PN-AAZ-503
55431

AGRICULTURAL POLICY ANALYSIS PROJECT
U. S. AGENCY FOR
INTERNATIONAL DEVELOPMENT
CONTRACT NO. DAN-4084-C-00-3087-00

MARGINAL UTILITY OF INCOME ESTIMATED AND APPLIED TO ECONOMIC PROBLEMS IN AGRICULTURE

Prepared by

LUTHER TWEETEN
and
GILEAD MYLAY

Department of Agricultural Economics
Oklahoma State University

August 20, 1986
Stillwater, Oklahoma

Report B-21

TABLE OF CONTENTS

	Page
OBJECTIVES	3
APPROACHES TO ESTIMATE UTILITY	3
OUTLINE OF PROCEDURE AND DATA	6
EMPIRICAL RESULTS	7
Construction of Dependent Variable	7
Independent Variables	9
Regression Equations	9
Recursive Approach	12
Evaluation of Results	15
SOME APPLICATIONS OF RESULTS	17
Risk Preference or Aversion	18
Distribution of Income and Wealth	21
Setting Tax Rates	24
Benefit-Cost Analysis	25
Summary and Conclusions	27
REFERENCES	29
APPENDIX	32

MARGINAL UTILITY OF INCOME ESTIMATED AND APPLIED TO ECONOMIC PROBLEMS IN AGRICULTURE

There is some agreement that people pursue what is variously termed happiness, utility, satisfaction, well-being, or quality of life. Efforts to increase utility of people lie directly or indirectly at the core of economic theory and applications.

Despite the central importance of utility to economics, economists have for the most part dismissed utility as being unmeasurable. The perceived inability to measure utility has seldom constrained implicit use of utility in applied economics. Traditionally, neoclassical economists have adopted the New Welfare Economics dichotomy. They have divided economics into equity (income and wealth distribution issues) and efficiency (more output per unit of input) dimensions, then have discarded the equity dimension. Radical economists and other social scientists have argued that equity is the most important dimension of economics and have rendered to economic efficiency the same obscurity which neoclassical economists have rendered to equity.

---

*Respectively, Regents Professor and former Research Assistant, Department of Agricultural Economics, Oklahoma State University. The generosity of the National Opinion Research Center and the Roper Institute in providing data at nominal cost for this study is greatly appreciated. Comments of Glenn Knowles and Daryll Ray on this manuscript are also appreciated. The authors are solely responsible for shortcomings of the study.

The motives of those who emphasize efficiency and those who emphasize equity are not in doubt -- both groups are concerned about the well-being of people. But neoclassical economists implicitly assume that the marginal utility of income is constant per dollar and equal for everyone so that maximizing efficiency maximizes utility. And social scientists who emphasize equity implicitly assume all individuals are equally efficient and motivated so that incentives are not of consequence for the general welfare. Both positions have elements of truth and error.

Reliable measures of the marginal utility of income are essential to bridge the gap between equity and efficiency in economics. Such measures are required to appraise the impact on the general welfare of public policies influencing the level and distribution of wealth -- hence of virtually all public policies. Measures of utility are also important to predict risk avoidance or preference behavior of farmers and others. Measures of utility can help economists to develop farm enterprise plans that farmers are likely to adopt to increase their satisfactions. In public policy decisions, measures of utility are essential to determine whether people will be better off from a resource development project (whatever its conventional benefit-cost ratio), from a revision in income tax rates, or from a commodity program to transfer income from taxpayers to farmers.

Economic indicators and economic accounts are recognized as important components of information systems for making decisions. Social indicators providing insights into diverse relationships that determine well-being of society are available and helpful. But for lack of a common unit of measurement (such as money used to aggregate

economic indicators into economic accounts), social indicators have not been aggregated into a system of social accounts despite valiant proposals to do so by Karl Fox and others. The utility measures derived herein are one potentially important building block in efforts to formulate social accounts from disparate social indicators.

Given that improving well-being is a major policy goal and given that benefits and costs of proposed public policies must be weighted by utilities to determine whether the public will be made better or worse off by implementing the proposed policy, why have social scientists not devised appropriate utility weights? One reason is that measuring utility poses formidable conceptual and operational problems. The presumption of this report is that utility now can be measured with useful accuracy using modern socio-psychological concepts of well-being and multivariate statistical techniques. Measures are sufficiently reliable to make intergroup but not necessarily to make interpersonal comparisons of utility.

OBJECTIVES

Two specific objectives of this study are to:

(1) Estimate the marginal utility of income, and

(2) Illustrate applications of the estimated marginal utility of income to economic issues in agriculture.

APPROACHES TO ESTIMATE UTILITY

Economists have pursued two principal lines to estimate utility. One line is the standard gamble technique, using the von

Neuman-Morgenstern approach or its many variants.[1] Individual utility functions are traced out from data obtained in personal interviews where the respondent specifies preferred choices from sets of alternative payoffs and probabilities. Serious drawbacks to this approach include (1) respondent burden and difficult questionnaires which because of high cost and complexity have been restricted to small non-random samples, and (2) confounding of utility and gambling effects.

A second approach is use of socio-psychological measures of well being, again obtained from personal interviews. Problems with this approach include (1) the subjective nature of responses which are perceived or expressed quality of life rather than actual utility, and (2) difficulties in agreement among social scientists concerning appropriate domains of life to include in measures of well-being.

Regarding the first problem, the responses given by an individual to the socio-psychological attitudinal scales may be subjective but the analysis which converts individual responses into an overall utility measure for groups can be objective. Furthermore, if the ultimate objective of policy is to increase utility and social scientists provide only "objective" income and employment indicators of the worth of proposed public policies, then someone else (e.g. political representatives) will need to make the link between objective indicators and the public interest. Although imprecise, the

---

[1] An excellent example of this approach is a study by Lin, Dean and Moore. The researchers found that utility maximization predicted farmer behavior better than did profit maximization but neither predicted very well (p. 507). Halter and Mason, Hildreth and Knowles, and Schoemaker provide a useful description of techniques of measurement, application of results, and review of literature.

estimates derived in this study using objective scientific procedures are likely to be an improvement over simple value judgments of the marginal utility of income.

Regarding the second problem, social scientists have not settled on what domains to include in measuring quality of life (for an extended discussion, see Coughenour and Tweeten). The principal candidates for domains or subindices are:

Hedonistic Subindex: Feelings of happiness or excitement with life. Reflects feelings (emotions) as opposed to cognitive (knowing, rational) dimensions of well-being.

Positive and Negative Affect Subindex: Negative and positive feelings about well-being (Bradburn, 1969). Negative Affect is associated with psychosomatic symptoms, tensions over interpersonal relationships and other sources of negative feelings. Positive Affect is associated with favorable associations such as social involvement and new and varied experiences.

Anomie Subindex: Lack of confidence in one's social environment. Anomie, a concept originating with Emile Durkheim to refer to normlessness, is characterized by feelings of fatalism, alienation, pessimism, and demoralization.

Confidence Subindex: Confidence in persons running institutions such as the educational system, government, business, labor unions, media, etc.

Satisfaction Subindex: Degree of satisfaction with various aspects of life including family life, marriage, neighborhood, community (city), job, friendships, etc.

Each of these subindices may be formed from several indicator variables (see Appendix for illustration). Thus perceived utility as measured by a quality of life index may differ from study to study depending on (1) subindices included, (2) the indicator variables in each of the subindices, (3) method of aggregation, and (4) the sample of respondents. An issue of concern is how robust are results among studies differing in one or more of the above four areas.

OUTLINE OF PROCEDURE AND DATA

Indicator variables shown in the Appendix are aggregated by factor analysis into a single dependent variable which is regressed on age, income, education, and other explanatory variables. A quality of life (QLI) index constructed from sample data is compared with results from an earlier independent sample. The year of the survey, subindices, and indicator variables differ between the two samples. But both samples are large, high-quality data sets containing a considerable number of indicator variables. Because domains are not independent of each other, most relevant information may be contained in a core subset of indicator variables common to each data set. Given the relatively high correlations between indicator variables and between indices, the single aggregate quality of life index constructed from each set may be similar to each other despite differences between data sets. Consistency in results between studies performed on independent data sets for different years not only would build assurance in the robustness and objectivity of the approach, but also would build confidence in applying utility indices to estimate risk preference coefficients and other values important to decisions in farm policy and other areas.

Basic data for this study are from personal interview surveys in 1976 and 1980 by the National Opinion Research Center (NORC). The sample included 1,499 respondents in 1976 and 1,468 respondents in 1980. Each general social survey was an independently drawn random sample of English-speaking persons 18 years of age or over living in non-institutional arrangements within the continental United States.

