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ABSTRACT

This document comprises 8 papers presented at the COBRE Research Workshop on Higher Education. The papers are: (1) "Schooling and Equality from Generation to Generation;" (2) "Time Series Changes in Personal Income Inequality: The United States Experience, 1939 to 1985;" (3) "Education, Income, and Ability;" (4) "Proposals for Financing Higher Education and Their Implications for Equity;" (5) "State Tuition Policy and Student Loans: An Exploration into Their Effects on Educational Attainment, Mobility, and the Distribution of Income;" (6) "The Role of Ability and Schooling in Determining the Lifetime Earnings Profile;" (7) "The Alternatives Before Us;" and (8) "Optimal Investment in College Instruction: The Efficiency-Equity Quandry." (HS)

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on
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or the square root of the fraction of the variance of x_j', the observed measure, which is accounted for by the variance of x_j.

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1. "Schooling and Inequality from Generation to Generation" by Samuel Bowles

2. "Time Series Changes in Personal Income Inequality: The United States Experience, 1939 to 1985" by Barry R. Chiswick & Jacob Mincer

3. "Education, Income, and Ability" by Z. Griliches & W. Mason

4. "Proposals for Financing Higher Education and Their Implications for Equity" by W. Lee Hansen

5. "State Tuition Policy and Student Loans: An Exploration into Their Effects on Educational Attainment, Mobility, and the Distribution of Income" by Robert W. Hartman

6. "The Role of Ability and Schooling in Determining the Lifetime Earnings Profile" by John C. Hause

7. "The Alternatives Before Us" by Harry G. Johnson

8. "Optimal Investment in College Instruction: The Efficiency-Equity Quandary" by Theodore W. Schultz

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Not for Quotation

Fragments of a Paper,

SCHOOLING AND INEQUALITY FROM GENERATION TO GENERATION

by

Samuel Bowles
Harvard University

A revised version of sections 3-5 on class and schooling which I am undertaking jointly with Herbert Gintis. I gratefully acknowledge help from him as well as from Valerie Nelson. The work presented here has been carried out with the financial support of the Social and Rehabilitation Service of the U.S. Department of Health, Education and Welfare.

In this section I will argue that the estimation of a model of this type using currently available data is likely to result in both significant underestimates of the importance of family social class as a determinant of eventual adult status and significant overestimates of the egalitarian influence of schooling. The biases in estimation arise from two main sources. First, the available data allow only a partial specification of the social class of the respondent's family. The specification bias resulting from these data limitations are exacerbated by the fact that while some of the available variables are measured with little error, others contain a major error component. Because the measurement of the social background of the respondents is much more subject to error than is the measurement of the respondents' years of schooling, the explanatory power of the social background variables is understated relative to the explanatory power of the respondents' years of schooling. I will first discuss the problem of specification bias, and then take up the errors in variables problem.

The data available to test this model are from a U.S. Census survey of slightly over 20,000 males 20-64 years of age in the year 1962.[1/] Respondents were asked to report their own occu-

1/ For a more complete description of the properties of the sample, see Duncan and Blau (1967), pp. 10-19. I will discuss estimates for the 25-34 year old age group only.

[illegible]ion and level of educational attainment (in years) as well as the occupation and educational level of their father or family head. Additional data collected included the number of siblings of the respondent and his income in the year previous to the survey. Because the importance of family size has been stressed by many students of mobility, I have included the number of siblings reported by the respondent as a measure of social background. The occupations of both respondents and their fathers were scaled according to the Duncan socio-economic status index. An index of years of schooling is the sole measure of educational attainment. A table of zero order correlations for these variables appears in an appendix.

Given the available data, the best attainable empirical representation of the underlying model of mobility appears to be:

1) ED = f(FOCC, FED, NSIB)

2) OCC = g(ED, FOCC, FED, NSIB)

where FOCC = the occupational status of the father or family head when the respondent was 16 years old, as reported by the respondent;

FED = the years of schooling attained by the father or family head as reported by the respondent;

NSIB = the number of siblings reported by the respondent;

OCC = the status of the occupation reported by the respondent;

ED = the reported years of schooling attained by the respondent; and

INC = the reported annual income of the respondent in the previous year.

A similar model will replace OCC by INC in equation 2.

In order to test the possibility that the transmission of social status operates primarily through genetic inheritance, I will also estimate a slightly modified version of equations 1 and 2:

1a) ED = f(FOCC, FED, NSIB, YINT)

2a) OCC = g(FOCC, FED, NSIB, ED, YINT)

where YINT = the respondent's IQ measured at a young age (around 6 years).[1]

I intend to use the method of least squares to estimate the model represented by equations 1 and 2 as a recursive system. The relationship represented by equation 1 is postulated as causally prior to that represented by equation 2. While this seems reasonable enough, the unbiased estimation of 2 requires the complementary assumption that the error term in the first equation is uncorrelated with that in the second.

1/The models represented by equations 1 and 2 and 1a and 2a are similar to those developed and estimated by O.D. Duncan. I have benefited greatly from Duncan's stimulating work on mobility. See Duncan, *et al.* (1968a), Duncan (1968b), and Blau and Duncan (1967).

This assumption is open to serious question. The occupational status of one's parents is an incomplete representation of one's social class background. The inclusion of a variable measuring the educational level of one's parents undoubtedly improves the specification of the social background of the respondent somewhat, but it can hardly substitute for the direct measurement of parents' income[1/] or perhaps a measure of the parents' position in the hierarchy of work relations. Because we expect parents' income and position in the authority structure of production to have some influence on the educational attainments of children independent of the parents' occupational status and educational level, it seems likely that the unexplained variance in the prediction of years of schooling is in part due to the exclusion of class and income as measures of the social background of the respondents.

[1/] Occupational status and educational level explain only .32 percent of the variance of earnings in the sample of 35-44 year old non-Negro, non-farm background males reported in Duncan, Featherman, and Duncan (1968). The r^2 reported here is based on corrected correlations. This particular age group seems relevant to our concerns, as it is the group most likely to have young children in the home.

Given the imperfect measurement of the social class of the respondent's family, the error term in equation 2 will reflect these unmeasured dimensions of social background, thus yielding a positive correlation between the error terms in the two equations. The years of schooling actually attained by the respondent will thus serve in equation 2 as a measure of both schooling and the unmeasured dimensions of the class of the parents. The effect of correlated error terms in this system is thus to impart an upward bias to the coefficient of years of schooling in the equation predicting the respondent's occupational status or income.

A further bias must also be mentioned. We may want to ask how much variance of the respondent's income or occupational status is explained by his educational attainment, above and beyond the variance explained by the prior factors measuring his class background. I will interpret this increment in the explained variance as a measure of the contribution of schooling to social mobility. To determine the magnitude of the increment in explained variance, I will estimate a reduced form equation in which the respondent's income or occupational status is expressed solely as a function of our exogenous variables measuring the social class background of the respondent. The degree by which the coefficient of determination in equation 2 exceeds that in the reduced form equation is a measure of that part of the effect of schooling on occupational status or income which operates independently of the social background of the respondent. But note that some of the variance of respondent's occupational status or income which is explained by the years of schooling variable is in fact attributable to the correlation of respondent's schooling with those dimensions of class not measured by the parental occupational status and parental education variables. Thus the difference in the fraction of variance explained exaggerates the independent influence of years of schooling, as it captures the influence of some unmeasured dimensions of social class as well.

I have made an attempt partially to rectify the specification bias by hypothesizing a parents' income variable and developing estimates of the relevant row and column in the product moment matrix on the basis of data from a variety of sources. The methods used are described in the appendix. The crucial assumption used in the estimation is that the zero order correlations between parents' income on the one hand and respondent's income and occupational status on the other are not smaller than the corresponding correlations between father's occupation and respondent's income and occupational status.

The above biases are due to the incomplete specification of the model and would arise even if the variables which I am forced to use were accurately measured. Unfortunately the available data contain serious inaccuracies. In the remainder of this section I will attempt to estimate the magnitudes of the error components in each variable and to develop a method of estimating equations 1 and 2 which will reduce the biases due to the errors in variables problem.

The data used in this essay were collected by surveys, and often required the respondent to provide retrospective information such as his father's occupation when the respondent was 16 years old. Quite apart from errors in responses likely in these cases, some of the data do not correspond exactly to the models which we seek to estimate. This errors in variables problem is to be distinguished from the problems associated with the inadequate specification of equations in the model due to the incomplete measurement of the social class of the respondent mentioned above. Confining attention to the incomplete set of variables on which we do have data, we find that the data available often do not measure what they purport to measure, and further, that the measure itself, even if accurately observed, does not correspond to the variable in our model. For example, in a model of the effect of education upon economic success, we would like to measure respondent's permanent income, yet our observations purport to measure only annual income. We may generalize the problem as follows: For each variable, x, and for any individual observation, i, we have

3) $x_i' = x_i + u_i$

where x_i = the true value of the variable,

x_i' = the observed value of the variable, and

u_i = the error in measurement.

We know that errors of this type will bias the least squares estimates of the regression coefficients as well as the coefficient of determination. The problem is complicated by the strong likelihood that in certain cases the errors in measurement for one variable are not independent of errors in other variables.

In order to eliminate the biases arising from the discrepancies between the observed and true values of the variables used, I will estimate the zero order correlation coefficients among the true variables, and use these corrected correlation coefficients to estimate the model of mobility.[1] If we assume that the errors, u_i, are uncorrelated with the true values, x_i, then it follows that[2]

4) $$var(x') = var(x) + var(u) .$$

Now define r_j, the correlation of the true value of x_j with its observed value, as

5) $$r_j = \sqrt{\frac{var\ x_j}{var\ x_j'}}$$

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[1]This method is formally equivalent to that suggested by Johnston (1963) and others. See appendix 1.

[2]To adopt a more realistic assumption would greatly complicate the task of calculating corrected correlation coefficients, and would require data which are not available.

or the square root of the fraction of the variance of x'_j, the observed measure, which is accounted for by the variance of x_j, the true measure. Then the observed correlation between any pair of variables x_k and x_j, r'_{kj} may be written as a function of the true correlation, r_{kj}, the correlations between the true and observed variables, r_k and r_j, and the correlation of the errors in the two observed variables, r_{ukj},

6) $$r'_{kj} = r_{kj}\, r_k\, r_j + r_{ukj} \sqrt{1 - r_k^2}\ \sqrt{1 - r_j^2}\ .$$

The corrected correlation coefficients, r_{kj}, will be used as the normalized x'x matrix to estimate the model of class immobility.

For each variable I attempt to introduce independent data concerning the degree of error in the measures which I have used in my regression equations. While the information used to estimate the accuracy of the measures is itself subject to serious question arising from differences in samples, ages of respondents, and variable definitions, I believe that the errors arising from erroneous estimates of reliability are considerably less serious than those which would result if I were simply to use the uncorrected data. Where the reliability estimates are particularly questionable, I will use a range of values to assess the sensitivity of my results to varying estimates of reliability.[1/]

I will consider the error in each variable in turn, and then deal with those pairs of variables for which it seems likely that the errors are correlated. Because the processes of estimating these values is somewhat complicated I have presented only a general description of the methods used in the text. A fuller description appears in appendix 1.

I turn first to problems concerning the definition and measurement of income. Abstracting from inaccuracies in the respondents' reported income, we have already noted that annual income is not the correct variable to use in a model of the intergenerational transfer of economic attainment. Most available studies do not allow us to distinguish between the variance in annual income due to year-to-year transient variations on the one hand, and simple reporting errors on the other. However, there are a number of estimates of the fraction of the variance of observed income which is accounted for by both reporting errors and the transient component in annual income. The estimate most consistent with the available data implies that only 70% of the variance of observed income is due to the variance of permanent income.[1] The square root of the figure, .84, is the estimate of the correlation of permanent and observed income which appears in column 3 of table 4.

Similar problems arise in the measurement of respondent's occupational status. The difficulty here is that the definition of the Duncan occupational status index used in most of this study may be an imperfect measure of

what we customarily understand by the word status. Duncan

[1] Appendix 1 explains the choice of this figure, and presents a series of alternative estimates.

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Table 4. Estimated Errors in Variables Measuring Social Class Background, Income, Educational Level, Occupational Status, and IQ

Variable required (1)	Measure used (2)	Estimated correlation of observed measure with true value of variable required (3)
1. Respondent's occupational status	Duncan's status score	.92
2. Respondent's permanent income	Respondent's annual income	.84
3. Respondent's educational attainment	Respondent's years of school attained (index)	.91
4. Occupational status of the father or family head of respondent	Duncan's status score for the occupation of father or family head	.80
5. Educational attainment of father or family head of respondent	Years of school attained (index) by father or family head	.80
6. Parents' permanent income	Parents' annual income	.84
7. Family size	Number of siblings	.96

Source: see section 3 and appendix 1.

s shown that his measure is a better predictor of intergenerational status transmission than the most likely other candidate, a direct measure of the social prestige of the occupations in question.[1/] While it is distinctly possible that a redefinition of his status index would yield a higher prediction of son's occupational status or income, no reasonable allowance for this possibility can be made in the absence of a compelling argument for an alternative empirical measure. While the Marxian notion of class, based on the person's position in the hierarchy of the social relations of production, was suggested (in section 2) as an alternative concept, no empirical measure of this class concept is at hand. Thus I will proceed on the basis that Duncan's status index is the appropriate measure.

[1/] Duncan, et al., (1968a), pp. 62-3.

The appropriateness of the measure, of course, does not obscure the problem of errors in reporting

t. respondent's occupation. I turn now to this problem, and related questions concerning the accuracy of respondent's reports of their own educational attainments.

Immediately following the 1950 Census, a post-enumeration survey was conducted to check the accuracy of the Census responses.1/ A comparison of the respondents' reports to both the Census and the Post-Enumeration Survey allows an estimate of the correlation of the true and reported values. I have calculated a number of values of this correlation based on alternative assumptions concerning both the relative accuracy of the Census and the Post-Enumeration Survey, and the correlation of errors in reporting to the two surveys. The method of calculation and the alternative estimates are described in appendix 1. The most plausible assumptions yield a correlation of .92 and .91 respectively between the true and observed values of the occupational status scale and educational attainments index. These correlations are reported in column 3 of table 4.

1/ U.S. Bureau of the Census (1960).

Note that while I have estimated the degree of error in reporting one's educational attainments (column 3 of table 4), I have assumed that years of schooling is an accurate measure of the level of educational attainment. Years of schooling attained should not be construed as an accurate measure of the total school resources devoted to a respondent's schooling. While the amount of resources "enjoyed" per year is associated with the years of school eventually attained, the correlation is far from perfect. Whatever bias arises due to this discrepancy operates -- though not necessarily with equal force -- for both the respondent's schooling and that of his parents.[1/]

Consider now the accuracy of the respondents' reports of their parents' occupation and education. The data used here are from a survey in which respondents were asked to report the highest level of schooling attained by the father or family head, as well as the occupation held by the father or family head at the time the respondent was a teenager. Errors in reporting these data are undoubtedly more severe than in reporting information concerning one's own educational level and occupation.

1/ See the next section for a discussion of biases arising from the inadequate measurement of schooling.

As part of their survey of intergenerational mobility, Blau, Duncan, and their associates administered a survey to 570 males in Chicago on which the usual questions concerning parents' status were asked, along with an item eliciting the respondent's address when he was 16 years old. The decennial Censuses nearest to the respondent's 16th birthday were then searched to extract the Census report of the respondent's father's occupation. It was found that of the original 570, there were 137 cases which could be used in the study. Inclusion in the study required that the respondent had correctly recalled his address and had responded to the question concerning father's occupation, and that the respondent's father had also responded to that question on the Census. A study of the matched responses then compared the occupation of the father as reported by the respondent with that reported to the Census (presumably by the father or mother of the respondent). When those reporting farm occupations to both surveys were eliminated (reducing the total to 115) and the occupations were scaled by the Duncan status score, the zero order correlation between the occupational status as reported by the father and by the son was .74. There is a downward bias in this measure, as the Census years from which the father's own reports were taken did not correspond exactly to the 16th year of age of the respondent. On the other hand, An upward bias is implicit in the method by which the sample to be studied was selected. The study automatically excluded respondents who could not correctly recall another retrospective fact (their address at age 16), as well as those who had left blank the question concerning father's occupation and those whose father had also not filled out that question when asked by the Census enumerator.

While these considerations would seem to point or balance to an upward bias in the estimated accuracy of the responses, use of the figure is consistent with the data on cohorts corrected by the 1962 occupational changes in a generation survey, as well as with other census data.[1] I have, therefore, used this figure, and, lacking any independent evidence on the accuracy of reports of parents educational attainments applied it to that variable as well.

It is shown in Appendix I that use of this reliability estimate in conjunction with independent census data implies a negligible correlation of errors in reporting occupational and educational attainment.

The estimate of the accuracy of reports of number of siblings is based on the following reasoning. Duncan reports[2] a correlation of .96 between mothers' census and reinterview reports of children ever born. Making the extreme assumption that the reinterview was totally accurate and that adults are as inaccurate in reporting number of siblings as in reporting children ever born,

1/ See Appendix I.

2/ In a personal communication.

the correlation between reported and actual number of siblings is .96.[1]

4. An empirical model of education and intergenerational mobility

The existence of significant errors in the main variables customarily used in social mobility research as well as the frequent exclusion of possibly important dimensions of social class may explain the apparent discrepancies in the results of a number of studies concerning the role of schools in the strat- ification process. Various studies using direct observation and quite detailed classification criteria have found a strong statistical relationship between the social class background of individuals and the type, quality, and amount of their schooling.[2] Other studies based on cruder measures of class, but using sta- tistical techniques which had the effect of minimizing reporting

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1/ If the reinterview mentioned by Duncan was as inaccurate as the Census, and the errors are uncorrelated, a figure of .98 would be more appropriate.

2/ Hollingshead (1949), Havighurst, Warner and Loeb (1944), Warner and Lunt (1941).

..rors have come to similar conclusions.[1]

On the other hand, one recent study, using individual data on the social class of parents reported by the respondents themselves, has found that social class plays a very minor role in explaining either the assignment of children to schools or the differences in performances within schools.[2]

O.D. Duncan has pointed out a further inconsistency in the evidence on schooling and social stratification.[3] He used a model similar to that described by equation 1a to predict the level of educational attainment in a sample of U.S. males 25-64 years of age. Because brothers share a common social background, as well as a similar (but not identical) genetic endowment, a model of this type should be able to predict the degree of correlation between the years of schooling attained by brothers. Duncan's estimates yield an expected correlation of .341. Yet the observed correlation is .69.[3] As Duncan notes, the major

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1/Sexton (1961), Owen (1969). By using average income in the neighborhood served by the school, rather than individual income, both Sexton and Owen significantly reduced the degree of error in their measures of class.

2/Hauser (1969).

3/This figure is corrected for errors in the reporting of one's educational level and that of one's brother, on the assumption that reports of one's older brother's educational attainments are as accurate as reports of one's own attainments.

discrepancy between the actual correlation and that predicted by his equations strongly suggests the existence of errors of measurement or model mis-specification. In section five I will subject my model to a similar test.

While it seems doubtful that all of the differences among these studies could be explained solely by shortcomings of speci- fication and errors in variables, the apparent importance of these problems in some studies, and the relative absence of these problems in others, does provide a clue to the major in- consistencies the findings reported.1/

It is not surprising, then, that the results of this study differ somewhat from those of studies using similar data uncorrected

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1/A similar comparison is suggested by studies of educational pro- duction functions. In my own work (Bowles (1970), Bowles and Levin (1968b)) I have found that measures of parents' education and other indices of social class reported by school children ordinarly explain only a minute fraction of the variance in scholastic achievement. Other studies suggest that the fraction of the variance of achievement scores explained by these and similar self-reported measures of parents' status does not exceed one-fifth. Yet a study by Wolf (1963) based on direct observation in the home found that the measure of the social background of the respondent explained 64% of the variance of scholastic achievement. Because Wolf's measures of the home envir- onment included observation of parental behavior as well as their objective circumstances, this figure appears to be an overestimate of the explanatory power of social class. Nonetheless, it does suggest that studies based on a complete and accurate measure of social class are likely to yield conclusions substantially different from the usual investigations based on incomplete and erroneously reported measures of class.

for errors of specification and measurement. Table 5 presents the estimates of modified versions of equations 1 and 2, relating our measures of the social background of the parents (including parents' income) to the respondents' educational achievement, and then relating both the background and educational attainment measures to the respondents' occupational and income status. Table 5 also presents the estimates of the reduced form equation using only the social background variables to predict the respondents' occupational and income status.

The following characteristics of the results should be noted. First, the measures of family background explain 52 percent of the variance of the years of schooling obtained by the respondent.[1/] Second, years of schooling attained appears to be a significant determinant of both the earnings and the occupational status of the respondent, although much more so for occupational status than for earnings. The gross relationship of schooling to income is over 1.5 times as large as the relationship net of the social class background presented here. This finding suggests that much of the apparent economic return to schooling is in fact a return to social class background. (It will be seen below that introduction of a measure of early IQ reduces the apparent net effect of schooling still further.)

Third, years of schooling and the social background of the

[1/] This is over twice the fraction of variance explained by the uncorrected variables in Blau and Duncan (1967).

Table 5. Regression Equations for the Model of Schooling and Mobility, U.S. Non-Negro Males with Non-Farm Backgrounds, 25-34 Years Old [c]

Dependent variable	Father's occupational status	Father's years of schooling	Parents' income	Respondent's number of siblings	Respondent's years of schooling	R^2
	Normalized regression coefficients of:[a]					
1. Respondent's years of schooling	.155 (58.8)	.204 (108.6)	.412 (832.3)	-.181 (185.6)		.517
2. Respondent's earnings	.112 (29.5)	b	.112 (27.7)	-.059 (10.9)	.203 (76.2)	.151
3. Respondent's earnings	.173 (77.3)	b	.197 (105.7)	-.102 (33.8)		.130
4. Respondent's occupational status	.057 (17.4)	b	b	b	.743 (2955.3)	.603
5. Respondent's occupational status	.154 (43.3)	.181 (62.3)	.309 (342.4)	-.114 (53.5)		.338

a. F-statistics in parentheses.

b. In a prior estimate this coefficient was insignificantly different from zero. The equation presented here was estimated without this variable.

c. Refers to experienced civilian labor force, 1962, as represented by the Occupational Changes in a Generation survey sample.

respondent together explain 15.1 percent of the variance of earnings and 60.3 percent of the variance of occupational status.[1/] While the variance of earnings explained is considerably greater here than in studies of the same sample taking no account of the errors in variables problem, it is still remarkably low.

Fourth, the variance of earnings explained by the social background variables alone is only slightly less than that explained by these variables along with the educational attainments of the respondent. The social background variables alone explain 13.0 percent of the variance of earnings.[2/] The additional variance explained by years of schooling is only 2.1 percent. I infer from this result that years of schooling attained exerts a comparatively minor independent influence on earnings independent of social background. Most of the impact of years of schooling on earnings appears to be a direct transmission of economic status from one generation to the next.

Notice however that this does not appear to be the case when occupational status is used as the dependent variable. The results suggest that while education exerts a major independent influence on occupational attainment, this influence does not translate into a major independent influence on earnings. The discrepancy between these results may be explained by the wide dispersion of earnings within occupational categories.

1/ Using the uncorrected correlation matrix from Duncan et al. (1968), the analogous figures are 8.7 and 42.3.

2/ The social background variables here include number of siblings. If that variable is excluded, the r^2 falls to .12. Using the uncorrected data from Duncan et al. (1968), the r^2 is .054 with number of siblings in the equation and .045 without.

It might be argued, of course, that the explanatory power of the schooling variable would be increased if I had used a measure of the quality as well as the duration of schooling. While this is undoubtedly true, the importance of this point is easily exaggerated. In the first place, if by school quality we refer to measures of resources used, we must ask whether these have any substantial effect upon the later occupational status and earnings of students. I am aware of only one study which has attempted to measure the impact of variables such as per pupil expenditure and class size on later earnings for the white population.[1/] Richard Morgenstern estimated the relationship between earnings of urban workers and the levels of resource use in schooling in the state of the worker's origin.[2/] In a rather fully specified model including measures of the social class of the respondents and their years of schooling attained, the esti-

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[1/] I found significant estimates of the effect of class size, teacher quality, and an index of educational innovation on earnings five years after leaving high school for a sample of about 200 northern blacks. (Bowles (1969).) However, the social class background of these students was so poorly measured that I am unable to exclude the possibility that the apparent importance of "school resources" in these estimates is a reflection of those aspects of the social class of the students which were not measured explicitly in the model and were highly correlated with the quality of the school inputs. For more evidence concerning blacks, beset with similar ambiguities, see Morgenstern (1970).

