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THE STRUCTURAL CHANGE HYPOTHESIS FOR EMPLOYMENT AMONG YOUTH, THE AGED, AND MINORITIES: A CRITICAL ANALYSIS

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[Arlington, Va.]
INSTITUTE FOR DEFENSE ANALYSES
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FOREWORD

In February 1965 the Institute for Defense Analyses, in response to a request to undertake a study for the Office of Economic Opportunity (OEO), organized a Poverty Research Project whose activities were completed in December of 1965. During this period, the project activities were reported to OEO in a series of 13 working papers which, together with a draft of a project summary report, have been under review since January 1966. A summary of the IDA research activity was presented to OEO in a briefing on 28 January 1966.

This document is one of several formal publications resulting from that work. The results reported here are incorporated in a project Summary Report written by the Project Leader, Richard F. Muth:

Report R-116 - Federal Poverty Programs: Assessment and Recommendations, January 1966.

Other supporting publications are:

S-244 - Richard F. Muth, The Evaluation of Selected Present and Potential Poverty Programs.

S-245 - Neil S. Weiner, The Distribution of the Gross Benefits of Present Federal Welfare and Income-Maintenance Programs.

S-246 - Richard X. Chase, An Evaluation of the Reduction in Poverty Among Various Demographic Groups, 1947-1963.

P-272 - Stanley W. Besen, Evaluating the Returns to Regional Economic Development Programs.

P-273 - Anthony Fisher, Poverty and Labor-Force Participation.

P-274 - Bette S. Mahoney, Areas of Declining Employment.

P-275 - Richard F. Muth, The Structural Change Hypothesis for Employment Among Youth, The Aged, and Minorities: A Critical Analysis.

P-277 - Elliot Wetzler, Determination of Poverty Lines.

P-278 - Elliot Wetzler, Projection of the Number of Poor Families to 1970 and 1975.

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SUMMARY AND RESULTS

Plans for the long run shape of the Poverty program must hinge, in part, on projections of the number and composition of the poor. Projections made by both IDA and the Council of Economic Advisors indicate that even rapid economic growth will still leave a substantial number of families poor in 1970 and 1980. Gallaway, in contrast, has argued that most poverty will be eliminated automatically if the US economy grows at the rate achieved in the period 1947-56, and that large expenditures or special poverty programs are unnecessary. The aim of this Paper is to compare and evaluate the projection methods used by the Council of Economic Advisors, Gallaway, and IDA.

The Council's projections were based on a straight-line extrapolation of the relative rate of decline in the period 1947-56 in the percentage of families with yearly incomes less than $3,000 (in 1963 dollars). Gallaway's projections were derived from regression analysis of the percentage of families poor by the Council's definition on median income and the unemployment rate. IDA's projections were based on probit analysis, using 1948 and 1960 data on median incomes and income distributions for population groups (e.g., farm, aged). Instead of a $3,000 poverty cut-off level for all families, adjustments were made for various population groups.

This Paper argues that:

(1) Failure of the Council and Gallaway to adjust the poverty cut-off level for farm families leads to an overstatement of the rate of poverty decline during the postwar years and to a downward bias in the projections of the number poor in 1970.

(2) Assuming that income is approximately log-normally distributed, the slopes of either the percent poor or its logarithm on the logarithm of the median income is likely to be

more nearly constant over time than that on median income in the natural form. The coefficient on median income in the natural form will tend to decline over time as median income increases; projections based on the average coefficient for an earlier period (like Gallaway's) are likely to overestimate the speed of poverty reduction in the future.

Also included in this Paper are regression estimates of alternative functional forms discussed above and comparisons of predictions based on them for 1963, 1970, and 1980. These indicate that a variety of forms may fit the data for the base period equally well and give approximately identical predictions for years adjacent to the base period, and yet they may give very different projections for 1970 and 1980.

From the comparisons presented here it would appear that the log-normal type projections used by IDA, the constant relative rate of poverty elimination, and the double-log regression of percent of families poor on median income and on the overall unemployment rate all yield about the same proportion poor for total US families when projecting to 1970 or 1980. However, the semi-log used by Gallaway, and even more so the natural regression projections, is likely to overstate the rate of poverty reduction in the future and to overestimate the reduction in poverty which a faster rate of economic growth would produce.

