4 B_i^2 + \beta_5 C_i \qquad (22)$$
$$+ \beta_6 C_i^2 + \beta_7 A_i \cdot B_i + \beta_8 A_i \cdot B_i^2 + \beta_9 A_i^2 \cdot B_i$$
$$+ \beta_{10} A_i^2 \cdot B_i^2 + \beta_{11} A_i \cdot C_i + \beta_{12} A_i \cdot C_i^2$$
$$+ \beta_{13} A_i^2 \cdot C_i + \beta_{14} A_i^2 \cdot C_i^2 + \beta_{15} B_i \cdot C_i$$
$$+ \beta_{16} B_i \cdot C_i^2 + \beta_{17} B_i^2 \cdot C_i + \beta_{18} B_i^2 \cdot C_i^2$$
$$+ \beta_{19} A_i \cdot B_i \cdot C_i + \beta_{20} A_i \cdot B_i \cdot C_i^2 + \beta_{21} A^2 \cdot B_i^2 \cdot C_i$$
$$+ \beta_{22} A_i \cdot B_i^2 \cdot C_i^2 + \beta_{23} A_i^2 \cdot B_i \cdot C_i$$
$$+ \beta_{24} A_i^2 \cdot B_i \cdot C_i^2 + \beta_{25} A_i^2 \cdot B^2_i \cdot C_i$$
$$+ \beta_{26} A_i^2 \cdot B_i^2 \cdot C_i^2 + \varepsilon_i,$$

where:

V_i is a utility or value response to the i^{th} treatment combination (alternative);

$\beta_0 - \beta_{26}$ are regression coefficients (a total of 27: one constant, 6 main effects, 12 two-way interactions, and 8 higher-order terms);

A_i is the linear effect of factor A; A_i^2 is its quadratic effect;

B_i is the linear effect of factor B; B_i^2 is its quadratic effect;

C_i is the linear effect of factor C; C_i^2 is its quadratic effect;

All remaining terms are the cross-products or interaction effects of the above three factors.

In order to create a fraction which has the properties discussed in the preceding paragraphs, one would usually want to select a sampling plan that leaves A_i, A_i^2, B_i, B_i^2, C_i and C_i^2 uncorrelated with one another and uncorrelated with as many of the two-factor cross-products (interactions) as possible. In fact, one usually tries to collapse such that terms like β_{19} through β_{26} are correlated with one another and some of the β_7 through β_{14} terms, but not with the β_1 through β_6 terms. This permits one to get estimates of the main effects (β_1 through β_6) unconfounded by correlations with other potentially highly significant terms.

However, in order to obtain maximally efficient estimates of these terms, one needs to be able to specify A and A^2, B and B^2, and C and C^2 in such a way that they are uncorrelated. In this case a factorial or fractional factorial sampling plan is a necessary but not sufficient condition to guarantee this independence. Unless one can transform A, B, and C into separate uncorrelated linear and quadratic terms, A and A^2 will be correlated, as will be B and B^2 and C and C^2. The creation of independence is accomplished by means of a transformation procedure termed the "method of orthogonal polynomial

transformations." Briefly, it consists of a mathematical function to transform the levels of any factor into terms that represent linear and squared effects and which are independent. This method is used in the main study tasks to insure independence of main linear and quadratic effects in analyzing the responses to the tradeoff surveys.

For example, in Table A-1, one can use the method of orthogonal polynomials to create all the terms of interest by replacing the codes in Table A-1 with the following:

a. For a linear effect, wherever the value "1" appears, replace it with "-1"; replace "2" with "0"; replace "3" with "1";

b. For a quadratic effect, wherever the value "1" appears, create a value of a new vector equal to "1"; for the level "2," create a value of "-2"; for the level "3," create a "1".

These new codes are given in Table A-2. In Table A-2, L stands for a linear effect; Q for a quadratic effect. Note that in each column the sum of the elements of the vector equals zero. The correlation between each pair of vectors is zero. The cross-product, A(L) · B(L) is formed simply by multiplying each pair of elements within a row (observation); thus, the first observation under A(L) is -1, and under B(L) is -1; their cross-product is A(L) x B(L), or (-1) x (-1) = +1. All cross-products are formed in the same way.

Table A-2 shows that there are six independent main effects which can be estimated; similarly, by expansion, one could find 20 interaction terms, all of which are independent. This is possible because the full factorial design, 3^3 or 27 combinations, is used. The 27 observations are sufficient to estimate 27 coefficients, although no degrees of freedom remain for estimating error. Now consider the effect of taking a one-third fraction of 9 combinations from the total 27; an example of a one-third fraction is given in Table A-3.

TABLE A-2

Orthogonal Coding of the Design of Table A-1

Main Effects						Some Example Interactions		
A(L)	A(Q)	B(L)	B(Q)	C(L)	C(Q)	A(L)B(L)	B(Q)C(L)	A(Q)B(1)C(L)
-1	+1	-1	+1	-1	+1	+1	-1	-1
-1	+1	-1	+1	0	-2	+1	0	0
-1	+1	-1	+1	+1	+1	+1	+1	+1
-1	+1	0	-2	-1	+1	0	+2	+2
-1	+1	0	-2	0	-2	0	0	0
-1	+1	0	-2	+1	+1	0	-2	-2
-1	+1	+1	+1	-1	+1	-1	-1	-1
-1	+1	+1	+1	0	-2	-1	0	0
-1	+1	+1	+1	+1	+1	-1	+1	+1
0	-2	-1	+1	-1	+1	0	-1	+2
0	-2	-1	+1	0	-2	0	0	0
0	-2	-1	+1	+1	+1	0	+1	-2
0	-2	0	-2	-1	+1	0	+2	-4
0	-2	0	-2	0	-2	0	0	0
0	-2	0	-2	+1	+1	0	-2	+4
0	-2	+1	+1	-1	+1	0	-1	+2
0	-2	+1	+1	0	-2	0	0	0
0	-2	+1	+1	+1	+1	0	+1	-2
+1	+1	-1	+1	-1	+1	-1	-1	-1
+1	+1	-1	+1	0	-2	-1	0	0
+1	+1	-1	+1	+1	+1	-1	+1	+1
+1	+1	0	-2	-1	+1	0	+2	+2
+1	+1	0	-2	0	-2	0	0	0
+1	+1	0	-2	+1	+1	0	-2	-2
+1	+1	+1	+1	-1	+1	+1	-1	-1
+1	+1	+1	+1	0	-2	+1	0	0
+1	+1	+1	+1	+1	+1	+1	+1	+1

TABLE A-3

1/3 Fractional Plan, Polynomially Coded

Main Effects						Some Two-Way Interactions						
A(L)	A(Q)	B(L)	B(Q)	C(L)	C(Q)	AB	AB^2	A^2B	A^2B^2	AC	BC	ABC
-1	+1	-1	+1	-1	+1	+1	-1	-1	+1	+1	+1	-1
-1	+1	0	-2	+1	+1	0	+2	0	-2	-1	0	0
-1	+1	+1	+1	0	-2	-1	-1	+1	+1	0	0	0
0	-2	-1	+1	+1	+1	0	0	+2	-2	0	-1	0
0	-2	0	-2	0	-2	0	0	0	+4	0	0	0
0	-2	+1	+1	-1	+1	0	0	-2	-2	0	-1	0
+1	+1	-1	+1	0	-2	-1	+1	-1	+1	0	0	0
+1	+1	0	-2	-1	+1	0	-2	0	-2	-1	0	0
+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1

All of the terms shown in Table A-3 are independent of each other; however, they are not independent of other terms not shown. For example, AC = AB^2C and AB = ABC^2. This can be found by the multiplication of the corresponding columns in Table A-2. In general, the sum of the inner products of two vectors must be zero for them to be independent of one another. Many of the possible terms not shown in Table A-2 fail to meet this criterion. Thus, one could estimate an effect or coefficient for AC or AB, but one would not be able to ascribe the coefficient to either effect. Note that in traditional demand data there will rarely be observations over all possible combinations, nor will there be balance in the number of observations of each level of each factor. Thus, traditional travel demand data constitute a non-orthogonal (non-independent) sampling plan with some effects confounded in a manner which cannot be determined prior to data collection. After data collection, an analysis of the independent variables in the data set could be performed to examine which main effects and interactions were confounded (collinear), as if the data were an experiment. In practice, most of the interactions would be confounded, and most likely also some main effects. On the other hand, factorial sampling plans permit one to know a priori what the confoundment structure is and what effects can be reliably estimated.

1.24 Forecasting Choices from Individual Utility Models

One can estimate either the full or some reduced form of Equation (22) for each individual or at the aggregate level. To forecast choices one must assume that there is a rank-order relationship between the values that are predicted by the individual equations and the likelihoods of choice, i.e.:

$$P(_i)_j = \begin{cases} 1 \text{ iff } V_{ij} \text{ is the largest } V_{ij} \text{ for individual } j, \\ 0 \text{ otherwise} \end{cases} \qquad (23)$$

where:

$P(_i)_j$ is the probability of alternative i being selected by an individual j (perhaps individual j's long-term frequency of choice);

V_{ij} is the response or attractiveness value that the j^{th} individual's equation will predict for alternative i.

Equation (23) implies that one must search through the V_i for each individual j and assign that individual to that alternative i with the highest V_i.

Thus, there are two approaches to forecasting:

1. Using a random sample of individuals, simulate their choice of mobility or housing situation for observed choices by substituting the levels or values of each attribute in each individual's equation for each type of mobility and housing. Each individual is assigned to that alternative with the highest predicted value. Population-wide choice proportions are obtained by calculating the proportions assigned to each mobility and housing type in the sample and expanding to the population. Any subgroup can be similarly estimated.

2. Using the mean or average equations estimated over all individuals, repeat the simulation as in method 1. A single equation is used to represent each individual, rather than a separate equation unique to each individual.

The notions outlined in this introductory section are used to develop individual and group aggregate tradeoff models from the tradeoff survey data. The specifics of application are explained in the next section.

Application of Information Integration Theory or Functional Measurement to the AoA Housing Tradeoffs Study

In the real world the elderly (or for that matter those who are not elderly) evaluate alternative housing opportunities and choose from among these opportunities that which best satisfies their preferences and needs subject to personal and household constraints. Theory in discrete choice analysis and information integration suggests that individuals evaluate a number of separate pieces of information about housing alternatives. We call these pieces of information "attributes" of the housing alternatives. It is assumed that elderly individuals evaluate the attributes of housing alternatives by trading off the levels of the attributes of one alternative against the levels of the attributes of other opportunities. For example, an individual might accept one less bathroom to get one additional bedroom or vice versa.

The role of information integration theory is to provide a theoretically sound and analytically tractable approach to the determination of individuals' tradeoffs and preferences. In this regard we must first specify the attributes which individuals take into account in their evaluations of housing opportunities. The research proposed to AoA involved presurveys to determine these attributes; however, the method employed to define the attributes was a literature search conducted by one of the research team. Hence, the attributes were specified according to previous findings, relying heavily upon previous sociological and economic research.* Once attributes have been defined they must be given levels and manipulated in a combinatorial

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*Note: Research in applications of Information Integration Theory has demonstrated that previous literature results are rarely a good guide to attribute definition (Hensher and MacLeod, 1977; Lerman and Louviere, 1978; Levin and Louviere, 1981). This is particularly true where reliance is placed upon findings from aggregate data such as census data.

experimental design. The principles behind such experiments were discussed in the immediately preceding section.

Although the research proposed to AoA involved the investigation of housing choices, the tradeoff survey focused upon mobility and residential situation tradeoffs. In this regard, two separate tradeoff surveys were developed. First was a mobility tradeoff study which involved four attributes (1) Type of Community: Center of a large city, Suburb of large city, Small town or Rural Location; (2) Cost of Living: 40%, 60%, or 80% of your income; (3) Region of Country/Climate: Southwestern state, mild to warm most of the year; Northern state, warm summers/cold winters; Southeastern state, mild to warm most of the year; and (4) Location of Close Relative: Close relative lives in same community, close relative lives in nearby community, close relative does not live in or near community. The second tradeoff study of residential situations involved an additional four attributes: (1) Number of dwelling units in building: Single family, 2 to 4, 5 or more; (2) Living arrangement: Owner-occupied unit with title in your name, Rental unit which is leased to you, Live in home of relative; (3) Average Income Level of Neighborhood: Low, less than $15,000 per year; Medium, between $15,000 and $30,000 per year; High, more than $30,000 per year; and (4) Cost of Housing and Utilities: 15%, 30%, 45% of your income. In the case of both tradeoff studies, there are 81 total possible mobility or residential situation alternatives. This is given by the factorial enumeration of all combinations of the three levels of the four attributes (3 x 3 x 3 x 3 = 81). In order to keep the survey as simple as possible, each respondent was asked to evaluate two sets of nine alternatives--nine mobility alternatives and nine residential situation alternatives. The nine alternatives were selected according to a main-effects, orthogonal, fractional factorial experimental design plan (see,

e.g., Hahn and Shapiro, 1966) which permits independent estimates of each respondent's tradeoffs assuming an additive tradeoff process (e.g.):

$$\text{Response}_i = k_o + w_1x_{1i} + w_2x_{2i} + w_3x_{3i} + w_4x_{4i}, \qquad (24)$$

where

$\underline{\text{Response}_i}$ is the respondent's evaluation of each of the i (= 1, 2, . . . , 9) mobility or residential situation alternatives.

$\underline{x_{1i}, x_{2i}, \text{etc.}}$ are the four attributes of the mobility or housing situation alternatives.

$\underline{w_1, w_2, \text{etc.}}$ are weights that reflect the relative tradeoffs among the attributes.

$\underline{k_o}$ is a constant necessary to define an origin for the respondent's response scale.

In practice, Equation (24) is approximated by means of multiple linear regression procedures. This permits us to define a unique set of regression constants for each respondent. An additional and important feature of the survey design is that there are five different sets of nine alternatives for both the mobility and residential situation survey forms. That is, there are forty-five different alternatives represented over five different survey forms. This permits the analyst to estimate non-additivities in the aggregate tradeoffs which could be important in policy analysis: non-additivities (or interactions) imply that the response to one attribute depends upon one or more levels of a second (or additional) attribute(s). These non-additivities, however, can be assessed only at an aggregated level; i.e., by combining the responses of several respondents. This aggregate analysis is necessary because each respondent completes only 1/5 of the 45 total combinations needed to adequately assess non-additivities.

A final feature of the survey design is that the mobility tradeoffs are answered first before the respondent evaluates the residential situation alternatives. This was done because it was assumed that respondents first make mobility decisions and then conditional upon those decisions they make residential situation decisions. An additional feature of the design is that one common alternative was included in all five tradeoff surveys so that if sampling differences appeared in the responses to the five different sets of tradeoffs, they could be rescaled with reference to the common base.

Respondents were also requested to evaluate their present residential situation in order to compare responses to the alternatives with the respondent's present situation. The implicit hypothesis is that only alternatives evaluated more highly than present situations are possible choice candidates. The actual survey forms employed in the tradeoff studies are included in Appendix B, together with a copy of the Instructions to the Respondents. It is important to keep in mind that the survey forms implement the information integration theory approach and because of this they require the respondent to evaluate the attributes, decide how important they are, compare the alternatives with each other and respond to the entire bundle of attributes. In this respect the survey forms differ sharply from typical opinion, attitude or related types of surveys.

APPENDIX B: MOBILITY TRADEOFF SURVEYS

PART II: INSTRUCTIONS

On the next page, you will find descriptions of several alternative places to live. Nine locations are included, each of which is described by a type of community, the cost of living in the community, the region of the country, and the distance to a close relative of you or other members of your household.

We would like to know how attractive each of these alternative places would be to you <u>if you were presently considering moving to a different residence</u>. For each alternative, please indicate whether it is either excellent, very good, good, fair, or poor. CIRCLE THE APPROPRIATE RESPONSE FOR EACH ALTERNATIVE RESIDENCE, INCLUDING YOUR PRESENT RESIDENCE.