[2/] Morgenstern (1970).

mate of the influence of school resources upon earnings was insignificantly different from zero. While improved measures of both social class and school resources might alter Morgenstern's results, his research does raise serious questions concerning the importance of the usual quality of schooling variables in a model such as this.[1/]

Second, even if we were to conclude that school resources made a major contribution to later occupational status and earnings, the importance of the bias resulting from the exclusion of this measure of school quality may still be questioned. Because the years of schooling attained and the average quality of schooling per year are highly correlated, some of the potential explanatory power of the quality dimension of schooling is already captured by the years of schooling variable. The positive association of quality and quantity of schooling arises in part because the college-bound students are likely to attend well-endowed elementary and secondary schools. But even in the absence of resource inequalities among students at a given level, the fact that resources per year rise as one proceeds from elementary through high school

[1/] Studies showing significant effects of school resources upon scholastic outcomes (achievement scores, for example) are not germane to this discussion unless it can be shown that the scholastic outcome being measured has some relationship to the later economic success of the student. For some doubts on this point, see Bowles (1970), and also the discussion below.

to junior college and finally to four-year colleges would produce a positive correlation between years attained and resources per year.

Third, even if the addition of school quality variables did increase the explanatory power of the respondents' education in the model, this would not necessarily alter my inference concerning the role of schooling in transmitting status from generation to generation. Differences in school resources, and their differential use on behalf of some children and against the interests of others, are prominent among the means by which family backgrounds are passed on to children.[1/] Thus I would expect to find that differences in school quality are closely associated with measures of the social class of the students. These class inequalities in school quality presumably operate both through inequalities at each given level and through greater likelihood that upper class students will attend school longer, thus increasing the portion of their educational experience in levels of schooling at which the average amount of resources per year for all students enrolled is relatively high. Evidence concerning social class inequalities in resources among schools at given levels is presented in table 6. Note that these esti-

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1/ See Hollingshead (1949) and Lynd (1930).

Table 6 : Inequalities in Elementary School Resources: Percent Difference in Resource Availability Associated with a One Percent Difference in Family Income[a]

Resource	Within cities[b] (1)	Between cities[c] (2)
1. Current real educational expenditure per student	n.a.	.73[e] (6.6)
2. Average real elementary school teacher salary	.20[d] (4.21)	.69[e] (5.0)
3. Teacher-student ratio	.24[d] (2.67)	n.a.
4. Real expenditure per pupil on teacher salary	.43[d] (3.79)	n.a.
5. Verbal ability of teacher	.11[d] (2.89)	1.20[d] (6.9)

a. t-ratios for the null hypothesis of no income effect in parentheses.

b. The first four within-city estimates are elasticities calculated from a linear equation at the means of the variables. Dependent variables in these equations were the residuals from a prior equation which regressed the level of these resource inputs upon the median family income of the city. The within-city variations in income refer to family income in the neighborhood served by the school. The sample included 200 public elementary schools in nine large U.S. cities. Data refer to the year 1965 and were drawn from James Coleman, et al. (1966) and U.S. Census tract reports. The estimate for the within-city teachers' verbal ability elasticity is from an equation including both city and school neighborhood family income, with the mean teachers' verbal ability score as dependent variable.

c. Elasticities calculated from an equation linear in the logarithms of the variables. Salaries, expenditures, and median family incomes were deflated by a cost of living index for each city. Data for the 92 cities and towns included in the sample refer to the year 1960 and were drawn from the U.S. Census and the National Education Association. The income elasticity for the teachers' verbal ability score is calculated from the equation described in the previous note.

d. Source: Owen (1969)

e. Source: Owen (1970

28v

...es may understate the degree of resource inequality, as they abstract from inequalities which arise within schools through tracking and other means of class segregation.

While it will no doubt be objected that school resources do not measure school quality, it is difficult to conceive of operational measures of school quality which will be at the same time important in their influence on adult economic success and not highly correlated with years of schooling attained and the social class of the respondent. The most commonly suggested measure -- scholastic achievement -- appears to fail on all counts. To the extent that we can explain the variance among individual students in scholastic achievement, the social class of the student seems to be the main explanatory variable. The increment in the explained variance of scholastic achievement scores associated with the introduction of school policy and resource variables in an equation already including crude measures of the social background of the student is ordinarily very small. Illustrative estimates are presented in table 7.

I infer from table 7 that available measures of school quality add very little to the explanatory power of social background in the prediction of achievement scores.[1] Better measures

[1] The data in table 7 do not suggest that variations in school policy or resources have no effect on scholastic outcomes, but rather that school policy and resources as conventionally measured exercise very little influence not already measured statistically by the social class variables. For a discussion of this problem see Bowles and Levin (1968a) and (1968b).

29.

Table 7.

Increment in Percent of Variance in Verbal Achievement Explained When Variables Representing School Resources and Policies[a] Are Introduced into an Equation in Which Various Indices of Student's Social Background[b] Are Measured

Sample of students	Grade 1	3	6	9	12
Black, South	2.14	.80	4.90	7.52	8.64
Black, North	2.38	2.96	.77	1.45	3.14
Black total, U.S.	.72	2.26	2.77	5.19	6.96
White, South	.96	.83	.57	1.60	3.16
White, North	.83	.33	.32	.73	1.87
White total, U.S.	.32	.33	.47	1.15	2.53

Source: J.S. Coleman, *et al.* (1966).

a. School characteristics are:
- Per pupil expenditure on staff
- Volumes per student in library
- Science lab facilities (9 and 12 only)
- Extracurricular activities (9 and 12 only)
- Presence of accelerated curriculum (9 and 12 only)
- Comprehensiveness of curriculum (9 and 12 only)
- Use of tracking (9 and 12 only)
- Movement between tracks (9 and 12 only)
- Size
- Guidance counselors (9 and 12 only)
- School location (city suburb, town, country)

b. Student's characteristics are:
- Urbanism
- Parents' education
- Father absent
- Family size
- Consumer durables in home
- Reading material in home

of school policies and resources would undoubtedly alter the picture conveyed by table 7 somewhat, but even a substantial change would not be of great import as long as the scholastic achievement scores themselves are highly correlated with the number of years of schooling attained. If the Armed Forces Qualification Test may be taken as a proxy for a scholastic achievement test, we arrive at an estimate of .68 for this correlation,[1] suggesting that a substantial part of the variance of scholastic achievement is already measured by the years of schooling variable.

The more serious problem involved in the use of the achievement score (or its relatives such as the AFQT score) is that there is very little evidence that the effect of schooling upon economic success operates to any significant degree through the effect of schooling upon the types of cognitive development measured in these tests. If the sole medium through which schooling operated was cognitive development as measured by achievement tests, then we would expect to find that the addition of an individual's test score to an equation using years of schooling to

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[1] The correlation refers to U.S. males 25-34 years old and is corrected for errors in both variables. The test-retest reliability of the AFQT is about .95. The uncorrected correlation is from Duncan (1968b). Other sources report a considerably higher correlation between AFQT score and year of schooling completed. See Personnel Research Division, The Adjutant General's Office (1945) for evidence on this correlation as well as on the reliability of the AFQT.

predict individual earnings would result in the coefficient of schooling falling to zero. On the other hand, if education contributed to earnings entirely independently of its effect on cognitive development, the coefficient of years of schooling would be reduced by a relatively minor amount.[1/] Independent unpublished studies by Cutright, Conlisk, and Griliches, as well as the study by Bajema ( ), indicate that the regression coefficient of years of schooling is only slightly reduced and remains highly significant upon the introduction of a measure of cognitive development to a function predicting individual earnings or income. Though preliminary, these results suggest that schooling exerts an influence upon earnings largely independent of its contribution to scholastic achievement.[2/]

In summary, the importance of biases arising from the exclusion of school quality variables cannot be adequately estimated, in part because of our inability adequately to specify what we mean by school quality. Nonetheless, the above considerations lead me to doubt that important modifications in the results would follow the successful inclusion of a school quality variable in the model.

Equally difficult to assess is a bias operating in the other

1/The reduction in the coefficient of education in this case would be explained by the assumed positive correlation between the level of cognitive development and the non-cognitive variables which in this model are hypothesized as the medium through which education affects earnings. See Gintis (1970).

2/This argument is based on Gintis (1969).

direction, towards the overstatement of the independent contribution of schooling to the attainment of high income or occupational status. This is the bias, mentioned earlier, which arises as a result of the specification error involved in the incomplete measurement of social class.

5. Intelligence and the inheritance of social class

An explanation consistent with the estimates presented in section four might assert that status immobility arises from the important role of inherited intelligence in occupational success. Thus it might be argued that high status parents have high intelligence which they pass on genetically to their children, who for this reason achieve high status. Note at the outset that this explanation holds that measured intelligence is both highly

---

1/ Because the average age of the AFDC sons is much lower than that of the 25-34 year old group, I have used equations predicting the first full-time job of the non-AFDC population, to afford a more appropriate comparison with Schiller's data, which refer to the actual job held.

heritable and an important determinant of adult status. While I will not question the first assertion, the second seems of doubtful validity. In a sample of white 25-34 year old U.S. males, a measure of general intelligence (the AFQT score) explains only 25 percent of the variance of occupational status, and 16 percent of the variance of earnings.[1/]

I have used scores on IQ tests for young children as an imperfect measure of genetic endowment. IQ tests administered at ages less than four years appear to measure a variety of traits, some of which are apparently not important in the IQ tests at later ages.[2/] For this reason I have avoided the use of test scores from very early ages and have used instead the scores for children aged 6 - 8.

Ideally I would be able to estimate the portion of the variance of the IQ scores attributable to variations in the genetic endowment and ascribe the remainder of the variance to "error." A

1/ The figures are based on Duncan's (1968b) simple correlation coefficients. His figures are corrected for restricted variability in the population of veterans. I have corrected, in addition, for unreliability of the test and for inaccuracy of the income and occupational SES scores.

2/ Bayley (1949).

serious difficulty arises here because the "error" component in this formulation would be explainable in large part by the social class variables -- parents' education, income, and occupation. (The IQ test itself is highly reliable, in the sense that repeated application of similar tests yields very highly correlated results.) Thus if I were to ascribe the non-genetic variance of the IQ test to "error" I would have to develop reasonable estimates of the correlation of this "error" with the true values of the social class variables used in the study. Although I attempt an illustrative calculation of this type below, I have little confidence in the actual estimates used. For this reason I have decided to let the IQ test scores represent nothing more than "measured IQ."[1]

Given the strong likelihood that IQ test scores at age 6-8 are to some extent a reflection of the social class of the parents and the length and quality of schooling already attained, as well as the subject's genetic inheritance, I believe that I am attributing considerably more explanatory power to the IQ measure than would be the case in a model which allowed empirical estimates of the purely genetic

[1] I used the test-retest reliability of the IQ test as the basis for calculating the reliability of this measure.

component of the intelligence score.

An adequate test of the genetic explanation would require (at the very least) data from a representative sample of adults for whom we had the usual occupational and educational information pertaining to themselves and to their parents, as well as a measure of IQ taken at some early age, before the major effects of schooling have been able to operate upon the IQ score.1/ Data of this type are simply not available for a sample which is at all representative of the white male U.S. population.

As a distinctly inferior alternative forced upon us by the absence of the appropriate data, we can construct the product moment matrix for a synthetic sample using various sources, and filling in missing cells on the basis of inferences from the available correlations.2/ This method involves adding to the correlation matrix used in the previous section, a column and a row representing the correlations with our already measured

---

1/Samples using scores on IQ tests administered to the respondents after they had reached adulthood, or even during adolescence, present almost insurmountable difficulties in interpretation, as the IQ score for these individuals measures the effects of schooling and the entire childhood experience of the child, as well as his genetic makeup.

2/This is the method used by Duncan (1968b).

variables of intelligence measured at an early age. The interpretation of the results of such an exercise is of course difficult, as the samples upon which the various correlations are based are not the same. Nonetheless, it seems worthwhile to attempt these estimates, taking as much care as possible with problems of non-comparability of samples, errors in measurement, and specification bias.

My method is based on direct estimates of the correlation of early IQ to both late IQ and years of schooling attained. These, along with correlations of late intelligence scores with the other variables in the model, are used to infer the values of the correlation between early intelligence and the occupation and income of the respondent as well as the educational and occupational attainments of his parents.[1/] My

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1/ The method is described in Duncan (1968b). Both methods of calculation make use of the causal model postulated in equations 1a and 2a, and the corrected normal equations in standard deviation form as expressed in equation A.3 in appendix 1. Thus

(continued on next page)

A more

results appear in table 8.

detailed description of the methods and sources appears in the notes to the table.

We are now in a position to re-estimate our mobility model using a measure of early intelligence as well as the social class of the parents as exogenous variables. The results for the two alternative sets of estimates appear in table 9. The following aspects of the results should be noted.

First, , early IQ appears to exert a considerable influence upon the level of educational attainments of the respondent.

Second, the introduction of IQ to the equation which predicts

---

$r_{ij} = \Sigma \beta_{kj} r_{ki}$

where β_{kj} is the normalized regression coefficient of variable k in an equation predicting variable j. In method I it is assumed that the effect of early intelligence on adult status operates entirely via its impact on adult intelligence and years of schooling attained.

Estimated Corrected Correlations of Early Intelligence with Other Variables[a]

		zero order correlation coefficients
1.	Earnings	.323[b]
2.	Occupation	.366[c]
3.	Parents' income	.283[d]
4.	Years of schooling	.472[e]
5:	Early IQ	1.000
6.	Number of siblings	-.274[f]
7.	Father's education	.248[g]
8.	Father's occupation	.260[h]
9.	Late IQ	.886[i]

a) See also tables A3 and A4.

b) See footnote 1 on page . $r_{15} = \sum_n \beta_{n1} r_{n5}$ for n = 2, 3, 8, 9. In this and other similar calculations below, the normalized regression coefficients, β; refer only to those which were significantly different from zero, at conventional levels of significance.

c) $r_{25} = \sum_n \beta_{n2} r_{n5}$ for n = 4, 8.

d) Based on data from the California Guidance Study. I am grateful to Marjorie Honzik and the Institute of Human Development at the University of California at Berkeley for making these data available to me. For a description of the sample see Honzik (1957).

e) Based on data from the California Guidance Study, adjusted by the estimated correlation between the true and observed values of years of schooling (.91) and the intelligence test (.95). If the corrected correlation between IQ at age 6-8 and at age 12 is about .90 (which seems reasonable on the basis of the California Guidance Study, Bayley (1949), and Bloom (1964)), the .472 reported here is roughly similar to the .54 correlation implied by Benson's (1942) study.

f) From Duncan (1968b), based on Anastasi (1956), corrected for IQ test reliability (.95).

g) The equation in footnote 1 on page implies that

$$r_{97} = \beta_{59} r_{57} + \beta_{49} r_{47}$$, from which it follows that

$$r_{57} = (r_{97} - \beta_{94} r_{47}) / \beta_{59}.$$

h) Using the above derivation, $r_{5,8} = (r_{98} - \beta_{94} r_{48}) / \beta_{59}$.

i) Bloom (1964), chapter 3, and Bayley (1949).

Table 9. Early IQ and Social Class as Determinants of Education, Occupational Status, and Earnings

Dependent variable	Normalized regression coefficients of:[a] Early IQ	Father's occupational status	Father's years of schooling	Parents' income	Respondent's number of siblings	Respondent's years of schooling	R^2
1. Respondent's years of schooling	.249 (390.5)	.138 (52.5)	.193 (107.9)	.364 (705.2)	-.130 (104.3)		.570
2. Respondent's earnings	.196 (112.0)	.118 (33.6)	b	.109 (27.4)	-.036 (4.2)	.118 (23.6)	.180
3. Respondent's earnings	.225 (166.3)	.150 (60.8)	b	.153 (64.8)	-.055 (9.8)		.174
4. Respondent's occupational status	b	.057 (17.4)	b	b	b	.743 (2955.3)	.603
5. Respondent's occupational status	.188 (150.6)	.141 (37.3)	.172 (58.8)	.273 (270.2)	-.076 (23.9)		.368

a. F-statistics in parentheses.

b. In a prior estimate this coefficient was insignificantly different from zero. The equation presented here was estimated without this variable.

earnings or occupation on the basis of parents' status and years of schooling attained increases the proportion of variance explained, although by a rather small amount.[1/]

Third, the importance of measured intelligence in the process of mobility appears to be relatively minor, when compared to the influence of parents' social class.[2/] Using the reduced form estimated from which the number of siblings variable has been eliminated (not shown in table 9), the effect upon occupational status of a standard deviation difference in measured social background is roughly three times as great as the effect of a standard deviation difference in IQ measured at an early age. The relative importance of early IQ in the equation predicting earnings is considerably greater, although the size of the regression coefficient of early IQ is still considerably less than those of the social background variables combined (still omitting number of siblings).

1/ Bajema (1968) and Conlisk (1968) find that the regression coefficient of early intelligence is insignificant in predicting occupational attainment in an equation using years of schooling and early IQ as explanatory variables. However, Griliches (1970), using Swedish data, found that the coefficients of both IQ at age 10 and years of schooling were highly significant in an equation predicting income.

2/ Duncan, who came to the opposite conclusion (1968b), used correlations for the early IQ measure which referred to a much older age group (not younger than 12, apparently), and which in addition had been corrected for errors in measurement. Not surprisingly, the use of these IQ correlations jointly with uncorrected correlations relating to the social background of the respondent resulted in the attribution of a substantial portion of the explained variance to early intelligence.

These figures would be modified somewhat in a model using genotype and class, rather than IQ score and parents' occupational and educational status, as our fundamental exogenous variables. I assume that parents' income and occupational and educational status are dimensions of class, and that IQ score is a measure of both genotype and class. Thus the parts of the full model relating to IQ at a young age, or YINT, as it is denoted, are

12) YINT = f(genotype, class),

and

13) OCC = g(YINT, class),

which imply that

14) $$\frac{\partial OCC}{\partial genotype} = \frac{\partial\, OCC}{\partial YINT} \cdot \frac{\partial YINT}{\partial genotype}$$

The coefficient of early IQ in the reduced form equation is an estimate of $\frac{\partial\ OCC}{\partial YINT}$, when both variables are measured in normalized form. An estimate of $\frac{\partial YINT}{\partial genotype}$ not likely to understate the importance of genetic inheritance of intelligence may be derived from Jensen (1969). On the basis of Burt's studies of identical twins (1958), Jensen estimates that 81 percent of the variance of the IQ score is explained by the variance in the genotype. Thus the estimate of $\frac{\partial YINT}{\partial genotype}$, also in normalized form, is the square root of this figure, or .9. Using this figure in our occupational status equation most favorable to the genetic interpretation, we arrive at an estimate of

15) $\frac{\partial OCC}{\partial genotype} = .9 \times .203 = .183$

The analogous correction of the social class measures would require that the direct effects of our class measures be augmented by an indirect influence of class operating via the IQ score. Thus the correction would result in some increase in their estimated effect of class, although the precise amount cannot be determined. If the variance of social class explains <u>all</u> of the variance of IQ scores which is not explained by the variance of genotype (which seems unlikely), the estimate (in normalized form) of the total impact of class on later occupational status is

16) $$\frac{\partial OCC}{\partial class} = \frac{\partial OCC}{\partial FED} \cdot \frac{\partial FED}{\partial class} + \frac{\partial OCC}{\partial FOCC} \cdot \frac{\partial FOCC}{\partial class} + \frac{\partial OCC}{\partial PINC} \cdot \frac{\partial PINC}{\partial class} + \frac{\partial OCC}{\partial IQ} \cdot \frac{\partial YINT}{\partial class},$$

where the term on the right represents the indirect effect of class operating through the medium of early intelligence.[1] Empirically equation 16 may be written,

17) $$\frac{\partial OCC}{\partial class} = .193 + .144 + .273 + .203\sqrt{1 - .81} = .698 .$$

It should be stressed that this figure constitutes a maximum upward adjustment, as it assumes all non-genetic elements in IQ scores are related to class. For this set of data the appropriate estimate would seem to lie between the unadjusted .610 and the maximum .698.[2] Similar adjustments for the determination of earnings suggest a minimum figure for $\frac{\partial EARN}{\partial genotype}$ of .212, compared with the directly estimated .237, and a maximum estimate for $\frac{\partial EARN}{\partial class}$, compared to the estimated .317.

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[1] Note that our definition of the relationship between class and parents' educational level and occupational status implies that

$$1 = \frac{\partial FED}{\partial class} = \frac{\partial FOCC}{\partial class} = \frac{\partial PINC}{\partial class} .$$

The estimates in equation 17 as well as those for earnings reported below are from an equation excluding number of siblings. All of the normalized regression coefficients used in expression 17 and in the analogous calculation for earnings were statistically significantly different from zero at conventional significance levels.

[2] The "unadjusted" figure is simply the sum of the first three terms on the right side of equation 17.

Equation 1 in table 9 allows a direct empirical test of the model. Recall that using a highly simplified model and equation 1a, we can predict the correlation between the educational levels attained by brothers. Thus where the superscript prime (') refers to the eldest brother of the respondent and the β's refer to normalized regression coefficients in an equation predicting the educational attainment of the respondent, ED, we have

18) $r_{ED,ED'} = \beta_{NSIB}\, r_{ED'NSIB} + \beta_{FOCC}\, r_{ED'FOCC} + \beta_{FED}\, r_{ED'FED} +$

$+ \beta_{YINT}\, r_{ED'YINT}$.

The term $r_{ED'YINT}$ is estimated from[1]

19) $r_{ED'YINT} = \beta_{YINT'}\, r_{YINT,YINT'} + \beta_{NSIB}\, r_{YINT,NSIB} +$

$+ \beta_{FOCC}\, r_{YINT,NSIB} + \beta_{FED}\, r_{YINT,FED}$.

Further, the correlation between the two brothers' early intelligence is estimated as .5.[2] Using our figures from tables 8, 9, and A.3, I arrive at .54

as the estimate of the correlation between the two brothers' education. These predictions compare with a figure of .65 based on the observed correlation between the education of brothers in the

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[1] The β's in the equation refer to the normalized regression coefficients in an equation predicting brother's educational level, ED'. Here and above, it is assumed that the β's and r's are identical for the brothers.

[2] Duncan (1968b). The figure .5 is of course that postulated by a simple genetic model. Empirical studies are reasonably consistent with this magnitude.

25-34 age cohort.[1/] The discrepancy between the predicted and estimated true correlations based on my model is substantially less than that reported by Duncan.[2/] The fact that the predictions based on my model fall somewhat short of the estimated true correlation is to be expected, given the incomplete specification of the social class background of the respondents. Nonetheless, the fact that the predicted value is quite close to the estimated true value lends some credibility to my estimates and to the model upon which they are based.

I conclude from the above that the available evidence offers little support for the view that intergenerational immobility is attributable primarily to genetic inheritance of intelligence rather than to the independent effects of social class. While it is certainly possible that some other trait characterized by high heritability might explain the results, I know of no evidence, or even serious conjecture, as to what this trait might be.

1/ The observed correlation (.536) was corrected for erroneous reporting on the assumption that the reporting of one's brother's educational level is as accurate as the reporting of one's own educational level. Duncan's equations yield an estimate of .3249 for this correlation.

2/ See page 34 above.

Appendix 1.

Methods Used to Estimate the Corrected Correlation Matrix

Contents:

This appendix is intended to supplement the discussion in section three of the paper. Table A.3 at the end of this appendix presents a summary of the corrections.

1. Equivalence to the more familiar errors in variables approach

I will first show that the method used is equivalent to the generalized errors in variables approach as described by Johnston ( ). First write the normal equations in the form

$$\text{A.1)} \quad \sum_{i=1}^{n} \hat{b}_i \, M'_{x_i x_k} = M'_{x_k x_j} \qquad (k = 1\ldots n \text{ equations})$$

where $\hat{b}_i$ is the estimated regression coefficient of variable i in an equation predicting variable j, and $M'_{x_i x_k}$ and $M'_{x_k x_j}$ are the observed second order sample moments. If the variables are measured with error (uncorrelated with the true variables) we may estimate unbiased regression coefficients using n equations which appear in the form

$$\text{A.2)} \quad \hat{b}_1 \left(M'_{x_1 x_1} - \text{var } u_1\right) + \sum_{i=2}^{n} \hat{b}_i \left(M'_{x_1 x_i} - \text{cov }(u_1, u_i)\right) = M'_{x_j x_1} - \text{cov }(u_j, u_1) \,,$$

etc.

where $\hat{b}_i'$ are the unbiased regression coefficients and u_i is the error term in the observed variable x_i'. Expressing equations A.2 in standard deviation units of the true variables yields the system

$$\text{A.3)}\quad \begin{bmatrix} 1 & M_{12} & \cdots & M_{1n} \\ \vdots & & & \vdots \\ M_{n1} & \cdots & \cdots & 1 \end{bmatrix} \begin{bmatrix} \hat{\beta}_1 \\ \vdots \\ \hat{\beta}_n \end{bmatrix} = \begin{bmatrix} M_{1j} \\ \vdots \\ M_{nj} \end{bmatrix}$$

where $\hat{\beta}_i$ is the unbiased estimate of the normalized regression coefficient of variable i, and where

$$\text{A.4)}\quad M_{ij} = \frac{M'_{x_i x_j} - \operatorname{cov}(u_i, u_j)}{\sigma_{x_i} \sigma_{x_j}} .$$

Rearranging, we have

$$\text{A.5)}\quad M_{ij} = \frac{M'_{x_i x_j}}{\sigma'_{x_i} \sigma'_{x_j}} \cdot \frac{\sigma'_{x_i} \sigma'_{x_j}}{\sigma_{x_i} \sigma_{x_j}} - \frac{\operatorname{cov} u_i u_j}{\sigma_{x_i} \sigma_{x_j}} .$$

Using the notations introduced in the text, and noting that $(\sigma'_{x_i} \sigma'_{x_j})/\sigma_{x_i} \sigma_{x_j} = (r_i r_j)^{-1}$, it follows from the fact that $\operatorname{cov}(u_i, u_j) = r_{uij}\ \sigma_{ui}\ \sigma_{uj}$, and, $1 - r_i^2 = \dfrac{\sigma^2_{u_i}}{\sigma^2_{x_i}}$ that

$$(A.6) \quad M_{ij} = \frac{r'_{ij}}{r_i r_j} - \frac{\sqrt{1 - r_i^2}\ \sqrt{1 - r_j^2}}{r_i r_j} \cdot r_{uij} ,$$

which is identical to expression 6 appearing on page 23 of the text.