I

INTRODUCTION

In the 1964 Economic Report[1], the Council of Economic Advisers made projections of the percent of families with income less than $3,000 per year (in 1963 dollars), essentially, by a straight-line extrapolation of the relative rate of decline in this percentage during the period 1947 to 1956. Soon after, Gallaway,[2] in a frequently quoted paper, presented an alternative set of projections derived from a regression analysis of the percentage of families who are poor by the Council's criterion on median income and the unemployment rate. Since the method of projection used in both studies differs from that utilized by IDA in projecting the percentage of families who are poor,[3] this Paper will compare the IDA method with the other two.

As a result of their analyses, the Council argued that, even at the rate of economic growth which took place prior to 1957, a substantial fraction of US families would remain poor by 1980, while Gallaway suggested that, to the contrary, a resumption of economic growth at the pre-1957 rate would substantially eliminate poverty. Although the primary concern here is not with the substantive issue of the effects of economic growth on the elimination of poverty, this aspect will be commented upon later. My major conclusion, notwithstanding

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1. U.S. Congress, Joint Economic Committee, January 1964 Economic Report of the President (Washington, D. C., Government Printing Office, 1964).

2. L. E. Gallaway, "The Foundations of the War on Poverty," American Economic Review, LV (March, 1965), 122-31.

3. Elliot Wetzler, Projections of the Number of Poor Families to 1970 and 1975, Institute for Defense Analyses, Economic and Political Studies Division, IDA Research Paper P-278 (Arlington, Va., in progress).

the difficulty of extrapolating past relationships, is that the projections made by Gallaway are likely to overstate the contribution that a more rapid rate of economic growth can make to the elimination of poverty.

II

THE EFFECTS OF NOT ADJUSTING FOR FARM-NONFARM DIFFERENCES

Neither the Council nor Gallaway made any adjustments to the poverty cut-off levels of different types of families in calculating the percent of poor families. This failure would probably not lead to any appreciable error in the estimates of size of family and age of family head. However, in the postwar period there was a marked reduction in the proportion of farm families, and a substantial adjustment in Census reported money-income levels for farm families is required to convert them into levels of equivalent well-being for nonfarm families. Elsewhere Wetzler[1] has argued that the appropriate poverty cut-off level for farm families is of the order of six-tenths of that for an otherwise similar nonfarm family.[2] Failure to adjust for farm vs. nonfarm differences would, besides overestimating the percent of poor at any given time, lead to a spuriously high poverty-elimination rate and an apparent slowdown in the rate of poverty elimination even if none existed.

For this reason the family income distribution has been adjusted as shown in Table 1: Farm families are allocated to adjusted overall income classes (farm and nonfarm) on the usual assumption made when one has only the grouped data available, namely, that items are distributed uniformly within any group or class interval. The total

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1. Elliot Wetzler, Determination of Poverty Lines, Institute for Defense Analyses, Economic and Political Studies Division, IDA Research Paper P-277 (Arlington, Virginia, in progress).

2. Wetzler's analysis also suggests that the poverty cut-off adjustment for farm families declines as income increases. Using a variable adjustment ratio, however, would have no effect on the fraction poor and but a negligible effect upon the median adjusted income. In fact, the major effect of the constant adjustment actually used on median income was to raise it by a constant $250 per year.

and farm-family income distributions in constant 1959 dollars, from which the nonfarm and adjusted total family distributions were derived, were obtained from Miller.[3] The median total family adjusted income was then calculated from the total family adjusted income distribution using the usual formula for calculating a median from grouped data. In calculating the percent of families poor from the adjusted income distribution, a cutoff of $2,650 was used; this figure is the same as the cutoff in 1959 dollars for a nonfarm family of 1959 average size. Since farm families are somewhat larger on the average than nonfarm families, the adjusted income cut-off level is larger for the former; but since farm families are a relatively small fraction of total US families, a weighted-average of the adjusted income cut-off levels for farm and nonfarm families is practically identical to the latter.