	Residence	Excellent	Very Good	Good	Fair	Poor
1	A	5	4	3	2	1
2	B	5	4	3	2	1
3	C	5	4	3	2	1
4	D	5	4	3	2	1
5	E	5	4	3	2	1
6	F	5	4	3	2	1
7	G	5	4	3	2	1
8	H	5	4	3	2	1
9	I	5	4	3	2	1
11	Your present residence	5	4	3	2	1

GROUP ONE: PLACES DESCRIBED BY FEATURES OF LOCATION

	LOCATION A	LOCATION B	LOCATION C	LOCATION D	LOCATION E
TYPE OF COMMUNITY	Suburb of a large city	Suburb of a large city	Center of a large city	Center of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	40% of your income	60% of your income	60% of your income	40% of your income	80% of your income
REGION OF COUNTRY; CLIMATE	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Southeastern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative lives in nearby community	Close relative does not live in or near community	Close relative lives in same community	Close relative does not live in or near community	Close relative lives in same community

	LOCATION F	LOCATION G	LOCATION H	LOCATION I
TYPE OF COMMUNITY	Center of a large city	Small town or rural location	Small town or rural location	Small town or rural location
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	80% of your income	40% of your income	80% of your income	60% of your income
REGION OF COUNTRY; CLIMATE	Northern state; warm summers, cold winters	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Southeastern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative lives in nearby community	Close relative lives in same community	Close relative does not live in or near community	Close relative lives in nearby community

GROUP LINK: PLACES DESCRIBED BY FEATURES OF LOCATION

	LOCATION A	LOCATION B	LOCATION C	LOCATION D	LOCATION E
TYPE OF COMMUNITY	Suburb of a large city	Suburb of a large city	Suburb of a large city	Small town or rural location	Small town or rural location
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	40% of your income	80% of your income	60% of your income	40% of your income	60% of your income
REGION OF COUNTRY; CLIMATE	Southwestern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Northern state; warm summers, cold winters	Northern state; warm summers, cold winters	Southeastern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative does not live in or near community	Close relative lives in nearby community	Close relative lives in same community	Close relative lives in nearby community	Close relative does not live in or near community

	LOCATION F	LOCATION G	LOCATION H	LOCATION I	LOCATION J
TYPE OF COMMUNITY	Center of a large city	Center of a large city	Center of a large city	Small town or rural location	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	60% of your income	40% of your income	80% of your income	80% of your income	60% of your income
REGION OF COUNTRY; CLIMATE	Southwestern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters
LOCATION OF CLOSE RELATIVE	Close relative lives in nearby community	Close relative lives in same community	Close relative does not live in or near community	Close relative lives in same community	Close relative does not live in or near community

Form 3

GROUP ONE: PLACES DESCRIBED BY FEATURES OF LOCATION

	LOCATION A	LOCATION B	LOCATION C	LOCATION D	LOCATION E
TYPE OF COMMUNITY	Suburb of a large city	Small town or rural location	Center of a large city	Center of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	60% of your income	80% of your income	60% of your income	40% of your income	40% of your income
REGION OF COUNTRY; CLIMATE	Southwestern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southeastern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative does not live in or near community	Close relative does not live in or nearby community	Close relative lives in same community	Close relative does not live in or near community	Close relative lives in nearby community

	LOCATION F	LOCATION G	LOCATION H	LOCATION I	LOCATION J
TYPE OF COMMUNITY	Small town or rural location	Small town or rural location	Suburb of a large city	Center of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	60% of your income	40% of your income	80% of your income	80% of your income	60% or your income
REGION OF COUNTRY; CLIMATE	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters
LOCATION OF CLOSE RELATIVE	Close relative lives in nearby community	Close relative lives in same community	Close relative lives in same community	Close relative lives in nearby community	Close relative does not live in or near community

GROUP ONE: PLACES DESCRIBED BY FEATURES OF LOCATION

	LOCATION A	LOCATION B	LOCATION C	LOCATION D	LOCATION E
TYPE OF COMMUNITY	Center of a large city	Small town or rural location	Small town or rural location	Suburb of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	60% of your income	40% of your income	60% of your income	80% of your income	60% of your income
REGION OF COUNTRY; CLIMATE	Southeastern state; mild to warm most of the year	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative does not live in or near community	Close relative does not live in or near community	Close relative lives in same community	Close relative does not live in or near community	Close relative lives in nearby community

	LOCATION F	LOCATION G	LOCATION H	LOCATION I	LOCATION J
TYPE OF COMMUNITY	Center of a large city	Center of a large city	Small town or rural location	Suburb of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	80% of your income	40% of your income	80% of your income	40% of your income	60% of your income
REGION OF COUNTRY; CLIMATE	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southeastern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Northern state; warm summers, cold winters
LOCATION OF CLOSE RELATIVE	Close relative lives in same community	Close relative lives in nearby community	Close relative lives in nearby community	Close relative lives in same community	Close relative does not live in or near community

GROUP ONE: PLACES DESCRIBED BY FEATURES OF LOCATION

	LOCATION A	LOCATION B	LOCATION C	LOCATION D	LOCATION E
TYPE OF COMMUNITY	Center of a large city	Small town or rural location	Suburb of a large city	Small town or rural location	Center of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	60% of your income	40% of your income	60% of your income	80% of your income	80% of your income
REGION OF COUNTRY; CLIMATE	Northern state; warm summers, cold winters	Southeastern state; mild to warm most of the year	Southeastern state; mild to warm most of the year	Northern state; warm summers, cold winters	Southeastern state; mild to warm most of the year
LOCATION OF CLOSE RELATIVE	Close relative lives in same community	Close relative lives in same community	Close relative does not live in or near community	Close relative does not live in or near community	Close relative lives in nearby community

	LOCATION F	LOCATION G	LOCATION H	LOCATION I	LOCATION J
TYPE OF COMMUNITY	Suburb of a large city	Center of a large city	Small town or rural location	Suburb of a large city	Suburb of a large city
COST OF LIVING (HOUSING, UTILITIES, FOOD, AND TAXES)	40% of your income	40% of your income	60% of your income	80% of your income	60% or your income
REGION OF COUNTRY; CLIMATE	Northern state; warm summers, cold winters	Southwestern state; mild to warm most of the year	Southwestern state; mild to warm most of the year	Southwestern state; mild to warm most of the year	Northern state; warm summers, cold winters
LOCATION OF CLOSE RELATIVE	Close relative lives in nearby community	Close relative does not live in or near community	Close relative lives in nearby community	Close relative lives in same community	Close relative does not live in or near community

We are also interested in your preferences for alternative location within a particular community. On the next page, nine alternative residences are described by four building and neighborhood characteristics (number of units in the building, the type of living arrangement, the cost of housing and utilities, and the average income level of the neighborhood or township in which the residence is located).

As before, we would like to know how attractive each of these alternative places would be to you <u>if you were presently considering moving to a different residence</u>. For each alternative, please indicate whether it is either excellent, very good, good, fair, or poor, CIRCLE THE APPROPRIATE RESPONSE FOR EACH ALTERNATIVE RESIDENCE, INCLUDING YOUR PRESENT RESIDENCE.

	Residence	Excellent	Very Good	Good	Fair	Poor
12	A	5	4	3	2	1
13	B	5	4	3	2	1
14	C	5	4	3	2	1
15	D	5	4	3	2	1
16	E	5	4	3	2	1
17	F	5	4	3	2	1
18	G	5	4	3	2	1
19	H	5	4	3	2	1
20	I	5	4	3	2	1
22	Your present residence	5	4	3	2	1

GROUP TWO: RESIDENCES DESCRIBED BY BUILDING AND NEIGHBORHOOD CHARACTERISTICS

Form 1

	RESIDENCE A	RESIDENCE B	RESIDENCE C	RESIDENCE D	RESIDENCE E
NUMBER OF DWELLING UNITS IN BUILDING	5 or more	2 to 4	5 or more	Single family	5 or more
LIVING ARRANGEMENT	Rental unit which is leased to you	Owner-occupied unit with title in your name	Owner-occupied unit with title in your name	Owner-occupied unit with title in your name	Live in home of relative
COST OF HOUSING AND UTILITIES	15% of your income	15% of your income	30% of your income	45% of your income	45% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Medium; between $15,000 and $30,000 per year	High; more than $30,000 per year	Low; less than $15,000 per year	Medium; between $15,000 and $30,000 per year	High; more than $30,000 per year

	RESIDENCE F	RESIDENCE G	RESIDENCE H	RESIDENCE I
NUMBER OF DWELLING UNITS IN BUILDING	2 to 4	Single family	2 to 4	Single family
LIVING ARRANGEMENT	Rental unit which is leased to you	Rental unit which is leased to you	Live in home of a relative	Live in home of a relative
COST OF HOUSING AND UTILITIES	45% of your income	30% of your income	30% of your income	15% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Low; less than $15,000 per year	High; more than $30,000 per year	Medium; between $15,000 and $30,000 per year	Low; less than $15,000 per year

GROUP TWO: RESIDENCES DESCRIBED BY BUILDING AND NEIGHBORHOOD CHARACTERISTICS

	RESIDENCE A	RESIDENCE B	RESIDENCE C	RESIDENCE D	RESIDENCE E
NUMBER OF DWELLING UNITS IN BUILDING	Single family	5 or more	2 to 4	Single family	Single family
LIVING ARRANGEMENT	Rental unit which is leased to you	Rental unit which is leased to you	Rental unit which is leased to you	Live in home of a relative	Owner-occupied unit with title in your name
COST OF HOUSING AND UTILITIES	30% of your income	15% of your income	45% of your income	15% of your income	45% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Low; less than $15,000 per year	High; more than $30,000 per year	Medium; between $15,000 and $30,000 per year	Medium; between $15,000 and $30,000 per year	High; more than $30,000 per year

	RESIDENCE F	RESIDENCE G	RESIDENCE H	RESIDENCE I	LOCATION J
NUMBER OF DWELLING UNITS IN BUILDING	2 to 4	2 to 4	5 or more	5 or more	2 to 4
LIVING ARRANGEMENT	Live in home of a relative	Owner-occupied unit with title in your name	Owner-occupied unit with title in your name	Live in home of a relative	Live in home of a relative
COST OF HOUSING AND UTILITIES	30% of your income	15% of your income	30% of your income	45% of your income	30% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	High; more than $30,000 per year	Low; less than $15,000 per year	Medium; between $15,000 and $30,000 per year	Low; less than $15,000 per year	Medium; between $15,000 and $30,000 per year

Form 3

GROUP TWO: RESIDENCES DESCRIBED BY BUILDING AND NEIGHBORHOOD CHARACTERISTICS

	RESIDENCE A	RESIDENCE B	RESIDENCE C	RESIDENCE D	RESIDENCE E
NUMBER OF DWELLING UNITS IN BUILDING	5 or more	2 to 4	Single family	5 or more	2 to 4
LIVING ARRANGEMENT	Live in home of a relative	Owner-occupied unit with title in your name	Rental unit which is leased to you	Owner-occupied unit with title in your name	Rental unit which is leased to you
COST OF HOUSING AND UTILITIES	15% of your income	30% of your income	45% of your income	45% of your income	15% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	High; more than $30,000 per year	High; more than $30,000 per year	High; more than $30,000 per year	Low; less than $15,000 per year	Low; less than $15,000 per year

	RESIDENCE F	RESIDENCE G	RESIDENCE H	RESIDENCE I	RESIDENCE J
NUMBER OF DWELLING UNITS IN BUILDING	2 to 4	5 or more	Single family	Single family	2 to 4
LIVING ARRANGEMENT	Live in home of a relative	Rental unit which is leased to you	Live in home of a relative	Owner-occupied unit with title in your name	Live in home of a relative
COST OF HOUSING AND UTILITIES	45% of your income	30% of your income	30% of your income	15% of your income	30% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Medium; between $15,000 and $30,000 per year	Medium; between $15,000 and $30,000 per year	Low; less than $15,000 per year	Medium; between $15,000 and $30,000 per year	Medium; between $15,000 and $30,000 per year

GROUP TWO: RESIDENCES DESCRIBED BY BUILDING AND NEIGHBORHOOD CHARACTERISTICS

	RESIDENCE A	RESIDENCE B	RESIDENCE C	RESIDENCE D	RESIDENCE E
NUMBER OF DWELLING UNITS IN BUILDING	2 to 4	2 to 4	5 or more	Single family	2 to 4
LIVING ARRANGEMENT	Live in home of a relative	Rental unit which is leased to you	Rental unit which is leased to you	Live in home of a relative	Owner-occupied unit with title in your name
COST OF HOUSING AND UTILITIES	45% of your income	15% of your income	30% of your income	30% of your income	30% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Low; less than $15,000 per year	High; more than $30,000 per year	Low; less than $15,000 per year	High; more than $30,000 per year	Medium; between $15,000 and $30,000 per year

	RESIDENCE F	RESIDENCE G	RESIDENCE H	RESIDENCE I	RESIDENCE J
NUMBER OF DWELLING UNITS IN BUILDING	Single family	5 or more	Single family	5 or more	2 to 4
LIVING ARRANGEMENT	Rental unit which is leased to you	Live in home of a relative	Owner-occupied unit with title in your name	Owner-occupied unit with title in your name	Live in home of a relative
COST OF HOUSING AND UTILITIES	45% of your income	15% of your income	15% of your income	45% of your income	30% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Medium; between $15,000 and $30,000 per year	Medium; between $15,000 and $30,000 per year	Low; less than $15,000 per year	High; more than $30,000 per year	Medium; between $15,000 and $30,000 per year

Form 5

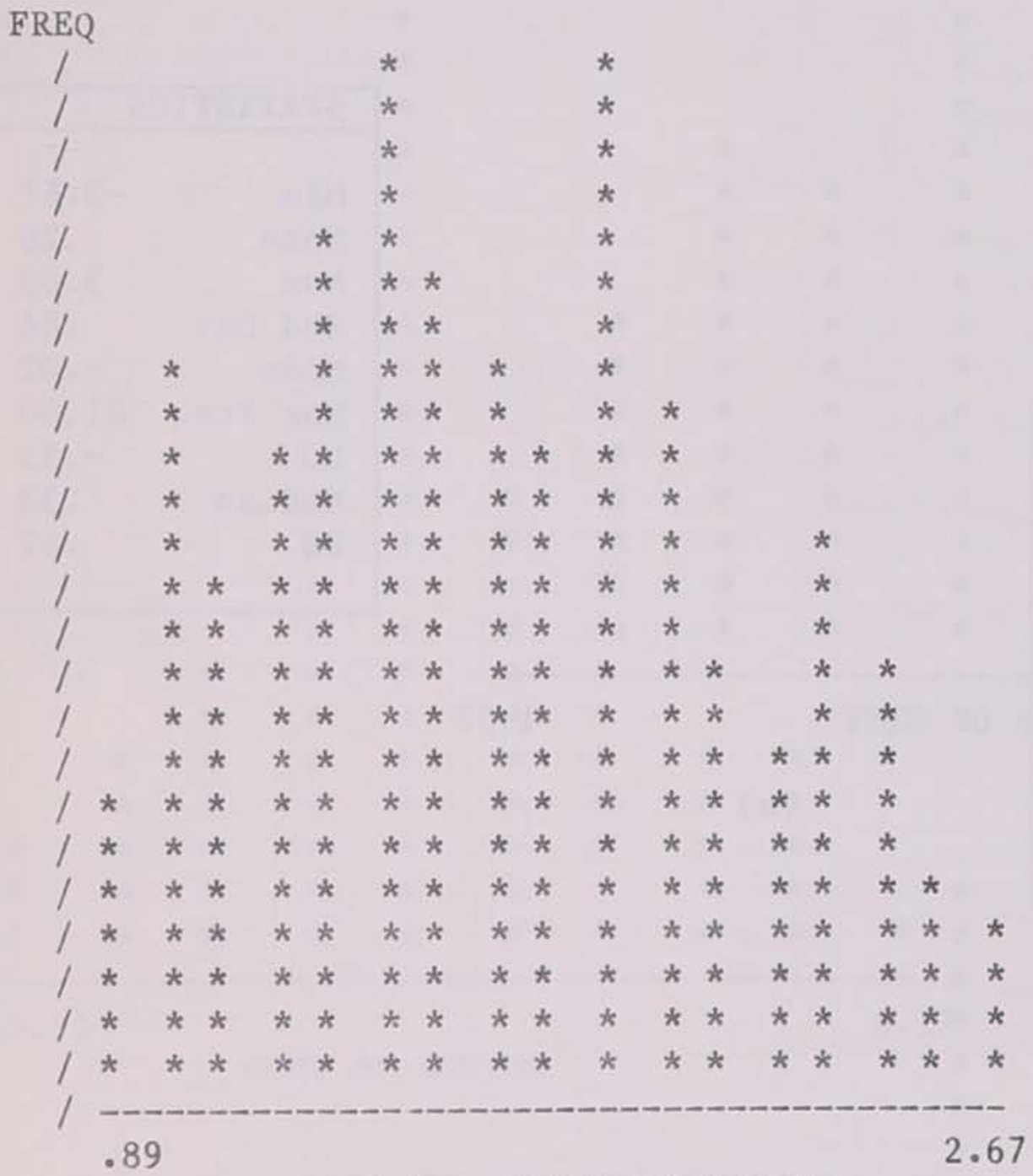
GROUP TWO: RESIDENCES DESCRIBED BY BUILDING AND NEIGHBORHOOD CHARACTERISTICS

	RESIDENCE A	RESIDENCE B	RESIDENCE C	RESIDENCE D	RESIDENCE E
NUMBER OF DWELLING UNITS IN BUILDING	Single family	2 to 4	Single family	5 or more	2 to 4
LIVING ARRANGEMENT	Owner-occupied unit with title in your name	Rental unit which is leased to you	Rental unit which is leased to you	Rental unit which is leased to you	Owner-occupied unit with title in your name
COST OF HOUSING AND UTILITIES	30% of your income	30% of your income	15% of your income	45% of your income	45% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Medium; between $15,000 and $30,000 per year	Low; less than $15,000 per year	High; more than $30,000 per year	Medium; between $15,000 and $30,000 per year	High; more than $30,000 per year