2. The accuracy of reported annual income as a measure of permanent income

Various estimates of the ratio of the variance of permanent income to observed annual income are available. The first is Friedman's estimate based on the elasticity of consumption with respect to income.[1/] Friedman's estimates for non-farm or urban families in 1935-36 and 1941 appear as lines 1 and 2 of table A.1.

We arrive at a second estimate if we define permanent income as that measured by the weighted sum of the income in a number of years, and then inspect the fraction of variance in any individual year's income explained by the incomes of other years. Using three adjacent years' income for a sample of 24,788 whites, we arrive at the estimates which appear in lines 3-5 of table A.1.[2/]

[1/] Friedman (1957) shows that the elasticity of consumption with respect to income is an estimate of the fraction of the variance of observed income attributable to the variance of permanent income. This estimate is based on the assumption that the transient components in annual income are not serially correlated.

[2/] The data are from Cutright (1969).

Table A.1.

Annual Income as a Measure of Permanent Income

Sample	Method	Fraction of observed variance in annual income due to variance in permanent income
Non-farm or urban families:		
1) 1935-36	Income elasticity of consumption	.82[a]
2) 1941		.87[a]
White veterans:		
3) 1962	Fraction of variance of each year's income explained by three other years' incomes	.73[b]
4) 1963		.71[b]
5) 1964		.77[b]
Urban spending units:		
6) 1947, 1948	Correlation of adjacent years' incomes	.83[c]
White veterans:		
7) 1962, 1963	Correlation of adjacent years' incomes	.83[b]
8) 1963, 1964		.83[b]
All Wisconsin taxpayers:		
9) average of six coefficients for all consecutive pairs of years, 1929-35	Correlation of adjacent years' incomes	.84[c]
White veterans and Wisconsin taxpayers:		
10) various years	Best estimate in explaining correlations among incomes at times separated by various numbers of years, assuming serially correlated errors	.70[d]

(notes on next page)

Table A. 1, cont'd.

Sources: a. Friedman (1957), p. 67.

b. Calculated from correlations of yearly income found by Cutright (1969). The additional year was 1958.

c. Friedman (1957), p. 187.

d. Data from Friedman (1957) and Cutright (1969). Method described in text.

Alternatively, we may use the correlation of incomes in adjacent years. Assuming that both income figures are imperfect measures of the underlying permanent incomes, and that the errors in each are uncorrelated, this correlation coefficient is an estimate of the portion of variance of observed income which is due to variations in the permanent income. Various estimates on this basis appear as lines 6 through 9 in table A.1.

It seems likely that the transient components in annual income will be serially correlated. This possibility is indicated by the fact that the correlation coefficients among annual incomes for given individuals decline as the number of years intervening between the years increases.[1/] Thus we may assume that the estimates in lines 1 through 9 represent overestimates of the fraction of the variance of observed annual income due to variations in permanent income.

Gintis has attempted to deal with the problem of serially correlated errors in a recent unpublished paper.[2/] He used the following basic model. Let y_t^i be the observed annual income of the ith individual in year t; y_p^i is the permanent income of the

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1/ Cutright (1957), Friedman (1969).

2/ Gintis (1970).

ith individual, and e_t^i is the deviation from the permanent income in year t. Then

A.7) $$y_t^i = y_p^i + e_t^i$$

and

A.8) $$e_{t+1}^i = p\ e_t^i + u_{t+1}^i$$

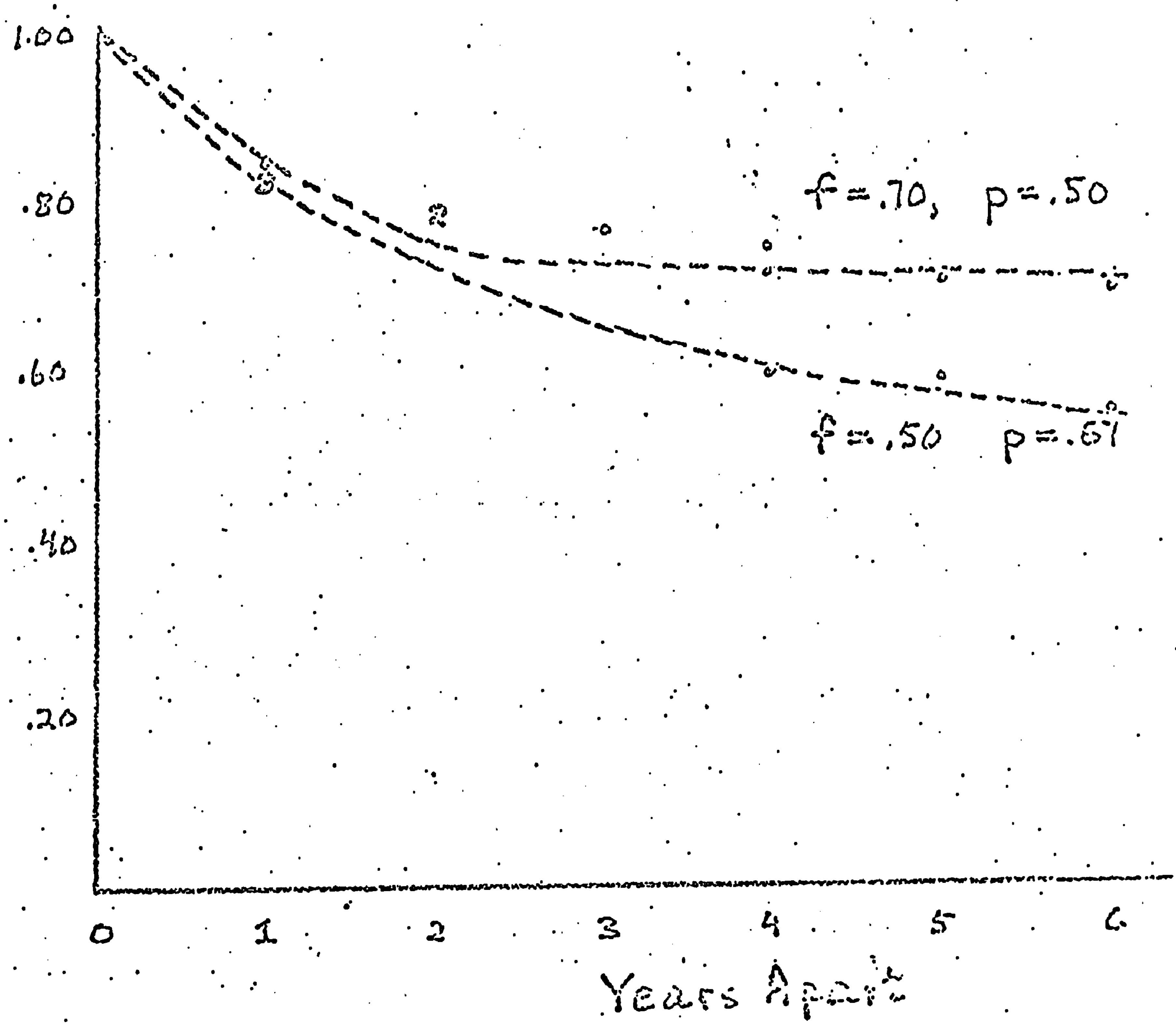
where the u^i are serially correlated. Gintis then showed that the correlation between incomes in h years apart, r_h, will be a function of the autoregressive pattern as described by p, and var(e)/var(y_p) the ratio of the variance of e to the variance of permanent income. Thus,

A.9) $$r_h = \frac{1 + p^h\ [\text{var}(e)/\text{var}(y_p)]}{1 + [\text{var}(e)/\text{var}(y_p)]}\ .$$

Using this equation and the data from Friedman and Cutright, I have arrived at estimates of p and var(e)/var(y_p). Figure A.1 presents the observed correlations, and those predicted using various values of p and $\frac{\text{var}(e)}{\text{var}(y_p)}$. I have selected var(e)/var(y_p) = .43 and p = .5 as the best estimates, implying

Figure A.1

Actual and Predicted Correlation Coefficients for Annual Incomes at Times Various Years Apart



Notes:
1. Observations indicated by numbers 2 and 3 indicate multiple observations of the same value for the indicated year.
2. Data are from Friedman (1957) and Cutright (1969).
3. Predicted correlations are based on expression A.9.
4. $f = \frac{\text{var } y}{\text{var } y}$

that 70 percent of the variance of observed income is attributable to the variance of permanent income.[1] The discrepancy between this estimate and those mentioned previously is explained by the fact that the lower estimate is based on the assumption that errors in observed income are serially correlated. Because the Gintis model fits the data so well[2], I conclude that the assumption of serially correlated errors is appropriate. I will therefore use .84 (= $\sqrt{.70}$) as the estimated correlation between observed and permanent income.[3] (See column 5 of table 4.)

[1] The very low correlation for years 4, 5, and 6 shown in figure 1 are all correlations with an income reported very early in the work experience of the respondent. It seems likely that the error variance of this early year's reported income is atypically large, and that the average annual rate of increase of observed income over this period is quite high. Both of these characteristics (the pattern of earnings in the early years will cause estimates based on expression A.9 to overstate the size of the error component in annual income.

[2] Note that simple models in which, assuming serially uncorrelated errors, (p = 0) would not predict the observed pattern of correlation coefficients, even as a rough approximation.

[3] Data from the 1950 Post-Enumeration Survey of the U.S. Census suggest that the correlation of reported incomes in the same year to two separate surveys is .80. This figure presumably represents pure reporting error, as it does not contain transient year-to-year variations in income. If we assume that the error component in the Census is twice as great as in the Post-Enumeration Survey, and further that the correlation between errors in reporting to these two surveys is .5, the estimated correlation between reported and actual annual income is .87. This calculation suggests that most of the "error" in reported annual income as due to erroneous reporting rather than to transience of annual income.

3. Errors in reporting education and occupation

On the basis of the 1950 Post-Enumeration Survey, the Census Bureau published matrices recording responses to the original Census enumerators and to the Post-Enumeration surveyors. I have scaled these responses using the Duncan occupational status scale, as well as his educational attainments scale , and correlated the two responses. The correlations were .86 for educational attainment and .88 for occupational status.

In order to use these correlation coefficients to estimate the error variance as a fraction of the variance of observed occupational status and educational attainment, two basic assumptions must be made: one concerning the accuracy of the original Census relative to the Post-Enumeration Survey, and the other concerning the degree to which errors in reporting to the original Census are correlated with errors in reporting to the Post-Enumeration Survey. Because the Current Population Survey data upon which my mobility estimates are based were collected by highly trained Census enumerators, I think it reasonable to assume that these data are about as accurate as the Post-Enumeration survey which was also conducted by a well-trained staff, and that both are highly reliable by comparison with the general Census data. Because the Post-Enumeration Survey took place very shortly after the Census, it also seems reasonable to assume that the errors in both sources are positively correlated. I have estimated various measures of the accuracy of the Post-Enumeration Survey, based on alternative assumptions concerning the degree of correlation of errors, and the relative accuracy of the Post-Enumeration Survey and the Census. These estimates are presented in table A.2. I have chosen the middle assumptions for each as the basis for the estimate of the correlation between observed and true variables for educational attainment and for occupational status.1/ These figures appear in column 5 of table 4.

1/Let r_p and r_c represent the correlations between the true measure and that measured by the Post-Enumeration Survey and the Census, respectively. Further, define r_{pc} as the correlation between Census and Post-Enumeration responses, and r_u as the correlation of errors in the two measures. Then (using equation 6) we have

$$r_{pc} = r_p r_c + r_u \sqrt{1 - r_c^2} \sqrt{1 - r_p^2} .$$

Table A.2.

mated Correlation of True and Observed Values
espondents' Reports of their Own Occupations
and Years of Schooling

OCCUPATION

Error variance of census / Error variance of PES	Correlation of errors in census and PES reports[a]		
	.0	.5	.7
1.0	.935	.870	.770
2.0	.959	.923	.882
3.0	.970	.950	.930

EDUCATION

rror variance of census / Error variance of PES	Correlation of errors in census and PES reports		
	.0	.5	.7
1.0	.930	.850	.730
2.0	.953	.910	.865
3.0	.965	.940	.920

a. These correlations measure the accuracy of the respondents' reports. They are not corrected for discrepancies between the occupational status score and "true" status.

4. Correlation of Errors and Internal Consistency of the Reliability Estimates.

The evidence from the Duncan and Blau census follow up study yielded the figure .8 as the estimate of the correlation between the observed and true parents occupational status. It was further assumed (page 18 , above) that the figure of .8 also represents the correlation between reported and real parents educational attainments. It remains to be shown, first that these estimates, together with other evidence on relia- bilities and with the fragments of independent evidence available, imply a negligible correlation of errors in reporting occupational status and parents income. Secondly, I will show that the reliability estimates themselves are consistent with the available data and with each other.

In order to do this I adopt the following procedure. First define r_{oe} as the correlation between the true occupational status and true educational attainment. Let a superscript p indicate that the correlation refers to the father or head of household of the respondent. Let the superscript prime (') indicate the observed correlations, and the subscript u indicate that the correlation refers to the correlation of error terms rather than the variables themselves.

Using equation 6, I can now write the observed correlations as a function of the true correlations, the correlations of the observed with the true variables, and the correlations of the error terms. Thus:

A.10) $$r^{p'}_{oe} = r^{p}_{oe}\, r^{p}_{o}\, r^{p}_{e} + r^{p}_{uoe} \sqrt{1 - r^{p2}_{o}} \sqrt{1 - r^{p2}_{e}}$$

A.11) $$r'_{oe} = r_{oe}\, r_{o}\, r_{e} + r_{uoe} \sqrt{1 - r^{2}_{o}} \sqrt{1 - r^{2}_{e}} \,.$$

We have some independent information on the trend in the correlation between occupational status and educational achievement. This evidence, in turn, will allow some inferences about the relationship between r^p_{oe} and r_{oe}. The evidence of a cohort analysis of the occupational changes in a generation sample suggest no trend in the correlation between occupational status and educational attainment.

Because the respondent's own occupational status is reported for different points in the individual life cycle for different age cohorts, not much can be inferred from the correlations between respondent's own occupational status and educational attainment. However, respondents were asked to report their parents' occupational status at a roughly similar time in the life cycle of the parents, namely, when the respondents were about 16. Thus the correlations among the parents' variables provide evidence largely independent of the position in the life cycle. For the four 10-year age cohorts from 25 to 64, the correlations are (from oldest to youngest): .5313, .4863, .5300, and .4885. There is no apparent secular trend, thus motivating the assumption that $r_{oe} = r^p_{oe}$.[1/] It can be seen

[1/]These are the observed correlations reported in Duncan, Featherman, and Duncan, p. . Folger and Nam (1967) present evidence that the degree of association between educational attainment and occupational status declined over the period 1940-1960. The Folger and Nam results must be seriously questioned, however. It may be seen from

(continued on next page)

from equation A.10 and A.11 that our estimated reliability and the assumption that $r_{oe} = r^{p}_{oe}$ imply that the correlations of errors r_{uoe} and r^{p}_{uoe} are negligible.[1/]

The evidence that there has been no secular trend in the relationship between occupational status and educational attainment may be further checked in a manner which provides evidence on the consistency of the no trend assumption with our estimated correlations of true and observed variables.

_If_ there has been no trend in the relationship between occupational status and educational attainment, and _if_ our estimate of the accuracy of the respondent's reports of his own and his parents' occupations and educations are accurate, then the corrected correlation of educational attainment and occupational status for the 25-34 year old respondents' parents should be roughly equal to the analogous correlation for the 35-44 year old respondents' own occupation and education. (The latter age

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equations A.10 and A.11 that any significant decline in this relationship, namely, $r_{oe} < r^{p}_{oe}$, implies a large negative correlation of errors in reporting occupation and educational attainment. This seems to be highly unlikely. In any case, acceptance of the Folger and Nam evidence over the OCG data would result in estimates showing education playing an even smaller independent role in intergenerational occupational mobility, and would thus lend further support to the position of this paper.

1/ It is assumed on this basis that the correlation of errors in reporting education and earnings is also zero. Assumption of a (perhaps more plausible) positive correlation of errors would result in a lower estimate of the independent effect of schooling upon earnings.

group is selected as that which is most likely to have 16-year-old children, and thus to correspond to the parents' status retrospectively reported by the 25-34 year old respondents referring to the period roughly 9 to 19 years ago when they were 16.) The corrected correlation for the 35-44 year olds is .7676, while that for the parents of 25-34 year olds is .7633. It should be stressed that the striking similarity of these two correlations demonstrates only the consistency of our estimates. Other estimates might also be consistent, although a little experimentation will show that an alternative set of consistent estimates is not easy to come by.

Table A.3. Corrected Zero Order Correlations among the Main Variables for Non-Negro Males, Aged 25-34, with Non-Farm Backgrounds in Experienced Labor Force, 1962

	1	2	3	4	5	6	7	8	9
1. Earnings	1.000	.4345	.3004	.3566	.3228	-.1889	.2283	.3004	.3885
2. Occupation	.840/.923	1.000	.4786	.7751	.3655	-.2793	.4632	.4786	.5132
3. Parents' income	b	b	1.000	.6031	.2832	-.1811	.4018	.4900	.2281
4. Years of schooling	.840/.910	.933/.91	.840/.91	1.000	.4719	-.3734	.5518	.5677	.6825
5. Early IQ	a	a	.840/.950	.910/.95	1.000	-.2741	.2479	.2603	.8865
6. Number of siblings	.840/.960	.923/.96	.840/.960	.910/.96	.95/.96	1.000	-.3504	-.2982	-.3257
7. Father's education	.840/.800	.923/.80	.840/.910	.910/.80	a	.96/.8	1.000	.7633	.3684
8. Father's occupation	.840/.800	.923/.80	.840/.923	.910/.80	a	.96/.8	.8/.8	1.000	.3816
9. Late IQ									

Note: Corrected coefficients appear above the diagonal. The first and second number in the cells below the diagonal are the estimated correlation between the true and observed variables denoted by the column and row headings, respectively. See table 4.

a) Values inferred from the other correlations. See notes to tables 8 and A5.

b) Corrected correlations for these cells are assumed to be equal to the respective corrected correlations of father's occupation with respondent's earnings and occupation, respectively.

Table A.4. Zero Order Correlations among the Main Variables for Non-Negro Males, Aged 25-34 with Non-Farm Backgrounds in Experienced Labor Force, 1962
ORIGINAL DATA AND SOURCES

	1	2	3	4	5	6	7	8	9
1. Earnings	1.000	.3369		.2726		-.1523	.1534	.2019	.3100
2. Occupation	a	1.000		.6510		-.2475	.3420	.3534	.4500
3. Parents' income	e	e	1.000	.4610	.2260	-.1460	.3071	.3799	.1820
4. Years of schooling	a	a	b	1.000	.4080	-.3262	.4017	.4133	.5900
5. Early IQ	e	e	b	b	1.000	-.2500			.8000
6. Number of siblings	a	a	b	a	g	1.000	-.2691	-.2290	
7. Father's education	a	a	c	a	e	a	1.000	.4885	.2800
8. Father's occupation	a	a	c	a	e	a	a	1.000	.2900
9. Late IQ	d	d	b	d	f	e	d	d	1.000

a) Duncan, Featherman, and Duncan (1968), p. 51.

b) Data provided by the California Guidance Study. I am grateful to Marjorie Honzik and the Institute of Human Development at the University of California (Berkeley) for making these data available to me, and to John Conlisk for drawing my attention to the data source and assistance in acquiring the data. These correlations are estimated for a sample of about 70 individuals and their families.

c) Duncan, Featherman, and Duncan (1968), p. 51. These figures are the actual correlations for 55-64 year old respondents' own earnings, education, and occupation.

d) From Duncan (1968b), p. 2.

(continued on next page)

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NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.

MEMORANDUM:

To: COBRE Workshop Participants (June 7, 1971)
From: B. R. Chiswick and J. Mincer
Date: May 26, 1971

Attached is our conference paper. The data table in Appendix B for means, variances and correlations referred to in the text will be distributed at the conference.

May 1971 Draft
Human Capital Conferenc
Chicago, June 7, 1971

Time Series Changes in Personal Income Inequality: The United States Experience, 1939 to 1985

Barry R. Chiswick and Jacob Mincer[1]

Columbia University and National Bureau of Economic Research

Data on the distribution of personal income in the United States indicate a decline in relative inequality from 1939 to the early post war years, but from then till now inequality has hardly changed.[2] This can be contrasted with the substantial growth in average income during this same period. Although these data have been subject to investigation, there has not been presented a unified theory to explain the pattern of change (or lack of it) in time series income inequality. The absence of a theoretical structure may have also inhibited the prediction of inequality in the future.[3]

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[1]Sara Paroush's skillful research assistance is greatly appreciated.

[2]H.P. Miller, Income Distribution in the United States, 1960 Census Monograph (Washington: Dept. of Commerce, 1966) pp. 15-28; H. Lydall, The Structure of Earnings, (Oxford: Clarendon Press, 1968) pp. 176-9; T.P. Schultz, "Secular Trends and Cyclical Behavior of Income Distribution in the United States; 1944-1965," Lee Soltow, ed, Six Papers on the Size Distribution of Wealth and Income (New York: National Bureau of Economic Research, 1969) p. 98. These sources cover the period up to 1965. From 1965 to 1969 there was a small decline in inequality which can be explained by the decline in unemployment.

The United States experience may be contrasted with that of Great Britain where, according to Lydall, there was a continuous, if not accelerating, decrease in pre-tax income inequality from 1938 to 1957. (Harold Lydall, "The Long Term Trend in the Size Distribution of Income," Journal of the Royal Statistical Society, Series A, Part I, 1959, pp. 6-9).

[3]One exception is Lee Soltow who used 1956 as a base to predict inequality in 1970 and 1980 by assuming an unchanged income concentration ratio between classes and within classes, and using projected schooling and age distributions to obtain class weights. See Lee Soltow, "The Distribution of Income Related to Changes in the Distributions of Education, Age and Occupation," Review of Economics and Statistics (November 1960) p. 450-53.

During the last fifteen years the relation between human capital and income distribution has been subject to theoretical and empirical investigation. This research has generally been limited to cross-sectional analyses.[3a] However, there is nothing inherent in the analysis which prohibits its application to a time series study. Hence, this paper, which is an analysis, based on the human capital earnings function, of the change and lack of change in income inequality over time in the United States.

Most of this paper's empirical analysis will focus on the post World War II period, solely because of the paucity of data for earlier years. We shall, however, look back to 1939 and forward to 1985. Our predicted inequality for 1939 can be compared with the actual inequality. As for 1985, we are willing to place bets.

In Part I an earnings function is generated which relates personal earnings to human capital and employment variables. By taking the variance of the earnings function, relative inequality becomes a function of the variances, levels, and intercorrelations among the human capital and employment variables.

In Part II a decomposition of the earnings inequality function is employed to ascertain the effects of changes in the explanatory variables on the income inequality of males.[4] Post-war changes in the explanatory variables are presented, and the data indicate that their relative stability did not allow for significant changes in inequality. In Part III, using 1959 as the base year, the inequality in each of the post-war years is predicted from the relative earnings function and the predicted

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[4]The empirical analysis is for income rather than earnings because of the scarcity of adequate earnings data.

[3a]See Jacob Mincer, "The Distribution of Labor Incomes: A Survey with Special Reference to the Human Capital Approach," Journal of Economic Literature (March 1970), pp. 1-26.

value is compared with the actual inequality. The model is found to have substantial explanatory power.

In Part IV the difference in income inequality for 1965 (a year of low unemployment) and 1939 is predicted, and it is found that the large inequality of employment in 1939 is in part responsible for the large inequality in that year. Projected schooling and age distributions for 1985 are used to predict the change in income inequality between 1965 and 1985. For males 25 to 64, no change is predicted, but for males 35 to 44 a small decline is anticipated.