EMPIRICAL RESULTS

Construction of Dependent Variable

A quality of life index was constructed from indicator variables (see Appendix) falling into the following general subindices:

Subindex	Designation	Number of Indicator Variables
Hedonistic	H	2
Anomie 1	A1	3
Anomie 2	A2	3
Confidence	C	14
Satisfaction	S	6

The choice of indicator variables and subindices for this study was based not only on conceptual relevance but also on availability of data. The coding used in each of the indicator variables is shown in the Appendix.[2]

Table 1 shows results of factor analysis used to group indicator variables into a single quality of life index. If the subindices

---

[2] Results are not invariant to the coding procedure. Although the coding procedure was designed to minimize bias, the reader is encouraged to review the indicator variables in the Appendix for possible sources of bias.

Factor scores in Table 1 were used to construct the dependent variable QLI used in Table 3. It is emphasized that the factor scores in the Appendix tables were used to construct the dependent variables in Table 6 only.

Table 1. Factor Scores for All Indicator Variables Used to Construct QLI[a].

Indicator Variable[b]	Factors[c]					
	F1	F2	F3	F4	F5	F6
HAPPY	.5811	.0465	.0757	.1077	-.1066	.0625
LIFE	.5541	.0709	.2631	.0010	.0267	-.0897
HELPFUL	.1717	.0678	.1348	.7282	.0192	.0680
FAIR	.1333	.0706	.1494	.7085	.0324	.0829
TRUST	.1646	-.0102	.2847	.6815	.0570	.0667
ANOMIE5	.0951	.0161	.6459	.1941	.0080	.1257
ANOMIE6	.1792	.0188	.6588	.1923	.0019	-.0233
ANOMIE7	.0217	.3908	.4322	.1701	-.1202	-.0253
CONFINAN	.0925	.0882	.1814	.0655	-.0755	.6329
CONBUS	.0784	.1013	.0586	.1039	-.0137	.6778
CONCLERG	.0146	.2975	-.1264	.2644	-.1053	.3204
CONEDUC	.0417	.5030	-.0719	.0641	.1108	.2188
CONFED	.0566	.6602	.1912	.0345	-.1182	.1842
CONLABOR	-.0156	.5770	-.2406	.0265	.1414	-.0808
CONPRESS	.0478	.2336	-.0542	.0328	.7084	.0798
CONMEDIC	.1204	.0990	-.0459	.0426	.2153	.4962
CONTV	-.0623	.1523	-.1350	-.0150	.4628	.4111
CONJUDGE	.0364	.5177	.2805	-.0325	.2210	.2352
CONSCI	.1072	.1147	.3387	.0959	.3571	.3467
CONLEGIS	.0535	.6636	.1400	-.0150	.0736	.1927
CONARMY	.0049	.3520	-.0400	-.0788	-.1023	.4838
GETAHEAD	.1553	.0606	-.0600	.0400	-.4050	.1745
SATCITY	.5391	.0970	-.1184	.2536	-.1058	.0888
SATHOBBY	.6520	-.0648	.0700	.0395	.0841	-.0031
SATFAM	.6677	.0428	-.1510	.0996	.0255	.0329
SATFRND	.6738	-.0067	-.1251	.2036	-.0007	.0406
SATHEALT	.5858	.0258	.1621	-.1199	.0456	.0009
SATJOB	.3919	-.0230	.1257	-.0804	-.0840	.1630

[a]Only factors associated with eigenvalues greater than 1 are extracted. Principle axis method, varimax rotation.

[b]See Appendix for definition and coding of indicator variables.

[c]Eigenvalues are as follows: F1 = 4.4, F2 = 2.7, F3 = 1.7, F4 = 1.2, F5 = 1.1, and F6 = 1.1.

comprise distinct domains of quality of life, each factor in Table 1 would be uniquely and prominently identified with a subindex. The expected pattern holds for Anomie 1 associated with factor F4 and Anomie 2 associated with factor F3. The Hedonistic and Satisfaction subindices load heavily on factor F1.

The Confidence subindex appears to be multidimensional. In factor F2, weights are large for variables measuring confidence in education, the executive branch of the federal government, organized labor, the U.S. Supreme Court, and the U.S. Congress. Confidence in the media, as measured by the press and television, weights prominently in factor F5. Confidence in banks and financial institutions and in major companies loads strongest in factor F6.

The Quality of Life Index (QLI) was constructed from results of the factor analysis in Table 1 as

$$(1) \qquad QLI = \sum_{i=1}^{N} \sum_{j=1}^{M} w_j \, a_{ij} \, x_i$$

w_j = eigenvalue associated with factor j,

a_{ij} = factor loading of indicator i in factor j,

x_i = normalized indicator variable i, $x_i = (X_i - \bar{X}_i)/s_i$ where original observations X_i are adjusted for the estimated mean $\bar{X}_i$ and standard deviation s_i.

A common, alternative method of aggregating indicator variables is simple summation:

$$(2) \qquad QLI' = \sum_{i=1}^{N} x_i$$

The aggregation in QLI is preferred conceptually; the aggregation in QLI' is preferred for simplicity and convenience. A methodological issue to be examined is whether the method of aggregation influences results.

Independent Variables

The independent variables used to account for variation in the dependent variable are listed in Table 2. As with the indicator components of the dependent variable, the independent variables are selected in part because they are conceptually relevant and in part because they are available. Theory suggests many additional variables for consideration but those listed have been found to be important in previous studies (see Harper and Tweeten).

Regression Equations

The quality of life index (QLI) derived from components listed in Table 1 was regressed on selected independent variables in Table 2, providing results shown in Table 3. Independent variables in Table 3 account for 24 percent of the variation in QLI, an R^2 typical for studies explaining variation in attitudes among individuals. Coefficient signs are consistent with apriori knowledge. Respondents with little education, raised in a single parent family in a large place (city), and in poor health are associated with lower quality of life than are other respondents.

Other things equal, being a male non-white living in the West is associated with a low QLI. Regional variables taken as a whole have little apparent impact on QLI. Based on results using a restricted

Table 2. Definition of Independent Variables.

Independent Variable[a]	Description
Male (SEX)	Male = 1 Female = 0
Unemployed (WRKSTAT)	Unemployed = 1 Other = 0
PRESTIGE	Hodge, Siegel, Rossi prestige scale coded from 1 for lowest prestige occupation to 8 for highest prestige occupation
Married (MARITAL)	Married = 1 Other = 0
AGE	10-19 years = 1 20-29 years = 2 . . . 80 + years = 8 No answer, don't know = 4
EDUC	Highest grade completed No answer, don't know = 8
White (RACE)	White = 1 Other = 0
FAMILY16	Were you living with both your own mother and your own father around the time you were 16? Yes = 1 No = 0

INCOME -- Constructed form VAR: INCOME and INCOME77. Continuous variable constructed from mid-range point estimates of 12 family income ranges in 1976 and 16 ranges in 1980 obtained in survey. The 1976 data were multiplied by 1.21 to adjust to same general price level. Point estimation for the highest survey income category ("$25,000 and over" in 1976 = $84,442; $50,000 and over" in 1980 = $121,780 estimated from earlier continuous distribution curves. Categories ("Don't know", "Refused", and "No answer") were coded $7,861 in 1976 and $8,500 in 1980.

REGION (East)	New England = 1 Middle Atlantic = 1 Other = 0
REGION (South)	South Atlantic = 1 East South Central = 1 West South Central = 1 Other = 0
REGION (West)	Mountain = 1 Pacific = 1 Other = 0

Independent Variable[a]	Description
Place Size (XNORCSIZ) - Coded from 1 to 10 with largest to smallest size of place of community residence.	
	Central city of over 250,000 population = 1
	Medium size central city of 50,000 to 250,000 = 2
	. . .
	An incorporated area less than 2,500 or an unincorporated area of 1,000 to 2,499 residents = 9
	Open country within a larger civil division such as township = 10
Rural (XNORCSIZ)	Adapted from above classification with above code 9, 10 = 1 Other = 0
Size of Place (SIZE) - Size of community (town, city, etc.) of interview, in thousands. Coded from U.S. Census data by NORC.	
HEALTH	Would you say your own health, in general, is excellent, good, fair or poor? Excellent = 1 Good = 2 Fair = 3 Poor = 4 Don't know, no answer = 2
Farmer (OCCUPATION)	Farmers (owner, operator, tenant, manager) and farm laborers = 1 Others = 0
FINALTER	During the last few years, has your financial situation been getting better, getting worse, or has it stayed the same? Getting better = 2 Getting worse = 0 Stayed same, don't know or no answer = 1

[a]Data from National Opinion Research Center (NORC). Variable names all in capital letters are the variable designations used by NORC.