	RESIDENCE F	RESIDENCE G	RESIDENCE H	RESIDENCE I	RESIDENCE J
NUMBER OF DWELLING UNITS IN BUILDING	2 to 4	5 or more	Single family	5 or more	2 to 4
LIVING ARRANGEMENT	Live in home of a relative	Live in home of a relative	Live in home of a relative	Owner-occupied unit with title in your name	Live in home of a relative
COST OF HOUSING AND UTILITIES	15% of your income	30% of your income	45% of your income	15% of your income	30% of your income
AVERAGE INCOME LEVEL OF NEIGHBORHOOD	Medium; between $15,000 and $30,000 per year	High; more than $30,000 per year	Low; less than $15,000 per year	Low; less than $15,000 per year	Medium; between $15,000 and $30,000 per year

APPENDIX FIGURE 1: COMPUTER GENERATED TRADEOFF COEFFICIENT DISTRIBUTIONS FOR MOBILITY TRADEOFFS SURVEY

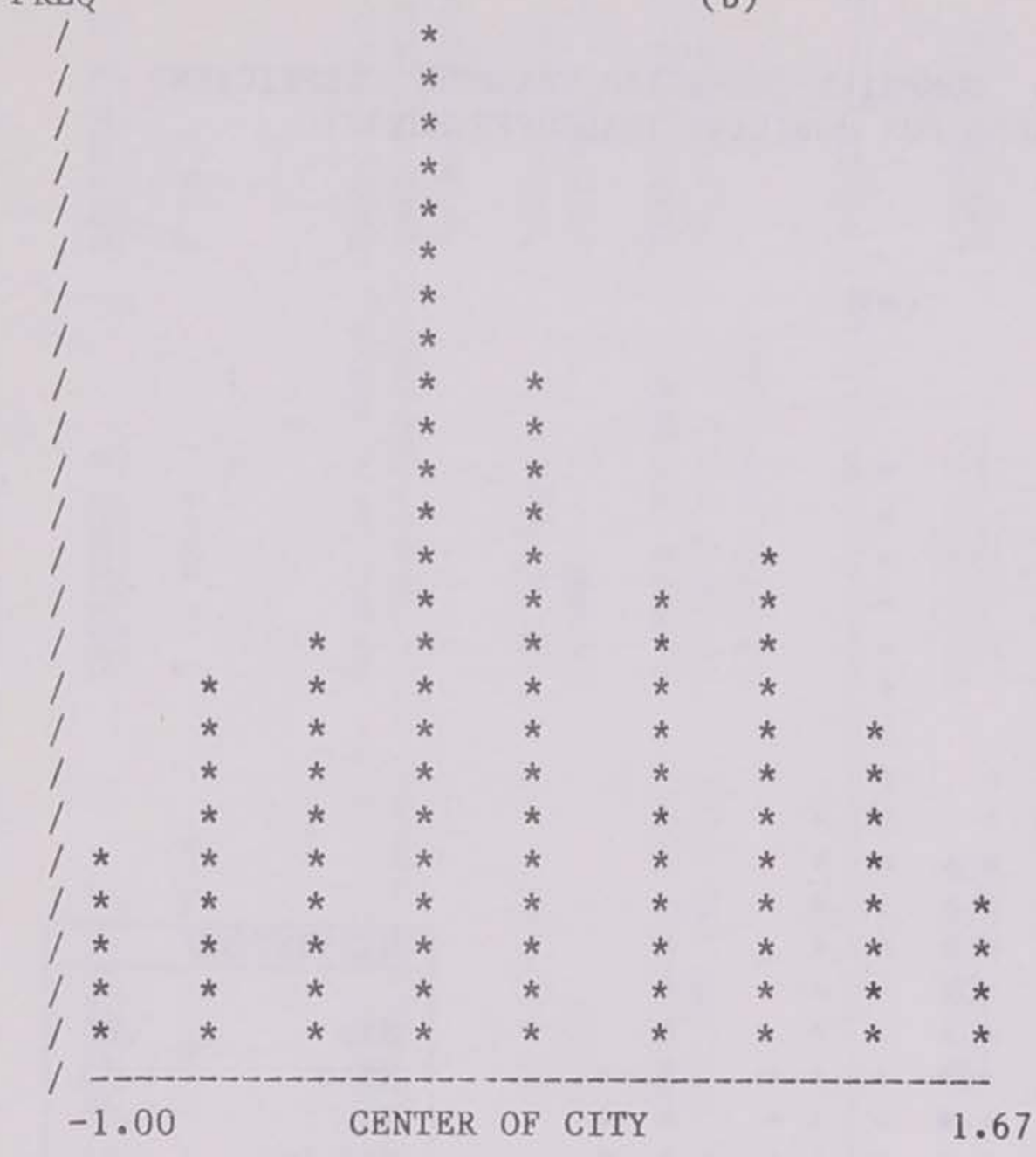
(a)



STATISTICS	
Min	.89
Mean	1.75
Max	4.00
Std Dev	.55
Mode	1.89
Max Freq	35.00
LQ	1.33
Median	1.67
UQ	2.06

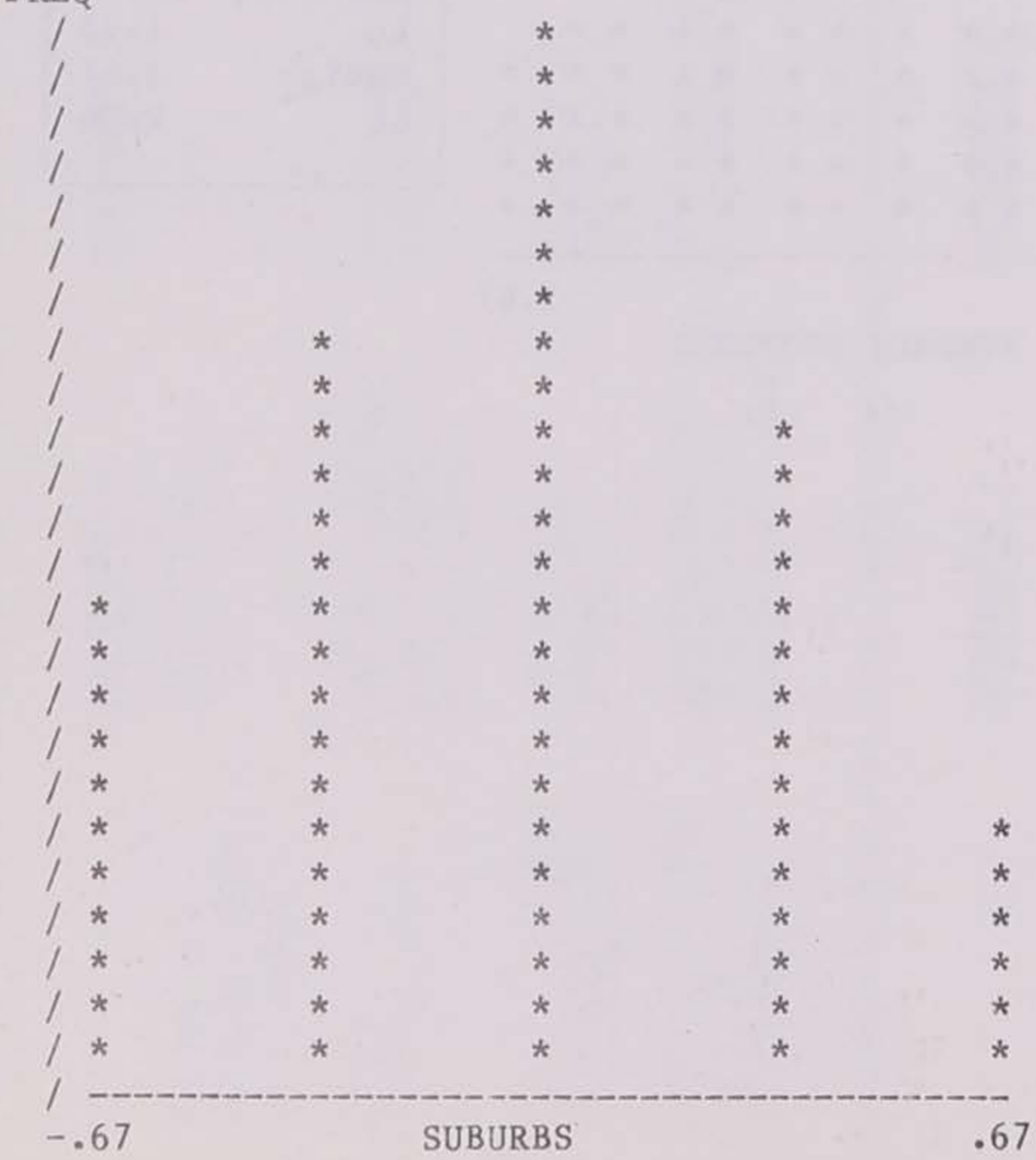
APPENDIX FIGURE 1 (cont.)

(b)



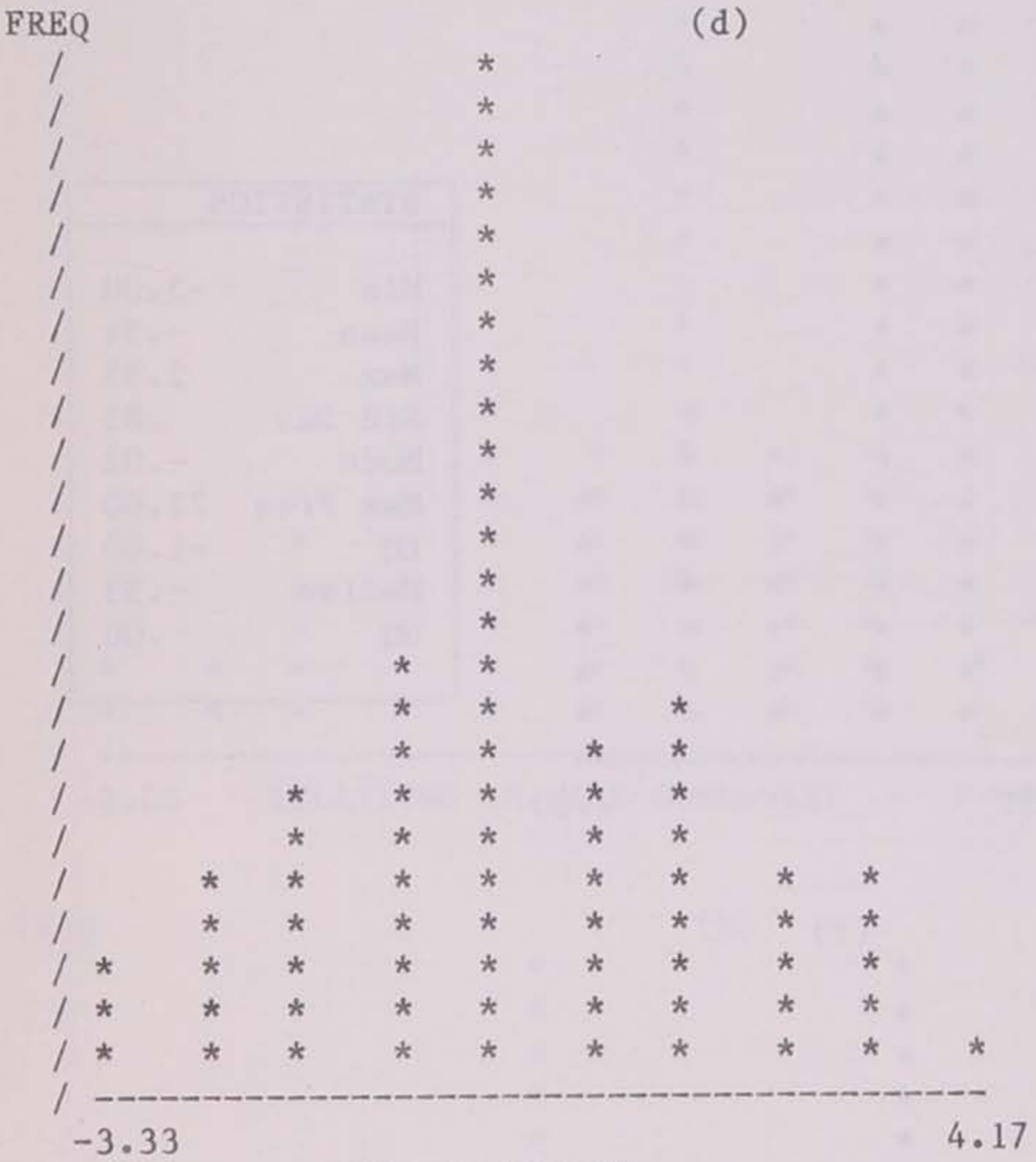
STATISTICS	
Min	-2.67
Mean	.26
Max	3.00
Std Dev	.84
Mode	-.02
Max Freq	81.00
LQ	-.33
Median	.33
UQ	.67

(c)