Part I - The Earnings Function[5]

The relation between gross earnings[6] and investment in human capital for the i^{th} person in year j can be written as

(1)
$$E_{ji} = E_{oi} + \sum_{t=0}^{j-1} r_{ti} C_{ti}$$

where the gross earnings (E_{ji}) is a function of the "original" endowment (E_{oi}) and the sum of the returns on previous investments (C_{t_i}), r_{t_i} being the average rate of return to the investment in the t^{th} year. In this expression, earnings are a linear function of dollars of investment.

An alternative specification of the relation between gross earnings and investment can be obtained by expressing C_{ji} as a fraction of E_{ji} (i.e., $C_{ji} = k_{ji}E_{ji}$). If the original endowment is assumed constant

[5]This section leans very heavily on Jacob Mincer, "Schooling, Age and Earnings," Human Capital and Personal Income Distribution (NBER, in progress).

[6]Gross earnings are earnings before the opportunity cost of contemporaneous investments in training are subtracted to obtain the observed net earnings.

across all years and individuals (E_0), we can write[7],

$$(2) \quad E_{ji} = E_0 + \sum_{t=0}^{j-1} r_{ti} k_{ti} E_{ti} = E_0 \prod_{t=0}^{j-1} (1 + r_{ti} k_{ti})$$

By taking the natural log of both sides of equation (2), since $r_t k_t$ is small, we obtain (approximately)

$$(3) \quad \ln (E_{ji}) = \ln E_0 + \sum_{t=0}^{j-1} r_{ti} k_{ti}$$

For the purposes of this analysis, equation (3) is superior to equation (1) as the basic earnings function. First, there appears to be more interest in changes in the relative inequality of earnings than in the absolute inequality and equation (3) is better suited for this purpose. Second, the available data sources permit the measurement of investments in human capital in terms of years of schooling and years of labor market experience, rather than the dollar investments, and equation (3) will be converted below into a years of training formulation. Finally, if earnings are more closely approximated by a log normal than a normal distribution, the structure in equation (3) will have residuals which are more homoskedastic than the structure in equation (1).

The number of periods of investment in training ($j-1$) can be decomposed into S years of schooling and j-S-1 years of labor market experience. It shall be assumed that an individual invested in experience

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[7]For the i^{th} person,

$$E_j = E_0 + \sum_{t=0}^{j-1} r_t C_t = E_0 + \sum_{t=0}^{j-1} r_t k_t C_t .$$

For $j=1$, $E_1 = E_0 (1 + r_0 k_0)$.

For $j=2$, $E_2 = E_0 + r_0 k_0 E_0 + r_1 k_1 E_1$.

$$E_2 = E_0 (1 + r_0 k_0)(1 + r_1 k_1).$$

in each year since he left school. That is, experience shall be measured as age minus schooling minus five ($T = A-S-5$). An additional assumption is that the direct costs of formal schooling equal the actual earnings of students at the level. This means we can write $k_{ji} = 1$ for the schooling years. It shall also be assumed that E_0 is the same for all individuals.

Equation (3) implicitly assumes full year employment. If E^* is designated full employment earnings, actual earnings are $E_i = E_i^* (w_i)^\gamma$ where W_i is the fraction of weeks worked and γ is the elasticity of earnings with respect to weeks worked.[8] Empirically, γ is greater than unity.[9] A γ greater than unity implies that average weekly wages are higher for those who work more weeks per year.[10] γ will be assumed constant across individuals.

When these modifications of the human capital earnings function are incorporated into equation (3), we obtain

(4) $$\ln E_{ji} = \ln E_0 + r_i S_i + \sum_{t=S+1}^{j-1} r_{ti} k_{ti} + \gamma(\ln W_i)$$

To evaluate the expression $\sum_t r_t k_t$ some assumption is needed as to how k_t changes, if at all, over time.[11] "There are several reasons for believing that kt, the fraction of gross earnings invested, declines over time."

First, if additional experience

[8]This formulation assumes a constant number of hours worked per week of employment.

[9]Mincer found that for white, non-farm males with earnings, $\gamma = 1.2$. (Mincer, "Schooling, Age and Earnings," Part II).

[10]This can be explained by factors affecting either labor supply or labor demand. On the supply side, workers with higher weekly wages may work more weeks because of an upward rising supply curve of labor, a lower quit rate because of greater amounts of specific training, or a shorter duration of unemployment due to the higher opportunity cost of their time. On the demand side, if firms have a larger investment in workers with more training, these workers have a lower rate and duration of lay-off. For an analysis of the relation between training and turn-over rates, see Gary Becker, Human Capital (New York:National Bureau of Economic Research,1964).Ch.2. An additional factor is the observed positive correlation between hours worked per week and weeks worked per year. (See V. Fuchs, "Differentials in Hourly Earnings by Region and City Size, 1959," (N.Y., NBER) Occasional Paper No.101, p.

[11]See Yoram Ben-Porath, "The Production of Human Capital and the Life Cycle of Earnings," Journal of Political Economy (August 1967), pp. 352-65.

increases the value of time more in employment than in the production of additional experience, the opportunity cost of time devoted to investments in experience rises over time, decreasing the profitability of additional investment. Second, with additional experience the length of the remaining working life declines. Finally, if an investment is profitable, it is most profitable (highest net present value) the earlier is it undertaken.

For simplicity, it shall be assumed that k_t declines linearly with respect to time. Then, $\sum_t r_t k_t$ is a parabolic function of the number of years of experience (T).[12]

Available data sources are for earnings net of the opportunity cost of training (Y_t) rather than for gross earnings (E_t). By definition

$$\ln Y_t = \ln E_t + \ln(1-k_0) + \frac{k_0}{T^*(1-k_0)}T + \left(-\frac{1}{2}\right)\left(\frac{k_0}{T^*(1-k_0)}\right)^2 T^2,$$

using a three term Taylor expansion.

Incorporating the net earnings relation and the linear decline in the experience term into equation (4) results in

$$(5)\quad \ln Y_t = \left(\ln E_0 + \ln(1-k_0)\right) + r_i S_i + \left(r_t k_0 + \frac{k_0 1}{T^*(1-k_0)}\right)T_i + \left(-\frac{r_t k_0}{2T^*} - \frac{k_0^2}{2T^2(1-k_0)^2}\right)T_i^2 + \gamma(\ln W_i) + U_i,$$

where U is a residual.

Data are available for individuals on net earnings (Y_t), years of

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[12] If $k_t = k_0(1 - \frac{t}{T^*})$, where T^* is the number of years of positive net investment, converting to continuous time, $\int^T r_t k_t \, dt = r_j k_0 T - \left(\frac{r_j k_0}{2T^*}\right)T^2$.

schooling, age, and weeks worked, but not for the coefficients of the explanatory variables. The equation is, however, extremely powerful for explaining differences in earnings. When the log of earnings is regressed on S_i, T_i, T_i^2 and LnW_i for white, non-farm males from the 1960 Census 1/1,000 sample, the coefficient of determination is over 50%.[13] Such a high explanatory power using micro-data is quite impressive.

The human capital earnings function for individuals can be used to analyze inter-temporal, inter-regional and inter-demographic group differences in the level, inequality and skewness of the distribution of earnings.[14] This paper, however, is concerned solely with the inter-temporal differences in earnings inequality. Before calculating the variance of both sides of the earnings function several modifications or assumptions shall be made.

First, the squared experience term shall be deleted. The squared term is of importance in an analysis of inequality only for older age groups. For the groups under investigation its inclusion would add more complications (in terms of third and fourth moments of experience) than light. The deletion of the squared experience term biases downward the slope coefficient of experience. If the population under study is approximately uniformly distributed by age, the slope of the experience term is approximately $\frac{k_t \, k_0}{2}$.

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[13] See Mincer, "Schooling, Age and Earnings," Part II.

[14] The function, or a modification of it, is used to analyze inequality and skewness in B.R. Chiswick, "Inter-Regional Analysis of Income Distribution," Human Capital and Personal Income Distribution (NBER, in progress), "Earnings Inequality and Economic Development," Quarterly Journal of Economics, February 1971, and "An Inter-Regional Analysis of Schooling and the Skewness of Income," W.L. Hansen, ed. Education, Income and Human Capital (NBER, 1970), and in J. Mincer, "Investment in Human Capital and Personal Income Distribution," Journal of Political Economy (August 1958), pp. 281-302, and "Schooling, Age and Earnings." Chiswick is currently analyzing state differences in level and inequality using the full equation.

Second, note that the variable experience is simply age minus schooling minus five. Public policy can change the distribution of schooling independently of age, but if it does so, the distribution of experience is necessarily altered. There is also more concern with the distribution of earnings by age group, than by experience group. Thus, it would be desirable to express earnings as a function of schooling and age. Fortunately, this is easy to do.

Finally, it shall be assumed that the coefficients of schooling and experience in equation (5) are random variables independent of S and T. This assumption is not as "strange" as it might at first seem. Thinking in terms of the "supply and demand for funds for investment in human capital" model developed by Gary Becker in his Wyotinsky Lecture[15], those with greater "training ability," for a given cost of funds schedule, have a higher average and marginal rate of return, and invest more. Those with lower levels of wealth, holding "training ability" constant, invest more but have a lower average and marginal rate of return. Greater wealth and greater "ability" are positively correlated, resulting in an ambiguous *a priori* relation between level of investment and marginal and average rates of return. Empirical support for this is the absence of a significant slope coefficient for the quadratic term when the log of earnings is regressed on schooling, schooling squared and the log of weeks worked.[16]

Using these modifications, equation (5) becomes

$$(6) \quad \ln Y_i = X' + r_i S_i + r_i'(A_i - S_i - 5) + \gamma(\ln w_i) + u_i$$

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[15] G.S. Becker, Human Capital and Personal Income Distribution: An Analytic Approach (Ann Arbor: University of Michigan Press 1967).

[16] See Mincer, "Schooling, Age and Earnings," Part II.

where $r_i' = \frac{r_i k_0}{2}$ and $X' = \ln E_0 + \ln(1-k_0)$.

The residual, U_i, reflects individual differences in earnings for given levels of schooling, age and employment. It includes the effects of discrimination, differences in the non-pecuniary aspects of jobs, non-labor income (if this is included in the income concept), and errors of measurement. For simplicity, it is assumed that the residual is a random variable.

Taking variances gives,

$$
\begin{aligned}
(7)\quad \sigma^2(\ln Y) = {} & \left[(\bar{r}-\bar{r}')^2 + \sigma^2(r) + \sigma^2(r')\right]\sigma^2(S) \\
& + \left[(\bar{r}')^2 + \sigma^2(r')\right]\sigma^2(A) + \gamma^2\sigma^2(\ln W) \\
& + \left[2\bar{r}'(\bar{r}-\bar{r}') - \sigma^2(r')\right] R_{as}\,\sigma(A)\,\sigma(S) \\
& + \left[2\gamma(\bar{r}-\bar{r}')\right] R_{sw}\,\sigma(S)\,\sigma(\ln W) + \left[2\gamma\bar{r}'\right] R_{aw}\,\sigma(A)\,\sigma(\ln W) \\
& + \sigma^2(r)\,\bar{S}^2 + \sigma^2(r')\,(\bar{A}-\bar{S}-5)^2 + \sigma^2(U),
\end{aligned}
$$

where it is assumed that r_i and r' are uncorrelated with each other.

Relative earnings inequality is now expressed as a function of the inequalities and inter-correlations among schooling, age and the log of weeks worked, and the levels of schooling and age. An interesting feature of the model is that relative earnings inequality is a function of the relative inequality in employment. Previous time series studies of earnings inequality included the unemployment rate as an explanatory variable.[17] For the United States, the unemployment rate is highly correlated with the inequality of weeks worked over the business cycle,

[17] See, for example, T.P. Schultz, op. cit. and Charles E. Metcalf, "The Size Distribution of Personal Income During the Business Cycle," American Economic Review (Sept. 1969), pp. 657-67.

but weakly correlated across states at a moment in time.[18]

The intercorrelations have economic meaning. A negative correlation between age and schooling reflects a secular trend in schooling.[19] Moderate secular trends in schooling have a narrowing effect on earnings inequality. This is because the young who would have low net earnings because of few previous investments and relatively large contemporaneous investments have, on the average, greater than average schooling which tends to raise their earnings. Up to a point, inequality decreases when the trend in schooling increases (R_{aA} becomes more negative).

The non-zero correlation between weeks worked and both schooling and age can be explained by both supply of labor and demand for labor factors. On the demand side, the increase in investments in specific training with higher levels of schooling and age (until older ages) decreases the firms incentive to lay-off the workers and thereby increases weeks worked. On the supply side, investments specific to the firm (e.g. training, non-vested pension funds) also increase with schooling and age (again, until older ages) thereby decreasing quite rates. In addition, those with higher opportunity costs of time have an incentive to economize on search time, and thereby work more weeks per year. One factor generating lower levels of weeks worked by the young may be a higher turnover rate due to their searching for information about the nature of jobs. When older males are included, the correlation between age and weeks worked declines.[20]

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[18]See N. Hashimoto, Ph.D. dissertation, Columbia University, 1971.

[19]For males aged 25 to 64 in 1965 the correlation was R = -.22. Lower mortality and higher migration rates for the more schooled affect the correlation, but are not important for the U.S. as a whole during the period under study.

[20]For labor force males aged 25 to 64 in 1965 the correlation between age and the log of weeks worked was -.06. For labor force males 18 and over it was +.12, and for those 25 and over it was -.22. The correlation between schooling and the log of weeks worked for labor force males 25 to 64 in 1959 was +.14.

Part II - Decomposition Analysis

In this section the income inequality function is decomposed into parts attributable to the human capital and employment variables.[1] The contribution of schooling, age and employment to inequality is identified. The effects of changes in the explanatory variables are examined to indicate future sources of change in inequality. In Part III, using 1959 as a base, inequality is predicted for adult males for the years 1949 to 1969, and compared to the observed inequality. The same structure is used in Part IV to "predict" inequality in 1939 and 1985.

Let us first look at a simplified version of equation (7), one in which the rate of return to schooling (r_i) and the experience coefficient (r_i') are assumed to be constant for all individuals rather than random variables. The coefficients $\bar{r}$, $\bar{r}'$, and γ could be computed by a regression analysis of the log of earnings on schooling, experience, experience squared and the log of weeks worked. The values $\bar{r} = .11$, $\bar{r}' = .04$ and $\gamma = 1.2$ were so obtained.[2] The income inequality of adult males aged 25 to 64 in 1959 was .6483. Using 1959 data for labor force males aged 25 to 64, income inequality in 1959 can be expressed as

[1]The sources of the data are presented in Appendix A. Appendix B contains the computed means, variances and correlations.

[2]They were calculated from a regression analysis for white, non-farm, non-enrolled males under age 65. The value of .04 for $\bar{r}'$ is one half of the slope coefficient of experience in the regression. See Mincer, "Schooling, Age and Earnings," Part II.

(8)
$$\begin{aligned}\sigma^2(\ln Y) &= (\bar{r}-\bar{r}')^2\,\sigma^2(S) + (\bar{r}')^2\,\sigma^2(A) + \gamma^2\,\sigma^2(\ln w)\\ &\quad + [2\,\bar{r}'(\bar{r}-\bar{r}')]\,R_{as}\,\sigma(A)\,\sigma(S) + [2\,\gamma(\bar{r}-\bar{r}')]\,R_{ws}\,\sigma(\ln w)\,\sigma(S)\\ &\quad + 2\gamma\bar{r}'\,R_{aw}\,\sigma(A)\,\sigma(\ln w) + \sigma^2(u)\end{aligned}$$

$$\begin{aligned}&= (.0049)\,\sigma^2(S) + (.0016)\,\sigma^2(A) + (1.44)\,\sigma^2(\ln w)\\ &\quad + (.0056)\,R_{as}\,\sigma(A)\,\sigma(S) + (.168)\,R_{ws}\,\sigma(\ln w)\,\sigma(S)\\ &\quad + (.096)\,R_{aw}\,\sigma(\ln w)\,\sigma(A) + \sigma^2(u)\end{aligned}$$

$$\begin{aligned}&= \underset{(S)}{.0637} + \underset{(A)}{.1808} + \underset{(w)}{.2160} + \underset{(A,\,S)}{(-.0493)}\\ &\quad + \underset{(w,\,S)}{.0468} + \underset{(A,\,w)}{(-.0198)} + \sigma^2(u).\end{aligned}$$

$$= .4383 + \sigma^2(u).$$

The model explains 68 percent ($R^2 = \frac{.4383}{.6483} = .68$) of individual differences in the log of earnings. Note that the direct contribution of schooling is small compared to that of age and employment.

Table 1 shows the effect of a change in the explanatory variables on the inequality of earnings based on equation 7. Using the same values as above, and assuming the coefficients of variation in r and r' are one-third, the effect of a unit change in the explanatory variables can be computed.(2a) For the means and standard deviations and correlations:

$$\frac{\partial \sigma^2(\ln Y)}{\partial \sigma(S)} = .046 \qquad \frac{\partial \sigma^2 \ln Y}{\partial \bar{S}} = .020 \qquad \frac{\partial \sigma^2(\ln Y)}{\partial R_{sA}} = .194$$

$$\frac{\partial \sigma^2(\ln Y)}{\partial \sigma(A)} = .031 \qquad \frac{\partial \sigma^2 \ln Y}{\partial \bar{A}} = .009 \qquad \frac{\partial \sigma^2(\ln Y)}{\partial R_{sw}} = .390$$

$$\frac{\partial \sigma^2 \ln Y}{\partial \sigma(\ln w)} = .185 \qquad \frac{\partial \sigma^2(\ln Y)}{\partial R_{wA}} = .341$$

(2a) There is some evidence that one-third may be an upper limit to the coefficient of variation of r. The earnings function can be written as $\ln Y = a + r H$, where H is accumulated human capital measured in time equivalents. Then, $\delta^2(\ln Y) = \bar{r}^2 \delta(H) + \bar{H}^2 \delta^2(r) + \delta^2(r)\,\delta^2(H)$. From regressing $\ln Y$ on H, $R^2 \approx 1/2$ and CV (H) $\approx 1/3$ (see Mincer, "Schooling, Age and Earnings," Part II). Thus,

$$R^2 = \frac{\bar{r}^2 \delta^2(H)}{\bar{r}^2 \delta^2(H) + \bar{H}^2 \delta(r) + \delta^2(r)\,\delta^2(H)} \approx 1/2,$$

and $CV(r) \approx 1/3.3 \approx 1/3$

If there is a true residual in the regression such that $\ln Y = a + rH + U$, then $1/3.3 \approx 1/3$ is an upper limit of CV(r).

Table 1

Partial Effects of the Explanatory Variables on Income Inequality

(1) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\delta\ (S)} = 2[(\bar{r}-\bar{r}^1)^2 + \delta^2(r) + \delta^2(r^1)]\delta(S)$$
$$+[2\bar{r}^1(\bar{r}-\bar{r}^1) - \delta^2(r^1)]R_{as}\delta(A)$$
$$+[2\gamma(\bar{r}-\bar{r}^1)]R_{ws}\ \delta(\mathrm{LnW}).$$

(2) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ (A)} = 2\ [\bar{r}^1 + \delta^2(r^1)]\ \delta(A) + [2\ \bar{r}^1(\bar{r} - \bar{r}^1) - \delta^2(r^1)]R_{as}\delta(S)$$
$$+[2\bar{r}^1\gamma]R_{aw}\ \delta(\mathrm{LnW})$$

(3) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\delta\ (\mathrm{LnW})} = 2[\gamma^2]\delta(\mathrm{LnW}) + [2\gamma(\bar{r}-\bar{r}^1)]R_{ws}\ \delta(S)$$
$$+[2\gamma\bar{r}^1]R_{aw}\ \delta(A)$$

(4) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ \bar{S}} = 2[\delta^2(r) - \delta^2(r^1)]\bar{S} - 2\ \delta^2(r^1)(\bar{A}-5)$$

(5) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ \bar{A}} = 2(\bar{A}-\bar{S}-5)\delta^2(r^1).$$

(6) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ R_{as}} = (2\ \bar{r}^1(\bar{r} - \bar{r}^1) - \delta^2(r^1))\ \delta\ (A)\ \delta(S)$$

(7) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ R_{ws}} = 2\ \gamma\ (\bar{r} - \bar{r}^1)\delta(\mathrm{LnW})\ \delta(S)$$

(8) $$\frac{\partial\delta^2(\mathrm{LnY})}{\partial\ R_{wa}} = 2\gamma(\bar{r}^1)\ \delta(\mathrm{LnW})\ \delta(A)$$

The standard deviation of schooling changes slowly over time. In the United States, for civilian labor force males aged 25 to 64, it fell fairly steadily from 3.70 years in 1949 to 3.04 years in 1970. This decline need not, however, continue in the future. A one unit decline in the standard deviation of schooling (which is approximately a 30 percent decline) reduces inequality by .046 points, or a decline of about 7 percent in the relative variance of income for males aged 25 to 64.

The decline by .66 years in the standard deviation of schooling from 1949 to 1970 would be responsible for a 4 percent decline in the variance of the log of income, or a 2 percent decline in its standard deviation.

A unit increase in the level of schooling increases inequality by .020 points. The average schooling of labor force males aged 25 to 64 has risen two years from 9.66 years in 1949 and 11.66 years in 1970. This would have increased inequality over the period by .04 points. The net effect of the postwar decline in the standard deviation of schooling by .66 years and the rise in level by 2.0 years is to leave virtually unchanged the relative variance of income.[3]

The income distribution is also affected by the correlation of age with schooling. The stronger the secular trends in schooling, the more negative is the correlation and the smaller is the inequality of schooling. If in 1959 the correlation were zero but the level and inequality of schooling were unchanged, inequality would have been greater by (.2304)(.194) = .0447 points, or by almost seven percent of the variance of logs. During the years 1949 to 1970, for males 25 to 64 the correlation ranged from a high of -.2340 (1949) to a low of -.2070 (1970), indicating a slight decline in schooling trends. Its effect on inequality would be small, a rise of (.0270)(.194) = .0052 points, or a less than one percent rise in the variance of logs.

[3]The change of (.046)(-.66) + (.020)(2.0) = +.0064 points is one percent of the 1959 level of inequality. Soltow examined the effect of actual and projected (1970 and 1980) changes in the schooling distribution of adult family heads and unrelated individuals on the concentration ratio of household income. Using the income distribution in 1956, he found that changes in the distribution of schooling predicted a decline in inequality from R = .420 in 1940 to R = .387 in 1980. For the twenty year period 1950(R=.416) to 1970(R=.396) Soltow predicts a 4.8 percent decline in the concentration ratio. (See Soltow, "Distribution.")

Even a drastic change in the distribution of schooling would not necessarily have a large effect. If the dispersion of schooling were reduced to zero but its mean level was not changed, income inequality would decline by .1656 points compared to 1959 [(3.6)(.046) = .1656.] A uniform level of schooling would increase the correlation between schooling and age from -.23 (1959) to zero. The net effect of the decreased variance and increased correlation would be a decline in inequality by .1683 points.[4] This represents a 26 percent decline from the 1959 income variance.

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[4]

	Variable	Change in Variable	Contribution to Change in Inequality
(1)	$\sigma^2(S)$	-3.6	$-.1656$
(2)	R_{as}	$+0.23$	$+.0446$
(3)	$\sigma^2(S)\ R_{as}$ (joint effect)		$-.0473$
Total			$-.1683$

If, however, the zero dispersion were due to a uniform level of schooling at 16.0 years, so that everyone is a college graduate, the increase in average schooling would be 5.37 years. This increases inequality by .1074 points [(5.37)(.02) = .1074]. The net effect would be a decrease of .0609 points. This is 9.4 percent decrease in the variance of income, or a 4.7 percent decline in the standard deviation of logs.

The standard deviation of age of adults changes slowly over time as a result of long swings in birth and death rates. For males aged 25 to 64 in the civilian labor force the standard deviation declined from 10.65 in 1949 to 10.52 in 1964, and then rose to 10.72 in 1970. The effect of a unit increase in the standard deviation of age on the variance of the log of income is .0313 points. During the post-World War II period the range of the standard deviation was two tenths of a unit and therefore would have had a trivial influence on overall inequality.

Again using 1959 data as the base, the effect of an increase in the level of age by one year is to increase inequality by .009 points. During the post-war period the average age of labor force males aged 25 to 64 increased fairly continuously from 42.52 (1949) to 43.67 (1970) years. This too would tend to produce a small increase in inequality. The predicted change in income inequality due to the change in the age distribution from 1949 to 1970 is [(10.72 - 10.65)(.0313) + (43.67 - 42.52)(.009) =] +.0125, or 2 percent of the 1959 income variance.[5]

[5] For United States data, Soltow studied the effect of actual and projected (1970 and 1980) changes in the age distribution of household heads (family and unrelated individuals) on the concentration coefficient of household income. Using the 1956 distribution of income by age he found a rising concentration coefficient, due to the aging of the population, from 1900 (R=.384) to 1970 (R=.418) and a slight decline to 1980(R=.414). The change from 1950(R=.405) to 1970 is 0.13 points, or 3 percent of the 1960 level. (See Soltow, "Distribution")

Soltow also studied income inequality in eight Norwegian cities (1840 to 1960) and found that the rate of growth of the male labor force had a significant negative partial correlation (holding constant the labor force size, an occupational index, a wealth income ratio and time) with income inequality. A more rapidly growing labor force, due to either a higher birth rate or migration, implies a lower level and lower dispersion of age. Soltow's findings are consistent with our analysis. [Lee Soltow, Toward Income Equality In Norway, (Madison: Univ. of Wisconsin Press, 1965) pp. 42-45.]