Table 3. Ordinary Least Squares Estimates Relating Quality of Life Index QLI to Selected Variables.[a]

Independent Variable	Parameter Estimate	PR > |t|	Standardized Parameter Estimate	Percent of RSS[b] Explained
Intercept	56.4003	.0001	--	--
Male	-2.6743	.0005	-.0574	.25
Unemployed	-8.5148	.0001	-.0670	2.09
PRESTIGE (Occupational)	.8130	.0108	.0485	2.78
Married	3.1814	.0003	.0664	2.59
AGE	.3662	.0017	.2915	.12
AGE^2	-.0019	.0943	-.1565	18.47
EDUC	.9359	.0001	.1308	9.24
White	6.5564	.0001	.0838	3.62
FAMILY16	2.0589	.0193	.0388	.81
INCOME	.0002	.0001	.3068	12.14
$INCOME^2$	-1.5696×10^{-9}	.0003	-.2531	14.76
REGION (East)	-3.9533	.0003	-.0699	.50
REGION (South)	-1.3854	.1557	-.0281	.22
REGION (West)	-4.7126	.0001	-.0776	2.31
Size of Place	-.3881	.0019	-.0543	.46
HEALTH	-8.6766	.0001	-.3313	29.36
Farmer X INCOME	9.2930×10^{-5}	.0450	.0336	.28

N = 2967 P > F = .0001 R^2 = .24

[a]See Appendix and Table 1 for source of dependent variable QLI and Table 2 for independent variables. Method of aggregation is shown in equation 1.

[b]Indicates the percent contribution by each variable to regression sum of squares (RSS). The figures are obtained using the following formula

$$L_i = [b_i^2 + \sum_j b_i b_j r_{ij}] \times 100$$

where L_i = percent contribution to regression sum of squares by variable i, r_{ij} = simple correlation coefficient between variable i and j, b_i = estimated regression coefficient, and b_j = estimated coefficients in the equation excluding b_j and the intercept.

and unrestricted model, an F-test of the hypotheses that the coefficients of the regional variables are jointly equal to zero could not be rejected at the 5 percent probability level.

QLI initially increases with age but at a decreasing rate. A similar pattern is apparent for income. Additional dollars of income add less and less to QLI. The marginal utility of income reaches zero at $80,000 of family income. The interaction variable (Farmer X INCOME) indicated a higher quality of life for a farmer versus other occupations for any given nonzero income, other things equal. Quality of life was also found to be higher for farmers than for others in an earlier study (Harper and Tweeten, p. 1003). Unfortunately, it is not possible to judge whether the result arises because farmers receive more satisfaction from income than do others or merely under-report income.

The standardized regression coefficients and the percent of regression sum of squares (RSS) accounted for indicate the relative importance of each independent variable. Age, income, and health overshadow other variables in influencing QLI. One standard deviation improvement in HEALTH (decrease in the algebraic value) raises QLI by .33 standard deviations. One standard deviation increase in education (EDUC) raises QLI by .13 standard deviations.

A common practice in attitudinal research is to simply aggregate indicator variables rather than weight them by multivariate statistical procedures such as factor analysis. Results in Table 4 for QLI', a simple sum of indicator variables, can be compared with results in Table 3. The regression coefficient parameter estimates cannot be compared directly because means and variances of the two

10a

Table 4. Ordinary Least Squares Estimates Relating Quality of Life Index QLI' to Selected Variables.[a]

Independent Variable	Parameter Estimate	$P > \|t\|$	Standardized Parameter Estimate
Intercept	22.9102	.0001	--
Male	-1.2000	.0004	-.0597
Unemployed	-3.8716	.0001	-.0707
PRESTIGE (Occupational)	.3872	.0056	.0536
Married	1.1359	.0026	.0550
AGE	.1779	.0005	.3285
AGE^2	-.0010	.0451	-.1905
EDUC	.3449	.0001	.1118
White	2.8216	.0001	.0837
FAMILY16	.8439	.0283	.0369
INCOME	9.7996×10^{-5}	.0001	.2830
$INCOME^2$	-6.158×10^{-10}	.0012	-.2304
REGION (East)	-1.5169	.0017	-.0622
REGION (South)	-.6529	.1254	-.0308
REGION (West)	-2.4496	.0001	-.0936
Size of Place	-.0004	.0007	-.0588
HEALTH	-3.4435	.0001	-.3051
Farmer x INCOME	3.9349×10^{-5}	.0507	.0331

N = 2967 $P > F = .0001$ $R^2 = .21$

[a]See Appendix for indicator variables in dependent variable QLI' and Table 2 for independent variables. Method of aggregation for dependent variable is shown in equation 2.

dependent variables are different. However, the standardized regression coefficients can be compared. They have the same signs and comparable magnitudes between equations in Table 3 and 4. The Durbin-Watson d statistic is 1.9 for each equation, giving no basis to reject the hypothesis of no first-order autocorrelation in the residuals. The proportion of variation accounted for fell from .24 in Table 3 to .21 in Table 4. The conclusion is that under certain circumstances a simple normalized additive aggregation procedure provides results very similar to results from more sophisticated aggregation.

Alternative specifications of the independent variables were attempted. As a measure of the contribution of personal economic conditions to QLI, wealth is an alternative or supplement to the family income variable (INCOME). Unfortunately, net worth data were not available. Respondents were asked whether their financial situation had been changing for the better or worse in the last few years, and this independent variable (see FINALTER in Tables 2 and 5) was inserted as a proxy for wealth and personal financial outlook. The result was a larger R^2 and somewhat similar coefficients to those in Table 3 for all independent variables except income.

Earnings are the flow of benefits from wealth. If the rate of return on wealth is constant from year to year and among families and individuals, then income and wealth would be highly correlated. INCOME and FINALTER to some extent measure the same thing, hence the smaller coefficients for the income variables in Table 5 than in Table 3 are expected. Because FINALTER is a very crude measure of change in wealth, is difficult to use in applications, and because income and

wealth are too closely related to include both variables in the equation for QLI, only the income variable is retained in subsequent empirical analysis.

Variants of the specification in Table 3 were estimated to explore further the association between QLI and INCOME. Specifically, cubic and logarithmic forms were attempted but were inferior to the quadratic form as measured by R^2 and coefficient signs and significance.

Alternative specifications also explored the contribution of rural living to QLI. Replacing Size of Place with Rural (see Table 2) in the specification in Table 3 resulted in a positive significant coefficient on the variable but reduced the R^2 to .23. Replacement of Rural by a variable equal to 1.0 (zeros elsewhere) for respondents residing in a county with no city of at least 10,000 population resulted in an insignificant coefficient on the variable and a lower R^2 than in Table 3. The coefficient on an interaction term between INCOME and Rural was highly insignificant, indicating that QLI does not respond differently to income for rural county residents than for other residents on the average.

Regressions also were run on males only. But because the results did not improve, the data were combined to benefit from more degrees of freedom.

Recursive Approach

The approach thus far was to assume that each of the indicator variables is equally admissible in the statistical model and that no

Table 5. Ordinary Least Squares Estimates Relating Quality of Life Index QLI to Selected Variables Including Perceived Financial Progress FINALTER.[a]

Independent Variable	Parameter Estimate	P > |t|	Standardized Parameter Estimate
Intercept	51.600	.0001	--
Male	-2.7764	.0003	-.0596
Unemployed	-6.6926	.0012	-.0527
PRESTIGE (Occupational)	.7225	.0213	.0431
Married	3.5138	.0001	.0734
AGE	.4880	.0001	.3883
AGE^2	-.0031	.0075	-.2468
EDUC	.8635	.0001	.1207
White	6.6581	.0001	.0851
FAMILY16	1.9410	.0247	.0366
INCOME	.0001	.0310	.1576
$INCOME^2$	-8.2779×10^{-10}	.0553	-.1335
REGION (East)	-3.3725	.0019	-.0596
REGION (South)	-1.3829	.1482	-.0281
REGION (West)	-5.6419	.0001	-.0281
Size of Place	-7.4009×10^{-4}	.0104	-.0432
HEALTH	-8.1400	.0001	-.3108
Farmer x INCOME	1.0878×10^{-4}	.0161	.0394
FINALTER	5.3153	.0001	.1746

N = 2967 Pr > F = .0001 R^2 = .26

[a]See Appendix and Table 1 for dependent variable QLI and Table 2 for independent variables.

subindices are prior to or subservient to others in QLI. We now drop these assumptions in proceeding to a hierachical, recursive approach to estimate quality of life. Specifically, it was assumed that the Hedonistic subindex is the apex expression of quality of life and that the Anomie, Satisfaction, and Confidence subindices do not contribute directly to quality of life but contribute recursively through the Hedonistic subindex. Furthermore, independent variables such as gender, occupational prestige, education, and income are assumed to influence the Hedonistic subindex indirectly through intervening or mediating Satisfaction and Confidence subindices. An assumption is that income does not influence quality of life directly but rather indirectly by raising satisfaction with various domains of life and confidence in institutions.