Table 1

ADJUSTMENTS IN FAMILY INCOME DISTRIBUTION

Farm Income Classes	Equivalent Nonfarm Income	Fraction of Farm Families in Adjusted Overall Family Income Classes (Farm and Nonfarm Included)						
		$0-$1[a]	$1-$2	$2-$3	$3-$4	$4-$5	$5-$6	$6-$7
$ 0-$1,000	$ 0-$1,667	.6	.4	-	-	-	-	-
$1,000-$2,000	$1,667-$3,333	-	.2	.6	.2	-	-	-
$2,000-$3,000	$3,333-$5,000	-	-	-	.4	.6	-	-
$3,000-$4,000	$5,000-$6,700	-	-	-	-	-	.6	.4

a. In thousands of dollars.

The result of these adjustments can be easily seen from Table 2. For each of the cyclical peak years in the postwar period, the percent of families poor based upon the unadjusted income distribution is larger than that calculated from the adjusted distribution, and

3. Herman P. Miller, Trends in the Income of Families and Persons in the United States: 1947 to 1960, Bureau of the Census Technical Paper No. 8 (Washington, D.C.: Government Printing Office, 1963).

the difference declines with the decline in the percent of farm families. More importantly, for the whole period 1948 to 1960 and for each of the subperiods shown in Part B of the table except 1953 to 1957, the poverty-elimination rate is greater for the unadjusted than for the adjusted distribution. Most important of all, probably, is the fact that the poverty-elimination rate based upon the adjusted distribution was virtually the same from 1953 to 1957 as from 1948 to 1953, but was about three-fourths of a percentage point lower in the later time period for the unadjusted distribution. This suggests that the fraction of families below a certain income level is more likely to be stable over time in relation to median income and other variables if the adjusted income level is used. The remainder of this Paper uses the adjusted definition of poverty exclusively.

Table 2

COMPARISON OF UNADJUSTED AND ADJUSTED DEFINITIONS OF POVERTY[a] FOR FAMILIES, CYCLICAL PEAK YEARS

Years	Definition		Farm Families as Percent of All Families
	Unadjusted	Adjusted	
A. Percent Poor			
1948	29.5	26.0	17.5
1953	23.5	21.3	12.9
1957	20.2	18.2	11.0
1960	19.0	17.6	7.7
B Relative Rate of Decline Per Year in Percent Poor			
1948-60	.0367	.0325	
1948-57	.0421	.0396	
1948-53	.0455	.0399	
1953-57	.0378	.0393	
1957-60[b]	.0204	.0112	

a. Poverty is defined here as family income less than $2,650 in 1959 dollars.

b. The data for this period are distorted as compared to earlier years by the Census Bureau's change in the definition of farm family in 1959.

III

COMPARISON OF METHODS OF RELATING PERCENT POOR TO MEDIAN INCOME

For regression or any other type of statistical analysis used as the basis for extrapolation, it is especially important to choose the proper functional form of the relationship dealt with. Any functional form can be used to approximate any other to any required degree of accuracy provided that the range of the variables is small enough. The further beyond the chosen range a relationship is extrapolated, the greater the inaccuracy of an incorrect functional form. In considering the fraction of families with incomes below a certain level in relation to the average income level of all families, the variables are related by the cumulative income distribution. So long as the frequency distribution is unimodal and not J-shaped, the cumulative distribution will exhibit a positive curvature for income levels below the mode.[1] This last consideration suggests that the logarithm of the percent poor will be more nearly linearly related to a measure of average income. If the income distribution is approximately logarithmically normal, as has been suggested by many writers for a variety of reasons,[2] the logarithm of median income is the mean of the income distribution; for this reason the slope of either the percent poor or its logarithm on the logarithm of median income is

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1. This fact is the basis for the variant of the "backwash" thesis advanced by the Council and by Anderson. In essence, the backwash thesis alleges that there exists a group of families and/or individuals of practically significant size whose incomes grow substantially less rapidly than average with general economic progress. (W. H. L. Anderson, "Trickling Down: The Relationship Between Economic Growth and the Extent of Poverty Among American Families," Quarterly Journal of Economics, LXXVIII (November, 1964), 511-24.