If the current decline in the rate of growth of the population continues, but remains non-negative, and retirement patterns are unaltered, the level and dispersion of age of labor force males will increase. Suppose a uniform distribution is obtained. The mean and standard deviation of age for those 25 to 64 would be 45.0 and 11.18 years respectively.[6] Compared to the 1959 values for level and standard deviation of 43.06 and 10.55 respectively, the income variance would be higher by .038 points.[7] This represents a 6 percent increase in the relative variance of income or a 3 percent increase in the standard deviation of logs. In the absence of negative population growth rates or catastrophic age-specific changes in mortality, this small change may be viewed as the maximum likely increase in inequality for males aged 25-64 due to age structure changes caused by slowing population growth.

The standard deviation in the log of weeks worked in 1959 for males aged 25 to 64 was .3872, while the average for 1965-1968, years of low unemployment, was .3445. Let us attribute this difference to cyclical factors. Then, if there were no cyclical unemployment in 1959, the variance in income would have been lower by 1.185 (.3872 - .3445) = .051 points, or almost 8 percent. The standard deviation of the log of income would have been lower by 4 percent.[8]

The year 1958 shows the highest dispersion ($\sigma(\ln w) = .4371$) and

[6] The standard deviations of age used in this paper are computed from four age groups (25-34, 35-44, 45-54, 55-64) on the assumption that all individuals are at the midpoint of the group. If the distribution of age for those 25 to 64 is uniform and continuous the standard deviation is 13.0. The difference between 11.18 and 13.0 reflects the loss of within interval variability. For the analysis of males aged 35-44, a continuous distribution is assumed, and the variance of age is 8.33 years squared.

[7] $(45.00 - 43.06)(.009) + (11.18 - 10.55)(.031) = .018 + .020 = .038$

[8] Several studies have shown that income inequality rises during periods of high unemployment, which are periods with a large relative variance in weeks worked. For recent empirical analyses of the effect of unemployment on income inequality see T.P. Schultz, op. cit., and C.E.Metcalf, op. cit.

lowest level of weeks work for the post-war period for males 25-64. In addition their income inequality was quite large in that year (.6447). If the dispersion in weeks worked were at the 1965-1968 level, inequality in 1958 would have been lower by .1097 [1.185 (.4371 - .3445) = .1097]. Thus, 17 percent of the variance of income (or just over 8 percent of the standard deviation of logs) in 1958 could be attributed to cyclical employment. Using 1959 as the base, the elimination of all differences in weeks worked would reduce income inequality by a substantial amount,[9] but would clearly be undesirable for other reasons even if it could, in principle, be achieved.

One realistic avenue for speculation would be the effect of the reduction in the relative dispersion of weeks worked for males aged 25 to 64 to that which prevails for workers aged 35 to 44 during years of low unemployment.[10] The average of these values for 1965-1968 was .2766 and the relative variance of income would decline by (1.185)(.3872 - .2766) = .13 points or by 20 percent. Compared to the relative variance at full employment, the hypothesized improved labor market efficiency would decrease the dispersion of weeks worked at full employment from .3445 to .2766, and decrease inequality (using 1959 values) from .597 to .517.[11] This represents a 13.4 percent decline in full employment (i.e., no cyclical unemployment) income variance, or a 6.5 percent decline in the variance of logs.

The correlations of the log of weeks worked with schooling and age also

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[9] The decline would be (1.185)(.3872) = .46 points.

[10] This could be achieved by increasing efficiency in the production and spread of information concerning job vacancies and available workers.

[11] .648 - (1.185)(.3872 - .3445) = .597 and
.648 - (1.185)(.3872 - .2766) = .517

influence the income distribution. For males aged 25 to 64, during the period 1949 to 1970 the range of the correlation of age and employment was from -.0236 (1958) to -.0746 (1953). The correlation is more negative in years of high unemployment because of the relatively lower levels of employment of older males. The range is, however, associated with a small difference in inequality [(.0510)(.390) = .0199 points].

Data on the correlation of schooling by the log of weeks worked are not available on a year by year basis. The correlation in 1959 for males aged 25 to 64 was +.142. If the correlation were cut in half, and this would presumably represent a substantial change in employment patterns, inequality would decline by .0242 points, or almost a four percent decline in the variance of logs. It is unlikely that the correlation had a significant effect on post World War II income inequality.

At present, therefore, it appears that changes in the levels, dispersions and intercorrelations of schooling, age and employment were not important sources for changes in relative income inequality during the postwar period, nor are they likely to be major sources of change for the remainder of this century, and possibly far into the next. If the current decline in the rate of growth of population continues, the level and dispersion in age will increase, tending to generate a small increase in aggregate inequality. The effect of the distribution of schooling is small. It was shown that even a drastic change in its level and dispersion need not have a large effect. The elimination of cyclical unemployment would have a significant effect for years in which unemployment is very high. The elimination of all differences in weeks worked would have a large effect but would be undesirable. However, increased labor market efficiency could significantly decrease the dispersion in income. The correlations among age, schooling and employment have a small effect, with only the elimination of trends in schooling being a possible source of change; a small rise (seven percent) in the income variance.

The levels and inequalities of the rates of return from training now warrant attention. Note that the rates of return r_i and r_i' are average, not marginal, rates to individuals. Let us assume the same percent change in $\bar{r}$ and $\bar{r}'$, and that the coefficients of variation in the rates of return are unchanged. Suppose the rate of return declines by thirty percent. This implies a fifty percent $[(.7)^2 = .49]$ decline in $\bar{r}^2$, $\bar{r}'^2$, $\sigma^2(r)$ and $\sigma^2(r')$. In equation (7), each of the terms is cut in half, except the covariance terms involving weeks worked which are cut by 30 percent, and the variances of weeks worked and the residual which are unchanged. The variance of logs falls by .1258 points, or by 19.4 percent of the 1959 level.[12] This represents an 9.3 percent decline in the standard deviation of logs. It is, however, unlikely that average rates of return are 50 percent above the equilibrium level or that rates of return will fall by the percent postulated over the next several decades. As for the post-war period, there is nc evidence of a change in full year employment rates of return from training.

If it is true that those with higher training ability have lower costs of obtaining funds for investment, the coefficient of variation of average rates of return to individuals can be substantial even if there is equality of marginal rates of return. Even if there were equality of opportunity and horizontal supply curves, average rates of return would

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[12]From equation (7), $\Delta\sigma^2(\ln Y) = (-.5)(.0832 + .2000 - .0478) + (-.3)(.0468 - .0198) = -.1057$; $\frac{.1258}{.6483} = .194.$

differ due to differences in ability or other dimensions of demand conditions.

In summary, the aggregate relative income inequality of adult males is dominated by the distributions of age and employment, with the schooling distribution playing a smaller role. During the post World War II period there has been no substantial secular change in income inequality because the secular changes in the explanatory variables, the levels and inequalities of schooling and age, have been small and their effects have been off-setting. This suggests that other factors whose changes have not been quantified for the post-war period (e.g., the rate of return, the coefficient of variation, and the residual variance) have either been fairly constant over time or their effects have been self-cancelling.

The decomposition analysis indicates the importance of the relative inequality of weeks worked for interpreting cyclical fluctuations in income inequality. This suggests that the large relative dispersion in employment in 1939 may be responsible for the large inequality of earnings in that year.

Looking into the future, if full employment is maintained, job search behavior does not undergo substantial change and the level and dispersion of the rate of return also remains constant, the inequality of personal income can be expected to remain at the present level during years of full employment (e.g., 1965). The full employment dispersion of weeks worked and the rate of return from training may be the two most important vehicles for altering the distribution of income.

The analysis has assumed a constant residual variance. The residual variance measures the dispersion of weekly wages within age and schooling groups, and appears to be a substantial component of aggregate inequality. This dispersion warrants investigation as it represents both a substantial source of income inequality and possible the only major avenue for changes in inequality in the future. An investigation of the residual variance is beyond the scope of this paper.

Part III: Predicted and Observed Inequalities: 1949 to 1969

One test of the strength of the model developed in Part I, and of the predictions of Part II is to see how well the analysis explains the behavior of the income distribution of adult males in the post-war period.

The observed income inequalities are the variances of the log of income of labor force males aged 25 and over, 25 to 64 and 35 to 44. The predicted measure of income inequality for each year and age group is derived from equation (8) by:

(a) using observed data on the level and inequality of schooling, age and the log of weeks worked, and the correlations between age and schooling and age and the log of weeks worked;

(b) assuming the correlation between schooling and the log of weeks worked in 1959 for each age group was unchanged over time;

(c) assuming the values of $\bar{r}$, $\bar{r}'$ and γ to be equal to that for non-enrolled males with earnings in the 1960 One-in-a-thousand Sample (same data as used in Part II), and that the coefficients of variation of rates of return are one third, and;

(d) the residual variance in each year is the same as in 1959 for that age groups.

The sources and calculating precedures appear in Appendix A and the data in Appendix B.

Table B-1 in Appendix B presents the observed and predicted inequality, and the ratio of predicted to observed for 1949 to 1969 for the three age groups. The predicted value is within 10 percent of the observed value for the 25 and over and 25-64 age groups except for 1949, 1950, 1958 and 1962 when it over-predicts.[1] For the 35 to 44 age group, the model appears to be a poorer predictor and substantially under-predicts in the period since 1965. The simple correlations of observed and predicted inequality (1959 deleted from the data) are R(25+) = .63, R(25-64) = .75, and R(35-44) = .61, all of which are significant at a 0.5 percent level.

Table 2 shows the results of a multiple regression of observed inequality on predicted inequality, time (1949=1) and time squared. The time variables are included to detect the presence of the net effects on inequality of any secular trends in the variables assumed constant. The Durbin-Watson statistic indicates the absence of significant autocorrelation.

Predicted inequality is always significant at a 2.5 percent level (one-tailed test). For the age group 25 and over, time is significant at a 5 percent and time squared is significant at a 10 percent level (two-tailed tests). The coefficients imply a secular rise in inequality (holding predicted inequality constant) from 1949 to 1960 (the peak) of .0630 points, and a decline by .0488 points from 1960 to 1969.[2]

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[1]The over-prediction for 1949 and 1950 may be due to the loss of observed variability due to grouping. The 1949 and 1950 income data contain 10 groups, with an upper end interval $10,000 and over. This differs from the 1951 to 1969 data only in that incomes of $10,000 and over are reported in two groups ($10,000 to $14,999 and $15,000 and over). Observed inequality is underestimated in 1949 and 1950 compared to the following years.

[2]The secular rise may be overstated due to the greater loss of within group variability in the 1949 and 1950 observed inequality than in later years. This applies for all age groups.

Table 2

Time Series Analyses of Observed and Predicted Income Inequality 1949-1969

Regression (Observat.)	Intercept	Predicted Inequality	Time (1949=1)	Time Squared	$\bar{R}^2$ Mult. R D-W
(1) Males aged 25+ (20)	.5258	.2358 (.0955) 2.47	.0098 (.0043) 2.28	-.0004 (.0002) -2.03	.48 .75 1.65
(2) Males aged 25-64 (20)	.3139	.4233 (.1063) 3.98	.0080 (.0045) 1.79	-.0003 (.0002) -1.64	.58 .80 1.33
(3) Males aged 35-44 (20)	.3832	.3301 (.1269) 2.60	-.0017 (.0059) -0.29	.0001 (.0003) 0.26	.26 .61 1.80

Notes to table: (a) 1959 is deleted from the data.

(b) For columns (3) to (5), row (1) contains the slope coefficient, row (2) the standard error and row (3) the Student's t ratio.

(c) For 16 degrees of freedom, one tailed test, t (.05) = 1.75, t (.025) = 2.12, t (.01) = 2.58.

(d) D-W is the Durbin-Watson Statistic. For three explanatory variables, 20 observations, a five percent level of significance and a two tailed test, the range for accepting the null hypothesis of no auto correlation is d = 1.55 to 2.00, and the range for neither accepting nor rejecting the null hypothesis is d = 0.89 to 1.55.

For the 25 to 64 age group, time is barely significant at a 10 percent level, and time squared is not significant at that level. However, the coefficients imply a rise of .0456 points from 1949 to 1961 (the peak) and then a decline to 1969 by .0176 points. The 35 to 44 age group shows no trend. Thus, the magnitudes of residual secular effects during the period under study are small or insignificant. At most they suggest an eight tenth of one percent per annum rise in the variance of logs for those aged 25 and over from 1949 to 1960, and an eight tenth of one percent per annum decline from 1960 to 1969. Finally, it is not clear whether the secular forces tending to reduce inequality in the 1960's are still operative or will be operative in the future.

The substantially smaller explanatory power for the 35 to 44 age group is not surprising. The age distribution for this group was assumed constant over time. In addition, the relative variance in weeks worked is small and varies less over the business cycle for this age group than the others. Thus, there is greater scope for the variation in residual factors to influence the overall inequality of males aged 35 to 44. This again suggests the importance of looking at the dispersion of weekly wages for age and schooling groups.

Part IV: Predicted Changes in Inequality: 1939 and 1985

In this section the income inequality function (equation 7) is used to predict changes in inequality from 1965, a year of low unemployment, to 1939 and to 1985. The components of the predicted change are examined.

A: <u>1939</u>

To what extent is the larger earnings inequality in 1939 compared to the post-war period due to the large dispersion in employment in that year?[1] Or, would earnings inequality have been larger in 1939 than in 1965 even if there were no differences in employment?

The level and inequality of schooling and age, and the correlation for males 20 to 69 in 1940 are compared with the values for labor force males aged 18 and over in 1965 in Table 3. The net effect of the different age and schooling distributions is a prediction of lower earnings inequality in 1939 than in 1965.[2] This is mainly due to the lower level of schooling. The picture changes when the relative inequality of weeks worked is considered. The employment effect outweights the net effect of the changed distribution of schooling and age. As a consequence, a large increase in inequality over the 1965 level is predicted for 1939.

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[1]The variance in the log of wage and salary income in 1939 of experienced members of the labor force in 1940 was 2.16. The relative inequality of earnings of males aged 18 and over in 1965 was 1.31.

In explaining the substantial decline in inequality from 1938 to 1957 in Great Britain, Lydall wrote: "It seems that several different forces have been at work. The most important of these, without any doubt, has been the achievement and maintenance of full employment." (Lydall, "Long Term Trends..." p. 33).

[2]Data are not available to correlate weeks worked with schooling or age in 1939, and it is assumed that these values are the same as in 1965. It is also assumed that the other parameters for which there are no time series data were constant over the interval.

Table 3

Comparison of Predicted Income Inequality in 1939 with 1965

	1939	1965	1939-1965	Contrib. to Change in Income Inequality
(1) A	39.38	41.84	-2.46	-.02149
(2) $\delta(A)$	14.21	13.65	+0.56	+.02822
(3) $\bar{S}$	8.83	11.16	-2.33	-.34525
(4) $\delta(S)$	3.70	3.41	+0.29	+.05336
(5) $\delta(LnW)$	0.737	0.565	+0.232	+.63400
(6) R_{as}	-0.26	-0.23	-0.03	-.00758
(7) $\delta(S)$ $\delta(LnW)$ joint effect				+.11323
(8) $\delta(A)$ $\delta(LnW)$ joint effect				+.01249
(9) R_{as} $\delta(S)$ $\delta(A)$ joint effect				-.00119
				+.46579

Notes to Table 3:

(a) 1965 data are for civilian labor force males aged 18 and over, except for the correlation of schooling and employment which is for labor force males aged 25 and over in 1959.

(b) Using 1965 as the base year, the partial effects on the variance in the log of income for males:

1) $\bar{A}$	+0.009
2) $\delta(A)$	+0.050
3) $\bar{S}$	+0.148
4) $\delta(S)$	+0.184
5) $\delta(LnW)$	+2.728
6) R_{as}	+0.253

The relative inequality for males of wage and salary income in 1939 (experienced labor force) was 2.1585 and in 1965 it was 1.3103 (wage and salary workers aged 18 and over). The observed difference is larger than the predicted difference (.4658) by .3824 points. The gap may be due to sampling variability, the different quality of the 1940 Census and the current Population Reports data, or to a decline in one or more of the parameters assumed constant over time.[1] The latter suggests there may have been a significant decline in the level or the coefficient of variation of the rate of return, or in the dispersion of weekly wages within age and schooling groups (the residual variance). Further study is required to identify the specific cause or causes of the underprediction.

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[1] A discussion of the sampling variability and quality of the CPR income data appears in Edward C. Budd, "Postwar Changes in the Size Distribution of Income in the U.S." American Economic Review (May 1970) pp. 247-60.

B: 1985

The Department of Commerce has projected age and schooling distributions for labor force males in 1985. These data are used here as the basis for predicting the income inequality of labor force males aged 25 to 64 and 35 to 44 in that year.

The projected data permit the calculation of the level and inequality of both age and schooling, and their intercorrelation. The variance in the log of weeks worked in 1985 was computed on the assumption that the mean and variance of the log of weeks worked for each age group in 1985 will be the same as in 1965. This assumes that 1985 will be a year of low unemployment. The correlation between age and the log of weeks worked was assumed to be the same as in 1965. The 1959 data used above for the other parameters are assumed to have the same value in 1985.

Table 4 contains the values of the schooling, age and employment variables for labor force males aged 25 to 64 in 1985 and 1965. A lower level but a wider dispersion of age is predicted presumably due to an assumed decrease in age of retirement on the part of many older males. The level of schooling is projected to increase by one and one third years, and its dispersion (standard deviation) decrease by almost one half a year. The change in age structure is projected to lower by a small amount (.005 points) the standard deviation of the log of weeks worked. The most dramatic projected change is a substantial increase in the correlation of age and schooling from $R_{as} = -0.22$ to $R_{as} = -0.10$. This increase implies a slowing down in the secular increase in the level of schooling.

Using 1959 values as the base, the effect of each of these variables, and their joint effects, on the change in income inequality from 1965 to 1985 is indicated in Table 4. The net effect of the change in the age ...

Table 4

Comparison of Predicted Income Inequality in 1985 with 1965, Males Aged 25 to 64

Variables	1985	1965	1985-1965	Contrib. To Change in Income Inequality
1) $\bar{A}$	41.31	43.60	-2.29	-.02061
2) $\delta(A)$	10.76	10.54	+0.22	+.00682
3) $\bar{S}$	12.50	11.17	+1.33	+.02660
4) $\delta(S)$	3.05	3.48	-0.43	-.01978
5) $\delta(\ln W)$	0.359	0.364	+0.005	-.00593
6) R_s	-0.10	-0.22	+0.12	+.02328
7) $\delta(S)\ \delta(\mathrm{Ln}W)$ joint effect				-.00051
8) $\delta(A)\ \delta(\ln W)$ joint effect				-.00001
9) $R_{as}\delta(A)\delta(S)$ joint effects				-.00240
				+.00740

distribution is a small decrease in inequality, while the net effect of the change in the distribution of schooling is a small increase. Taken as a whole, changes in the levels and inequalities of schooling will have a small negative effect. However, the change in the correlation of age and schooling is to increase inequality by a larger amount. The effect of the change in the relative inequality of weeks worked is small.

Combining the separate and joint effects indicates an increase in predicted inequality of +.0074 points, which is approximately one and one-half percent of the variance in the log of income in 1965. Thus, if the rate of return from schooling and the residual inequality remain unchanged, and if 1985 is a year of full employment, no change in income inequality from the 1965 level is predicted.

Although Part III indicated that the model was more successful for predicting inequality for the age group 25 to 64 than the group 35 to 44, it would be interesting to examine the change in predicted inequality for the latter. Table 5 presents the data for males 35 to 44. It is assumed that the level and inequality of age will not change. An increase in the level of schooling of over one year and a decrease in its standard deviation by one-half year is projected. It is assumed that the correlation between age and schooling in a given year for males aged 35 to 44 is the same as for males 25 to 64. Thus, an increase in the correlation by .12 points is assumed. It is also assumed that the dispersion in employment and the correlations of employment with schooling and age are unchanged.

The contribution of each of the variables which are assumed to change is computed using 1965 as the base year. The differences in the partial slopes shown in the footnote of Table 5 and in Part II for males 25 to 64

Table 5

Comparison of Predicted Income Inequality in 1985 with 1965, Males Aged 35-44

Variables	1985	1965	1985-1965	Contrib. To Change in Income Inequality[a]
1) $\bar{S}$	12.81	11.58	+1.23	+.01722
2) $\delta(S)$	2.85	3.34	-0.49	-.06321
3) R_{as}	-0.10	-0.22	+0.12	+.00660
4) R_{as} $\delta(S)$ joint effect				-.00077
				-.04016

(a) For males 35-44, using 1965 as the base year, $\frac{\partial\delta^2(\text{Ln}\,Y)}{\partial \bar{S}} = .014$, $\frac{\partial\delta^2(\text{Ln}\,Y)}{\partial\delta(S)} = .129$, $\frac{\partial\delta^2(\text{Ln}\,Y)}{\partial R_{as}} = .055$.

are mainly due to the different values of the variables held constant for the two age groups. The effect of the projected change in the distribution of schooling will be to decrease inequality. This will be partially offset, however, by the rise in the correlation of age and schooling. The net effect is a projected decrease in inequality by .0402 points. This represents a decline of approximately seven percent below the observed variance in 1965. Thus, in the absence of cyclical unemployment in 1985, if the variables assumed constant do in fact remain constant, the relative income variance in 1985 among males aged 35 to 44 is expected to be only slightly lower (by seven percent) than in 1965.

Part V: Conclusion

This paper demonstrated that a human capital earnings function can be used to explain time-series changes in income inequality. The model relates income inequality to the distributions of age, schooling, employment and rates of return, and the intercorrelations among these variables.

For adult males in the United States the income distribution is dominated by the distributions of age and employment. During the post-war period, changes in the level and inequality of age and schooling were small, and could not be expected to have had a large effect on the overall distribution, especially since they tended to have cancelling effects. Income inequality is significantly influenced by the business cycle through the effects on weeks of employment.

A substantial decline in inequality in the future could come about through increased efficiency in the market for information about available jobs and workers (decreasing the dispersion of employment), or a decline in the rates of return from training. If rates of return are not far above the equilibrium level, the latter hypothesized source for decreasing inequality may not materialize. The analysis suggests that the residual variance, the inequality of weekly wages within age and schooling groups, deserves study as it represents a substantial proportion of income inequality, and it may be the only avenue for significant changes in overall inequality in the future.

The analysis of the difference in inequality between 1939 and 1965 indicates that a substantial proportion of the larger inequality in 1939 was due to the large dispersion in employment. The analysis also suggest that there may have been a decline from 1939 to the post-war years in the level or the coefficient of variation of the rate of return, or in the residual inequality.

Predicted changes in income inequality from 1965 to 1985 are generated for labor force males aged 25 to 64 and aged 35 to 44 on the assumption that age specific employment is the same in both years. No net change is predicted for the broader age group, but for males aged 35 to 44 a decline in inequality by seven percent of the 1965 level is forcasted. These predictions, however, assume that the rate of return from training and the residual variance do not change in the interim.

Appendix A: Data Sources

(1) Income Inequality: Interval midpoints and Pareto estimate for upper open end interval.

(a) 1949 to 1964: Trends in the Incomes of Families and Persons in the United States: 1947-1964, Technical Paper 17 (Dept. of Commerce, 1967), Table 14. 1949-50, ten groups, otherwise eleven groups. Money income.

(b) 1965 to 1969: Current Population Reports P-60 (Dept. of Commerce), Nos. 51, 53, 60, 66 and 75. Eleven groups. Money income. (1965, earnings, 16 grou

(c) 1939: Census of Population: 1940, Vol. III, The Labor Force (Dept. of Commerce) Table 71. 14 groups. Wage and salary income for the civilian labor force.

(2) Schooling and Age: Averages, variances and correlation. Civilian labor force males.

(a) 1949: Census of Population: 1950, Special Report N. 58, "Education" (Dept. of Commerce) Table 9.

(b) 1952 and 1957: Current Population Reports P-50 (Dept. of Commerce) Nos. 49 and 78.

(c) 1959 - 1968: Educational Attainment of Workers, Special Labor Force Reports (Dept. of Commerce) Nos. 1, 30, 53, 65, 83, 92 and 103.

(d) Missing observations for age distribution obtained from Handbook of Labor Statistics: 1970 (U.S. Dept. of Labor) Table 1.