The model is specified as follows:

(3) H = h(A1, A2, C, S, Unemployment, male, PRESTIGE, etc.)

(4) A1 = a1(Male, PRESTIGE, EDUC, INCOME, $INCOME^2$)

(5) A2 = a2(Male, PRESTIGE, EDUC, INCOME, $INCOME^2$)

(6) C = C(Male, PRESTIGE, EDUC, INCOME, $INCOME^2$)

(7) S = S(Male, PRESTIGE, EDUC, INCOME, $INCOME^2$)

The factor weights used to aggregate indicator variable components for A1, A2, C, and S are shown in the Appendix Tables 1 to 4. The regressions of these subfactor dependent variables on selected independent variables are shown in Table 6. The coefficients of the liear and squared income variables were highly significant and displayed expected signs in each of the equations predicting A1, A2, and C but not in the equation predicting the Satisfaction subindex S.

Table 6. Ordinary Least Squares Estimates Relating Subindices to Selected Independent Variables.

	Intercept	Independent Variable[a]				
		Male	PRESTIGE	EDUC	INCOME	$INCOME^2$
Dependent Variable[b]: Anomie 1(A1), R^2 = .07 Pr > F = .0001						
b_i	1.0602	-.2852	.3960	.0963	2.3097×10^{-5}	-1.3537×10^{-10}
Pr > |t|	.0001	.0001	.0426	.0001	.0001	.0001
Standardized b_i		-.0801	.0371	.1760	.3761	-.2857
Dependent Variable: Anomie 2(A2), R^2 = .12 Pr > F = .0001						
b_i	.0836	.0134	.2038	.1098	2.0789×10^{-5}	-1.0406×10^{-10}
Pr > |t|	.4089	.7981	.1953	.0001	.0001	.0001
Standardized b_i		.0045	.0230	.2417	.4078	-.2645
Dependent Variable: Confidence Subindex (C) R^2 = .001, Pr > F = .6448						
b_i	1.0289	-.0498	.6827	.0234	-1.9383×10^{-5}	9.3200×10^{-11}
Pr > |t|	.0560	.8585	.4146	.6101	.3159	.5221
Standardized b_i		-.0034	.0154	.0103	-.0761	.0474
Dependent Variable: Satisfaction Subindex (S), R^2 = .07 Pr > F = .0001						
b_i	15.9217	-.7428	1.2849	.1697	.0001	-8.4274×10^{-10}
Pr > |t|	.0001	.0003	.0348	.0001	.0001	.0001
Standardized b_i		-.0666	.0385	.0992	.7063	-.5683

[a]See Table 2 for definitions of independent variables. All equations extimated with 2967 observations.

[b]See Appendix for indicator variables and aggregation weights for components of each dependent variable.

The results of the recursive estimation using A1, A2, C, and S as predetermined variables and with H the dependent variable are shown in Table 7.[3] Coefficient estimates in the table are not directly comparable with those in Table 3 and must be interpreted differently. For example, to obtain the full impact of EDUC on H, it is necessary to substitute equations from Table 6 for A1, A2, C, and S in Table 7. In the recursive model the marginal response of the Hedonistic subindex H to INCOME is

$$(8)\quad \frac{\partial H}{\partial INCOME} = \frac{\partial H}{\partial A1}\frac{\partial A1}{\partial INCOME} + \frac{\partial H}{\partial A2}\frac{\partial A2}{\partial INCOME} + \frac{\partial H}{\partial C}\frac{\partial C}{\partial INCOME} + \frac{\partial H}{\partial S}\frac{\partial S}{\partial INCOME}$$

where variables were defined earlier. This equation will be used below to quantify the response of H to INCOME.

We now summarize responses under three approaches to estimate marginal utilities. Based on results reported in Table 3, the marginal response of QLI to income is

$$(9)\quad \frac{\partial QLI}{\partial INCOME} = .00025 - 3.1392 \times 10^{-9} INCOME.$$

According to results in Table 4 for QLI' with uniform weights of indicator variables, the marginal response is

$$(10)\quad \frac{\partial QLI'}{\partial INCOME} = 9.7996 \times 10^{-5} - 1.2316 \times 10^{-9} INCOME.$$

Based on regression estimates in Tables 6 and 7 and the formula in equation 8, the estimated marginal response is

$$(11)\quad \frac{\partial H}{\partial INCOME} = 1.4085 \times 10^{-5} - 2.1119 \times 10^{-10} INCOME.$$

---

[3] Actual values of A1, A2, C, and S rather than predicted values from Table 6 were used to estimate the equation in Table 7.

Table 7. Ordinary Least Squares Estimates Relating Hedonistic Subindex (H) to Selected Independent Variables.[a]

Independent Variable	Parameter Estimate	P > |t|	Standardized Parameter Estimate
Intercept	1.1345	.0001	--
Male	.0266	.4054	.0131
Unemployed	-.1151	.1890	-.0208
PRESTIGE (Occupational	.0205	.0881	.0280
Married	.1466	.0001	.0701
AGE	-.0079	.1036	-.1441
AGE^2	6.9192×10^{-5}	.1476	.1274
White	.1576	.0050	.0462
FAMILY16	.0721	.0488	.0311
REGION (East)	-.1449	.0014	-.0587
REGION (South)	.0259	.5281	.0120
REGION (West)	.1093	.0226	.0413
Size of Place	-.0019	.7140	-.0061
HEALTH	-.1528	.0001	-.1336
Anomie 1 Subindex (A1)	.0441	.0001	.0772
Anomie 2 Subindex (A2)	.0527	.0001	.0766
Confidence Subindex (C)	.0036	.1016	.0265
Satisfaction Subindex (S)	.1119	.0001	.3757

N = 2967 Pr > F = .0001 R^2 = .30

[a]See Appendix for source of dependent variable (Hedonistic Subindex) and Table 2 for independent variables.

Evaluation of Results

We now review the results of three approaches to measure quantitatively the marginal utility of income. One purpose of this study is to examine the robustness of marginal response of quality of life indices to assumptions and procedures. The arbitrary scale for the dependent variable precludes direct comparisons of the previous equations but alternative procedures can be employed. A key parameter is the point at which additional income does not add to quality of life. The respective estimates for the three equations 9-11 are:

$$\frac{\partial QLI}{\partial INCOME} = 0 \text{ when INCOME} = \$79,634$$

$$\frac{\partial QLI'}{\partial INCOME} = 0 \text{ when INCOME} = \$79,653$$

$$\frac{\partial H}{\partial INCOME} = 0 \text{ when INCOME} = \$66,694$$

Estimates of the level of INCOME at which A1, A2, C, and S are at a maximum and beyond which greater values of INCOME reduce their values are:

$$\frac{\partial A1}{\partial INCOME} = 0 \text{ when INCOME} = \$85,244$$

$$\frac{\partial A2}{\partial INCOME} = 0 \text{ when INCOME} = \$9,989$$

$$\frac{\partial C}{\partial INCOME} = 0 \quad \text{(Indeterminate; coefficients not different from zero.)}$$

$$\frac{\partial S}{\partial INCOME} = 0 \text{ when INCOME} = \$59,382.$$

The estimates for QLI and QLI' are preferred on theoretical and practical grounds. These estimates are based on the most information. Estimates of the level of INCOME at which A1, A2, C and S are a maximum give erratic and less acceptable results in measuring the impact of INCOME on overall quality of life.

We now compare results of QLI in Table 3 with results of an independent study by Harper and Tweeten using an entirely different sample. The Harper-Tweeten study used data from 1969 and 1971 from families (2,014 observations , approximately half from families interviewed in 1969 and half from the same families interviewed in 1971) in Iowa and North Carolina participating in the Rural Income Maintenance Experiment. A quality of life index QL was constructed in a manner similar to QLI in this study but from indicator variables falling into socio-psychological subindices of alienation, worry, and self-esteem. The marginal response to quarterly family income y was

$$\frac{\partial QL}{\partial y} = .01923246 - .00000188y \tag{12}$$

$$\frac{\partial QL}{\partial y} = 0 \text{ when } y = \$10,230.$$

Multiplied by four to represent <u>annual</u> income, the income associated with maximum QL is $40,920. Adjusted to 1980 by the GNP implicit price deflator, the income value of maximum QL (zero marginal response to y) is $79,934. The similarly of this result from a sample of 10 years earlier to the results from equations 9 and 10 provides some basis for optimism for consistency of results among independent studies. This support for objectivity of the method probably does not extend to partial estimates of quality of life based solely on the

hedonism, alienation, satisfaction, confidence, or any other subindex used alone.