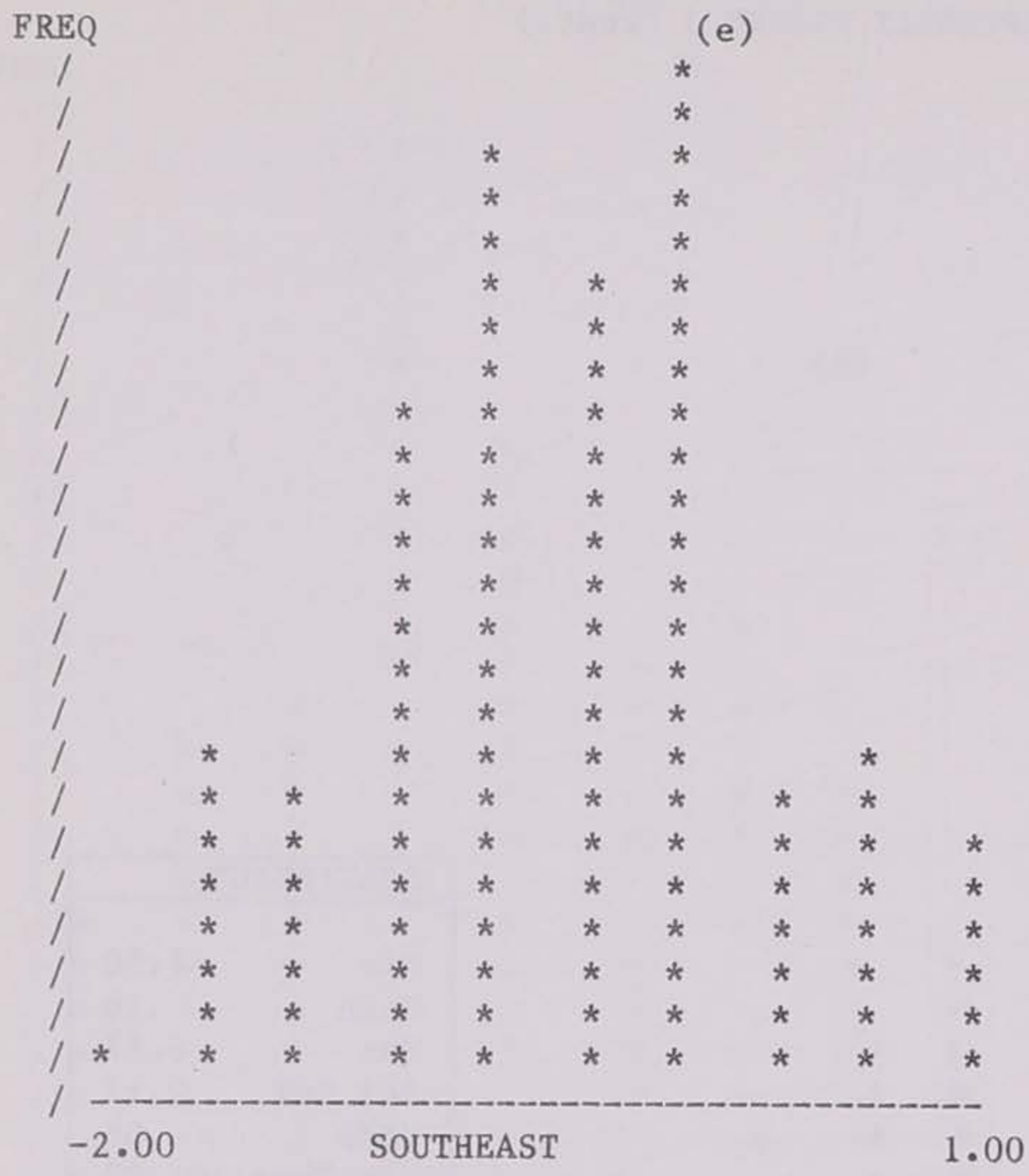


STATISTICS	
Min	-2.33
Mean	.03
Max	2.67
Std Dev	.77
Mode	-.02
Max Freq	92.00
LQ	-.33
Median	.00
UQ	.33

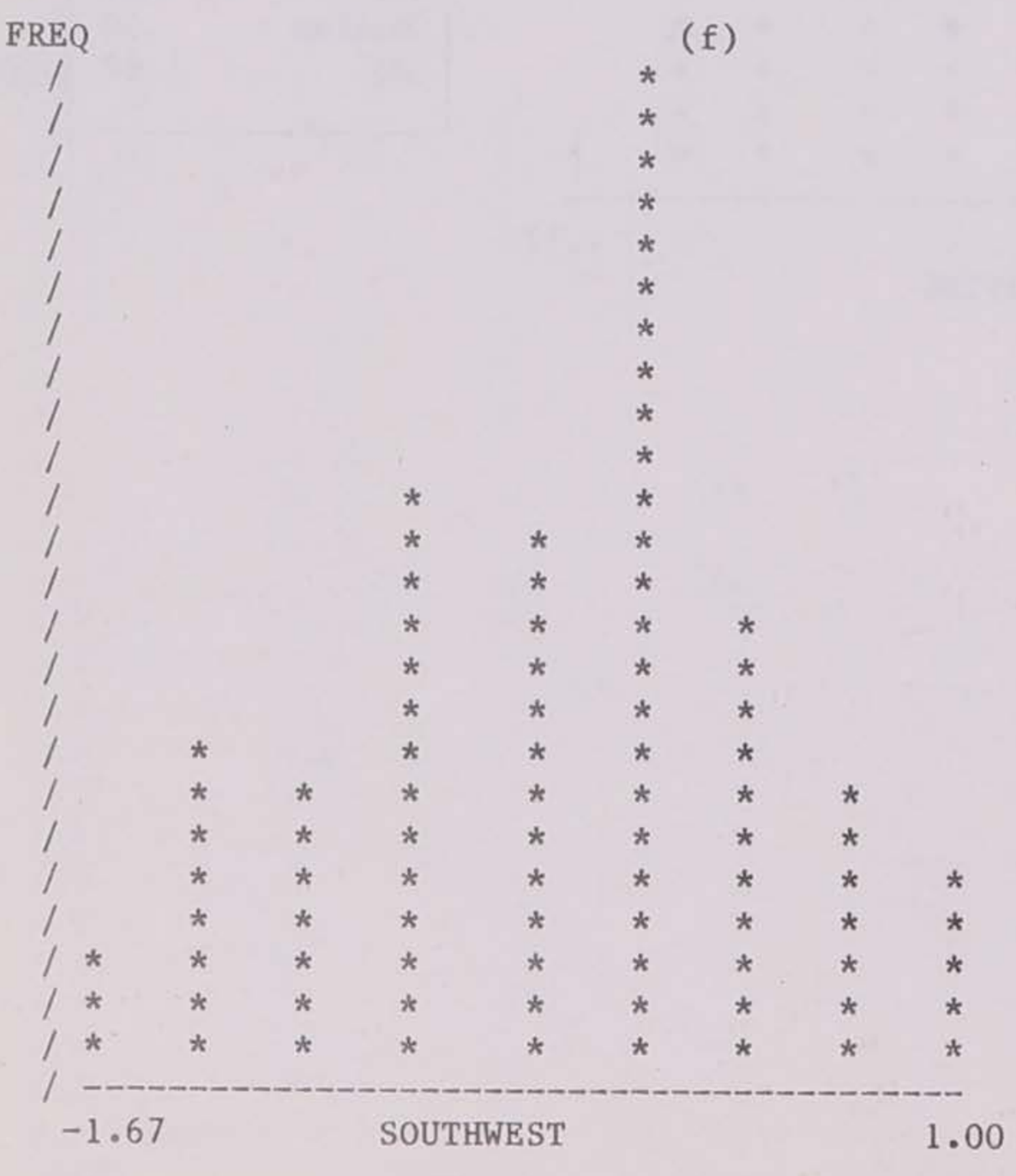
APPENDIX FIGURE 1 (cont.)



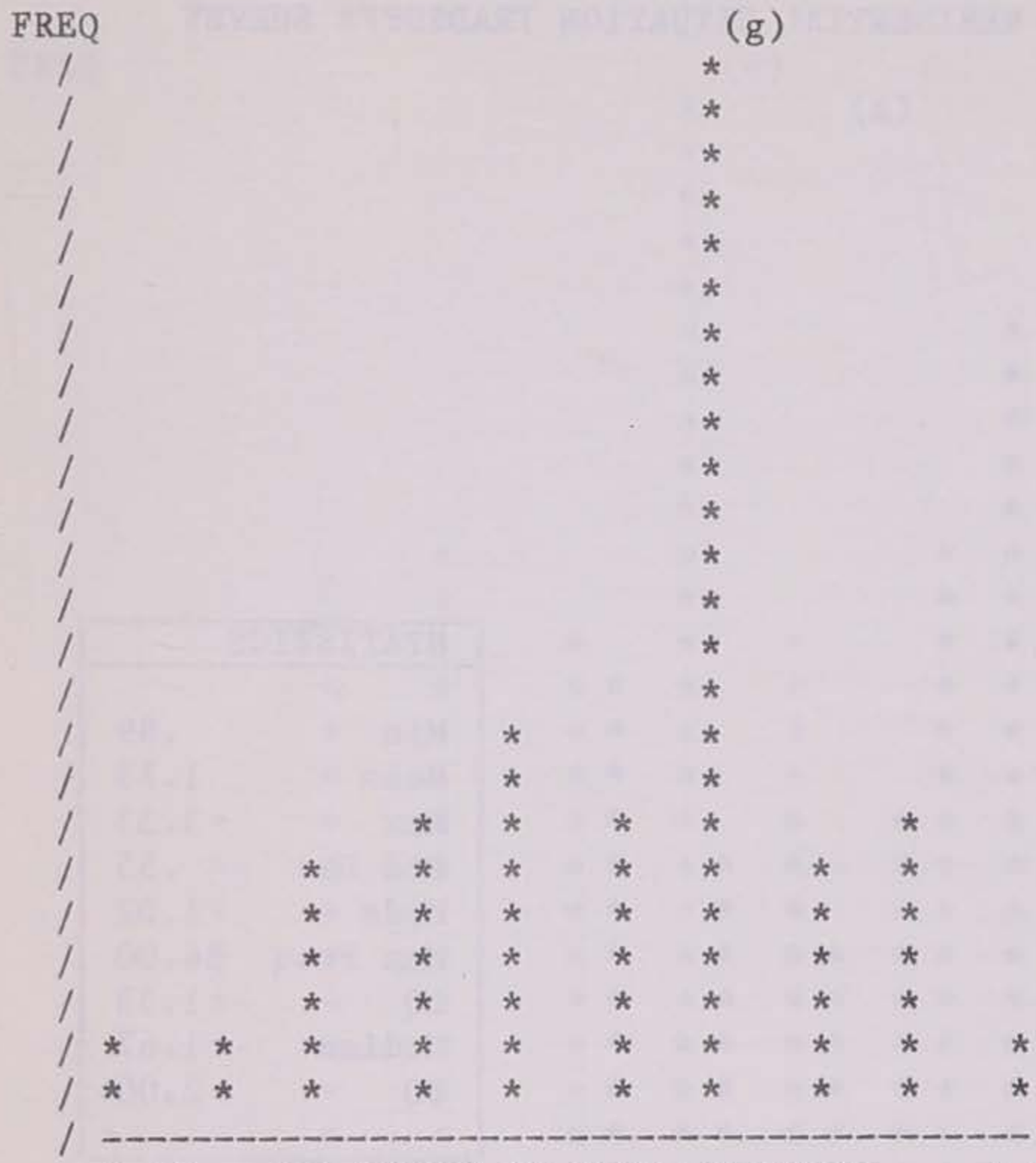
STATISTICS	
Min	-7.50
Mean	.16
Max	6.67
Std Dev	2.17
Mode	-.04
Max Freq	101.00
LQ	-.83
Median	.00
UQ	1.67



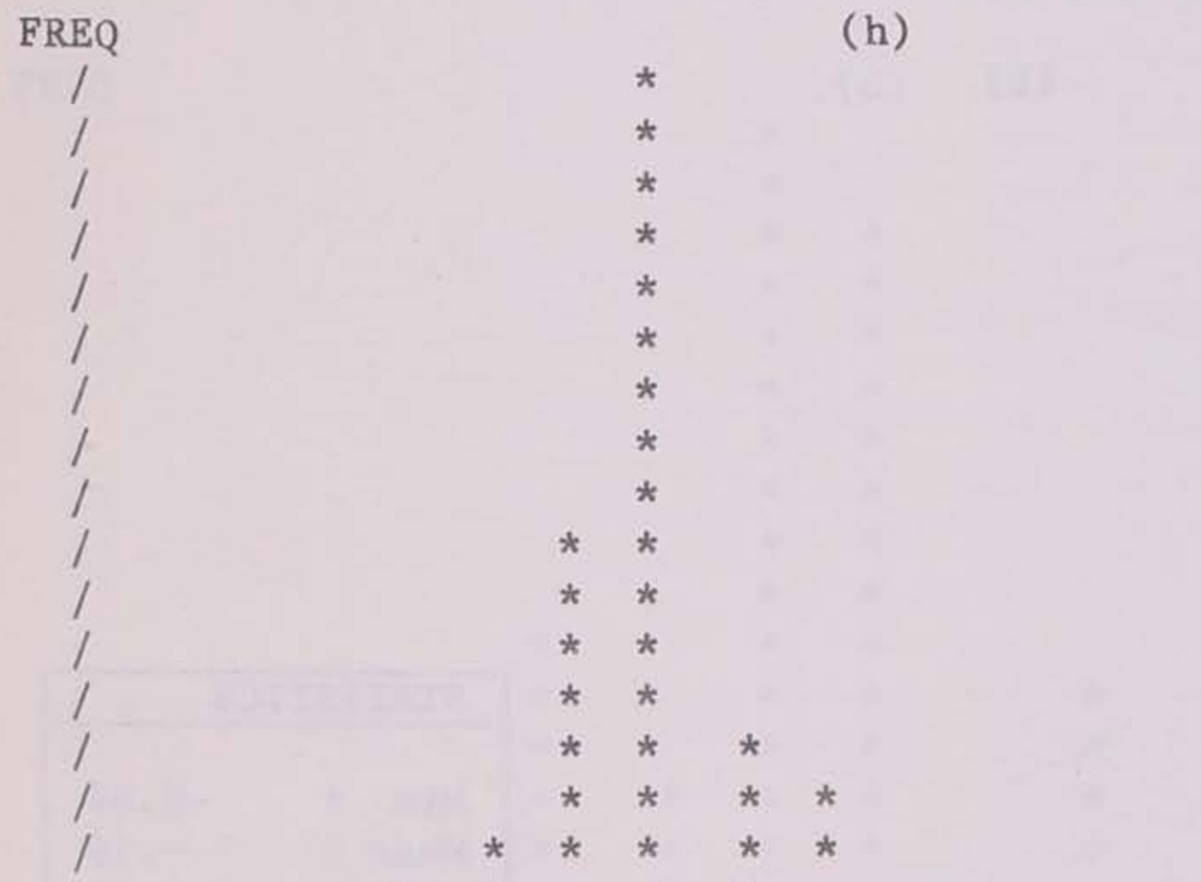
STATISTICS	
Min	-3.00
Mean	-.34
Max	2.33
Std Dev	.83
Mode	-.02
Max Freq	72.00
LQ	-1.00
Median	-.33
UQ	.00



STATISTICS	
Min	-3.00
Mean	-.22
Max	2.67
Std Dev	.83
Mode	.02
Max Freq	87.00
LQ	-.67
Median	.00
UQ	.33

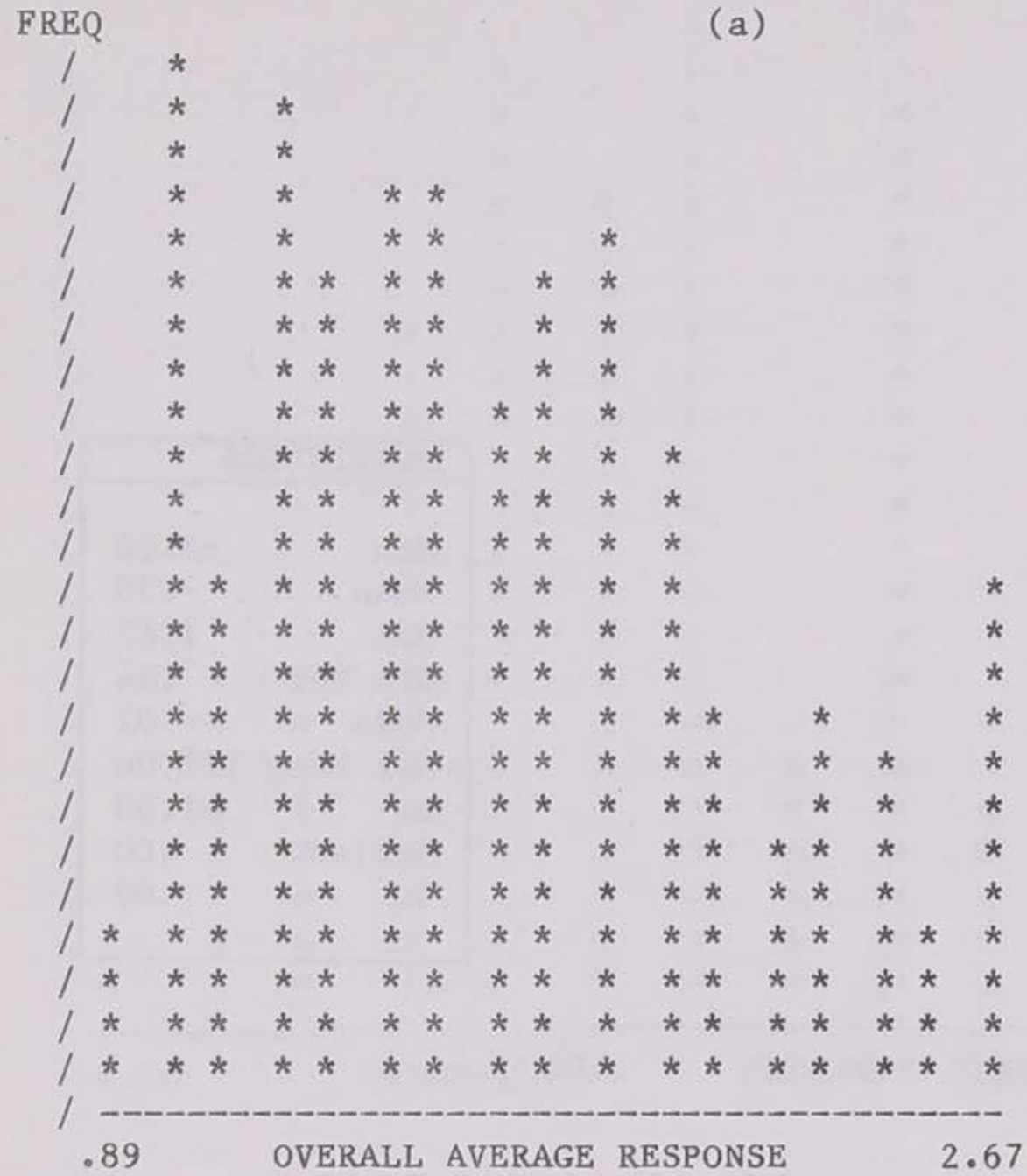


STATISTICS	
Min	-3.00
Mean	-.30
Max	1.67
Std Dev	.84
Mode	-.02
Max Freq	112.00
LQ	-1.00
Median	.00
UQ	.00