(e) Missing observations for schooling distribution and correlation obtained from linear interprolations.

(f) 1985: U.S. Labor Force: Projections to 1985 Special Labor Force Report 119 (Dept. of Commerce, 1970) and Education of Adult Workers: Projections to 1985, Special Labor Force Report 122 (Dept. of Commerce, 1970).

(g) 1939: Census of Population: 1940 Vol. III, The Labor Force, Tables 28 and 32 and Vol. IV, Characteristics by Age Table 18. Schooling data and the correlation for males aged 25 to 69 in 1940. Age data for males in the labor force in 1940.

(3) Weeks Worked: Varniance of the log of weeks worked and correlation with age for civilian labor force males. Five employment groups for 1949, 1950 and 1969, otherwise six groups.

(a) 1950 - 1958: Current Population Reports P-50 (Dept. of Commerce) Nos. 35, 43, 48, 54. 59, 68, 77, 91.

(b) 1959 - 1968: Work Experience of the Population, Special Labor Force Reports (Dept. of Commerce) Nos. 11, 19, 25, 38, 48, 62, 76, 91, 107, and 115.

(c) 1969: Current Population Reports P-60 (Dept. of Commerce) No. 75.

(d) Missing observations 1949 assumed equal to 1950, 1957 interprolated.

(e) 1985: Projected age distribution in 1985, and level and variance of the log of weeks worked by age group for 1965.

(f) 1939: Census of Population: 1940 Vol. III, "The Labor Force," p. 13 and Table 88. The months worked data (Table 88) were converted to weeks worked (p. 13).

(4) Correlation between schooling and employment: Census of Population: 1960 Subject Report, "Employment Status and Work Experience: Table 20. For labor force males in 1959.

(5) Other Parameters: Rates of return (r and r') and the elasticity of earnings with respect to weeks worked (γ). Computed from the Census of Population: 1960, One-In-A-Thousand Sample, for white, non-farm, non-enrolled males 14 and over with earnings.

TABLE B-1

OBSERVED AND PREDICTED INEQUALITY

year	25+			45-64			35-44		
	Obs.	Pred.	Ratio	Obs.	Pred.	Ratio	Obs.	Pred.	Ra[illegible]
1949	0.74	0.83	1.12	0.65	0.71	1.09	0.62	0.56	0.[illegible]
50	0.76	0.83	1.10	0.63	0.71	1.12	0.55	0.56	1.0[illegible]
51	0.70	0.71	1.03	0.56	0.60	1.07	0.49	0.44	0.[illegible]
52	0.67	0.71	1.06	0.53	0.58	1.10	0.48	0.46	0.[illegible]
53	0.74	0.69	0.94	0.58	0.57	0.97	0.52	0.46	0.[illegible]
54	0.78	0.79	1.01	0.65	0.66	1.01	0.59	0.51	0.[illegible]
55	0.77	0.71	0.93	0.64	0.58	0.91	0.52	0.40	0.[illegible]
56	0.77	0.73	0.95	0.63	0.59	0.93	0.53	0.40	0.[illegible]
57	0.77	0.81	1.06	0.63	0.67	1.06	0.55	0.50	0.[illegible]
58	0.77	0.89	1.16	0.64	0.76	1.18	0.53	0.61	1.[illegible]
59	0.78	0.78	1.00	0.65	0.65	1.00	0.52	0.52	1.[illegible]
1960	0.79	0.83	1.05	0.66	0.68	1.02	0.59	0.53	0.[illegible]
61	0.82	0.86	1.05	0.69	0.72	1.06	0.60	0.62	1.[illegible]
62	0.76	0.86	1.13	0.64	0.72	1.12	0.53	0.57	1.[illegible]
63	0.75	0.82	1.09	0.63	0.67	1.06	0.52	0.50	0.[illegible]
64	0.76	0.78	1.02	0.63	0.63	1.00	0.54	0.48	0[illegible]
65	0.76	0.74	0.98	0.63	0.60	0.96	0.56	0.44	0[illegible]
66	0.74	0.71	0.95	0.58	0.57	0.98	0.49	0.43	0[illegible]
67	0.73	0.68	0.93	0.57	0.55	0.97	0.50	0.38	0[illegible]
68	0.70	0.67	0.95	0.56	0.55	0.98	0.42	0.36	0[illegible]
69	0.73	0.67	0.92	0.56	0.55	0.95	0.52	0.36	0[illegible]

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Education, Income, and Ability

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1. Introduction

Current estimates of the contribution of education to economic growth have been questioned because they ignore the interaction of education with ability. Whether the neglect of ability differences in the analyses of the income-education relationship results in estimates that are too high was considered in an earlier paper by one of the authors (Griliches, 1970) and a negative answer was conjectured. In this paper, we pursue this question a bit further, using a new and larger body of data. Unfortunately, a definitive answer to this question is hampered both by the vagueness and elasticity of "education" and "ability" as analytical concepts and by the lack of data on early (pre-schooling) intelligence.

The data examined in this paper are from a subsample of army veterans from the 1964 Consumer Population Survey for which a variety of additional information was collected, both from army records and directly.[1] Most importantly, these data con-

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1 See Klassen (1966) and Rivera (1965) for a description of the sample. These data have also been used by Duncan (1968) and Mason (1968,1970) among others.

tain AFQT (Armed Forces Qualification Test) scores, indicators of parental status, region of residence during adolesence, and a division of the school years variable into that acquired before and after military service. They allow us, therefore, to inquire into the separate effects of parental background, intelligence and schooling.

The basic problems and analytical framework can be set out very simply. Let income be a linear function of education and ability, or:

$$Y = \alpha + \beta_1 E + \beta_2 G + u$$

where Y is income, E is education, G is ability, and u are other factors affecting income, assumed to be random and uncorrelated with E and G. The relation is presumed to hold true for cross-sectional data. If education and ability are positively associated, then a measure of the contribution of education to income which ignores the ability variable (most commonly, the simple least squares coefficient of Y on E) will be biased upward by the amount $\beta_2 b_{GE}$, where b_{GE} is the regression coefficient of ability on education in the particular sample. The first substantive section of this paper (Section 3) investigates the magnitude of this bias, via the estimation of income generating equations containing measures of both education and ability.[2]

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2. Concern with the accuracy of the education estimate due to the omission of ability may, of course, be readily extended to other factors associated with educational attainment and known also to contribute to the determination of socioeconomic

Unfortunately, we don't have good measures of either the output of the educational process or the stock of native ability. What we have is the number of years spent in all kinds of educational institutions and the performance on a test at an age where much of the schooling has already been completed. Consider the first problem first, assuming that the test scores in fact measure ability correctly. What we'd like to have is a measure of education achieved (E), what we have are years of schooling completed (S). Let us call the discrepancy between these two measures "quality" (Q, $E = S + Q$) and assume that it is uncorrelated with the quantity of schooling (S).[3] At the same time, the quality of schooling is likely to be correlated with ability, because there is some correlation between social class and ability, because more able students are more likely

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2 . (continued) outcomes. Denison (1964), for instance, notes the salience of race, inherited wealth, family position, and diligence, and the list can easily be lengthened. In the present analysis we control for these factors to a considerable degree.

3. This is not too unreasonable an assumption, since there is a wide variation in quality of schooling at all levels of schooling. It is possible, however, that children going to better schools are also more likely to accumulate more years of schooling. If that is the case, we define Q to be that part of the "quality" distribution which is uncorrelated with "quantity." The rest follows in similar manner.

to get into better schools, and lastly because our measure of ability (test scores at 18) may in fact be a measure of the quality of schooling.

Allowing for such differences in the quality of schooling makes the story somewhat more complicated. The true equation is rewritten as:

$$Y = a + \beta_1 E + \beta_2 G + u = a + \beta_1 S + \beta_1 Q + \beta_2 G + u$$

In this framework, ignoring not only G but also Q leads to the same result as before since b_{QS} (the regression coefficient of quality on quantity of schooling) is zero by assumption. The situation becomes more complicated however when a measure of ability is included in the estimating equation. The estimated coefficient of schooling is then equal to:

$$b_{YS \cdot G} = \beta_1 + \beta_1 b_{QS \cdot G}$$

where $b_{QS \cdot G}$ is the partial regression coefficient of quality on quantity of schooling holding ability constant.[4] Given our assumptions it can be shown (see the Appendix to this paper) that:

$$b_{QS \cdot G} = -b_{QG} \cdot b_{GS}/(1-r^2_{GS})$$

4 These formulae hold as computational identities between least squares coefficients. They can also be interpreted as expectations of computed least squares coefficients from random samples from a population satisfying our assumptions.

Where r^2_{GS} is the square of the correlation coefficient between the quantity of schooling and ability.

Since we expect both b_{QG} (the relationship between the quality of schools and the individual's ability) and b_{GS} (the relationship between ability and years of schooling) to be positive, $b_{QS\cdot G}$ will be negative. That is, by going from b_{YS} to $b_{YS\cdot G}$, we will reduce the coefficient of schooling for two reasons:

$$b_{YS} - b_{YS\cdot G} = -\beta b_{GS} - \alpha b_{QG} \cdot b_{GS} / (1 - r^2_{GS})$$

First we eliminate the upward bias due to the earlier omission of ability. At the same time, however, we <u>introduce</u> another bias due to the correlation of ability with the left out quality variable. The second bias is a function (among other things) of the magnitude of the correlation between quantity of schooling and ability. We solve the problem of this second bias by concentrating our attention on that part of schooling which occured after military service (SI -- schooling increment), which turns out to be almost entirely uncorrelated with our measure of ability and hence is not subject to this type of bias.

The availability of the post military service schooling variable helps us also to solve another vexing problem, how to disentangle the question of causality when the available measure of ability may itself be in part the result of schooling. The post military service schooling variable (SI) is also a post-test variable and hence could not affect these scores in its turn.

these scores. This is then the reason why we shall be putting most of the stress on the results for only a part of schooling in the subsequent sections.

The second major part of this paper, Section 4, is devoted to the problem of measurement error in the ability variable. What we have are test scores around age 18 (we shall refer to this variable here after as T). These can be interpreted as a measure of achievement at age 18, which is a joint function of heredity, parental and social inputs, and schooling. This measure is subject to error, however, both because these tests may not focus adequately on "income earning ability" which is the relevant definition here, and because of random fluctuations in the performance of individuals on such tests. A direct application of least squares techniques in the presence of random errors of measurement in our ability measure may understate the effect of ability on income and simultaneously bias the education coefficient upward. To circumvent this difficulty we devise a model of income determination that contains an unobserved achievement variable in place of measured ability. Manipulation of this model leads to equations estimable by means of two-stage or instrumental variables approach, securing a reading of the effect of ability freed of random errors.

The last part of the paper, Section 5, summarizes our results and compares them to previous work in this field. By being able to focus on a relatively independent part of total schooling, schooling after military service, we get a much better and less biased reading of the pure effect of a change in schooling than was possible before.

2. The Sample and the Variables

Our analysis is based on a sample of post World War II veterans of the U.S. military, contacted in a 1964 Current Population Survey (CPS) of the Bureau of the Census. The population consists of men who were then in the age range 16 to 34, primarily the ages of draft eligibility. The sample includes about 3,000 veterans, for whom supplementary information from individual military records was collated with the CPS questionnaire responses. Of special interest to us is that a substantial proportion of the veterans' military records contain individual scores on the Armed Forces Qualification Test (AFQT) which we use here in lieu of standard civilian mental ability (IQ) tests.

The men who serve in the United States military do not represent any recent cohort of draft age men, since those at either extreme of the ability and socioeconomic distributions are less likely to serve than those in the middle.[4] Thus,

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4 Educational deferments have channeled substantial numbers of young men into entirely civilian careers, and a low score on the AFQT reduces the probability of being drafted. For a general discussion of this aspect of the Selective Service System see; U.S. President's Task Force on Manpower Conservation (1964). For an overview of Selective Service, see Davis and Dolbeare (1968).

conclusions based on our analysis of these data apply only to the veterans population. But, since this population is sizable, the data are of interest despite their obvious limitation. Moreover, this is one of the few relatively large sets of data combining information on income, education, demographic characteristics, mental test scores, and family socioeconomic background, the latter three being important as controls in estimating the income-education relationship.

Within the veterans sample, the individuals on whom we base our conclusions are 1454 men who were employed full-time when contacted for the CPS survey, who were between the ages of 21 and 34, not then enrolled in school, who were either white or black, who provided complete information about their current occupation, income, education, family background, and for whom AFQT scores were available.[5]

The major characteristics of our sample and the variables we used are summarized in Table 1. The definition and measurement

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5 The variables noted above account for the greatest reduction in sample size, but the data file used also contains a number of other variables of interest and is consequently slightly smaller than it would be solely on the basis of the above mentioned variables.

of most of the variables is standard and we shall comment here only on a few of the more important ones.

Income is gross weekly earnings in dollars. It is an answer to the question: "Give your usual earnings on this job before taxes and other deductions." The data provide also another concept of income: "earnings expected from all jobs in 1964." We experimented at some length with both concepts of income with somewhat better (more stable) results with the first (actual) income measure. Since the major results were similar for both measures of income, we shall report here only those for the first (actual) income measure. We also experimented a bit with functional form before settling on the semi-log form for the "income-generating" function, leading to the use of the logarithm of income (LINC) as our main dependent variable.

Education is measured in years of school (highest grade) completed and is recorded at two points of time:[6] before

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6 The education measure is based on 8 categories of school years completed and is scored as follows: Less than 8 years = 4, 8 years = 8, 9 to 11 years but not high school graduate = 10, high school graduate = 12, some college but less than 2 years = 13.5, two or more years of college but no degree = 15, B.A. = 16, graduate study beyond the B.A. = 18.

entry into military service and at the time of the survey. Taking the difference between total grades of school completed (ST) and grades completed before military service (SB) give us a measure of the increment in schooling (SI) acquired during or after military service. The minimum values of this variable is zero (no increment in schooling) and the maximum in our sample is six grades. As noted above, this incremental measure of education is central to our analysis both because it occurs after the time at which ability was measured by the AFQT scores and because it is so little correlated with them. Unfortunately, neither of these schooling vairables allows for differences in the quality of schooling. This is why we make the perhaps somewhat artificial distinction between "schooling" and "education".

Performance on the AFQT is scaled as a percentile score estimated from eight grouped categories.[7] This test is intended primarily as a global measure of mental (cognitive) ability and includes questions on vocabulary, arithmetic and

7. The percentile scoring is computed as the midpoint of each of the eight categories provided in the data. For a number of individuals for whom other test scores were available instead of the AFQT, these were converted to AFQT equivalents by the Department of Defense prior to the release of these data.

spatial relations, but also contains a section on tool knowledge.[8] This test has been used widely as equivalent to an IQ measure, though as noted above, it is rather doubtful that it (or for that matter the IQ test itself) is a good measure of innate ability, if we knew how to define and measure the latter.

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8 For the most complete published discussion of the AFQT, see Karpinos (1966, 1967), who asserts (1967:39) that "the examinee's score on the tests depends on several factors: on the level of his educational attainment; on the quality of his education (quality of the school facilities); and other knowledge he gained from his educational training or otherwise, in the outside of the school. These are interrelated factors, which obviously vary with the youth's socioeconomic and cultural environment, in addition to his innate ability to learn -- commonly understood as IQ, nor are they to be translated in terms of IQ." Our use of the AFQT is consistent with this view. Like Jensen (1969), Duncan (1968) and others we use the AFQT as one representative of the various tests used to score individuals on <u>phenotypic</u> IQ. To do so in no way implies a commitment to any level of heritability ("innate ability to learn") in phenotypic IQ.

First, since the test is given at the age of 18 to 20, the results may be very much affected by the individual's intervening schooling experience. Second, the test itself, because it contains a section on tool knowledge, seems to be directed more towards the measurement of achievement than the discovery of "innate" talent. Third, the observed regional and racial differences in performances on these tests seem larger than could be sustained by a genetic interpretation of these data.[9] Fourth, since these scores are not based on repeated tests of the same individuals, they may also be contaminated by a possibly large (probably random) error of measurement of whatever it is that they are actually measuring.[10] This explains our interest in the errors-in-variables approach which we shall come back to below.

The long list of other variables considered can be divided, somewhat imperfectly, into personal background, and current location and success variables. Among the first

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9 See Griliches (1970), pages 92-104 for additional discussion of this and related issues and Jensen (1969) for a contrary view.

10 Reference on reliability of IQ tests to be supplied.

group, we have the usual variables for age (in years), color (dummy, white = 1, black = 0), and region and place of <u>origin</u> dummies (these are in terms of places "you lived most until age 15") which record growing up in the South, in a large city (over 100,000 in population), or in a suburb of such a city. In addition to these, we have also two measures of parental status: Father's schooling (in years of school completed -- FS) and father's occupation (FO, codded according to Duncan's 1961 SES scale).[11]

The age variable is usually included in such studies because older men (within the range of our data) are likely to have had more training on the job and have had more opportunity to find the better jobs that are appropriate to their training. This, however, is probably measured better not by calendar time but by the actual time spent in the civilian labor force accumulating work "experience."[12] We

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11 These are of course only incomplete measures of the family's socioeconomic status and are subject to the possibility of significant recall error and misperception on the part of the respondents (sons), from whom this information was elicited. See Bowles (1970) for further discussion of this point.

12 The use of such a measure was suggested to us by Jacob Mincer.

can estimate this roughly by defining:

Potential Experience = Age - 18 - (Education before AMS - 12) - Education after AMS - Total AMS (in months) / 12.

Since this measure is a linear function of variables that we include anyway (age and schooling), there is no need to compute it explicitly. It does provide, however, an interpretation for the role of time spent in military service (AMS), when the latter variable is introduced separately.[13]

The "current location and success" variables are represented by a regional dummy variable classification of current location as South, Northeast-Northcentral and West (RNS and RNW); a dummy variable for current residence in a Standard Metropolitan Statistical Area (SMSA); a measure of the length of time on current job (LCJ, in months); a dummy variable for never married (NM) as opposed to other possibilities; and a measure of the socioeconomic status of the individual's current occupation (LOSES, the logarithm of Duncan's occupational SES scale). Each of these factors intervenes between education and income, and helps to explain the relationship between these two variables.

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13 There is scant reason (Mason, 1970) to believe that military service conveys an advantage in subsequent experience in the civilian labor force. Thus, we expect the AMS variable to have a negative coefficient in the income generating equation.

For example, more education may lead to greater "interpersonal competence" and "social desirability" which in turn may lead to a greater likelihood of being married. Individuals in this status may be expected to have the incentive of responsibility for others, and this may in turn lead to higher income.

Although we present some results which take into account factors intervening between education and income, they are not of central interest to us. We shall, therefore, not emphasize them in our dicussion but concentrate instead on the contribution of the education and ability estimates in the presence of background factors alone.

Table 1 presents means and standard deviations for the variables to be used. Note that this group of veterans is young, and hence will not exhibit differentials in income by education as large as those occuring in later, peak earnings, years. Also, the number of blacks is quite small, which prevents us from exploring the issue of white-nonwhite differentials in income seriously. Instead, differences for blacks and whites will be characterized only by the coefficient for the color dummy variable assuming that all of the difference is multiplicative (since we are using the logarithm of income as our dependent variable). Observe, finally, that the average increment in schooling for this group of men is nearly one complete grade (0.8). Actually, 68 percent of the group did not return to school during or after service, and it is clear that those with additional schooling must have completed on average more than one additional grade. Since the grades completed range from a high school grade to a graduate school grade, it appears that the incremental schooling variable may justifiably stand alone in the income estimating equations.

Table 1:

Means and Standard Deviations of Variables:
Veterans Age 21-34 in the 1964 CPS Survey[a]

Variable	Mean or fraction in sample	Standard Deviation	Symbol in Subsequent Tables	Gro Na
Personal Background:				
Age (years)	29.0	3.5	Age	
Color (white)	.96	b	C	
Schooling before service (years)	11.5	2.3	SB	
Total schooling (years)	12.3	2.5	ST	
Schooling increment (years)	.8	1.4	SI	
AFQT (percentile)	54.6	24.8	AFQT	
Length of active military service (months)	30.7	16.9	AMS	
Father's schooling (years)	8.7	3.2	FS	Fa.S
Father's occupational SES	29.0	20.6	FO	
Grew up in South	.29	b	ROS	
Grew up in large city	.22	b	POC	Reg.
Grew up in suburb of large city	.05	b	POS	
Current Location:				
Now living in the South	.27	b	RNS	
Now living in the West	.15	b	RNW	Reg.
Now living in a SMSA	.68	b	SMSA	
Current Achievement:				
Length of time in current job (months)	54.3	42.8	LCJ	Curr
Never married	.14	b	NM	
Current Occupational SES	39.2	22.7	--	
Log current occupational SES	3.47	.68	LOSES	
Actual income (weekly, dollars)	122.5	52.4	--	
Log actual income	4.73	.40	LINC	

Table 1: continued

a N = 1454, for this and subsequent tables based on the 1964 CPS survey.

b The standard deviation for a dummy variable is equal to $\sqrt{f(1-f)}$, where f is the fraction in the sample having the requisite characteristic. Thus, it is computable from the numbers given in the first column.

3. Direct Results

A major objection to the usual estimates of the contribution of education to economic growth is their dependence on cross-sectional income-schooling relationships. The latter are likely to overestimate the "true" effect of schooling because of its intercorrelation with social status and native ability. Our sample provides us with two ways of meeting this objection. First, we do have measures of ability and parental status and can thus attempt to control for these biases directly. But more importantly we can break down our schooling variable into two, the second part of which, schooling during and after military service (SI), is much less related to such other factors and hence also much less subject to this objection.

In Table 2 we list the simple correlation coefficients between the major variables of our sample. Note that there is very little correlation between the increment in schooling (SI) and various personal background variables such as color, father's schooling and occupation, and the respondent's AFQT score. None of these seem to account for more than 1 percent of the variance of the schooling increment variable. We have in this variable something as close to a well designed experimental situation as we are likely to get in social science statistics.

Table 2

Correlations (r's) Between Selected Variables in the 1964 CPS Survey Subsample

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Age	1.000	-.055	-.010	.109	.052	-.056	.216	.120	-.093	-.004
(2) Color		1.000	.011	-.028	-.006	.174	.116	.031	.044	.089
(3) Schooling before AMS			1.000	-.170	.830	.469	.264	.397	.283	.307
(4) Schooling increment				1.000	.405	.098	.149	.217	.103	.085
(5) Total schooling					1.000	.490	.329	.490	.321	.333
(6) AFQT						1.000	.235	.311	.229	.242
(7) Log income							1.000	.338	.114	.229
(8) Log Occ. SES								1.000	.250	.266
(9) Father's schooling									1.000	.431
(10) Father's occupational SES										1.000

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In Table 3 we present a number of regression results relating the logarithm of income to the various variables at our disposal. Regressions 1 through 9 are arranged to correspond to the following implicit model:

(1) Schooling before AMS = F(Background)

(2) Measured Ability (AFQT) = G(Schooling before AMS, Background)

(3) Schooling after AMS = H(AFQT, Schooling before AMS, Background)

(4) Current success variables = K(Schooling before AMS, Measured Ability, Schooling after AMS)

(5) Income = L(Schooling, Measured Ability, Current success variables)

In regressions 1 through 8,, variables are added according to the postulated causal ordering. An assessment of the "total" coefficient of a variable, measuring both its direct and indirect contribution to income, is given by the coefficients of a regression containing no "higher order" variables in it. Thus, for example, Father's status and region and place of origin variables explain directly and indirectly about .1 of the variance in income (compare regressions 1 and 2 where the R^2's are .06 and .16 respectively).