2. A discussion of the argument used by several of these writers is given in Aitchison and Brown (J. Aitchison and J.A.C. Brown, The Lognormal Distribution (New York: Cambridge University Press, 1957)).

likely to be more nearly constant over time than that on median income in natural form.

To be more precise, let P = percent poor, and assuming that the income distribution is log-normal,

$$P \text{ or } \ln P = f(U) \tag{1}$$

and

$$U = \frac{L - \mu}{\sigma}$$

where

U = the unit normal deviate

L = the logarithm of the poverty cutoff

μ = the logarithm of median income

σ = the standard deviation of the log-normal income distribution

f = essentially the probit transformation, although the precise f depends upon whether P or lnP is considered.

Then,

$$dP \text{ or } d \ln P = f'x - \left(\frac{1}{\sigma} d\mu + \frac{(L - \mu)}{\sigma_2} d\sigma\right). \tag{2}$$

If, now, $d\mu = d \ln Y = dY/Y$, where Y is median income,

$$\frac{\partial P}{\partial Y} \text{ or } \frac{\partial \ln P}{\partial Y} = - \frac{f'}{\sigma Y},$$

and (3)

$$\frac{\partial P}{\partial \ln Y} \text{ or } \frac{\partial \ln P}{\partial \ln Y} = - \frac{f'}{\sigma}.$$

Thus, the constancy of any of the partial derivatives displayed above in Eq. 3 depends upon the constancy of the slope of the transformation used and that of σ. In addition, either slope on median income in natural form will tend to decline over time as median income increases. The poverty elimination-rate is given by

$$\frac{\partial P}{\partial t} \text{ or } \frac{\partial \ln P}{\partial t} = - \frac{f'}{\sigma} \left(\frac{\partial \ln Y}{\partial t} + U \frac{\partial \sigma}{\partial t}\right). \tag{4}$$

In addition to the constancy of f' and σ, if median income grows at a constant relative rate, as it appears to have done over relatively long periods of time, the first term in parentheses will tend to be constant. It appears that the implicit standard deviation of the log-normal distribution, that value which combined with the log-median and log-cut-off level yields the observed proportion of families who are poor, has tended to increase at a more or less constant rate during the postwar period.[3] As U decreases with a reduction in the percent poor, the effect of the increasing standard deviation on the poverty-elimination rate becomes more important relative to the effects of the increase in median income.[4]

Table 3 shows the values of the partial derivatives in Eq. 3 which have been calculated from data described in the footnotes to the table. The first two lines show the value of f' for P in natural and log form, respectively. The first of these declines drastically over time in the relevant range while the second tends to increase. As a result, the effects of increasing σ and Y are partly offset in $\partial \ln P/\partial Y$ but reinforced in $\partial P/\partial Y$, while $\partial \ln P/\partial \ln Y$ is practically constant over the range of currently relevant values. If projection is to be made via regression methods, these considerations suggest that a double-log regression--one with both P and Y in log form--would be more satisfactory than the regressions of P or ln P on Y, which Gallaway used. The last three lines suggest that projecting poverty elimination at a constant relative rate is also likely to be rather satisfactory, especially so between 1963 and 1970, since the rise in the elimination rate due to the increase in median income tends to be offset by the effects of an increased standard deviation. Of course, on the assumption of log-normality, given the mean and standard deviation of the distribution, the percent of families who are poor could always be determined exactly. In practice, though, the predictability of P would depend upon that of μ and σ.

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3. Elliot Wetzler, Projections of the Number of Poor Families to 1970 and 1975, Institute for Defense Analyses, Economic and Political Studies Division, IDA Research Paper P-278 (Arlington, Va., in progress).