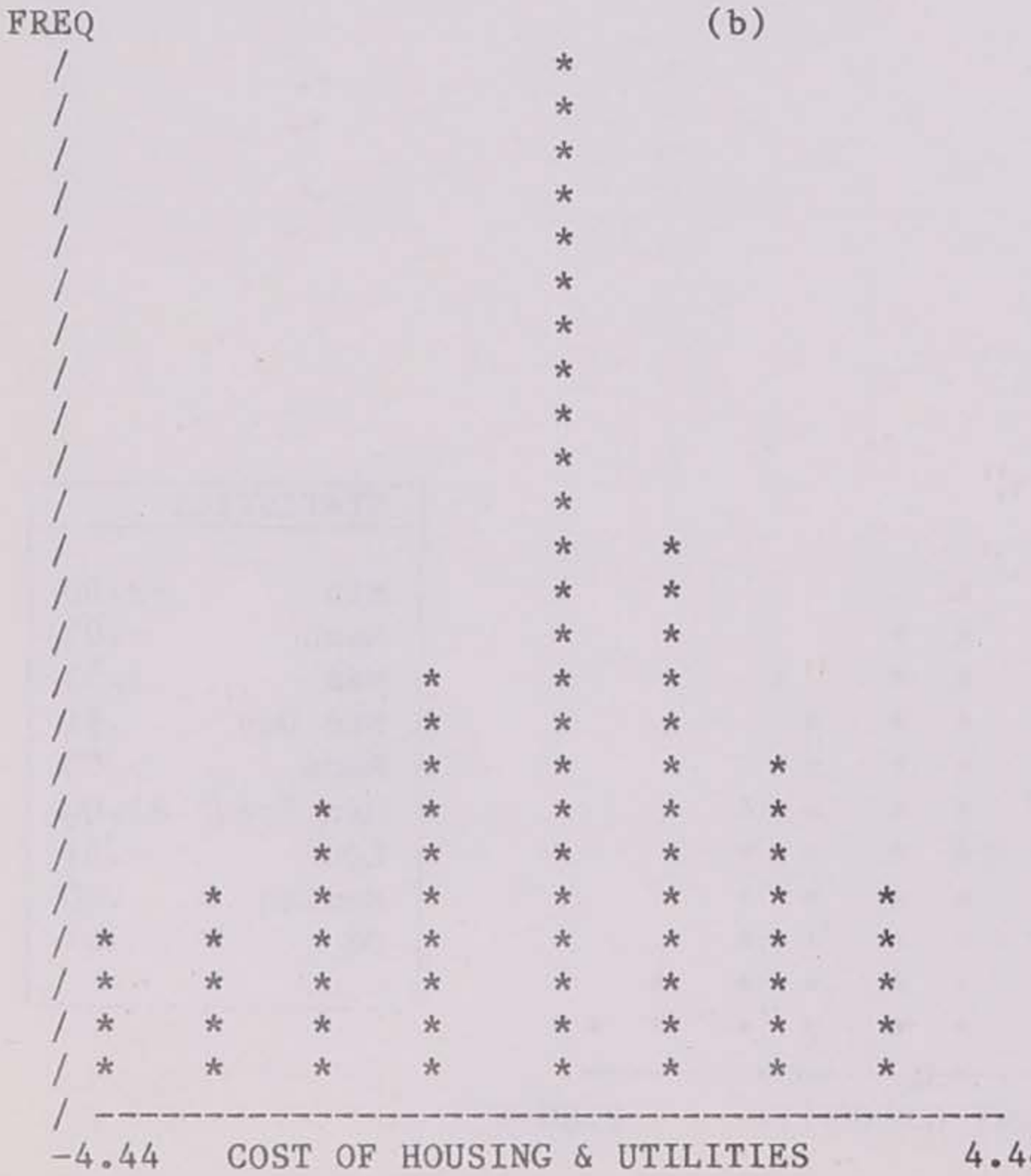


STATISTICS	
Min	-3.00
Mean	-.05
Max	2.33
Std Dev	.91
Mode	-.05
Max Freq	31.00
LQ	-.67
Median	.00
UQ	.67

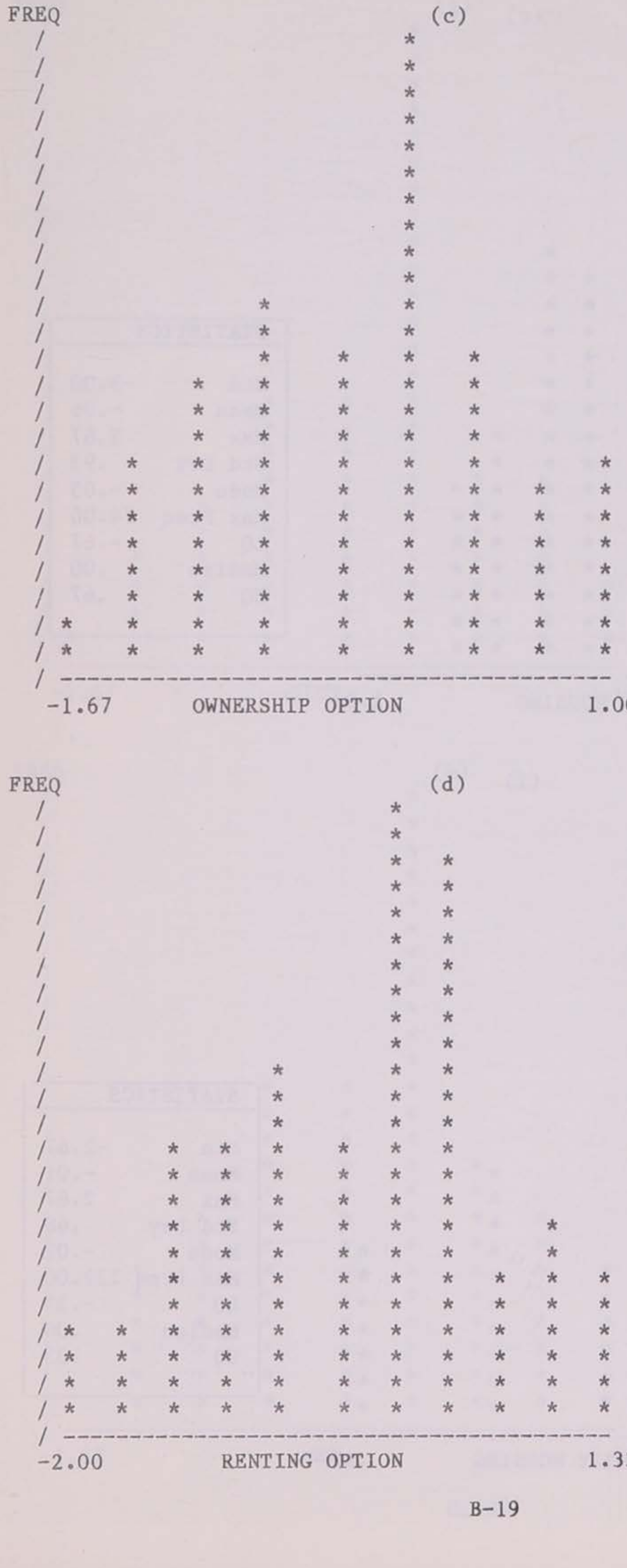
APPENDIX FIGURE 2: COMPUTER GENERATED TRADEOFF COEFFICIENT DISTRIBUTIONS FOR RESIDENTIAL SITUATION TRADEOFFS SURVEY



STATISTICS	
Min	.89
Mean	1.73
Max	3.33
Std Dev	.55
Mode	1.02
Max Freq	34.00
LQ	1.33
Median	1.67
UQ	2.00

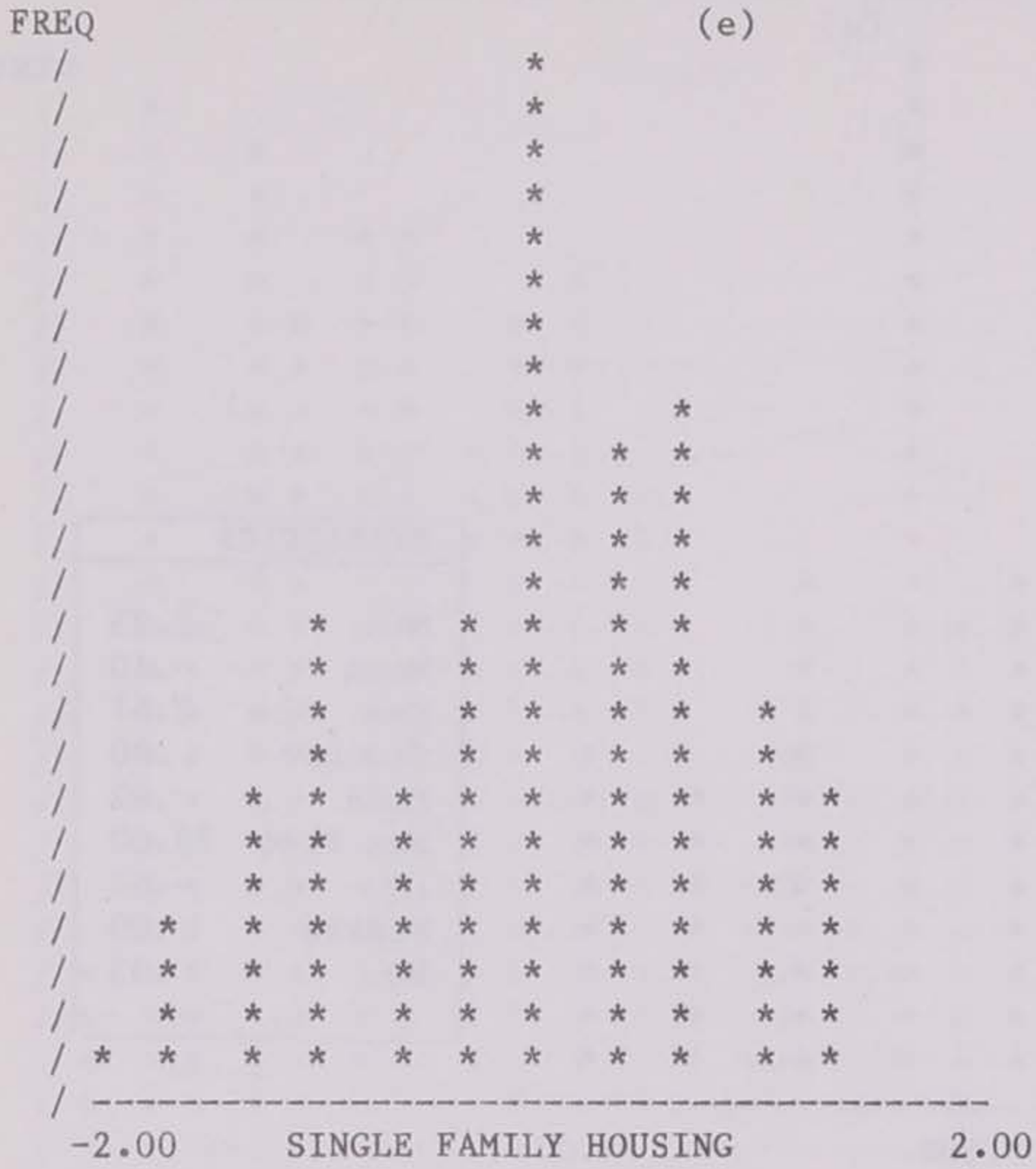


STATISTICS	
Min	-8.89
Mean	-.19
Max	7.78
Std Dev	2.88
Mode	.11
Max Freq	100.00
LQ	-2.22
Median	.00
UQ	1.11

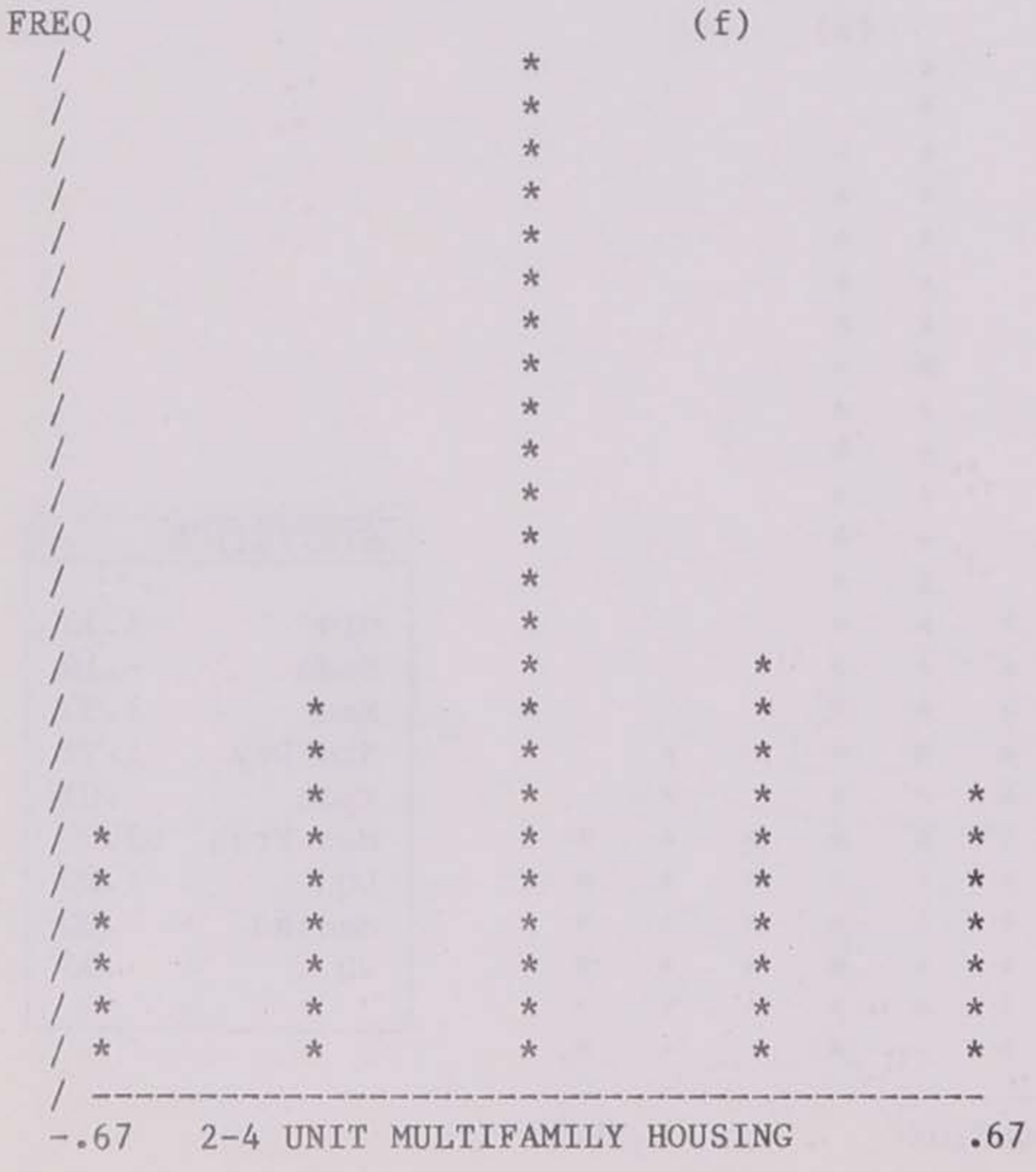


STATISTICS	
Min	-2.33
Mean	-.10
Max	2.67
Std Dev	.90
Mode	.02
Max Freq	79.00
LQ	-.67
Median	.00
UQ	.33