The QLI equation in Table 3 normalized so that at U.S. median family income ($21,000 in 1980) MU = 1 for estimated utility (U) as a function of family income Y is:

(13) $U = 1.3582Y - .000008527Y^2$

where U is normalized estimated utility. From (9), the estimated marginal utility MU is expressed as

(14) $MU = 1.3582 - .00001706Y.$

To avoid adjustment for changes in the general price level it may be useful to express equations 13 and 14 normalized so that median family income MY = 1.0. With MY expressed as a proportion of family income equation 13 becomes:

(15) $U = 1.3582MY - .7163MY^2$

and equation 14 becomes

(16) $MU = 1.3582 - .3582MY.$

Equation 16 is shown graphically in Figure 1. The graph is essentially the same for QLI' and QL. Another dollar of income is estimated to add less than 20 percent as much to the quality of life of a family with $70,000 as to a family with an income of $21,000 (median U.S. family income in 1980). On the other hand, a family with little income derives about 1.4 times as much satisfaction from another dollar of income than does a family with $21,000.

SOME APPLICATIONS OF RESULTS

The utility function has numerous potential applications. Equation 13 (or 15) is used to demonstrate such applications for risk

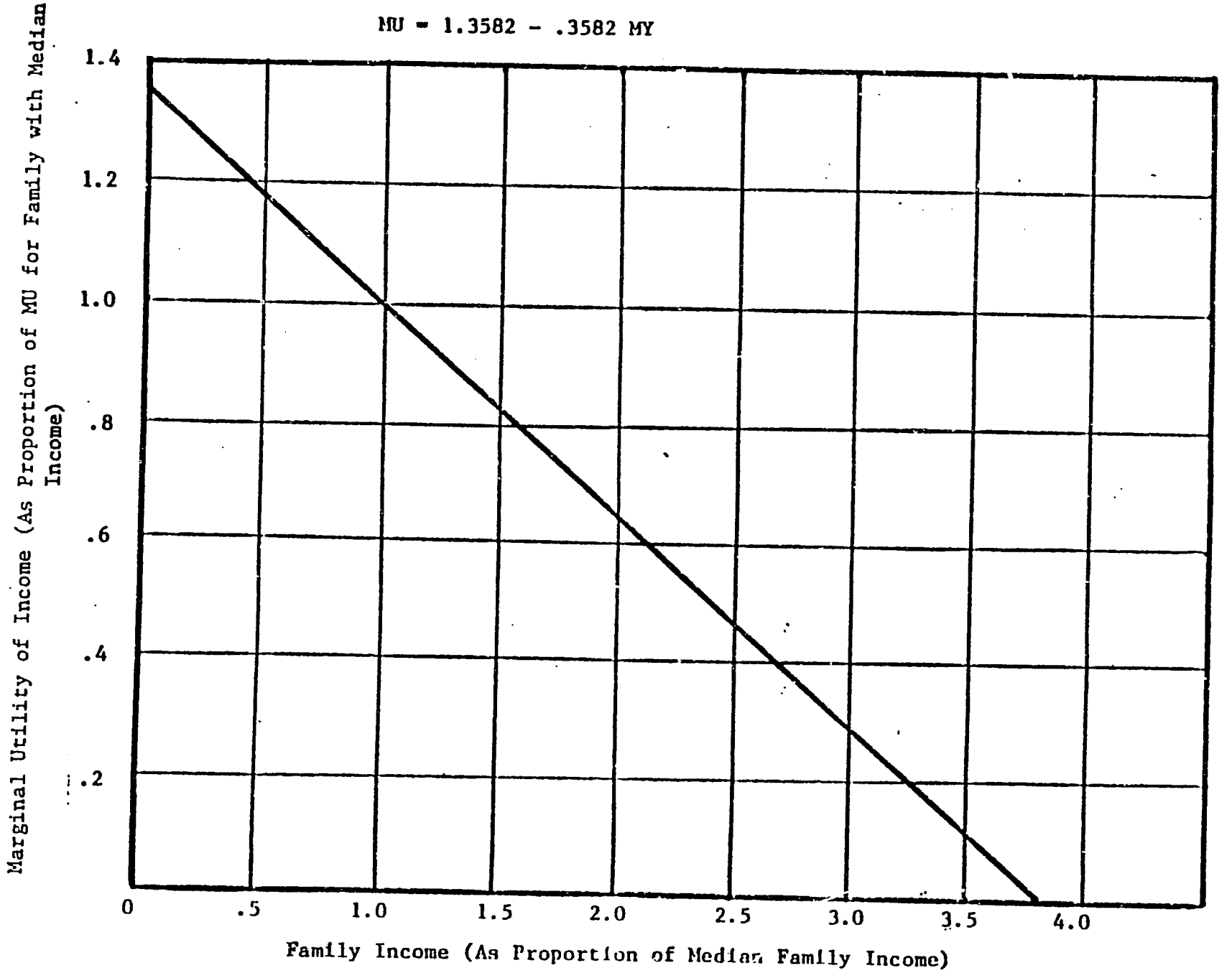

Figure 1. Estimated Marginal Utility of Income from Equation 16.

preference, project analysis, and for income redistribution and tax policies.

Risk Preference or Aversion

A utility function can be used to estimate preference tradeoffs between the mean and variance of income. One measure of mean-variance tradeoff is $d\mu/d\sigma^2$, where μ is average income and σ^2 is the variance of income. This derivative shows how much mean income must be changed to compensate for a change in risk and be left no worse off. People having a preference for risk must be compensated by higher mean income when income risk (variance) is reduced to leave them no worse off, hence $d\mu/d\sigma^2$ is negative. Persons averse to risk are willing to forego some income to reduce risk. Hence $d\mu/d\sigma^2$ is positive. The value of $d\mu/d\sigma^2$ can be estimated from the quadratic equation:

$$(17)\ U = B_0 + B_1 Y + B_2 Y^2.$$

The expected value of E(QLI), given $E(Y) = \mu$, is

$$(18)\ E(U) = B_0 + B_1\mu + B_2\mu^2 + B_2\sigma^2$$

where σ^2 is the variance of Y. Taking the total differential and holding U constant ($dU = 0$), the result is

$$(19)\ \frac{d\mu}{d\sigma^2} = -\frac{B_2}{B_1 + 2B_2\mu}$$

Since B_2 is negative and the denominator is the marginal utility, it follows from (19) that risk aversion prevails up to an income of about $80,000 (MU is positive). For higher income (MU is negative), risk preference dominates. Thus risk aversion decreases with very high income given the quadratic utility function. But for positive

marginal utility of income, the degree of risk aversion increases with increasing income.[4]

Pratt's <u>absolute risk coefficient</u> (PC) is widely used to measure risk preference or aversion and is defined as the ratio of the second derivative to the first derivative of QLI with respect to Y or

$$(20) \quad PC = U''/U' = -\frac{2B_2}{B_1 + 2B_2Y}$$

or at the mean of Y is $2\frac{d\mu}{d\sigma^2}$ from (19).

Arrow proposed a <u>relative risk coefficient</u> (AC) defined as the absolute risk coefficient multiplied by income. Newbery and Stiglitz estimated values of relative risk coefficients for individuals ranging from .5 to 1.2.

The elasticity of mean income with respect to variance is defined as the <u>relative risk premium</u>. This elasticity expresses the discount (dollars) for risk as a proportion of the discount from a stable return. The relative risk premium may be expressed as

$$(21) \quad \frac{\partial\mu}{\partial\sigma^2}\,\frac{\sigma^2}{\mu} = \frac{\mu PC}{2}\left(\frac{\sigma}{\mu}\right)^2 = AC\left(\frac{\sigma}{\mu}\right)^2$$

or one-half the relative risk coefficient multiplied by the coefficient of variation squared.

Computed at the 1980 median income value of $21,000 from the normalized equation 13, the results are:

---

[4] Hildreth and Knowles argue persuasively that risk aversion can be expected to decrease with greater income and suggest algebraic forms to depict such behavior. It is cautioned that the equations estimated in this study had few observations for high income respondents. Thus the quadratic functions shown above may be reliable for lower incomes but unreliable predictors of risk aversion for higher incomes. Marginal utility may become low but remain positive for high income levels.