4. This last observation provides a second rationale for the so-called "backwash" thesis.

Table 3

CALCULATED PARTIAL DERIVATIVES OF PROPORTION OF FAMILIES POOR, ASSUMING LOG-NORMALITY

	Year[a]		
	1953-57	1963	1970
$\frac{dP}{dU}$	.276	.227	.164
$\frac{d \ln P}{dU}$	1.41	1.58	1.80
$\frac{\partial P}{\partial \bar{Y}} \times 10^4$	- .718	- .450	- .251
$\frac{\partial \ln P}{\partial \bar{Y}} \times 10^3$	- .366	- .312	- .276
$\frac{\partial \ln P}{\partial \ln \bar{Y}}$	- 1.86	-1.90	-2.03
$\frac{\partial \ln P}{\partial t}$[b]	- .0351	- .0323	- .0315
due to $\partial \frac{\ln Y}{\partial t}$	- .0507	- .0517	- .0554
due to $\frac{\partial \sigma}{\partial t}$	.0156	.0194	.0239

a. In making the calculations shown in the body of the table, averages of the slopes of P or ln P with respect to U for the following ranges were used: 1953-57, P = (.15, .25); 1963, P = (.10, .20); and 1970, P = (.05, .15). Likewise, for Y and σ we used:

	1953-57	1963	1970
Y	5,071	6,084	7,360
σ	.7592	.8303	.8882

For 1953-57 the values used are averages of actual values for the two years; for 1963, the actual value for that year; and for 1970, the values used for the projection comparisons shown in Table 7.

IV

EMPIRICAL FINDINGS

The appraisal presented in the preceding section depends, of course, on how well the log-normal distribution approximates the lower-tail of the income distribution. Ultimately, the degree of confidence in any method of projection depends upon how well it agrees with known data. To determine this, two sets of regression equations of the different functional forms already discussed have been fitted using postwar data through 1960. In the first set of these the median adjusted income of families (MINC) was taken as given, and the percent of families with adjusted incomes less than $2,650 in 1959 dollars (POOR) was regressed on MINC as well as on the overall unemployment rate (UNEM) and a linear time trend (TREND). In the second set MINC was replaced by the median wage and salary income of male operatives (WSOP),[1] so that, in effect, the regression first predicts MINC and then POOR.

Also calculated are regression equations with MINC and the implicit standard deviation of the log-normal income distribution (STDV) as dependent on WSOP, UNEM, and TREND as independent. For these, all variables are in natural log-form except the last. For all the regressions described so far, only those independent variables that had t-ratios of unity or more were retained in the regression equations used. The last equation calculated is the regression equation appropriate for the hypothesis that poverty declines at a constant relative rate over time, i.e., the regression of ln P on TREND. This last was

1. This last was available only for 1950 and subsequent years, so I restricted the analysis to the period 1950 to 1960. Data for WSOP are from Miller (Herman P. Miller, Trends in the Income of Families and Persons in the United States: 1947 to 1960, Bureau of the Census Technical Paper No. 8 (Washington: U.S. Government Printing Office, 1963)).

calculated in first-difference form, since departures from trend caused by cyclical forces are likely to produce serially correlated residuals in the original form of the data. On the whole the Durbin-Watson ratios calculated for the original form of the other regressions gave no strong indication of serial correlation, so first-differences were not used for them. The constant poverty-elimination rate comparison is a natural "naive" hypothesis with which to compare the other regressions.

In Table 4 the various forms of the regression equation with POOR dependent are presented. The coefficients of MINC in Table 4 all agree roughly in magnitude with the values presented earlier in Table 2 for the period 1953 to 1957 but are all singificantly smaller than the latter. The primary reason for this discrepancy probably is due to an increase in the implicit standard deviation of the income distribution over time. As is obvious from Eq. 2, such an increase will tend to reduce the decline in poverty which accompanies rising incomes. Equation 3, of course, shows only the partial effects of income changes. The total effect of income changes when accompanied by changes in σ are given by

$$\frac{dP}{dY} \text{ or } \frac{d \ln P}{dY} = -\frac{f'}{\sigma Y} - \frac{f'U}{\sigma}\left(\frac{\partial \sigma}{\partial t} \Big/ \frac{\partial Y}{\partial t}\right), \tag{5}$$

and

$$\frac{dP}{d \ln Y} \text{ or } \frac{d \ln P}{d \ln Y} = -\frac{f'}{\sigma} - \frac{f'U}{\sigma}\left(\frac{\partial \sigma}{\partial t} \Big/ \frac{\partial \ln Y}{\partial t}\right).$$

When the total derivatives in Eq. 5 are evaluated using the information in the 1953 to 1957 column of Table 3 and the appropriate trends in the income distribution parameters, one finds the predicted income coefficient values shown below.