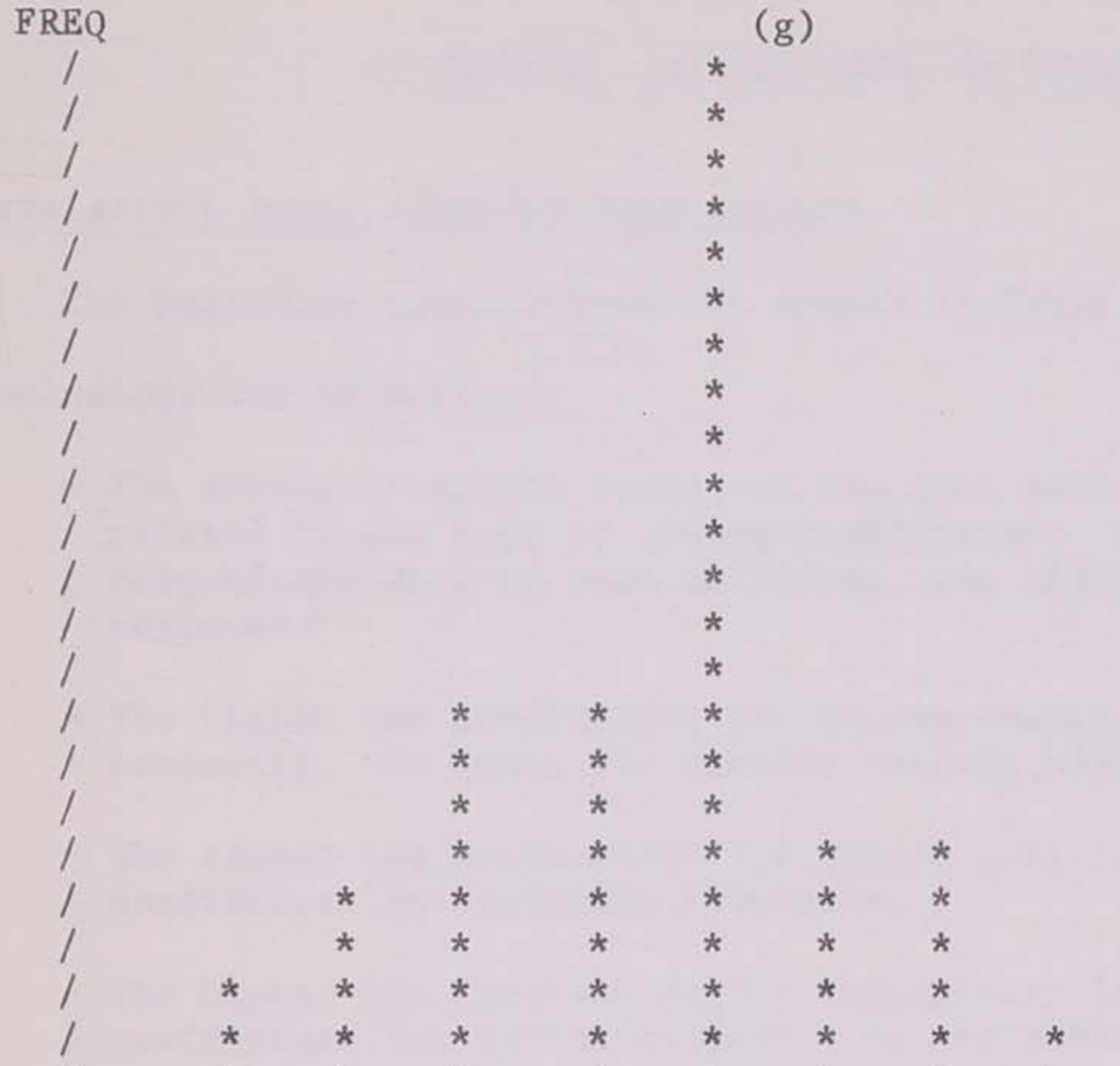
STATISTICS	
Min	-3.33
Mean	-.10
Max	3.33
Std Dev	1.12
Mode	.03
Max Freq	63.00
LQ	-1.00
Median	.00
UQ	.33



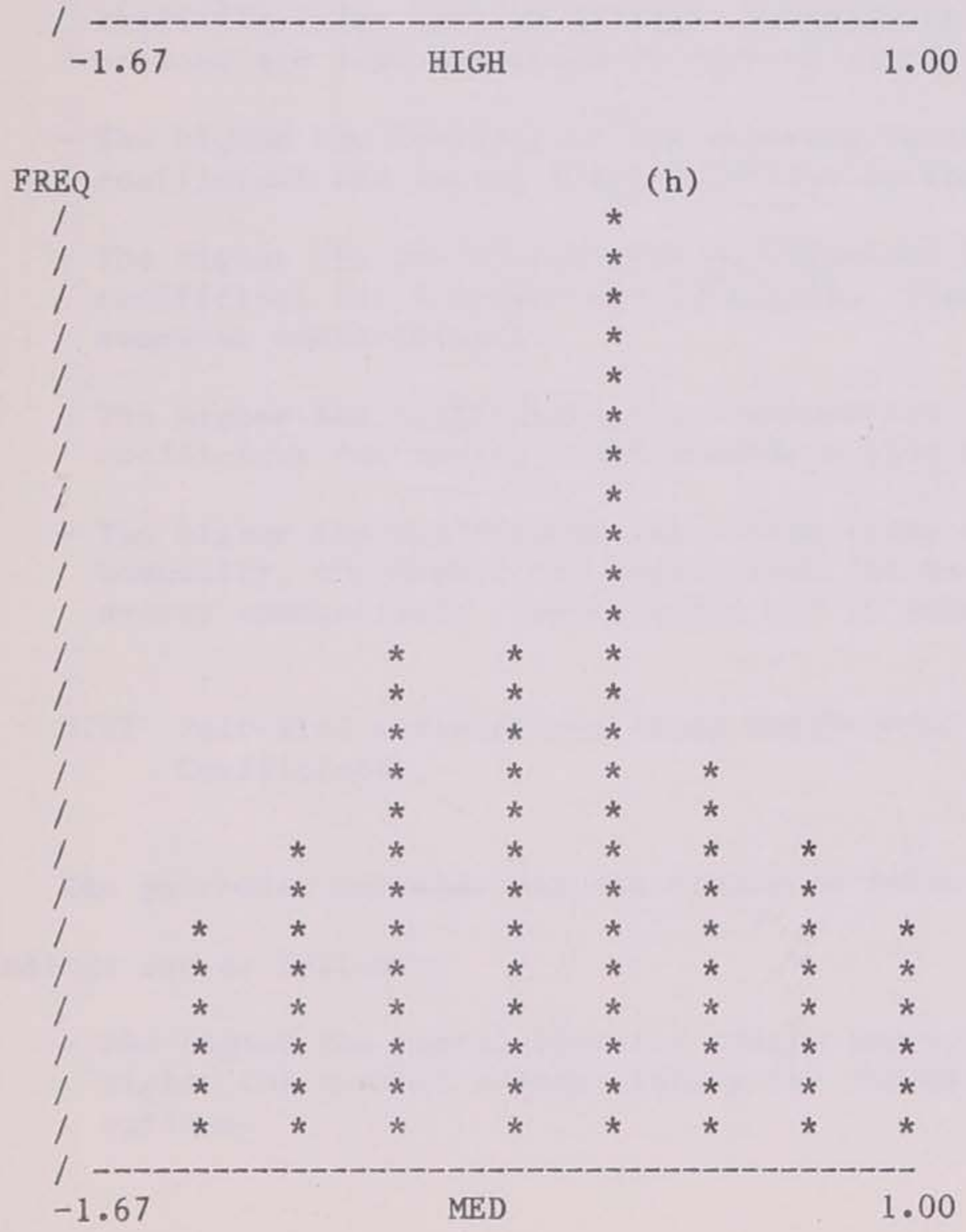
STATISTICS	
Min	-3.00
Mean	-.06
Max	2.67
Std Dev	.93
Mode	-.05
Max Freq	74.00
LQ	-.67
Median	.00
UQ	.67



STATISTICS	
Min	-2.67
Mean	-.01
Max	2.67
Std Dev	.68
Mode	-.02
Max Freq	122.00
LQ	-.33
Median	.00
UQ	.33



STATISTICS	
Min	-2.67
Mean	-.16
Max	2.00
Std Dev	.69
Mode	.02
Max Freq	115.00
LQ	-.67
Median	.00
UQ	.33



STATISTICS	
Min	-2.67
Mean	-.12
Max	2.33
Std Dev	.74
Mode	.02
Max Freq	95.00
LQ	-.67
Median	.00
UQ	.33

APPENDIX C: DESCRIPTIONS OF CORRELATIONS

Correlations Among Mobility Coefficients

The pair-wise correlations are listed in Table C-1. Some notable conclusions are as follows:

- The average response to any of the nine mobility options is negatively related to the cost of living coefficient: the less sensitive respondents were to cost of living, the lower their overall average response.

- The higher the coefficient for having relatives living in the same community, the lower the overall average response.

- The higher the coefficient for center city locations, the higher the coefficient for suburban locations.

- The higher the coefficient for center city locations, the higher the coefficient for having relatives in the same community.

- The higher the coefficient for suburban locations, the higher the coefficient for cost of living: respondents attracted to suburban options are less sensitive to cost of living.

- The higher the coefficient for suburban locations, the higher the coefficient for having close relatives in the same community.

- The higher the coefficient for Southeastern locations, the higher the coefficient for Southwestern locations. These locations are evidently somewhat substitutable.

- The higher the coefficient for Southwestern locations, the lower the coefficient for having close relatives live in nearby communities.

- The higher the coefficient for having close relatives live in the same community, the higher the coefficient for having relatives live in nearby communities: these levels are to some degree substitutable.

3.22 Pair-Wise Correlations Among Residential Situation Tradeoff Coefficients

The pair-wise correlations are listed in Table C-2. Some of the notable findings are as follows:

- The higher the coefficient for single family dwelling unit options, the higher the overall average rating for the nine residential situation options.

TABLE C-1: PAIR-WISE CORRELATIONS BETWEEN ATTRIBUTE LEVEL COEFFICIENTS FOR THE MOBILITY SURVEY

Pair-wise Mobility Tradeoff Correlations	Overall Average Response	Center of the City	Suburb of the City	South-east Location	South-west Location	Cost of Living	Relatives in Same Community	Relatives in Nearby Community
Overall Average		.07	-.03	.02	-.05	-.10	-.13	.08
Center of City	.07		.28	-.05	.05	-.00	.12	-.05
Suburb of City	-.03	.28		-.01	.07	.10	.20	.09
Southeastern Locations	.02	-.05	-.01		.47	.07	-.09	.03
Southwestern Locations	-.05	.05	.07	.47		-.00	-.07	-.16
Cost of Living (% Income)	-.10	-.00	.10	.07	-.00		-.08	-.03
Relatives in Same Community	-.13	.12	.20	-.09	-.07	-.08		.58
Relatives in Nearby Community	.08	-.05	.09	.03	-.16	-.03	.58	

TABLE C-2: PAIR-WISE CORRELATIONS BETWEEN ATTRIBUTE LEVEL COEFFICIENTS FOR THE RESIDENTIAL SITUATION SURVEY

Pair-wise Residential Tradeoff Correlations	Overall Average Response	Single Family Unit	2-4 Family Unit	Ownership Option	Rental Option	Cost of Housing & Utilities	Upper Income Neighbor-hood	Middle Income Neighbor-hood
Overall Average		.13	.13	-.15	-.13	-.14	.03	-.03
Single Family Dwelling Unit	.13		.58	-.51	-.41	-.30	.03	-.03
2-4 Unit Complex	.13	.58		-.26	-.21	-.23	.19	.09
Ownership Option	-.15	-.51	-.26		.73	.24	-.12	-.04
Rental Option	-.13	-.41	-.21	.73		.29	-.18	.02
Cost Housing/ Utilities	-.14	-.30	-.23	.24	.29		-.24	-.12
Upper Income Neighborhood	.03	.03	.19	-.12	-.18	-.24		.57
Middle Income Neighborhood	-.03	-.03	.09	-.04	.02	-.12	.57	

- The higher the coefficient on 2-4 unit multifamily housing, the higher the overall average rating for the nine residential situation options.

- The higher the coefficient for the ownership option, the lower the overall average response to the nine residential situation options.

- The higher the coefficient for the rental option, the lower the overall average response to the nine residential situation options.

- The higher the coefficient for cost of housing and utilities, the lower the overall average response to the nine residential situation options: those less sensitive to cost have lower ratings.

- The higher the coefficient for single family dwelling units, the higher the coefficient for 2-4 unit multifamily complexes.

- The higher the coefficient for the ownership option, the lower the coefficient for single family dwelling units.

- The higher the coefficient for the rental option, the lower the coefficient for 2-4 unit multifamily complexes.

- The higher the coefficient for single family housing, the lower the coefficient for cost of housing and utilities: respondents favoring single family units are those most sensitive to housing costs.

- The higher the coefficient for the ownership option, the lower the coefficient for 2-4 unit multifamily housing options.

- The higher the coefficient for the rental option, the lower the coefficient for 2-4 unit multifamily housing options.

- The higher the coefficient for housing costs, the lower the coefficient for 2-4 unit multifamily housing complexes: those who are least sensitive to costs are most negative to 2-4 unit complexes.

- The higher the coefficient for 2-4 unit multifamily housing complexes, the higher the coefficient for higher income neighborhoods.

- The higher the coefficient for the ownership option, the higher the coefficient for the rental option: they are somewhat substitutable.

- The higher the coefficient for the ownership option, the higher the coefficient for housing cost: those attracted to ownership are less sensitive to housing costs.

- The higher the coefficient for the ownership option, the lower the coefficient for higher income neighborhoods.

- The higher the coefficient for the rental option, the higher the coefficient for housing costs: those less sensitive to costs are most attracted to renting.

- The higher the coefficient for the rental option, the lower the coefficient for the high income neighborhood option.

- The higher the coefficient for the higher income neighborhood option, the lower the housing cost coefficient: those attracted to higher income neighborhoods are most cost sensitive.

- The higher the coefficient for the middle income neighborhood option, the lower the housing cost coefficient: those attracted to middle income neighborhoods are somewhat cost sensitive.

- The coefficient for high income neighborhood is positively related to the coefficient for middle income neighborhood: they are somewhat substitutable.

Correlations Among Mobility and Residential Tradeoff Coefficients

These correlations are listed in Table C-3. They reflect the simple association between the coefficient in one survey and a second coefficient in the other survey. We will present them as though the residential situation coefficients depend upon the mobility coefficients because the structure of the overall tradeoff analysis implies this causal link. Some of the notable results are as follows:

- The overall average in the residential survey is positively related to the overall average in the mobility survey. This implies that both residential and mobility options are related in the respondent's view.

- The higher the overall average in the mobility survey, the higher the coefficient for single family dwelling units.

- The higher the overall average in the mobility survey, the higher the coefficient for 2-4 unit multifamily housing.

- The higher the overall average in the mobility survey, the lower the ownership coefficient.

- The higher the overall average in the mobility survey, the lower the rental coefficient.

- The higher the overall average in the mobility survey, the lower the housing cost and utilities coefficient.