But regression 9, which corresponds to the last line of the above model and assumes that all of the background variables "work" via the later ability and success variables, shows that in fact almost all of their influence

Table 3

Regression Equations with Log Income as Dependent Variable

Reg. No.	Coefficient (standard error) of Color	SB	SI	ST	AFQT	Other sets of variables in Equation[a]	R
1						Age.	.06
2	.1743 (.0488)					Age, Fa. Stat., Reg. Bef.	.15
3	.1848 (.0480)	.0319 (.0044)				Age, Fa. Stat., Reg. Bef.	.18
4	.1561 (.0485)	.0247 (.0048)			.00162 (.00044)	Age, Fa. Stat., Reg. Bef.	.19
5	.1718 (.0479)	.0337 (.0050)	.0450 (.0071)		.00104 (.00045)	Age, Fa. Stat., Reg. Bef.	.21
6	.1714 (.0479)	.0328 (.0050)	.0462 (.0071)		.00105 (.00045)	Age, Fa. Stat., Reg. Bef., AMS.	.21
7	.2052 (.0456)	.0320 (.0048)	.0445 (.0068)		.00115 (.00045)	Age, Fa. Stat., Reg. Bef., Reg. Now, Curr. Exp., AMS.	.29
8	.1970 (.0452)	.0244 (.0050)	.0352 (.0100)		.00095 (.00042)	Age, Fa. Stat , Reg. Bef., Reg. Now, Curr Exp., AMS, LOSES.	.31
9	.2240 (.0449)	.0372 (.0046)	.0468 (.0068)		.00129 (.00043)	Age, Reg. Now, Curr. Exp., AMS.	.28
10	.1332 (.0489)				.00253 (.00041)	Age, Fa. Stat., Reg. Bef.	.17
11	.1732 (.0479)			.0365 (.0046)	.00097 (.00044)	Age, Fa. Stat., Reg. Bef., AMS.	.21

Table 3--Continued

...eg. ...).	Color	SB	SI	ST	AFQT	Other sets of variables in Equation[a]	R^2
	.2538 (.0472)	.0510 (.0042)	.0513 (.0070)			Age	.164[illegible]
	.2545 (.0472)	.0502 (.0042)	.0528 (.0070)			Age, AMS.	.166[illegible]
	.2225 (.0479)	.0418 (.0049)	.0475 (.0072)		.00154 (.00045)	Age, AMS.	.173[illegible]
	.2317 (.0470)	.0431 (.0045)	.0430 (.0071)			Age, AMS, Fa. Stat.	.181[illegible]
	.1904 (.0473)	.0379 (.0045)	.0496 (.0070)			Age, AMS, Fa. Stat., Reg. Bef.	.212[illegible]

a Variable groups are denoted as follows:

Fa. Stat.: Fa. Occ. and Fa. Schooling.

Reg. Bef.: ROS, POC, POS.

Reg. Now: RNS, RNW, SMSA.

Curr. Exp.: NM, LCJ.

See Table 1 for definitions.

is indirect since adding the Father's status and Region before variables (leading back to regression 7) increases the R^2 by only .01.

Regression 10 is included to show that schooling does in fact make some significant independent contribution to the explanation of income (it is to be compared with regression 5); regression 11 is included to show that the difference between the two schooling coefficients in 6 is not "statistically" significant (the computed F statistic is 3.2 while the critical F value for this test is 3.8 at the conventional 5 percent level. It is "significant" though at about the 8 percent level); while regression 12 provides the "baseline" estimates of the schooling coefficients, estimates that do not allow for the effects of ability, father's status, and region of origin. Regressions 12 through 16 provide additional information on how the schooling coefficients change when different sets of variables are introduced in turn.

In the context of analyzing the contribution of education to economic growth, the most appropriate estimate is that given by the coefficient of incremental schooling in the 6th regression, a regression that does not include the later current experience and success variables. It is .046 and only 10 percent lower than the .051 given by the 12th regression which does not contain any of the background and ability measures. Thus, while the usual estimates of the contribution of education may be biased upward due to the omission of such variables, this bias does not appear to be large, and is much smaller than the 40 percent originally suggested by Denison (1962).

A comparison of regressions 5 and 4 and 12 indicates that even though the two schooling variables are acquired at different times and under different circumstances, their effect on income is very similar. The coefficient of schooling before army service does decline more when AFQT, father's status, and region of origin variables are introduced (36 percent from regression 12 to 6) but as we noted in the introduction, that is to be expected given the correlation of these measures with the left out variable of school quality.[14] This is why we prefer

14 The argument is slightly more complicated than that outlined in the introduction because of the presence of two schooling variables. Considering only differences in the quality of schooling before military service and assuming that they are uncorrelated with both SB and SI, leads to the conclusion that the introduction of the AFQT variable will bias the estimated SB coefficient downward (due to the assumed positive correlation of quality of schooling, Q, with AFQT and the observed positive correlation of AFQT with SB). The estimated coefficient of SI would remain unbiased provided that it really was uncorrelated with SB, AFQT, and the unobserved Q. The correlation of SI with AFQT is effectively zero ($r^2 = .007$) but it does have a non-negligible negative correlation with SB. This leads also to a downward but smaller bias in the coefficient of SI; the ratio of the two biases (in the coefficient of SI relative to the bias in the coefficient of SB) being equal to $b_{SB,SI}$, which is about .3 in our data. See the Appendix for further details.

the coefficient of SI as an estimate of the effect of an incremental change in schooling. But even if one attributes all of the schooling-AFQT interaction to AFQT and "heredity", the decline in the coefficient of Total Schooling is only 29 percent of which only less than a half can be associated with the introduction of the AFQT variable, the rest being due to parental background and region and size of city of origin, variables that are likely to be closely related to the omitted school quality dimension.[15]

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15 The coefficient of total schooling is ..0511 with Age and Color alone and goes down to .0436 when AFQT is added (ahead of Father's Status and Region Before). It is .0508 in a regression with Age, AMS, and Color as the other variables and declines to .0408 when the Father's Status and Region Before variables are added, and to .0365 when AFQT is added last (regression 11).

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Given the great role attributed to "ability" in the sociological literature, and the common use of the AFQT scores as a proxy for IQ and other measures of native ability (cf. Jensen, 1969), the performance of this variable is rather disappointing. While it is relatively highly intercorrelated with schooling before army service and with the other personal background variables, its own <u>net</u> contribution to the explanation of the variance in the income of individuals is very small. For example, introducing AFQT into regression 3 increases the R^2 by only .008 (relative to regression 2). Dropping it from regression 6 would only reduce the R^2 by .003 (see regression 16) or almost not at all. Even if one attributed all of the indirect schooling effects (including the schooling before army service and hence before the date of these tests) to the AFQT variable one would raise its contribution to the R^2 to only .02 (regression 10 versus 2).[16]

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16 Another way to look at the relation between income and AFQT is to decompose the correlation between them into components using path coefficients, (See Duncan, 1966). Doing so is equivalent to a repeated application of the excluded variables formula given in the introduction, remembering that when all the variables are "standardized" (scaled in units of their standard deviations) the resulting least squares coefficients are "beta" coefficients, and that first order "betas" are equal to zero order correlation coefficients. Dividing our variables into AFQT (T),

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Footnote 16 continued.

SI (S), and Other (O) and calling the dependent variable y, we can write:

$$b_{yT\cdot O} = b_{yT\cdot OS} + b_{yS\cdot OT}\, b_{ST\cdot O}$$

and

$$b_{yT} = b_{yT\cdot O} + b_{yO\cdot T}\, b_{OT}$$

Substituting the first formula into the second, we get:

$$b_{yT} = b_{yT\cdot OS} + b_{yS\cdot OT}\, b_{ST\cdot O} + b_{yT\cdot O}\, b_{OT}$$

or a division of the simple regression coefficient of y on T into a "net" effect, the effect of T via S, and the interaction of T with O. Switching to standardized variables we get the "path" coefficients equation:

$$r_{yT} = \beta_{yT\cdot OS} + \beta_{yS\cdot OT} \cdot \beta_{ST\cdot O} + \beta_{yT\cdot O} \cdot r_{OT}$$

The advantage of such a decomposition is that it is additive, while the discussion in the text which is in terms of the changes in R^2 is not. On the other hand, this decomposition is not unique and must be based on an assumed causal ordering.

The decomposition of r_{yT} via path coefficients yields the conclusion that more than half of the observed simple correlation between income and AFQT is "due to" or "joint with" the logically prior variables of Age, Color, Fa. Stat., Reg. Bef., and SB. Regression 5, together with a regression of SI on all the rest of the variables implies $r_{Income,AFQT}$ = .235 = (.065 net) + (.037 through SI) + (.133 joint with, or due to, prior factors) = (.102 attributable to AFQT net of prior factors) + (.133 attributable to correlations between AFQT and prior factors). In terms of the

Since parental status and AFQT are the only potential "pure" carriers of genetic heredity effects, it is interesting to note that their total maximal effect (holding childhood location, age, and color constant) is only .052 (the R^2 of LINC with Age, Color, and Reg. Bef. is .126 vs. the .178 of 10). Even if one added all of the color variable to it, one could only boost the role of these "heredity" associated variables to .061 (the R^2 of LINC with Age and Reg. Bef. is .117), or only about a fifth of the total "explainable" variance in income (the maximal R^2 is .31 in regression 8). And this makes no allowance for the effects of quality of schooling and discrimination that are confounded with the color, regional origin, and parental status variables. Thus, the measurable potential effects of genetic diversity on income appear to be much smaller than is usually implied in debates on this subject.

Footnote 16 continued.

model used here, over half of the initial correlation between income and AFQT is explained by factors in the model which are prior to AFQT. And, even if schooling before service were not taken as predetermined with respect to AFQT it would still be the case that over half of the zero order correlation would be allocated to the joint influence with other causally prior or independent variables. In assessing this total "independent" effect of AFQT one should keep in mind that $r = .1$ implies $r^2 = .01$.

By including almost all of the variables available to us in regression 8 we can account for about a third of the observed (logarithmic) variance in income. This is comparable with the results of other studies based on observations of individuals (cf. Hanoch, 1967), but it is clear that the bulk of the variance in individual income is not accounted for by our equations, even when using a rather long list of variables.

Table 4 lists all of the coefficients of regression 8, providing some more information on our results. Since the dependent variable is the logarithm of income, these coefficients (times 100) give the percentage effect of a unit change in the respective variables on income. The more interesting findings here are: (1) The non-significance of the Father's schooling variable in the presence of Father's occupational SES score. This is true also in most of the other regressions. (2) The relative importance of current location (being in an SMSA and in the West). (3) The rather surprising strong negative effect of not having married. (4) The negative effect of time spent in the army and the implied positive effect of potential experience in the labor force on income.[17]

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17 Since, except for constants, Potential Experience = Age - SB - SI - AMS/12, in a regression that already contains Age, SB, and SI, its coefficient is given by the negative of the coefficient of AMS times 12. In this case, it is .0132, and this is also the predicted coefficient for Age. Since the actual coefficient for Age is .0126, the two are

Table 4: Coefficients of Regression 8

Dependent variable LINC, N = 1454

Variable	Coefficient	t-ratio	Consecutive R^2
Age	.0126	(.1)	.0467
Color	.1970	(4.4)	.0632
FO	.0016	(3.2)	.1112
FS	-.0038	(-1.2)	.1131
POC	.0325	(1.4)	.1290
POS	.0971	(2.4)	.1369
ROS	-.0238	(-.7)	.1560
SB	.0244	(4.9)	.1849
AFQT	.00095	(2.2)	.1925
SI	.0352	(4.8)	.2144
RNS	-.0751	(-2.3)	.2236
RNW	.1173	(4.5)	.2339
SMSA	.1365	(6.7)	.2572
LCJ	.0013	(5.7)	.2782
NM	-.1496	(-5.7)	.2958
LOSES	.0804	(5.3)	.3095
AMS	-.0011	(2.0)	.3114
(Constant)	3.6483		

In Table 5 we gather some results on the interrelationships among the other variables in our model. Among the more interesting of these are the rather large effects of region, color and schooling before service on AFQT, and the minor influence of parental status variables. This is hardly consistent with Jensen's (1969) treatment of variance in AFQT scores as primarily heritable. The other interesting fact is that using occupational status rather than income as the dependent variables gives similar results; significance for the schooling variables, and only marginal importance for parental status and AFQT.

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17 consistent and support the interpretation that both calendar age and time spent in military service influence income via their effect on "experience". Another way of testing this is to constrain the coefficient of age to equal 12 times minus the coefficient of AMS. The computed F-statistics for such constrained versions of regressions 6 and 13 are 3.7 and 2.8 respectively, indicating that the data are consistent with the validity of such a constraint at the conventional 5 percent significance level (the critical F is 3.8). For regression 6, the constrained version implies that a year of experience is worth a 2.3 percent increase in income, on the average, and that holding "experience" (but not age) constant leads to estimated 7.3 and 7.8 increases in income per year of schooling, for pre and post army schooling respectively.

Table 5

Interrelations Between the Major Determinants on Income
(t-ratios)

Dependent Variable	Color	FO	FE	POC	POS	ROS	SB	SA	AFQT	AGE	R^2
SB	* -4	8 6	6 4	4 3	* *	5 3			17		.152 .289
AFQT	5 6	5 2	5 3	2 *	* *	6 4	17				.139 .271
SI	-2	3	4	*	*	3	-11		8	5	.120
NM	*	2	*	*	*	-3	*	*	*	-9	.073
LCJ	*	*	*	*	*	*	3	3		18	.200
RNS	3	*	*	*	*	46	*	*		*	.625
RNW	*	*	*	4	*	-5	3	*	*	*	.043
SMSA	-3	*	*	11	6	-4	*	3	*	*	.141
LOSES	*	2	3	6	*	*	12	10	3	5	.270

*In the equation but estimated t-ratio less than 2.

4. Errors in Variables and Other Extensions

The results reported in the previous section assume that the variables we used do in fact measure well what they purport to measure and moreover that these measures correspond well to those attributes that we would have liked to have measured. This is unlikely to be true for many of the more interesting variables. We have, for example, years of school completed. What we would have liked to have is a measure of formal education that would take into account subject, type of school, and quality of instruction. Father's occupational SES is unlikely to capture well the much richer concept of the family's social status. Nor does it provide anything directly on mother's education and capability and hence contribution to the intellectual development of the child. Similarly, the AFQT measure is subject first to the usual problem of "reliability", being the result of a sample of responses from an individual whose responses may vary from question to question and from day to day. Second, the "abilities" that the AFQT does measure may not be all that relevant from an economic (market) point of view, and they may also be aggregated (weighted) wrongly.[18]

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18. See Gintis (1969) for an elaboration of this point of view.

All of these reasons should lead one to explore some alternative approaches to this problem. A possible line of attack is to go outside the sample for bits of evidence on orders of magnitude of such errors, adjust the correlation matrices for them, and recompute the estimates.[19] This line has its own dangers. First, the different bodies of data are rarely comparable and it is doubtful whether the various correlation coefficients are as easily transferable as they are often taken to be.[20] Moreover, there is a danger in adjusting for "obvious" things, such as the reliability of the AFQT's and the recall-error in estimates of parental status, but leaving school years unadjusted because the error in measuring them is small. The error of using unweighted school years as a measure of educational achievement may be as large or larger than the earlier mentioned errors. Any non-symmetric treatment can introduce very strong biases into the final results.

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19. This is the approach followed by Duncan (1968) and Bowles (1970).

20. For example, the correlation between schooling and early IQ or between parental status as perceived by children and by neighbors may differ across samples covering differing socio-economic and cultural populations.

Having said all this, we shall limit ourselves to our original set of data, and concentrate on the possibility that errors in the measurement of AFQT, both as a measure of IQ and as a measure of economically relevant intellectual achievement, lead us to underestimate the role of ability in the determination of income and overestimate the role of formal education. To do so, we shall have to expand somewhat the model sketched out in the previous section and introduce an unobservable "achievement" variable.

Let us assume the following simple linear model, summarized in Table 6, where the time subscripts 0, 1, 2 represent measurements taken before the start of formal schooling (approximately age 6), before entry into the Army (approximately age 18), and at the time of the survey (age in 1964) respectively. The symbols are intended to be mnemonic; random disturbances appear only in equations with observable dependent variables. We also assume that all variables are measured around their mean levels obviating the need for constants in these equations. Basically we have an unobservable achievement (human capital) variable, which is augmented by schooling, and the stock of which (G) is estimable (subject to error) via test scores (T). We assume in this model that all of the influence of class and heredity are indirect, via the early achievement variable. Note that we assume that the contribution of unit a change in SI ($S_2 - S_1$) to achievement is the same as that of a unit

Table 6

Schematic Model of the Interrelationships Between Schooling, Ability and Income

(1) $G_0 = a_1B + a_2H$

(2) $T_0 = G_0 + t_0$

(3) $S_1 = b_1B + b_2H + e$

(4) $G_1 = G_0 + \gamma S_1$

(5) $T_1 = G_1 + t_1$

(6) $S_2 - S_1 = c_1S_1 + c_2B + w$

(7) $G_2 = G_1 + \gamma(S_2 - S_1)$

(8) $I_2 = \beta G_2 + u$

G -- achievement, or ability to earn income, unobservable directly.

B -- background factors including social class of parents (Fa. Stat.) and location of adolesence (Reg. Bef.).

H -- heredity, or potential IQ at birth, unmeasured.

T -- test score, purporting to measure G (T_1 = AFQT).

S -- schooling (S_1 = SB, S_2 = ST, $S_2 - S_1$ = SI).

I -- income (LINC).

e,t,w,u -- random forces, uncorrelated with each other and with the causally prior exogenous variables of the system. I.e., the t's are assumed to be uncorrelated with each other and with all the other variables in the model except the T's; e is assumed to be uncorrelated with B and H, w also with S_1 and u also with S_2-S_1.

change in S_1 (SB) and that the schooling increment is uncorrelated with the error in observed test scores (t_1) and with that part of heredity (H) which is not already reflected in S_1 or correlated with B. These assumptions (equality of the coefficients of S_1 and S_2 and no correlation between $S_2 - S_1$ with t_1 and H net of S_1 and B) are the important identifying restrictions in our model.

The present data are not sufficient to estimate this model in its entirety. We have no measure of G, T_0 and H. Yet, we can mesh our data with this model in a way which may allow us to escape the effect of errors in AFQT.

Substituting equations (4) and (1) into (5) gives:

$$(9) \quad T_1 = \gamma S_1 + a_1 B + a_2 H + t_1$$

and substituting (7) and (5) into (8) results in

$$(10) \quad I_2 = \beta[\gamma(S_2 - S_1) + (T_1 - t_1)] + u = \beta\gamma(S_2 - S_1) + \beta T + u - \beta t_1$$

Since the error (t_1) in T_1 is not observable, we have again an errors-in-variables problem (or a simultaneity problem in the sense of a non-zero correlation of T_1 with the new disturbance $u - \beta t_1$). To solve this problem we can use the observable predetermined variables (S_1 and B) not appearing in equation (10) in a two-stage instrumental variables procedure.

In the first stage, we estimate (9), ignoring the unavailable H variable and get a predicted value of T_1, $\hat{T}_1$ (AFQT Hat), based on the observed predetermined variables. This predicted value replaces T in (10). In the second stage, we regress I_2(LINC) on $S_2 - S_1$ (SI) and $\hat{T}_1$(AFQT Hat) to estimate $\beta\gamma$ and β. (Color and Age or Experience are also included because they are assumed to have an independent effect on income). This procedures solves the problem of error in T_1, assuming that our model is correctly specified, but does little about the effect of the omitted variable H (except for its influence via S_1). Here we have to count on the presumed relative independence of the increment in schooling from H, net of their joint relationship with S_1 and the variables contained in B.

Table 7 summarizes the two-stage calculations. Comparing regressions 17 and 18 with 5, 7, and 9 (Table 3), we note - that the estimated coefficient of incremental schooling does not decrease. Constraining the model so that background factors and schooling before service work through the unobserved achievement variable gives the same results for the remaining schooling variable as the unconstrained regressions. Allowing for direct effects of measured AFQT, schooling before service, and social background improves the fit only marginally (regression 5 versus 17 or 7 versus 18). Thus, the approach taken here suggests that our initial estimate of the schooling effect on income is robust with respect to the presence of measurement errors in AFQT. Moreover, the comparable levels of fit in the error model and the unconstrained regressions support the model outlined in Table 6.

Table 7

Two Stage and Other Regressions

gression nber	Coefficient (standard error) of Color	SI	AFQT Hat[a]	AFQT	Other Variables in Equation	R^2
	Dependent Variable is Log. Income					
7	.0310 (.0494)	.0487 (.0068)	.01065 (.00078)		Age	.1855
3	.0730 (.0468)	.0483 (.0065)	.00889 (.00078)		Age, Reg. Now, Curr. Exp., AMS.	.2855
9	.1982 (.0458)	.0331 (.0067)		.00298 (.00038)	Age, Reg. Now, Curr. Exp., AMS.	.2526
	Dependent Variable is Log Occ. SES					
	-.4021 (.0815)	.1302 (.0113)	.02569 (.00137)		Age	.2628
	-.3517 (.0809)	.1277 (.0113)	.02626 (.00134)		Age, Reg. Now, Curr. Exp., AMS.	.2880
	.0157 (.0831)	.0843 (.0121)		.00809 (.00069)	Age, Reg. Now, Curr. Exp., AMS.	.1779
	.1014 (.0787)	.1151 (.0117)		.00253 (.00073)	Age, Reg. Now, Curr. Exp., Fa. Stat., Reg. Bef., SB, AMS.	.3034

Table 7 continued

[a]The equation used to define this variable is:

$$\text{AFQT Hat} = -19 + \underset{(2.83)}{17.85}\ \text{Color} + \underset{(.0309)}{.0735}\ \text{FO} + \underset{(.1481)}{.5505}\ \text{FS} + \underset{(.262)}{4.434}\ \text{SB} - \underset{(1.282)}{5.472}\ \text{ROS}$$

with $R^2 = .271$

Considering next the AFQT Hat variable, note that its coefficient in regressions 17 and 18 is much larger and more highly significant than those for the original AFQT measure (Table 3). "Purging" AFQT of errors thus increases its contribution to income, even though it does not modify the estimated contribution of education. Observe also that a bound can be set on the effect of ignoring the H variable in equations (9) and (10) derived from the error model. In particular, the gain in predicting income with the estimate of error-free AFQT more than offsets the loss due to lack of a measure of the direct influence of H. That is, the ignored systematic part of ability, the part of heredity that is uncorrelated with the variables defining AFQT Hat, has a smaller cariance than the variance of error in observed AFQT, since the R^2 in 19 is greater than in 18.[21]

The only novel result in Table 7 pertains to the coefficient of the white-black dummy variable in the presence of the AFQT Hat variable. It is insignificant now, indicating that all of the color effects were captured by AFQT Hat. Taken at face

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21 Let $G = S + H$, and H be defined so as to be uncorrelated with S. Then using the observed T as a variable implies leaving out from the regression $-\beta t$, the error of measurement in T. Using $\hat{T} = S$, implies the leaving out of βH. The latter causes a smaller reduction in the explained variance than the former.

value, this result implies that discrimination against blacks does not affect white-black differences in income once person-to-person differences in ability and achievement are adjusted for random measurement error. This outcome could not have been forecast on the basis of any previous literature. Since the number of blacks in the sample is very small, the result cannot be taken for anything more than an invitation for further work along the above lines.