Form of Equation	Coefficient
Natural	$-.491 \times 10^{-4}$
Semi-log	$-.250 \times 10^{-3}$
Double-log	-1.29

The latter all agree much more closely than the values shown in Table 3 none being more than about two standard errors different than the corresponding coefficient in Table 4. All the predicted coefficients, however, are smaller than the actual ones. The remaining differences might reflect the effects of correlated variables which have been omitted from the regression equations shown in Table 4 or shortcomings in the log-normal approximation to the adjusted income distribution of all US families.

Table 4

REGRESSION EQUATIONS WITH POOR DEPENDENT, ALL US FAMILIES, 1950-60[a]

	Form of Equation		
	Natural	Semi-log[b]	Double-log[c]
Constant	.486 (.020)	- .254 (.086)	10.3 (.8)
MINC	$-.589 \times 10^{-4}$ (.045)	$-.278 \times 10^{-3}$ (.019)	- 1.38 (.08)
UNEM	.317 (.158)	1.22 (.68)	$.494 \times 10^{-1}$ (.237)
r^2 with percent poor[d]	.961	.972	.978
Durbin-Watson ratio	1.64	1.59	1.57
Constant	.540 (.024)	$.110 \times 10^{-1}$ (1.07)	11.4 (.8)
WSOP	$-.878 \times 10^{-4}$ (.062)	$-.420 \times 10^{-3}$ (.028)	- 1.58 (.10)
r^2 with percent poor[d]	.957	.966	.965
Durbin-Watson ratio	1.81	1.72	1.59

a. The variables used in this table are defined in the Appendix.
b. Dependent variable in natural logs, independent variables in natural form.
c. All variables in natural logs.
d. Simple correlation coefficient of actual percent poor and predicted dependent variable transformed to natural form.

In all three cases in Table 4 where MINC is used, UNEM enters with a positive coefficient which exceeds its standard error, but in none of the cases where WSOP is used instead of MINC does it do so. This is probably because the effects of unemployment are largely reflected in reduced annual earnings. Finally, note that all six equations do about as well for explaining variations in the fraction of families who are poor.[2] Not surprisingly, when WSOP is used instead of MINC the r^2 is smaller in each case. As might be expected from my earlier analysis, the equations with POOR in natural form do somewhat less well than those with POOR in natural logs. The double-log form, that with the independent variables in log form as well, does a little better when MINC is used. But by and large the differences in goodness of fit seem rather small.

Table 5 shows the results obtained when MINC and STDV are regressed on WSOP, UNEM, and TREND. The former is seen to be highly predictable in terms of WSOP and TREND. The regression with STDV on WSOP and UNEM yields reasonable coefficients. An increase in earnings of employed persons, while perhaps inducing some persons previously not in the labor force to enter it, would tend to increase the disparity in incomes between families with full-time earnings and those with part-time earnings or no members with earnings. At the same time, if higher unemployment rates lead to a greater loss in earnings for some families than for others, the dispersion of incomes within the population would tend to widen. The R^2 in this last equation, however, is much lower than for any other regression equation presented.

For comparison with the regression equations in Table 5 with MINC included, actual values of MINC and those for STDV predicted by the regression equation just discussed were substituted into the definition of U and the implied percent of families poor was found. This series had an r^2 with the actual percentage of .974, a little smaller than

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2. The r^2 presented is the simple coefficient between the actual fraction poor in natural form and the predicted dependent variable for the equation in question transformed to natural form. Hence it need not be the same as the conventional R^2 for a regression equation .