- The higher the center city coefficient in the mobility survey, the lower the single family housing coefficient.

- The higher the center city coefficient in the mobility survey, the lower the 2-4 unit multifamily housing complex.

TABLE C-3: PAIR-WISE CORRELATIONS BETWEEN ATTRIBUTE LEVEL COEFFICIENTS FOR BOTH THE MOBILITY AND RESIDENTIAL SITUATION SURVEYS

Pair-wise Correlations Between Coefficients of Both Surveys	Overall Average Response	Single Family Unit	2-4 Family Unit	Ownership Option	Rental Option	Cost of Housing & Utilities	Upper Income Neighbor-hood	Middle Income Neighbor-hood
Overall Average	.50	.16	.11	-.17	-.12	-.13	.02	-.01
Center of City	-.03	-.15	-.10	.27	.34	.16	-.07	.02
Suburb of City	-.04	-.01	.02	.15	.18	-.04	.00	-.01
Southeastern Locations	.01	.17	.03	-.10	-.11	-.01	.00	.07
Southwestern Locations	-.07	-.13	-.02	.23	.20	.04	-.06	.04
Cost of living (% Income)	.00	-.23	-.06	.26	.19	.10	.03	.05
Relatives in Same Community	-.17	.07	.13	.03	.22	-.00	-.06	.04
Relatives in Nearby Community	.05	.20	.12	-.16	-.00	-.13	-.12	-.06

- The higher the center city coefficient in the mobility survey, the higher the ownership option coefficient.

- The higher the center city coefficient in the mobility survey, the higher the rental option coefficient.

- The higher the center city coefficient in the mobility survey, the higher the cost of housing coefficient: those attracted to city centers are less sensitive to cost.

- The higher the suburban option coefficient, the higher the ownership coefficient.

- The higher the suburban option coefficient, the higher the rental option coefficient.

- The higher the Southeastern location coefficient, the higher the single family dwelling unit option coefficient.

- The higher the Southeastern location coefficient, the lower the ownership option coefficient.

- The higher the Southeastern location coefficient, the lower the rental option coefficient.

- The higher the Southwestern location coefficient, the lower the single family dwelling unit option coefficient.

- The higher the Southwestern location coefficient, the higher the ownership option coefficient.

- The higher the Southwestern location coefficient, the higher the rental option coefficient.

- The higher the cost of living coefficient, the lower the single family dwelling unit option coefficient: the less sensitive to costs of living, the less attracted to single family units.

- The higher the cost of living coefficient, the higher the ownership coefficient: the less sensitive to living costs, the more attracted to ownership status.

- The higher the cost of living coefficient, the higher the rental coefficient: the less sensitive to living costs, the more attracted to rental status.

- There is a positive relationship between cost of living coefficients and costs of housing and utilities coefficients.

- The higher the coefficient for having relatives living in the same community, the lower the overall average response to the residential situation options.

- The higher the coefficient for having relatives living in the same community, the higher the coefficient for 2-4 unit multifamily residential complexes.

- The higher the coefficient for having relatives living in the same community, the higher the coefficient for the rental option.

- The higher the coefficient for having relatives living in nearby communities, the higher the single family dwelling unit coefficient.

- The higher the coefficient for having relatives living in nearby communities, the higher the coefficients for 2-4 unit multifamily dwelling complexes.

- The higher the coefficient for having relatives living in nearby communities, the lower the coefficients for the ownership option.

- The higher the coefficient for having relatives living in nearby communities, the lower the coefficient for housing and utility costs: respondents attracted to the "relatives nearby" option also tended to be more cost sensitive.

- The higher the coefficient for having relatives living in nearby communities, the lower the coefficient for the higher income neighborhood option.

APPENDIX D: MOBILITY TRADEOFF VALUES

Overall Average or Grand Mean Rating Response

The regression equation relating the respondents' overall averages to their personal characteristics is significant beyond the .01 level. The regression equation accounts for 38.2% of the variance in the individuals' overall means. We report on regression coefficients which are interpretable even if they are not significant in terms of the precision of the estimate because there is considerable collinearity present in the data which cannot be easily assessed if at all. Bearing this in mind, the results that appear meaningful are:

- The older the individual, the less highly he/she rates any of the housing alternatives.

- If there are reported to be leaks in the respondent's roof, the average rating of any alternative is higher than if there are no leaks.

- If there are reported to be cracks in the walls or peeling plaster, the average rating of any alternative is lower than if there are no cracks or peeling.

- If the respondent reports that if they had to move they could find a suitable place to live, the average response is higher than if they said that they could not.

- The higher the percent of 1979 income spent on housing reported by the respondent, the lower the average rating given to any mobility alternative.

- The more individuals over 18 years of age residing in the respondent's household, the higher the average rating given to any mobility alternative.

- Respondents who state that they are currently married have lower average ratings of mobility alternatives than those not currently married.

- There are interesting ethnic differences: respondents of Hispanic origin give higher average mobility responses than other groups. The next highest ratings are given by blacks, then whites, and lastly Orientals. This implies that of all racial groups in the over 55 age group, respondents of Oriental origin are least likely on average to find mobility alternatives attractive.

- Of various employment status groups, respondents reporting themselves to be currently not working have the highest average ratings of mobility options; they are followed by retired respondents, homemakers, part-time workers, and full-time employees. Thus, respondents working full time are least likely to rate any mobility alternatives as attractive.

- Individuals who report themselves to be currently residing in a mobile home rate mobility alternatives more highly on average than those who reside in a home or those who reside in multifamily housing. Those who currently reside in multifamily housing rate the mobility alternatives lower on average than others--this is consistent with responses to multifamiy housing reported in earlier sections.

- Individuals currently residing in medium sized cities or centers of large cities rate the mobility alternatives higher on average than those who reside respectively in suburbs, small cities or towns, rural non-farm situations, or rural farms and ranches.

- The more rooms reported to be in the resondent's present residence, the lower the average rating of the mobility options.

- The more years that the respondent has spent at his/her present residence, the lower the average rating of the mobility options.

- The more satisfied the respondents report themselves to be with their present residences, the lower the average rating.

- Higher ratings of mobility alternatives are associated with income from investments, wages, and social security pensions; lower ratings are associated with income from public assistance, unemployment compensation, or "other" regular contributions.

- The higher the average respondent rating for the residential situation options, the higher the average rating of the residential mobility options.

Coefficient for Attractiveness of a Center City Location.

The regression equation for this coefficient is significant beyond the .01 level. The equation accounts for 29.2% of the variation in the attractiveness coefficient of a Center City Location. Some of the notable findings are as follows:

- Males find city center locations less attractive on average than females.

- The more stories or floors presently in the respondent's residence, the higher the attractiveness of city centers.

- Respondents who report access to complete, working kitchens rate center cities more attractive than those who don't.

- Respondents who report that they have modern sewage facilities, rate center city locations less attractive than those who don't.

- Respondents who report roof leaks rate center city locations lower than those who don't.

- Respondents who report cracked or peeling paint rate center city locations higher than those who don't.

- The more flush toilets respondents report that their residence has, the lower the rating of center city locations.

- Respondents who report making repairs or improvements in the past 12 months rate center city locations higher than those who don't.

- The higher respondents rate their present residence, the higher they rate center city locations.

- The larger the number of adults reported to be residents, the higher the rating for center city locations.

- Segmenting by racial groups, whites rate center city locations higher on average, followed by blacks, then Hispanics, and then Orientals.

- Among employment groups, non-workers rate center city locations higher on average, followed by part-time workers, then full-time workers, then retired persons, and lastly homemakers.

- Respondents who live in houses rate centers of cities higher than multifamily housing or mobile home dwellers.

- Among categories of residents by residential location, there are few differences among categories, although present suburban dwellers rate centers of cities lowest.

- The longer the respondents have lived in their present residences, the lower the rating for center city locations.

- Respondents who report difficulties in walking or getting around rate center city locations higher than those who don't.

- Among categories of reported sources of income, respondents reporting income from unemployment or investments rated center city locations higher than those who didn't. These groups were followed by those reporting income from wages or public assistance. The lowest average ratings for center city locations were given by those on social security pensions or those reporting regular contributions from "other" sources.

- The higher the percent of 1979 income spent on housing, the higher the rating given to center city locations on average.

- The higher the coefficient on housing costs from the residential situation survey, the higher the rating given to center city locations. This implies that those most insensitive to housing costs are those who find center city locations most attractive.

- The more attractive are higher income neighborhoods to respondents in the residential situation survey, the higher the rating for center city locations.

Coefficient for Suburban City Location

The regression equation for a suburban location is significant at the .10 level. The equation estimated accounts for 20.8% of the variance in the relative attractiveness of suburban locations among individuals. Some of the notable results are:

- Respondents who have access to complete kitchens on average rate suburban locations higher than those who don't.

- Respondents who report leaks in their roofs on average rate suburban locations higher than those who don't.

- Respondents who report holes in their floors on average rate suburban locations lower than those who don't.

- The more flush toilets reported by the respondents to be in their present residence, the lower the average rating of suburban locations.

- Respondents who reported expenditures on housing improvements in the past 12 months rate suburban locations more highly than those who don't.

- Respondents who report intentions to spend money on housing improvements in the next 12 months rate suburban locations less highly than those who don't.

- Among ethnic groups, Hispanics rate suburban locations less highly than whites, blacks or Orientals who are similar in their ratings.

- Part-time and full-time workers rate suburban locations more highly than do nonworkers or those who are unemployed; homemakers and retirees rate such locations lower than other groups.

- Among present locational situations, repondents presently residing in rural non-farm, middle-sized urban or suburban situations rate suburban locations more highly than those presently residing in small towns, farms and ranches, or centers of large cities.

- The older the respondents' residences, the higher they rate suburban locations on average.

- Among sources of income groups, those on social security pensions rate suburban locations more highly than those with public assistance payments, investment income, wages income or unemployment compensation.

- Respondents who rated the "renting" option in the residential situation survey highly on average also rated the suburban location option highly.

- Respondents who were least sensitive to housing cost in the residential situation survey on average rate suburban locations lower.

- Respondents who rate middle income neighborhoods more highly in the residential situation survey on average rate suburban locations lower.

Coefficient for Southeastern State/Climate

The regression analysis relating the individual coefficients for Southeastern State/Climate to personal and situational measures is significant beyond the .05 level. The equation accounts for 26.7% of the individual variation in coefficients for Southeastern State/Climate. Some notable results are as follows:

- The older respondents are, the lower the ratings given to Southeastern State/Climate.

- Males rate Southeastern States more highly than females on average.

- The greater the number of floors or stories in the respondent's present place of residence, the higher the rating given to Southeastern States on average.

- The more flush toilets currently in the respondent's residence, the lower the rating of Southeastern States on average.

- Respondents who report that their structure is in need of repair rated Southeastern Climates lower on average.

- Respondents who reported having made a home improvement in the past 12 months or who plan to do so in the next 12 months rate Southeastern locations lower than those not involved in home improvements.

- Respondents who report that their head of household has moved in the past two years rate Southeastern locations lower on average than those who don't.

- Respondents who report that if they had to move they could find a suitable place rate Southeastern locations lower on average than those who don't.

- As respondents' ratings of their present residences in the residential survey increase, their ratings of Southeastern locations decrease.

- The larger the number of individuals currently residing in the household, the lower the average rating for Southeastern locations.

- Among ethnic groups, whites and blacks rate Southeastern locations higher than Hispanics and Orientals. Orientals rate them considerably lower on average than other groups.

- Among employment categories, full-time workers and homemakers rated Southeastern locations higher on average than did part-time workers, retirees, and nonworkers.

- Respondents currently residing in mobile homes rate Southeastern locations higher than those residing in multifamily housing or single homes.

- Among residential location groups, respondents currently residing in center city areas rate Southeastern locations the highest, followed by those in medium sized cities, then small cities and rural farms and ranches. Those rating Southeastern locations lowest on average are suburban and rural non-farm residents.

- The higher the level of satisfaction reported for the respondent's current living situation, the higher the average rating given to Southeastern locations.

- Among sources of income groups, those on unemployment, social security pensions, public assistance, or "other" sources rate Southeastern locations higher on average than those respondents reporting income from investments or wages.

- Respondents who rated 2-4 dwelling unit complexes higher in the residential situation survey rated Southeastern locations lower on average.

- Respondents who rated renting of dwelling unit higher in the residential situation survey rated Southeastern locations lower on average.

- Respondents who rated high income neighborhoods higher on the residential situation survey on average rated Southeastern locations lower.

- Respondents who rated middle income neighborhoods higher on the residential situation survey on average rated Southeastern locations higher.

Coefficient for Southwestern State/Climate

The regression equation for Southwestern State/Climate is significant at the .05 level. The equation accounts for 22.3% of the variation in individual coefficients for Southwestern State/Climate. Some of the notable results are:

- Males rate Southwestern locations higher than females on average.

- Respondents reporting modern sewage facilities rate Southwestern locations higher than those who don't.

- Respondents reporting that they have a source of home heating rate Southwestern locations lower than those reporting no heating.

- Respondents who report that if they had to move they could find a place to suit them rate Southwestern locations lower than those who do not report same.

- The higher respondents rate their present residences in the residential situation survey, the lower the rating for Southwestern locations on average.

- The more individuals over 18 years of age reported to be residing with the respondent, the lower the rating given to Southwestern locations on average.

- Respondents who are married rate Southwestern locations higher on average than those who aren't.

- Among ethnic groups, whites and blacks rate Southwestern locations highest on average, followed by Hispanics; Orientals give the lowest ratings of the groups to Southwestern locations.

- Among employment groups, homemakers rate Southwestern locations higher than other groups, followed by full- and part-time workers and retirees. Nonworkers on average rate Southwestern locations lowest of all.

- There appear to be no discernable differences between respondents who reside in homes, multifamily units, or mobile homes.

- Among residential location groups, center city, rural farm/ranch, and medium sized city residents rate Southwestern locations highest. Suburban and small city residents rate Southwestern locations somewhat lower, and rural non-farm residents rate Southwestern locations lowest of all.

- Among sources of income groups, those respondents receiving unemployment or public assistance on average rate Southwestern locations higher than those with income from wages and investments or social security pensions.

- The higher the proportion of 1979 income spent on housing, the higher the average rating given to Southwestern locations.

- Respondents who rate ownership higher in the residential situation survey also rate Southwestern locations higher. A similar conclusion can be drawn about responses to renting in the residential situation survey.

- Respondents who rate high income neighborhoods higher on average rate Southwestern locations lower.

- Respondents who rate middle income neighborhoods higher on average rate Southwestern locations higher.

Coefficient for Cost of Living

The regressions analysis for the individual cost of living coefficients is not significant at the .10 level, but is significant at a level only slightly below this. The equation accounts for 20.2% of the variation in the individual cost coefficients. We will proceed to interpret some of the major results, but the reader should note that this equation is much less significant than the previous ones discussed.

- As the respondent's age increases, cost coefficients increase, which implies decreasing sensitivity to cost with age.

- The greater the number of individuals residing in the household, the more sensitive the respondent is to cost of living.

- The greater the number of adults over 18 years of age residing in the household, the less sensitive to cost is the respondent on average.

- Among ethnic groups, whites and blacks are less sensitive to cost of living than are Hispanics and Orientals.

- Among employment groups, retirees, homemakers, and full- and part-time employees are less sensitive to cost of living than nonworkers.

- Among residential location groups, residents of centers of cities and rural non-farm situations are less cost sensitive than residents of small or medium sized cities or suburbs. Residents of farms and ranches are most cost sensitive.

- Among sources of income groups, the least sensitive to cost of living are those on public assistance and "other" sources. These are followed by respondents on unemployment. The most sensitive are those with income from social security pensions, wages or investments.

- As the respondent's overall mean response to the residential situation survey increases, the sensitivity to cost decreases.

- The higher the respondents' rating of owning their own residences in the residential situation survey, the less sensitive they are to cost of living.

Coefficient for Relatives Living in the Same Community

The regression equation for the individual coefficients measuring the relative attraction of relatives living in the same community is significant beyond the .05 level. The estimated equation accounts for 26.2% of the variation in the individual coefficients. Some of the major results are as follows:

- Respondents who report holes in the floors of their present residences on average give a higher rating to the condition that relatives are living in the same community.