Description	Algebraic Notation	Value from Table 3 data
Mean-variance tradeoff	$\partial\mu/\partial\sigma^2$	.000008527
Pratt's absolute risk coefficient (PC)	$2\frac{\partial\mu}{\partial\sigma^2}$	.00001706
Arrow's relative risk coefficient (AC)	μ(PC)	.3582
Relative risk premium	$\frac{\partial\mu}{\partial\sigma^2}\frac{\sigma^2}{\mu} = AC(\frac{\sigma}{\mu})^2$	Firm: (given $\frac{\sigma}{\mu}$ = .50) Total: .0896 Industry: (given $\frac{\sigma}{\mu}$ =.25) Total: .0224

These risk parameter estimates are on the average somewhat lower than estimates reported for individuals (see Miller and House). Assuming a coefficient of variation in income of .5 at the farm firm level and .25 at the industry level, the relative risk premium indicates that rates of return at the farm level need to be approximately .9 percent higher than returns on stable investments to compensate farmers for risk. With less variability at the industry level, less compensation for risk (only 2 percent) is required (see Tweeten, December 1983, for coefficient of variation of farm income).

As indicated earlier, the evidence is not compelling to use a separate utility function for farmers as a group than for others. The above results are based on the entire sample and are not unique to farmers. But taking at face value the coefficient of the interaction between farmers and income, results from Table 3 indicate that farmers

may be less risk averse than are other survey respondents. That is, farmers seem to require less compensation than do others in mean income for greater variance in income. However, the results indicate that farmers like other people on the whole benefit from increased stability. The dominant pattern among farmers and others is expected to be insurance to reduce risk rather than gambling to increase risk.

Distribution of Income and Wealth

Utility measures are essential to determine the impact of income redistribution on well-being of society. A Pareto Optimum exists when allocation is so efficient that someone cannot be made better off without making someone worse off. That allocation occurs when the marginal rate of substitution between any two products (inputs) is equal among firms and consumers. This Pareto Optimum alone is not a satisfactory allocation, however, because it can exist while one person starves and another is sated with goods and services.

Numerous Pareto Optimums are possible -- the one that prevails depends on the initial distribution of resources, goods and services. The optimal allocation to maximize well-being in society requires a Pareto Optimum coupled with equal marginal utilities of income or resources among individuals.

In a short run when goods and incomes are already produced and distributed, production incentives can be ignored. Assume that X_i is initial income of individual i and U is the utility or social welfare function. Overall income in the assumed two-person society is X. The following shows that maximization of utility requires equality among marginal utilities if output (income) is fixed:

(22) $X = X_1 + X_2$ (Income constraint)

(23) $U = U(X_1, X_2))$ (Utility or social welfare function)

The utility function is maximized subject to the income restraint:

(24) $U^* = U(X_1, X_2) + \lambda(X - X_1 - X_2)$

where λ is the Lagrangian multiplier. Taking derivatives with respect to X_1, X_2, and λ

$$(25)\quad \frac{\partial U^*}{\partial X_1} = \frac{\partial U}{\partial X_1} + \frac{\partial U}{\partial X_2}\frac{\partial X_2}{\partial X_1} - \lambda = 0$$

$$(26)\quad \frac{\partial U^*}{\partial X_2} = \frac{\partial U}{\partial X_2} + \frac{\partial U}{\partial X_1}\frac{\partial X_1}{\partial X_2} - \lambda = 0$$

$$(27)\quad \frac{\partial U^*}{\partial \lambda} = X - X_1 - X_2 = 0$$

and assuming no externalities in consumption

then

$$(28)\quad \frac{\partial U}{\partial X_1} = \lambda; \quad \frac{\partial U}{\partial X_2} = \lambda$$

and

$$(29)\quad \frac{\partial U}{\partial X_1} = \frac{\partial U}{\partial X_2} .$$

In equilibrium, marginal utilities of income λ are equal among individuals.

Dropping the assumption of a fixed total income (output), the analysis becomes more complex. Again the assumption of a Pareto Optimum (equal marginal rates of substitution between any two products between any two firms, etc.) must hold but additional conditions are required to maximize utility.

For simplicity, assume a one-commodity world of two consumer-producers where q_1 is consumption (income) of individual 1 and q_2 is consumption (income) of individual 2. Total utility is expressed by the separable social welfare function

(30) $U = U[q_1(x_1), q_2(x_2)]$.

The production function for consumer-producer 1 with X_1 resource (may be constant-dollar weighted sum of all resources) is

(31) $q_1 = q_1(x_1)$,

and for consumer-producer 2 with x_2 resource is

(32) $q_2 = q_2(x_2)$.

Given total primary resources $x = x_1 + x_2$, maximizing utility subject to the resource constraint is accomplished by taking the derivative of the Langrangian expression

(33) $U^* = [q_1(x_1), q_2(x_2)] + \lambda(x - x_1 - x_2)$

with respect to x_1, x_2 and λ and setting the expressions equal to zero.

(34) $$\frac{\partial U^*}{\partial x_1} = \frac{\partial U}{\partial q_1}\frac{\partial q_1}{\partial x_1} - \lambda = 0$$

(35) $$\frac{\partial U^*}{\partial x_2} = \frac{\partial U}{\partial q_2}\frac{\partial q_2}{\partial x_2} - \lambda = 0$$

(36) $$\frac{\partial U^*}{\partial \lambda} = x - x_1 - x_2 = 0$$

(37) $$\frac{\partial U}{\partial q_1}\frac{\partial q_1}{\partial x_1} = \frac{\partial U}{\partial q_2}\frac{\partial q_2}{\partial x_2}$$

(38) $$\frac{\frac{\partial U}{\partial q_1}}{\frac{\partial U}{\partial q_2}} = \frac{\frac{\partial q_2}{\partial x_2}}{\frac{\partial q_1}{\partial x_1}}$$

(39) $$\frac{MU_1}{MU_2} = \frac{MPP_2}{MPP_1}$$

(40) $$\frac{\partial U}{\partial x_1} = \frac{\partial U}{\partial x_2}.$$

Thus resources are allocated so that the marginal utility of resources is equal among individuals to maximize utility to society as shown in equation 40. Marginal utilities of income are inversely proportional

to marginal productivity between individuals. If income is a simple linear proportion (constant fraction) of resources for all individuals, it follows that marginal utilities of income and resources (wealth) can be used interchangeably.

The income distribution to increase well-being of society must consider the impact on well-being of utility gained by a more equal distribution and the utility lost through disincentives caused by redistribution. Movement toward a more equal distribution of income reduces output but increases utility with a given output. Movement toward a more unequal income distribution may raise output but lower utility generated by any given output. The optimal distribution represents the appropriate compromise of these conflicting effects. The optimal distribution of income is neither a maximum total income nor equal income for all.

An earlier study (Tweeten and Walker) which at least crudely accounted for incentives and lost output from redistribution estimated that well-being of society would be increased by less income inequality, but the optimal income distribution appeared to be only somewhat less unequal than the actual distribution in the 1970s based on the marginal utility curve in Figure 1.

Setting Tax Rates

Marginal utility can be used to establish tax rates. Overall effective tax rates for combined local, state, and federal taxes are essentially proportional over a considerable range of income (Sisson). Based on results shown in Figure 1, a proportional system is not consistent with equal real sacrifice to all. The income tax schedule

reflecting equal marginal sacrifice would need to be progressive throughout according to Figure 1. However, an optimal tax rate must also consider disincentives to output associated with high marginal tax rates on persons in higher income brackets.

Benefit-Cost Analysis

The traditional practice in benefit-cost project analysis is to compute the present value of future benefits and future value of discounted costs, ignoring who receives benefits and who pays costs. Projects are judged to be economically feasible if net benefits exceed costs, i.e. the economic benefit-cost ratio (B-C) exceeds 1.0. If the marginal utility of each dollar of output generated by the project is low and if the marginal utility of each dollar sacrificed to pay for the project is high, implementation of projects with B-C ratios even above 1.0 may reduce overall utility.

To avoid this shortcoming of the economic B-C ratio as a guide to investment, Tweeten (1979, Chapter 16) suggested a satisfaction-sacrifice ratio or social benefit-cost ratio to guide funding of public projects, with projects to be judged socially feasible if the social benefit-cost exceeds 1.0. Social benefits are economic benefits multiplied by marginal utilities of those who receive additional output; social costs are economic costs multiplied by marginal utilities of those who pay the cost of the project.