Table 5

REGRESSION EQUATIONS WITH LOG-NORMAL INCOME DISTRIBUTION PARAMETERS
DEPENDENT, ALL US FAMILIES, 1950-60
(All Except TREND in Natural Logs)

	Dependent Variable	
	MINC	STDV
Constant	2.88 (.89)	- 1.80 (.58)
WSOP	.688 (.111)	.329 (.067)
UNEM	--	$.470 \times 10^{-1}$ (.155)
TREND	$.140 \times 10^{-1}$ (.027)	--
R^2	.993	.873
Durbin-Watson ratio	2.41	1.67

that for the double-log regression using MINC but a little larger than for the other two. For comparison with the regression equations using WSOP in place of MINC, I substituted the calculated values of both MINC and STDV from the regressions shown in Table 5 into the definition of U to find a calculated POOR. Here the r^2 with the actual series was .971, actually a little larger than for any of the three regression equations. In comparison, the calculated series for POOR from the first-difference regression of ln P on t yielded an r^2 with the actual POOR of only .907, decidedly smaller than for all the others. Incidentally, this last regression yielded an annual poverty-elimination rate of .0379, which agrees rather closely with the value calculated for 1953 to 1957 shown in Table 3.

Using the results described thus far, I next attempted to predict the percent of families poor for the year 1963 using known values of the variables used by a particular relationship and the particular

regression equation estimated from 1950 to 1960 data.[3,4] In addition, projections were made to 1970 and 1980 by extrapolating variables used by a particular relationship at their average relative rates of increase for the period 1950 to 1963, except in the case of UNEM for which the average level 1950 to 1963 rate was used. All values of the variables used in these predictions and projections are shown in Table 6.

Table 6

VALUES OF VARIABLES USED FOR PROJECTIONS

	MINC	WSOP	UNEM	TREND
Actual, 1963	6,084	4,594	.057	17
Projected:[a]				
1970	7,360	5,470	.047	24
1980	9,670	7,030	.047	34

a. MINC and WSOP projected at average relative rate of growth, 1950 to 1963. Projected UNEM is 1950 to 1963 average.

The predictions and projections of the percent of families who are poor discussed in the preceding paragraph are summarized in Table 7. In every case the values obtained using WSOP are a little lower than those using MINC. The extrapolation of the poverty-elimination rate, the double-log regression, and log-normal equation all yield values

3. With the exception of UNEM, all the data used were obtained from the current population survey for 1963. Current dollar magnitudes, of course, were converted to 1959 dollars by deflating the consumer price index. All other computations were performed in a manner analogous to those already described. (U.S. Department of Commerce, Bureau of the Census, "Income of Families and Persons in the United States: 1963," Consumer Income, Current Population Reports, Series P-60, No. 43, September, 1964 (Washington; D.C.: Government Printing Office, 1964.)

4. At the time the research reported here was done, 1963 was the latest year for which income data were available. Comparisons of actual with the various predicted values would have been less revealing for earlier years because the changes from the sample period would have been less marked.

which differ but little from each other for each of the three years. As would be anticipated from the earlier comparison of the constancy of the partial derivatives of P (POOR) with respect to Y (MINC) for the various functional forms, the semi-log regression yields somewhat smaller values and the natural form of the regression smaller still. While the differences are not large for the 1963 predictions, the differences are certainly big enough to be of substantial practical importance for 1980,[5] despite the fact that, apart from the constant poverty-elimination rate regression, all the equations estimated for 1950 to 1960 data fit just about equally well. Using the definition of poverty adopted for these comparisons, the actual value calculated for 1963 was 15.8 percent. Somewhat surprisingly, since it fit the data for the sample period distinctly less closely, the extrapolation of the poverty-elimination rate came closer than any of the predictions for 1963, but both the double-log and log-normal equation predictions were also quite close.

Before concluding this Section I should like to return for a moment to Gallaway's (op. cit.) contention that a more rapid rate of economic growth would substantially eliminate the poverty problem by 1980 apart from a "hard-core group," which he estimated would comprise about 1 out of 16 families rather than the Council's estimate of 1 in 10. Apart from the other issues his remarks raise,[6] it seems that Gallaway's estimate of the extent of poverty 15 years hence, based as it was on a semi-log regression of P on Y, is likely to underestimate the extent of future poverty. This follows largely from the fact that the regression coefficient which approximates $\partial \ln P/\partial Y$ is likely to be numerically smaller in the future than during the 1950's. For this reason, too, Gallaway's estimates seem likely to overestimate the reduction in poverty which would result from a more rapid rate of economic growth. Part A of Table 8 shows the reduction in the percentage of

5. In fact, the natural form of the regression yielded negative values in both cases for 1980, so the projected value was set to 0 in Table 7.