- Respondents who have modern sewage facilities on average give a lower rating to having relatives in the same community than respondents who do not have such facilities.

- Respondents who report peeling or cracked paint in their residences have a higher value for relatives in the same community than those who report otherwise.

- The higher the rating for present residence given in the residential situation survey, the higher the average rating for relatives living in the same community.

- The higher the respondent's reported income base in 1979, the lower the rating for relatives living in the same community.

- The larger the number of individuals residing in the respondent's household, the higher the rating for relatives living in the same community.

- Among employment groups, retirees and nonworkers tend to rate having relatives in the same community higher than other groups.

- Respondents who presently reside in mobile homes rate relatives in the same community lower than those who reside in other housing.

- Respondents living on farms or ranches rate having relatives in the same community lower than other residential situation groups on average.

- Among income source groups, respondents reporting income from wages, investments or social security payments rate having relatives in same community higher than those in other income source groups.

- The higher the respondent's overall average rating of the residential situation options, the lower the rating of relatives in the same community.

- The less sensitive (the more positive) the cost of housing and utilities coefficient in the residential situation survey, the lower the rating for having relatives in the same community.

- The higher the rating for high income neighborhoods in the residential situation survey, the lower the rating for having relatives in the same community.

Coefficient for Having Relatives Residing Nearby

The regression equation for the "relatives nearby" coefficient is almost significant at the .05 level and is significant beyond the .10 level. The estimated equation accounts for 22.0% of the variation in individual coefficients for having relatives live nearby. Some of the more interesting results are as follows:

- The greater the number of floors or stories in the respondent's present residence, the higher the rating for relatives nearby.

- Respondents who report that their heads of household moved in the past two years rate relatives nearby lower than those who don't.

- The larger the number of individuals residing in the household, the higher the rating for having relatives nearby.

- Among ethnic groups, Hispanics rate having relatives nearby somewhat higher than whites, blacks or Orientals.

- Among employment groups, nonworkers and retirees rate having relatives nearby higher than other groups.

- Among residential situation groups, rural non-farm residents rate having relatives nearby higher than other groups.

- As the number of rooms reported to be in the respondent's present residence increases, the rating for having relatives nearby decreases.

- The longer the respondents have lived at their present residences, the lower the rating for having relatives nearby.

- Among income source groups, those reporting wages and social security payments rated having relatives nearby higher than other groups. Those who were unemployed rated relatives nearby lower than other groups.

- Respondents rating the owning option higher in the residential situation survey, rated relatives nearby lower.

- Respondents rating the owning option higher in the residential situation survey, rated relatives nearby lower.

- Respondents rating the rental option higher in the residential situation survey, rated relatives nearby higher.

- The less sensitive (the more positive) respondents were to the cost of housing and utilities in the residential situation survey, the lower they rated the relatives nearby option.

- The higher the respondent's rating for living in a high income neighborhood in the residential situation survey, the lower the rating for having relatives live nearby.

APPENDIX E: RESIDENTIAL TRADEOFF COEFFICIENTS

The Coefficient for Overall Attractiveness (Grand Means)

The regression equation for the coefficient of Overall Attractiveness for the Residential Situation Tradeoff Survey is significant beyond the .01 level. The estimated regression equation accounts for 39.3% of the variation in the individual overall averages. Some of the notable results are as follows:

- The more flush toilets reported to be present in the residence by the respondent, the higher the overall average.
- Respondents reporting that they made home improvements in the last 12 months have higher overall averages than those who don't.
- Respondents who report that they can find a place to suit them if they were to move have higher overall averages than those who don't.
- The higher the base income reported by the respondent, the higher the overall average.
- The more individuals in the respondent's household, the higher the overall average.
- The more individuals over 18 years of age in the respondent's household, the lower the overall average.
- Among ethnic groups, Orientals and blacks have higher overall averages than whites; Hispanics on average have the lowest overall averages.
- Among employment groups, there is little to no difference in overall averages.
- Among residential situation groups, there are few differences in overall averages.
- Respondents reporting they required help to walk or get around have higher overall averages than those not reporting same.
- The higher the proportion of 1979 income spent on housing, the lower the overall average.
- The higher the overall average for mobility tradeoffs, the higher the overall average for residential situation tradeoffs.
- The higher the respondent's coefficient for having a relative living in the same community, the lower the overall average for the residential options.

- The higher the respondent's coefficient for having a relative living in a nearby community, the higher the overall average for the residential situations tradeoff survey.

The Coefficient for a Single Family Dwelling Unit Option

The regression analysis for the single family dwelling unit coefficient is significant at the .05 level. The estimated regression equation accounts for 31.2% of the variation in the respondent's individual coefficients. Some of the chief findings are as follows:

- Respondents reporting heating facilities have lower ratings for single family options than do those who have none.

- Respondents reporting roof leaks have higher ratings for single family options than do those who have none.

- Respondents who report holes in the floor have lower ratings for single family options than do those who have no holes.

- Respondents who report that they've made improvements on their homes in the past 12 months have higher ratings for single family options than those who don't.

- Respondents reporting that their head of household has moved in the last 24 months rate single family options higher than non-movers.

- The higher respondents rated their present residences in the residential situation tradeoffs survey, the higher the rating for single family options.

- Among ethnic groups, Hispanics rate single family options higher than other groups; whites and blacks are next highest, and Orientals are significantly lower.

- Among employment groups, nonworkers rate single family options lower than other groups. Other groups are similar in their ratings.

- There are few reliable differences in ratings of single family options among residential situation groups, although there is some tendency for residents of mobile homes to rate single family options lower than other groups.

- Among residential location groups, rural non-farm and suburban residents rate single family options higher than other groups, which show few differences.

- The longer the respondents have resided in their present residences, the higher the rating for single family options.

- Among income source groups, respondents reporting income from social security pensions and investments rate single family options higher than those in other groups, who have similar coefficients.

- The higher the overall average for the mobility tradeoffs, the higher the rating for single family options.

- The higher the rating given to center city options in the mobility tradeoff survey, the lower the rating for single family options.

- The higher the rating for Southeastern locations in the mobility tradeoff survey, the higher the rating for single family options.

- The higher the rating for Southwestern locations in the mobility options survey, the lower the rating for single family options.

- The higher the cost of living coefficient (the less sensitive respondents are to cost), the lower the rating for single family options.

- The higher the rating for having relatives living in a nearby community in the mobility tradeoffs survey, the higher the rating for single family options.

The Coefficient for 2-4 Unit Multifamily Complexes

The regression analysis for 2-4 unit complexes is not significant at the .10 level. Therefore, we omit discussion of the statistical results because they are unreliable.

The Coefficient for Owning One's Own Residence

The regression analysis for the ownership coefficient is significant beyond the .01 level. The estimated regression equation accounts for 36.2% of the variation in the individual ownership coefficients. Some of the major results are as follows:

- The older the respondent, the lower the coefficient for ownership.

- The more floors or stories reported by the respondents for their present residences, the higher the ratings for ownership.

- Respondents reporting home heating facilities on average rate ownership higher than those who have no heating.

- Among ethnic groups, Orientals rate ownership most highly, followed by whites and blacks, with Hispanics rating ownership lowest.

- Among employment groups, nonworkers rate ownership highest, followed by part-time employees and retirees. Lowest ownership ratings are given by full-time workers and homemakers.

- There are few significant differences among residential location groups.

- Among income source groups, the highest ownership ratings are given by those reporting income from investments, wages, and social security pensions; the lowest ownership ratings are associated with public assistance and unemployment.

- The higher the percentage of 1979 income spent on housing, the higher the rating for ownership.

- The higher the overall average for the mobility tradeoffs survey, the lower the rating for ownership.

- The higher the center city option coefficient in the mobility tradeoffs survey, the higher the ownership ratings.

- The higher the suburban option coefficient in the mobility tradeoffs survey, the higher the ownership option ratings.

- The higher the ratings for Southeastern locations in the mobility tradeoffs survey, the lower the ratings for ownership options.

- The higher the ratings for Southwestern locations in the mobility tradeoffs survey, the higher the ownership option coefficients.

- The more positive the cost of housing coefficient (the less sensitive respondents are to costs) in the mobility tradeoffs survey, the higher the ownership ratings.

- The higher the ratings for having relatives nearby for the mobility tradeoffs survey, the lower the ownership ratings.

The Coefficient for the Rental Option

The regression analysis of the rental option coefficients is significant beyond the .01 level. The estimated regression equation accounts for 38.9% of the variation in the individual rental option coefficients. Some of the notable statistical results are as follows:

- Males find the rental option more attractive than do females.

- Respondents who have heating facilities rate the rental option higher than those who do not have such facilities.

- Respondents who report roof leaks rate the rental option lower than those not reporting leaks.

- Respondents reporting cracks or holes in their walls rate the rental option higher than those who do not so report.

- Respondents whose head of household has moved in the last 24 months rate the rental option lower than do households whose heads have not moved.

- Respondents who report that they can find a place to suit them if they move rate the rental option higher than those who don't.

- As the number of individuals over 18 years of age residing in the household increases, the higher the rating of the rental option.

- Individuals who are married rate rental options lower than those who are not married.

- Orientals rate the rental option higher than other ethnic groups; other groups rate renting similarly.

- Among employment groups, full- and part-time workers rate the renting option higher than other groups such as nonworkers and retirees. Homemakers rate the rental option lowest.

- Of the residential situation groups, those in mobile homes rate the renting option higher than those in multifamily residences, and those in houses rate the renting option lowest.

- Of the residential location groups, only those in rural non-farm and rural farm/ranch locations differ from other groups: they rate renting lower than do other groups.

- Of the income source groups, there are few differences between groups, except those reporting income from "other" contributions who are more positive toward renting options.

- The higher respondents' overall means on the mobility tradeoff survey, the lower the attractiveness of the rental option.

- The higher the coefficient on the center city option in the mobility tradeoff survey, the higher the attractiveness of renting.

- The higher the coefficient for Southeastern locations in the mobility tradeoff survey, the lower the rental ratings.

- The higher the coefficient for Southwestern locations in the mobility tradeoff survey, the higher the ratings for the rental option.

- The higher the coefficient for cost of living from the mobility tradeoff survey (the less sensitive the respondent is to cost), the higher the rental option ratings.

- The higher the ratings for having relatives in the same community in the mobility tradeoff survey, the higher the rental option ratings.

The Coefficient for Cost of Housing and Utilities

The regression analysis for the cost coefficient is almost significant at the .10 level. We proceed to interpret the results, although we caution the reader that the equation would normally not be considered significant. The estimated equation accounts for 20.6% of the variation in the individual cost coefficients. Some of the notable results are as follows:

- Respondents who report access to a complete working kitchen are more sensitive to costs on average than those who report no access.

- The higher the reported income base in 1979, the more sensitive to the cost levels were the respondents.

- The more individuals over 18 years of age reported to reside in the respondent's household, the less sensitive to cost.

- Married respondents on average were more sensitive to cost than unmarried respondents.

- Among ethnic groups, whites and Orientals are least sensitive to cost, followed by blacks. Hispanics are the most cost sensitive.

- Among employment groups, those least sensitive to cost are homemakers and nonworkers, followed by part-time workers and retirees; the most sensitive to cost are full-time workers.

- Among residential situation groups, the least cost sensitive are those residing in mobile homes, followed by those residing in homes, and lastly, those residing in multifamily homes.

- Among residential location groups, there are no reliable differences among the groups.

- The older the respondent's home, the more sensitive the respondent is to cost.

- The more rooms reported by the respondents to be in their residences, the less sensitive the respondent is to cost.

- Respondents who own their own residences are more sensitive to cost than those who do not own their residences.

- The higher the respondent's overall average in the mobility tradeoffs survey, the more sensitive the respondent is to cost.

- The higher the respondents rate the center city option in the mobility tradeoff survey, the less sensitive they are to cost.

- The higher the respondents rated the suburban option in the mobility tradeoffs survey, the more sensitive they are to cost.

- The less sensitive respondents are to the cost of living in the mobility tradeoffs survey, the less sensitive they are to cost in the residential situation tradeoffs survey.

- The higher respondents rate having relatives living in nearby communities, the more sensitive they are to cost.

The Coefficient for the Higher Income Neighborhood Option

The regression analysis for the Higher Income Neighborhood coefficient option was significant at the .05 level. The estimated regression equation accounts for about 22.9% of the variation in the individual respondent higher income neighborhood coefficients. Some of the notable results are as follows:

- The older the respondent, the lower the respondent's rating of higher income neighborhoods.

- Respondents who report modern sewage facilities on average rate the higher income neighborhood option higher than those who do not report such facilities.

- The more flush toilets reported to be in the residence by the respondent, the lower the rating of the higher income neighborhood option.

- Respondents who report that they plan to make improvements in the next 12-24 months rate higher income neighborhood options lower than other respondents.

- Married respondents rate high income neighborhood options higher than do respondents who are not married.

- Among ethnic groups, Hispanics rate the high income neighborhood option highest, followed by whites and blacks; the lowest ratings are given by Orientals.

- Among employment groups, full- and part-time workers rate high income neighborhoods highest, followed by homemakers and retirees; nonworkers rate such options the lowest.

- Among residential situation groups, those who reside in homes rate higher income neighborhoods highest, followed by those in mobile homes and, finally, those in multifamily housing.

- Among residential location groups, there are few reliable differences.

- The longer the respondents have resided in their present residences, the lower the attractiveness of higher income neighborhoods.

- Among sources of income groups, the highest ratings for higher income neighborhood options are given by those with income from social security pensions, investments, and "other" contributions; next are respondents with income from wages, unemployment, and public assistance.

- The higher the proportion of 1979 income reported to be spent on housing, the higher the rating for higher income neighborhoods.

- The higher the coefficient for center city options in the mobility tradeoffs survey, the lower the higher income neighborhood coefficients.

- The higher the ratings on Southwestern locations in the mobility tradeoffs survey, the lower the higher income neighborhood ratings.

- The higher the ratings for having relatives living in nearby communities, the lower the ratings of the higher income neighborhood option.

The Coefficient for the Middle Income Neighborhood Option

The regression analysis for the individual middle income neighborhood coefficients is significant beyond the .10 level and almost at the .05 level.

The estimated regression equation accounts for 22.1% of the variation in the individual respondent middle income neighborhood coefficients. Some of the results are:

- The more floors or stories reported to be part of the respondent's residence, the lower the rating on middle income neighborhood options.

- Respondents who report complete working plumbing facilities on average rate middle income neighborhood options lower than those who don't have working plumbing.

- Respondents reporting having modern sewage disposal facilities rate middle income neighborhoods higher on average than those without such facilities.

- Respondents who report cracked and peeling paint on average rate middle income neighborhoods lower than other respondents.

- The more flush toilets reported to be in the residence by the respondent, the lower the attractiveness of middle income neighborhood options.

- The higher the 1979 base income on the proportion of 1979 income spent on housing, the lower the rating for middle income neighborhood options.

- Among ethnic groups Orientals rate middle income neighborhoods higher than other groups, followed by blacks and whites, and finally Hispanics.

- Among employment groups, part-time and full-time workers rate middle income neighborhoods the highest, followed by homemakers and retirees; nonworkers rate middle income options the lowest.

- Differences among residential location groups are slight; there is a slight tendency for rural farm/ranch respondents to rate middle income neighborhoods higher than the other groups.

- Respondents who own their residences rate the middle income neighborhood option higher than respondents who do not.

- The longer the length of residence in the present location, the lower the rating for the middle income neighborhood option.

- Among sources of income groups, those reporting income from social security pensions, "other" contributions, investments and public assistance rate middle income neighborhoods higher than those reporting income from wages or unemployment.

- As the coefficient for the suburban option in the mobility tradeoffs survey increases, the ratings for middle income neighborhoods decrease.

- As the ratings for Southeastern locations increase in the mobility study, the ratings for middle income neighborhoods increase.

- The higher the cost coefficient in the mobility tradeoffs survey, the higher the rating for middle income neighborhood options.

- The higher the ratings for having relatives living in the same community from the mobility tradeoffs survey, the higher the middle income neighborhood ratings.

- The higher the ratings for having relatives living in nearby communities, the lower the ratings for middle income neighborhoods.

This concludes the discussion of detailed individual findings for separate coefficients.