Table 8 provides a hypothetical example for a public irrigation project. The hypothetical project with an unfavorable conventional economic benefit-cost ratio of .94 has a favorable social benefit-cost ratio of 1.44 when benefits and costs are weighted by marginal

Table 8. Hypothetical Example of Economic Benefit-Cost Versus Social Benefit-Cost Analysis for Agricultural Irrigation Project

Family Income	Economic		MU[a]	Social		Pure Transfer	
	Benefits	Costs		Benefits	Costs		
	$ Million			$ Million Utility Adjusted		$ Million[b]	$ Million Util. Adj.
$0 - $10,000	5	2	1.2729	6.36	2.55	3	3.82
$10,000 - $20,000	4	3	1.1023	4.41	3.31	1	1.10
$20,000 - $40,000	3	3	0.8465	2.54	2.54	0	0.00
$40,000 - $80,000	2	4	0.3349	0.67	1.34	-1	-0.33
$80,000 +	2	5	0.0000[c]	0.00	0.00	-3	0.00
	16	17		13.98	9.74	0	4.59
	Economic B-C ratio 0.94 Net economic benefits $16 - 17 mil. = -$1 mil.			Social B-C ratio 1.44 Net social benefits $13.98 - 9.74 mil. = $4.24 mil.		Net social benefits $4.59 million	

[a]Marginal utility computed from equation 14.

[b]Economic benefits less costs. Because costs exceeded benefits, transfers from higher income group exceeded those to lower income groups. With pure transfer, net transfer is zero -- an outcome brought about by arbitrarily reducing the net transfer out of the $40-80 thousand income group by $1 billion.

[c]Family income if over $80,000 was outside the range of data. Although equation 14 predicts negative marginal utility for incomes over $80,000, a zero value is assumed because marginal utility may not continue to decline for very high incomes.

utilities among income groups. (The assumption is that project changes have a small impact on income so only marginal utilities are considered. If large changes in income are engendered, the marginal utility weights suitable for small changes in income will be inappropriate.) Because marginal transfers of income from median income persons to very low income persons provide a social benefit-cost ratio of 1.4, it follows that pure transfer payments void of incentive effects can as efficiently raise utility as can investment projects which have a conventional economic benefit-cost ratio less than 1.4 -- assuming investment projects only involve costs and benefits for families with median income. Of course, other dimensions such as freedom and administrative cost must also be considered.

The final two columns in Table 8 illustrate a very important principle -- a pure transfer is a more cost-effective means to redistribute income to raise utility than is funding an economically inefficient project such as the irrigation facility. Thus funding of the irrigation project in Table 8 socially is more beneficial than doing nothing but it is a second best solution -- foregoing the project and merely redistributing income is socially even more beneficial.

In reality, pure transfers that do not reduce the available quantities of goods and services are rare or nonexistent. Also, considerable disutility can arise from the very act itself of taxing the wealthy and from reducing incentives to employ resources, especially savings and investment. Thus redistribution needs to emphasize (1) policies such as property and estate taxes that

interfere minimally with efficient resource allocation and (2) positive policies such as investment in human resources of the disadvantaged, an approach which can be consistent with both economic efficiency and equity.

Summary and Conclusions

One conclusion of this report is that methodology now available offers promise for deriving useful indicators of group (but not individual person) utility, a vital first step in specifying a social welfare function whose arguments include the level, distribution, and variability of income. Estimates of the marginal utility curve appear to be somewhat robust to some changes in indicator domains, geographic regions, time, and methods of analysis. It appears that consistency requires a rather comprehensive set of indicator variables, careful gathering and processing of data, and large samples. Although rural populations do not seem to differ from the U.S. population, the farm population may be unique. Hence results from samples of the farm population will not necessarily conform to results from nationwide cross-sectional samples. Of special interest is the extent to which the methodology of this study can be extended to other countries and cultures.

Results indicate that the U.S. population and farmers are risk averse. Persons in lower-income families tend to derive greater satisfaction from an additional dollar of income than do persons in higher income families. Families with little income were estimated to derive approximately 40 percent more satisfaction from an additional dollar of income than a family with national median income. And

families with incomes four or more times the national median were found to derive little utility from additional income.

From such analysis, redistribution to the poor would appear to raise well-being of society. The issue of a welfare-maximizing income-wealth distribution cannot be resolved from marginal utility of income alone although measures in this study are important building blocks. An appropriate distribution of income and wealth also depends on incentives, economic efficiency, and income growth as well as values regarding taxation and rights to property and acquired wealth. The intent of this study is not to advocate income or resource redistribution but rather to provide a tool to analyze the implications for well-being of redistribution. Actual decisions are made by political and other processes.

"Objective" socio-economic indicators such as income, education, and marital status are often used by analysts as proxies for well-being. Although such indicators are sometimes grouped by factor analysis into a single index to measure socio-economic development, such "objective" indicators may best be regarded as independent explanatory variables in search of a dependent variable such as derived herein to measure quality of life.

Results presented here are for the United States. A useful point of departure for future studies is to determine to what extent results generalize to other cultures.

REFERENCES

Arrow, Kenneth. Aspects of the Theory of Risk-Bearing. Helsinki: Academic Book Store, 1965.

Bradburn, Norman. The Structure of Psychological Well-Being. Chicago: Aldine, 1969.

Coughenour, Milton and Luther Tweeten. "Quality of Life Perceptions and Farm Structure." (Paper prepared for S-148 Committee on Farm Structure). Knoxville: Department of Rural Sociology, University of Kentucky, 1986.

Durkheim, Emile. Suicide: A Study in Sociology. New York: The Free Press, 1951.

Fox, Karl. "The Eco-Behavioral View of Human Societies and Its Implications for Systems Science." International Journal of Systems Science, 14(1983): 895-914.

Halter, A. N. and Robert Mason. "Utility Measurement for Those Who Need to Know." Western Journal of Agricultural Economics. 3(December 1978): 99-109.

Harper, Wilmer and Luther Tweeten. "Socio-psychological Measures of Quality of Rural Life: A Proxy for Measuring the Marginal Utility of Income." American Journal of Agricultural Economics, 59(December 1977): 1000-05.

Hildreth, Clifford and Glenn Knowles. "Some Estimates of Farmers' Utility Functions." Technical Bulletin No. 335. St. Paul: Agricultural Experiment Station, University of Minnesota, 1982.

Lin, William, G. W. Dean, and C. V. Moore. "An Empirical Test of Utility Versus Profit Maximization in Agricultural Production. American Journal of Agricultural Economics, 56(August 1974): 497-508.

Miller, Thomas and Robert House. "World Food Study: Implications of Increasing World Market Instability on U.S. Agriculture." (Paper presented at GPC-10 Annual Meeting, Big Sky, Montana, June 2, 1983.) Fort Collins: ERS-USDA and Department of Economics, Colorado State University, 1983.

National Opinion Research Center. General Social Surveys, 1972-1980: Cumulative Code Book. Chicago: NORC, University of Chicago, July 1980.

Newbery, David and Joseph Stiglitz. The Theory of Commodity Price Stabilization. Oxford: Clarendon Press, 1981.

Pratt, J. W. "Risk Aversion in the Small and Large." Econometrica, 32(January-April 1964): 122-36.

Schoemaker, Paul J. H. "The Expected Utility Model: its Variants, Purposes, Evidence and Limitations." Journal of Economic Literuature, 20(June 1982): 529-63.

Sisson, Charles Adair. Tax Burdens in American Agriculture. Ames: Iowa State University Press. 1982.

Tweeten, Luther and Neal Walker. "Economic Cost of Poverty." Chapter 4 in Robert Coppedge and Carlton David, eds. Rural Poverty and the Policy Crisis. Ames: Iowa State University Press, 1977.

Tweeten, Luther. "Economic Instability in Agriculture." American Journal of Agricultural Economics, 65(December 1983): forthcoming.

Tweeten, Luther. Foundations of Farm Policy. Lincoln: University of Nebraska Press, 1979.

APPENDIX

VARIABLES USED TO CONSTRUCT QUALITY OF LIFE INDEX

Hedonistic Subindex (H)

Indicator Variables

[VAR: HAPPY] Taken all together, how would you say things are these days -- would you say that you are very happy, pretty happy, or not too happy?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Very happy	2	511	496
Pretty happy	1	800	771
Not too happy	0	188	195
Don't know	0	0	1
No answer	0	0	5

[VAR: LIFE] In general, do you find life exciting, pretty routine, or dull?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Exciting	2	660	672
Routine	1	761	708
Dull	0	54	82
No opinion	0	9	6
No answer	0	15	0

Factor Analysis

The two indicator variables weighted equally (.8) as scores in factor analysis; the results are not shown. The above two indicator variables were weighted equally to form H.