6. Important among them being the relative cost of faster economic growth as compared with those of specific anti-poverty measures which would accomplish the same reduction in poverty.

Table 7

PROJECTED PERCENT OF FAMILIES POOR

	1963	1970	1980
Extrapolation of Poverty Elimination Rate	15.7	12.1	8.3
A. Using MINC			
Regression equation:			
Natural	14.6	6.7	0
Semi-log	15.3	10.6	5.6
Double-log	15.5	11.8	8.1
Log-normal equation	16.1	12.5	9.1
B. Using WSOP			
Regression equation:			
Natural	13.7	6.0	0
Semi-log	14.4	9.0	5.2
Double-log	14.6	11.1	7.5
Log-normal equation	15.0	11.1	7.6

US families who are poor at the end of the period which I have calculated from the regressions described earlier, on the assumption that median income grows at a rate which is 1 percent per year more rapid than the actual 1950 to 1963 rate during the periods 1963 to 1970 and 1963 to 1980. Again the double-log and log-normal equations agree fairly well but the semi-log form of the regression Gallaway used as the basis for his projections yields an estimate which is substantially larger than those for each of the periods. I have also calculated from all four equations the reduction in poverty which might result from a reduction of the overall unemployment rate by one point from the 1950-63 average, 4.7 percent, to the average rate for the first three postwar cyclical peak years, 3.7 percent. No matter which of the equations is used the reduction in poverty would appear to be quite small.

Table 8

THE EFFECTS OF A MORE RAPID GROWTH IN INCOME AND A REDUCTION OF THE TOTAL UNEMPLOYMENT RATE ON THE PERCENT OF FAMILIES POOR

Equation Type	Change in Percent Poor, Percentage Points	
	1970	1980
A. 1 Percent/Year More Rapid Growth in Income		
Regression equation:		
Natural	-3.1	-10.8
Semi-log	-1.5	- 2.2
Double-log	-1.1	- 1.7
Log-normal equation	-1.0	- 1.4
B. Reduction of Total Unemployment Rate from 4.7 to 3.7 Percent		
Regression equation:		
Natural	- .3	- .3
Semi-log	- .1	- .1
Double-log	- .1	- .1
Log-normal equation	- .3	- .2

V

CONCLUSIONS

Perhaps the most important conclusion to be drawn from this analysis is that a variety of functional forms of a relationship may fit the data for a given time period equally well and yet imply quite different values for the future. Such a conclusion, of course, is far from novel, but the fact needs to be emphasized again. From the comparisons presented here it would appear that the log-normal type projections used by Wetzler,[1] the constant relative rate of poverty elimination, and the double-log regression of percent of families poor on median income and the overall unemployment rate all yield about the same proportion poor for total US families when projecting to 1970 or 1980. However, the semi-log (used by Gallaway) and even more so the natural regression projections are likely to overstate the rate of reduction of poverty in the future and to overestimate the reduction in poverty which a faster rate of economic growth would produce. While economic growth will, no doubt, be beneficial to the vast majority of US families, the evidence for generally increasing standard deviations of log-normal distributions approximating actual income distributions presented in this paper and by Wetzler (ibid.) as well as the slower growth rates of median incomes for families with aged and with female heads, suggest additional reasons for the "backwash" or "hard core group of poor" hypothesis advanced by the Council.

1. Elliot Wetzler, Projections of the Number of Poor Families to 1970 and 1975, Institute for Defense Analyses, Economic and Political Studies, IDA Research Paper P-278 (Arlington, Va., in progress).

APPENDIX

DEFINITION OF VARIABLES USED

DEFINITION OF VARIABLES USED

POOR: Fraction of families with adjusted incomes less than $2,650 in 1959 dollars (as described more fully in text).

MINC: Median adjusted income of families in 1959 dollars (as described more fully in text).

STDV: Implicit standard deviation of log-normal adjusted income distribution of families (details of its calculation are discussed in text).

WSOP: Median wage and salary income of male operatives in 1959 dollars.

UNEM: Fraction of total labor force who are unemployed.

TREND: Year minus 1946.