Anomie 1 Subindex (A1)

Indicator Variables

[VAR: HELPFUL] Would you say that most of the time people try to be helpful, or that they are mostly just looking out for themselves?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Try to be helpful	2	646	714
Just look out for themselves	0	756	678
Depends (Vol.)	1	91	64
Don't know	1	5	9
No answer	1	1	3

[VAR: FAIR] Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Would take advantage of you	0	542	505
Would try to be fair	2	887	882
Depends (Vol.)	1	62	63
Don't know	1	8	18
No answer	1	0	0

[VAR: TRUST] Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Most people can be trusted	2	664	665
Can't be too careful	0	775	741
Other, depends (Vol.)	1	56	55
Don't know	1	2	5
No answer	1	2	2

Factor Analysis

Appendix Table 1 shows results of the factor analysis of indicator variables for Anomie 1. Each variable weighted .8, indicating a .8 simple correlation with the overall factor.

Appendix Table 1. Factor Scores for Anomie 1 Subindex A1.[a]

Indicator Variable	Factor F1
HELPFUL	.7828
FAIR	.7680
TRUST	.7953

[a]Data for indicator variables obtained from National Opinion Research Center (NORC).

Anomie 2 Subindex (A2)

Indicator Variables

[VAR: ANOMIA5] In spite of what some people say, the lot (situation/condition) of the average man is getting worse, not better.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Agree	0	877	986
Disagree	2	570	449
Don't know	1	50	32
No answer	1	2	1

[VAR: ANOMIE6] It's hardly fair to bring a child into the world with the way things look for the future.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Agree	0	621	685
Disagree	2	821	743
Don't know	1	53	38
No answer	1	4	2

[VAR: ANOMIE7] Most public officials (people in public office) are not really interested in the problems of the average man.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Agree	0	976	1038
Disagree	2	487	383
Don't know	1	31	44
No answer	1	5	3

Factor Analysis

Factor scores for Anomie 2 are shown in Appendix Table 2. Anomie 7 loaded somewhat less than the other two indicator variables.

Appendix Table 2. Factor Scores for Anomie 2 Subindex A2.[a]

Indicator Variable	Factor F1
ANOMIE5	.7595
ANOMIE6	.7811
ANOMIE7	.5997

[a]See Appendix Table 1 footnotes for source.

Confidence Subindex C

Indicator Variables

As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?

[VAR: CONFINAN] Banks and financial institutions.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	590	463
Only some	0	717	737
Hardly any	-1	149	223
Don't know	0	36	40
No answer	0	7	5

[VAR: CONBUS] Major companies.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	328	399
Only some	0	764	779
Hardly any	-1	324	208
Don't know	0	75	80
No answer	0	8	2

[VAR: CONCLERG] Organized religion.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	457	517
Only some	0	667	631
Hardly any	-1	273	261
Don't know	0	94	56
No answer	0	8	3

[VAR: CONEDUC] Education.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	668	438
Only some	0	672	815
Hardly any	-1	229	183
Don't know	0	30	30
No answer	0	10	2

[VAR: CONFED] Executive branch of the federal government.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	201	177
Only some	0	874	737
Hardly any	-1	374	502
Don't know	0	45	49
No answer	0	5	3

[VAR: CONLABOR] Organized labor.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	173	220
Only some	0	710	727
Hardly any	-1	493	434
Don't know	0	118	85
No answer	0	5	2

[VAR: CONPRESS] Press.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	424	322
Only some	0	776	849
Hardly any	-1	263	253
Don't know	0	27	43
No answer	0	9	1

[VAR: CONMEDIC] Medicine.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	807	768
Only some	0	527	568
Hardly any	-1	138	109
Don't know	0	20	22
No answer	0	7	1

[VAR: CONTV] TV.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	279	235
Only some	0	779	801
Hardly any	-1	406	406
Don't know	0	26	25
No answer	0	9	1

[VAR: CONJUDGE] U.S. Supreme Court.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	528	361
Only some	0	650	734
Hardly any	-1	229	286
Don't know	0	84	87
No answer	0	8	0

[VAR: CONSCI] Scientific community.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	638	607
Only some	0	564	622
Hardly any	-1	112	93
Don't know	0	172	140
No answer	0	13	6

[VAR: CONLEGIS] Congress.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	205	136
Only some	0	869	779
Hardly any	-1	381	493
Don't know	0	39	58
No answer	0	5	2

[VAR: CONARMY] Military.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A great deal	1	584	405
Only some	0	616	764
Hardly any	-1	199	237
Don't know	0	92	61
No answer	0	8	1

[VAR: GETAHEAD] Some people say that people get ahead by their own hard work; others say that lucky breaks or help from other people are more important. Which do you think is most important?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Hard work most important	2	931	927
Hard work, luck equally important	1	357	409
Luck most important	0	197	118
Other (specify)	1	0	0
Don't know	1	11	11
No answer	1	3	3

Factor Analysis

The Confidence Subindex contains at least three dimensions (only factors with eigenvalues exceeding 1.0 were retained) according to Appendix Table 3, confidence in education, the federal goverbment and labor are prominent in factor F1, in the press and television in factor F2 and business, finance and science in factor F3.

Appendix Table 3. Factor Scores for confidence Subindex (C).[a]

Indicator Variable	Factors		
	F1	F2	F3
CONFINAN	.1714	.0523	.6203
CONBUS	.1244	-.0287	.6526
CONCLERG	.2306	-.0188	.3965
CONEDUC	.4728	.1715	.2083
CONFED	.7085	-.1359	.1940
CONLABOR	.5467	.2116	-.1583
CONPRESS	.1723	.7543	.0594
CONMEDIC	.1494	.2743	.5300
CONTV	.1315	.6433	.2489
CONJUDGE	.5708	.1304	.2591
CONSCI	.1392	.2244	.4738
CONLEGIS	.6913	.0614	.1871
CONARMY	.4551	-.0630	.3343
GETAHEAD	-.0988	-.2700	.3615

[a]See Appendix Table 1 footnotes for source.

Satisfaction Subindex (S)

Indicator Variables

For each area of life, tell the number that shows how much satisfaction you get from that area.

[VAR: SATCITY] The city or place you live in.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	293	347
A great deal	4	446	450
Quite a bit	3	260	224
A fair amount	2	307	267
Some	1	101	82
A little	0	57	65
None	-1	29	27
Don't know	0	4	6
No answer	0	2	0

[VAR: SATHOBBY] Your non-working activities -- hobbies and so on.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	332	399
A great deal	4	524	500
Quite a bit	3	267	230
A fair amount	2	163	161
Some	1	84	72
A little	0	74	60
None	-1	45	38
Don't know	0	6	7
No answer	0	4	1

Satisfaction Subindex (S)

Indicator Variables

For each area of life, tell the number that shows how much satisfaction you get from that area.

[VAR: SATCITY] The city or place you live in.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	293	347
A great deal	4	446	450
Quite a bit	3	260	224
A fair amount	2	307	267
Some	1	101	82
A little	0	57	65
None	-1	29	27
Don't know	0	4	6
No answer	0	2	0

[VAR: SATHOBBY] Your non-working activities -- hobbies and so on.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	332	399
A great deal	4	524	500
Quite a bit	3	267	230
A fair amount	2	163	161
Some	1	84	72
A little	0	74	60
None	-1	45	38
Don't know	0	6	7
No answer	0	4	1

[VAR: SATFAM] Your family life.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	570	648
A great deal	4	564	496
Quite a bit	3	161	148
A fair amount	2	92	90
Some	1	39	27
A little	0	33	27
None	-1	31	23
Don't know	0	3	7
No answer	0	6	2

[VAR: SATFRND] Your friendships.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	438	502
A great deal	4	597	609
Quite a bit	3	241	184
A fair amount	2	142	112
Some	1	40	30
A little	0	26	18
None	-1	8	12
Don't know	0	4	1
No answer	0	3	0

[VAR: SATHEALT] Your health and physical condition.

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
A very great deal	5	364	421
A great deal	4	528	513
Quite a bit	3	219	198
A fair amount	2	243	184
Some	1	58	58
A little	0	51	61
None	-1	31	29
Don't know	0	3	4
No answer	0	2	0

[VAR: SATJOB] On the whole, how satisfied are you with the work you do -- would you say you are very satisfied, moderately satisfied, a little dissatisfied, or very dissatisfied?

RESPONSE	WEIGHT	NUMBERS	
		1976	1980
Very satisfied	4	617	584
Moderately satisfied	2	407	444
A little dissatisfied	-1	108	159
Very dissatisfied	-2	53	59
Don't know	0	3	1
No answer	0	17	7

Factor Analysis

The Satisfaction Subindex appears to have one dimension according to the factor analysis in Appendix Table 4. Satisfaction with family and friends weights more heavily than satisfaction with employment.

Appendix Table 4. Factors scores for Satisfaction Index

Indicator Variable	Factor F1
SATCITY	.6113
SATHOBBY	.6837
SATFAMILY	.7037
SATFRND	.7257
SATHEALT	.5698
SATJOB	.3991

[a]See Appendix Table 1 footnotes for source.