Having set up the model outlined in Table 6, we could add additional equations connecting other indicators of success, such as Occupational SES, to the unobserved G_2 (Achievement in 1964) variable. Such an extension is outlined in Figure 1. It would imply a proportionality of coefficients in equations with different success measures as dependent variables which could be used in another estimation round to get a constrained but more efficient set of estimators for the coefficients of the independent variables. (See Zellner 1970 and Goldberger 1971). Since we are primarily interested in the effect of these variables on actual income, we haven't pursued this further here. We doubt, however, that it is reasonable to impose such a proportionality assumption across the coefficients of <u>all</u> the variables in our data. It would not be surprising if variables such as marital status or race have different relative effects in income and occupational status. The last set of regressions in Table 7 point up the problem. With Log Occupational SES as

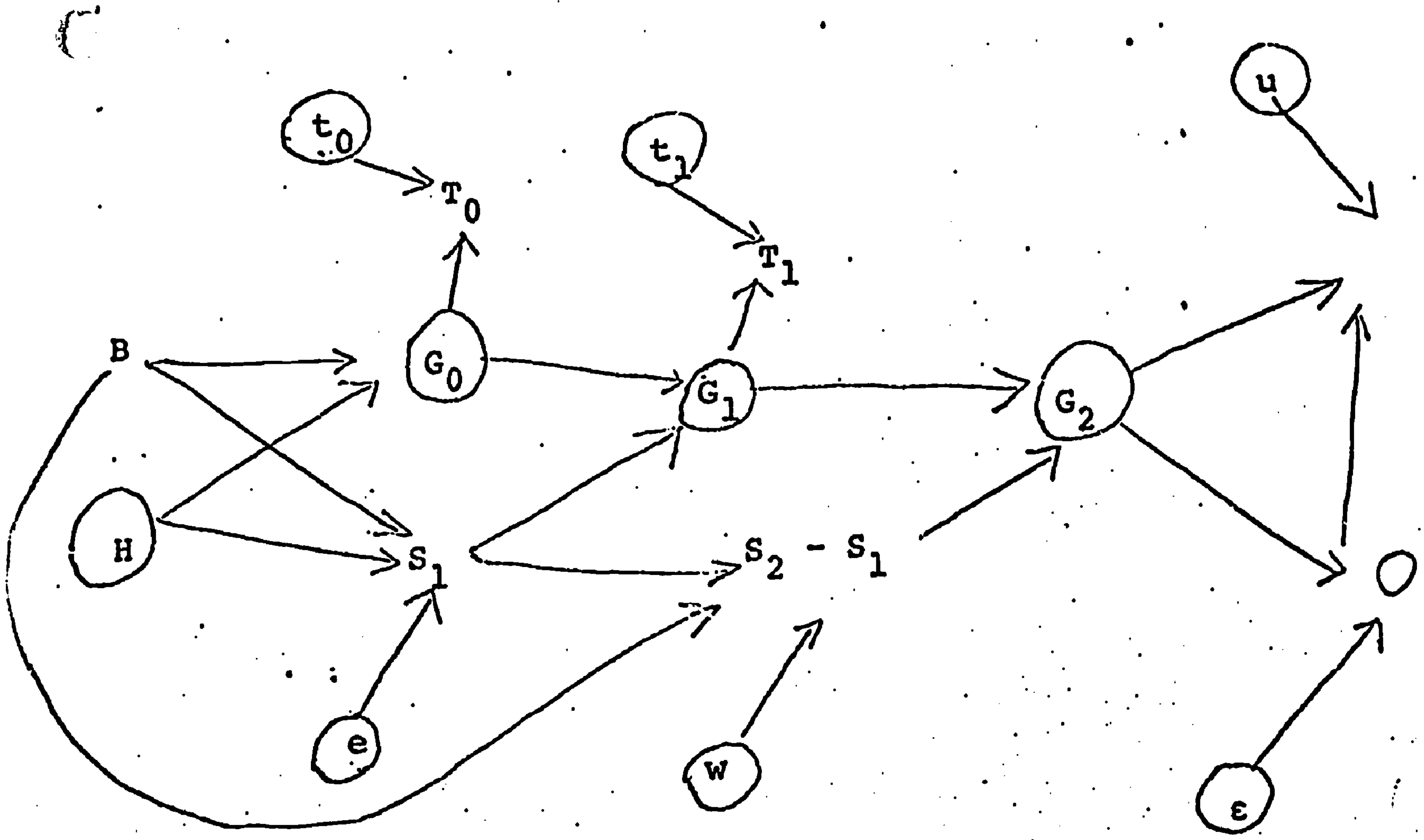

Fig. 1. Assumed Paths of Causality

O -- occupation and other measures of current success. Other symbols are defined in Table 6. Circles denote unobservables.

the dependent variable the coefficients of incremental schooling and AFQT (or AFQT Hat) are roughly proportional to those with log income as the dependent variable. Comparing regression 20 to 17, the coefficients stand in the ratio 2.7 and 2.4 for the SI and AFQT Hat variables respectively. In regressions 22 and 19 the ratios are 2.5 and 2.7 respectively. This is not too bad. But the color coefficients stand in a ratio of .5 for the second comparison and are actually of opposite sign for the first. Thus, proportionality across <u>all</u> the coefficients is not apparent in the data and is also unlikely for such variables as color and marital status. Procedures are available for dealing with such more complicated models but we do not pursue this topic further here.[22]

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22 See Hauser and Goldberger (1970) for more details. To rationalize these facts we must assume that there is also some direct effect of variables like color and marital status on income outside and beyond their contribution to the unobserved achievement variables. In terms of Fig. 1, color would be contained in B but might have additional independent and different paths to I_2 and O. Similarly, marital status could be interposed between G_2 and I_2 and O, having differential effects on the two latter variables. In general, if income and occupational success depend not only on cognitive achievement (AFQT, schooling, and related measures) but also on "motivation", where motivation may be a function of previous achievement, some of the same background variables, and other random variables, then only smaller subsets of coefficients are subject to proportionality constraints.

5. Discussion and Summary

We have tried to compare our results to those of other similar studies, but without too much success. None of the other studies use an incremental schooling variable, a distinction on which much of our results rest. Also, such studies tend to treat years of school as the conceptually right and error free measure of educational attainment, a position that is hardly tenable in light of the extreme diversity of the educational system in the U.S.

Duncan's (1968) major study uses similar data to ours but extends them to all white males age 25 to 34, and introduces early intelligence and number of siblings variables from other sources. In the process, he has to make a number of questionable imputations, such as extending the observed correlation between the AFQT scores and other variables for veterans in the sample to the sample as a whole (which is about twice as large). He also uses expected rather than actual income as his dependent variable and introduces the early intelligence variable by assuming a rather high persistence over time (r = .9) for this variable. (In data from the California Guidance study, supplied by John Conlisk, the correlation between IQ test scores for the same individual at age 18 and earlier doesn't rise above about .7). In his study the coefficient of total schooling declines about 31 percent when parental background, the number of siblings and early intelligence variables are introduced. But his results do not control for the rather important age-experience and regional origin variables and do not allow for the correlation of the parental background variables with the left out quality of schooling variable.

Hansen, Wiesbrod, and Scanlon (1970) analyze a sample of 17-25 year old low achievers (army rejectees) and conclude that schooling is a much less important income determinant in their sample. Their estimate of the coefficient of total schooling drops about 50 percent when the AFQT variable is introduced and even further when such current success variables as training and martial status are added. Their sample is peculiar in that it concentrates on the very young and on blacks (about half of their sample is non-white versus 9 percent in our sample). It is well known that schooling-income differentials are rather low at the beginning of the labor force experience and that there is little evidence for a strong schooling-income relationship for blacks (see Hanoch, 1967). This is also the population where there is likely to be a great diversity in the schooling experience and the AFQT may in fact be a better measure of accumulated learning than years spent in a Northern slum or Southern rural school. It does remind us, however, that we cannot take our sample as representative of the whole population either.[23]

There are several other yet unpublished studies on similar topics by Bowles, Cutwright, and Taubman-Wales. But since they are still unpublished and in any case do not make the distinction between schooling acquired at different times and circumstances, we shall not discuss them further here.

Using a "clean" schooling variable, incremental schooling, we concluded that the bias in its estimated coefficient due to the omitted ability dimension is not very large, on the order of 10 percent. The earlier (before army service) schooling coefficient falls more, but we interpret this to be the consequence of the interrelationship between test scores and father's status variables with the other important omitted variable -- the quality of schooling. Unfortunately, given the restricted

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23 Several other studies should be noted here: Ashenfelter and Mooney(1968), Rogers (1969), Taubman and Wales (1970), and Weisbrod and Karpoff (1968), none of which came up with large estimates for the bias in the schooling coefficient due to left out ability variables. The last study can be also interpreted to show a rather significant effect of variation in the quality of (college) schooling.

nature of our sample, both as to the selectivity inherent in being a veteran, and because of restriction to a relatively young (under 35) group of males, these results cannot be taken as representative for all males. Nevertheless, this is one of the largest samples ever brought to bear on this problem and we'd expect them to survive extension to a more complete population.

Our findings support the economic and statistical significance of schooling in the explanation of observed differences in income. They also point out the relatively low independent contribution of measured ability (AFQT scores). Holding age, parental background, region of origin, and the AFQT score constant, an additional year of schooling would add about 4.5 percent to income in our sample. At the same time. a 10 percentile improvement in the AFQT score would only add about 1 percent to income. If the psychological literature is to be believed, both as to the closeness of the AFQT measure to IQ and as to the great difficulty of affecting the latter, it should be much easier (less costly) to affect income via changes in schooling than changes in measured ability.

Similarly, these results throw doubt on the asserted role of genetic forces in the determination of income. If AFQT is a good measure of IQ and if IQ is largely inherited then the direct contribution of heredity to current income is minute. Its indirect effect is also not very large. Of course, the AFQT scores may be full of errors and heredity may be very important, but then previous conclusions about the importance of heredity are also in doubt since they were drawn on the basis of the same kind of data.

Appendix

The formulae used in the text are all repeated variations on the "left out variable" formula.[24] Let the true equation be:

$$y = \beta_1 x_1 + \beta_2 x_2 + e$$

Where all the variables are measured around their means (and hence we ignore constant terms) and e is a random variables uncorrelated with x_1 and x_2.

Now, consider the least squares coefficient of y on x_1 alone:

$$b_{y1} = \Sigma x_1 y/\Sigma x_1^2 = \Sigma x_1(\beta_1 x_1 + \beta_2 x_2 + e)/\Sigma x_1^2$$

$$= \beta_1 + \beta_2\ \Sigma x_1 x_2/\Sigma x_1^2 + \Sigma x_1 e/\Sigma x_1^2$$

Since the expectation of the last term is zero, we can write

$$Eb_{y1} = \beta_1 + \beta_2 b_{12}$$

where $b_{12} = \Sigma x_1 x_2/\Sigma x_1^2$ is the (auxillary) least squares coefficient of the left out variable x_2 on the included x_1.

Moreover, if e were to refer to the computed least squares residuals, $\Sigma x_1 e$ would equal zero by construction. Hence, the same formula holds also as an identity between computed least squares coefficients of different order. That is,

$$b_{y1} = b_{y1\cdot 2} + b_{y2\cdot 1} b_{21}$$

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24 These formulae are given, in a different context, in Appendix C of Griliches and Ringstad (1971). See Yule and Kendall (1950), Chapter for the notation used here.

This same formula, with a suitable change in notation, applies also to higher order coefficients:

$$b_{y1\cdot 2} = b_{y1\cdot 23} + b_{y3\cdot 12} \cdot b_{31\cdot 2}$$

In what follows we shall assume that we are talking either about least squares coefficients or about population parameters and we shall not carry expectation signs along. The discussion could be made somewhat more rigorous by inserting the plim (probability limit) notation at appropriate places.

The model we deal with can be written as

$$y = \beta_1 E + \beta_2 T + e$$

$$= \beta_1 S + \beta_2 T + \beta_1 Q + e$$

where $E = S + Q$ is education, S is quantity of schooling, Q is quality of schooling, and T is a measure of ability (here assumed to be error-free). Q is uncorrelated with S but is correlated with T. Then, estimating the equation with both T and Q out, leads to

$$b_{yS} = \beta_1 + \beta_2 b_{TS} + \beta_1 b_{QS} = \beta_1 + \beta_2 b_{TS}$$

since $b_{QS} = 0$ by assumption. Including T in the equation also gives

$$b_{yS\cdot T} = \beta_1 + \beta_1 b_{QS\cdot T}$$

Now, while b_{QS} is zero, $b_{QS\cdot T}$ need not be zero. Given our assumptions we can write, however,

$$b_{QS} = b_{QS\cdot T} + b_{QT\cdot S}\, b_{TS} = 0$$

which implies that

$$b_{QS\cdot T} = -b_{QT\cdot S}\, b_{TS} < 0$$

Since both $b_{QT\cdot S}$, the partial relationship of school quality to test scores, and b_{TS}, the relationship between test scores and levels of schooling, are expected to be positive, we also have

$$b_{QT} = b_{QT\cdot S} + b_{QS\cdot T} \cdot b_{ST}$$

Substituting the previous formula into the one above we get

$$b_{QT} = b_{QT\cdot S} - b_{QT\cdot S} b_{TS} \cdot b_{ST}$$

Solving for

$$b_{QT\cdot S} = b_{QT}/(1-r^2_{TS})$$

and remembering that $b_{TS}b_{ST} = r^2_{ST}$, gives

$$b_{QS\cdot T} = -b_{QT}b_{TS}/(1-r^2_{TS})$$

The algebra gets a bit more complicated when S is divided into two components, which for ease of subscripting will be called B (before) and A (after) here. The model now is

$$Y = \beta_1 B + \beta_1 A + \beta_2 T + \beta_1 Q + e$$

Then

$$b_{yB\cdot AT} = \beta_1 + \beta_1 b_{QB\cdot AT}$$

and

$$b_{yA\cdot BT} = \beta_1 + \beta_1 b_{QA\cdot BT}$$

Assume, as is approximately true in our sample, that A is uncorrelated with T. Since we have already assumed that Q is uncorrelated with both A and B, we have:

$$b_{QB \cdot A} = b_{QB \cdot AT} + b_{QT \cdot AB} \cdot b_{TB \cdot A} = 0$$

$$b_{QA \cdot B} = b_{QA \cdot BT} + b_{QT \cdot AB} \cdot b_{TA \cdot B} = 0$$

and hence

$$b_{QB \cdot AT} = -b_{QT \cdot AB} b_{TB \cdot A}$$

$$b_{QA \cdot BT} = -b_{QT \cdot AB} b_{TA \cdot B}$$

Thus, we can see immediately that the relative magnitude of the biases in the two schooling coefficients depends on the size of $b_{TB \cdot A}$ relative to $b_{TA \cdot B}$. Now because

$$b_{TA} = b_{TA \cdot B} + b_{TB \cdot A} b_{BA} = 0$$

by assumption, we have

$$b_{TA \cdot B} = -b_{TB \cdot A} b_{BA}$$

which we can substitute in

$$b_{TB} = b_{TB \cdot A} + b_{TA \cdot B} \cdot b_{AB}$$

to yield

$$b_{TB \cdot A} = b_{TB}/(1-b_{AB} b_{BA}) = b_{TB}/(1-r^2_{AB})$$

and

$$b_{TA \cdot B} = -b_{TB} b_{BA}/(1-r^2_{AB})$$

Now, if A (after army schooling) was entirely uncorrelated with B (before army schooling), $b_{BA} = 0$ and its coefficient ($b_{yA \cdot BT}$) would be unbiased ($b_{QA \cdot BT} = -b_{QT \cdot AB} \cdot b_{TA \cdot B} = +b_{QT \cdot AB} \cdot b_{TB} \cdot b_{BA}/(1-r^2_{AB}) = 0$), while the coefficients of before army schooling would be biased downward. In our sample, however, b_{BA} is actually negative and on the order of -.3, implying that the coefficient of A is also biased downward but only by about a third of the bias in the coefficient of B.

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Proposals for Financing Higher Education

and Their Implications for Equity

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This paper considers the equity effects of alternative methods of financing higher education. Because the concept of equity is so elusive, this task is a difficult one. Yet it must be undertaken if we are to understand the implications of different financing plans, most of which are justified, at least in part, by their equity effects.

Before beginning, we must define the scope of our inquiry. Throughout, the discussion is limited to undergraduate education; we ignore other activities such as graduate and professional education, research, public service, and the array of other activities that go under the name of higher education. While we recognize that there is jointness in the production of undergraduate education and these other activities at many of the major colleges and universities, it is also quite apparent that most undergraduate students are enrolled at institutions that concern themselves almost exclusively with undergraduate teaching. Hence, it is not inappropriate to focus only on undergraduate education. In addition, our focus will be on students rather than institutions of higher education, for it is students that public policy seeks to affect by encouraging the purchase of more higher education. Thus, institutional effects get secondary consideration. In viewing the financing, we focus on the public versus non-public sources of support -- taxpayers versus students and their parents. We shall be less concerned with whether the public support comes from federal, state, or local government, even though that is an important policy issue. And finally, we shall of necessity focus largely on undergraduate education obtained through public institutions, inasmuch as it is here that the equity problems are of most interest and most amenable to policy. By these limitations it should be possible to highlight the central issues even at the risk of some oversimplification.

The organization of the paper is as follows. The first section sets out the economic efficiency-based argument for public financing of undergraduate education and then comments briefly on the evidence supporting this argument. The next section sketches out several different views about what criteria might be used to evaluate the equity of alternative systems of financing higher education. This is followed by a brief survey of the evidence on the extent to which the present system of finance does indeed achieve some measure of equity. Next we consider alternative proposals that seek to promote greater equity and we explore their potential effects. The discussion emphasizes the difficulty of evaluating alternative proposals because educational expenditures represent only one of several alternative methods by which parents and society transfer wealth from generation to generation.

Economic Efficiency

What is the basis for subsidizing the purchase of undergraduate education? Let us first try to visualize undergraduate education as being entirely financed and provided by the private sector. In such a situation we would expect to find the education market functioning reasonably efficiently, with those people desiring to make purchases doing so at prevailing market prices and with those entrepreneurs who are producing education earning a normal rate of return. We would expect to observe a wide range of educational offerings, by type, quantity, quality, and price. These offerings would no doubt range from general education to highly specific training; some of this would be provided in formal institutional surroundings and some would be closely job-related. The duration of the offerings would differ, as would the intensity. The quality of the offerings would vary, with prices largely reflecting these quality differences.

If we examined this system at any point in time, we would expect to find vast differences in the types and amounts of education-training possessed by individuals, and probably even wider differences in the costs that had been incurred to obtain the education-training. But presumably there would be no more concern about this distribution than about, say, the distribution of automobile ownership in this country. In the private sector efficiency is presumed to produce equity. Of course, there would be some market imperfections, such as inadequate information, discrimination, barriers to entry, and the like. But such imperfections would not provide a clearcut case for public subsidies.

What makes the product "education" different and thereby justifies the public financing (and usually, the public provision) of undergraduate education? The conventional justification is that significant external benefits are produced as individuals seek to enhance their own private benefits.[1] Without public subsidies, a less than optimal quantity of

1. For a discussion on this point, see E. G. West, Education and the State (London: Institute for Eaconomic Affairs, 1965).

education would be purchased, and consequently, society as a whole would be worse off. By providing subsidies, the private rate of return is raised to approximate the level of the social rate of return, and this then indicates to potential purchasers of education the proper rather than some distorted price signal. In summary, the argument goes that social welfare is maximized by the diversion of resources from taxpayers in general to those young people enrolling in higher education, because of the external benefits their educational purchases will generate.

Evidence supporting the efficiency-based argument for the public financing of undergraduate education is woefully weak. We hear bold assertions about the existence and size of external benefits from higher education, and sometimes even from undergraduate education; and we have long lists of these external benefits which include everything from "improved citizenship" to "enhancing manners and refinement of conduct."[2] Yet there is little firm evidence as to the exact nature of these benefits, whether they exist, and if they do, how substantial in magnitude they are. It seems strange that despite the growing numbers of economists studying the economics of education, little if any effort has been given over to filling in our knowledge about external benefits of undergraduate education.

Even if the public financing of undergraduate education can be justified on efficiency grounds, some nagging questions arise about the equity or distributional side effects. Given that the typical approach is to provide uniform subsidies to all students, in recognition of the externalities, we

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2. See Howard R. Bowen, "Finance and the Aims of American Higher Education," in M. D. Orwig (ed.) Financing Higher Education: Alternatives for the Federal Government (Iowa City: American College Testing Program, 1971), pp. 155-170.

get rather diverse effects. Those student-families who might have been willing to pay the unsubsidized cost will have gained a windfall by the amount of the subsidy. Other student-families who would have been unable to pay the unsubsidized cost but can pay the subsidized cost will now be able to attend college and thereby tap into the returns which result from greater educational attainment. Still others will be unable to attend at either the unsubsidized or subsidized price. They, along with the rest of the population, gain no direct benefits from the subsidy program. Quite obviously, the immediate as well as the prospective distribution of income will be different after as contrasted to before the implementation of the subsidy program.

This line of reasoning ignores two important considerations: the distribution of the external benefits and the incidence of the taxes that are imposed to raise revenue for the subsidies. As noted above, little is known about the nature or magnitude of the external benefits. Even less is known, and speculation on this point is almost nonexistent, about the distribution of external benefits. Do they accrue in roughly equal absolute amounts to everyone or do they bear some proportional relationship to say income? Are they more likely to accrue to those people whose education was subsidized for the very reason that external benefits would result, or do they go largely to the less-educated? At the moment we have little or no information for answering these questions.

About the incidence of taxes, little can be said. If changes in subsidy are accompanied by changes in tax rates, then it may be possible to infer exactly who is paying the subsidies. Ordinarily simple cases like this do not occur; various categories of public expenditures are increasing and a variety of considerations enter into determining how the tax increases will be distributed. This means that it will be largely fruitless to try to link higher education subsidies with higher education taxes paid, so as to find out on balance whether benefits and payments balance out.[3] Clearly, some redistribution is going on but we cannot isolate it without recourse to highly arbitrary assumptions.

The redistributive effects of higher education have not gone unrecognized, even if one assumes that subsidies are provided largely on efficiency grounds. The very obvious fact that a subsidized price is lower than an unsubsidized price means that some additional lower income students who are qualified to attend college will now have an opportunity to do so. This broadening of opportunities -- greater equity -- is frequently emphasized when arguments are made for reducing tuition payments (increasing the subsidies). (Paradoxically, when objections are raised to the charging of low tuition rates to students, many of whom could pay a larger fraction of the total costs, it is frequently claimed that the higher taxes paid in later life by those receiving the subsidies will more than offset the amount of the subsidy provided by taxpayers.) Much the same argument is made in the search for additional student financial aid.

A fair summary might be that while the external benefits justification is an appealing one, we have no guidelines to use in knowing how to appraise these benefits for purposes of establishing the proper subsidy level. More-

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3. For a discussion of this point, see W. Lee Hansen and Burton A. Weisbrod, "On the Distribution of Costs and Benefits of Public Higher Education: Reply," Journal of Human Resources, Summer 1971, Vol. 6, No. 3.

over, the subsidy approach has important distributive or equity consequences that are not always fully recognized.[4]

Equity Effects

The steady growth of concern about the equity effects our current system of undergraduate education suggests the need to treat equity as a separate objective and, possibly, to regard it as coequal with efficiency. But what do we mean by equity in higher education and in higher education finance? Being able to set forth some unambiguous definition of equity, comparable to that of efficiency, would be helpful. But views about what is equitable differ widely among individuals, and as yet there is no emerging consensus to help provide an objective criterion by which the system could be evaluated. At best, we can examine the distributional effects of the present system and of alternatives to it, thus permitting independent observers to see the effects of one system versus another. How to determine what is more or less equitable is still a question of some difficulty.

A useful starting point may be to consider what kinds of objectives lie behind various proposals designed to insure greater equity. There appear to be four distinctly different equity objectives: changing the distribution of student input to the educational system, changing the distribution of student output of the system, changing the distribution of student subsidies, and changing the distribution of the lifetime income of the population. In all of these cases one is concerned with observing the extent to which the system is providing more equal treatment to individuals classified and

4. See. W. Lee Hansen and Burton A. Weisbrod, "A New Approach to Higher Education Finance," in Mel D. Orwig (ed.), Financing Higher Education . . ., pp. 117-142.

cross-classified by various background characteristics over which they themselves have little or no control. Let us consider each of these objectives.

Changing the distribution of student input to undergraduate education forces an explicit consideration of the distinction between access to opportunities for attending college and actual attendance. Access involves an ex ante determination of the extent to which attendance opportunities are indeed open to all, whereas the attendance involves an ex post determination of the extent to which these opportunities are realized.[5] Actual attendance patterns differ considerably, reflecting a gap between opportunities and their realization. Many forces intervene, among them student interest, aptitude, and motivation, and the like, plus the financial barriers which reflect limited student-parent resources to finance the costs of college. Some of these same forces may have also operated earlier in affecting who is qualified for access. Hence, there is a choice of criteria to use in evaluating how effectively proposals meet the objective of altering the student mix.

If one views the objective as that of changing the student output of the system, then here too a distinction can be made between opportunities for achievement and actual achievement. This distinction is exemplified in discussions of equality of opportunity in this country's elementary and secondary schools.[6] The potential for achievement is considerable; yet wide

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5. This distinction is made effectively in a recent report of the Carnegie Commission on Higher Education, A Chance to Learn (New York: McGraw-Hill, 1970), pp. 11-14.

6. See James Coleman and Samuel Bowles in "Equal Educational Opportunity, Special Issue," Harvard Education Review, Winter, 1968, Vol. 38, No. 1.

differences in achievement levels exist, even though attendance is almost universal. So far, less interest has been evidenced in this objective at the undergraduate level, largely because of the assumed higher correlation between attendance and achievement. On the other hand, we know little about differences in what is achieved -- or learned -- at different colleges and universities or among different students. And we probably know even less about the connection between what is achieved and the cost of the resource inputs used up.

Still another objective, and a not unrelated one, might be that of changing the distribution of the subsidies provided through the higher education system. Given the uncertain interpretations of attendance and the virtual lack of information on realized achievement, the amounts of subsidies gained by different student groups may be a useful, if not revealing measure of the distributional effects that are being produced.

A potentially more important and more interesting equity objective is that of changing the distribution of the lifetime income of the population. To the extent that more post-secondary education leads to greater earning power, then who attends college, for how long and how much they achieve will affect the shape of the future distribution of income. One can visualize a system operating in such a way that the intergenerational distribution of income remains largely unchanged, as contrasted to a system of great fluidity in which the positions of at least some people may be dramatically altered via undergraduate education from one generation to the next.

The extent to which one or another of these equity objectives is being achieved by the present system can be sketched out briefly.[7] To simplify,

7. Much of the evidence reported in the following paragraphs comes from W. Lee Hansen, "Financial Barriers to College Attendance," in U. S. Office of Education, Trends in Post-Secondary Education (Washington: Government Printing Office, 1971).

the presentation, we shall focus largely on students classified by income or SES; they could just as well be grouped by other characteristics.

The evidence shows rather clearly that the higher the family's income and/or its socio-economic status, the more likely its children are to plan to attend college, to actually enroll in college, and to complete college. While higher percentages of the more able students within each income or SES class plan to attend and do indeed attend college, the proportions of the most able students who attend are substantially higher as family circumstances improve. The net result is that sizeable numbers of apparently qualified (in the upper half of their high school classes) young people from less affluent families do not attend college, while slightly smaller numbers of apparently less qualified (in the bottom half of their high school classes) young people from more affluent families do attend college. Given the apparent importance of financial barriers, reflected by limited parental resources, the system appears to be inequitable in its treatment of people.

The present method for offsetting the financial barriers that limit attendance by well-qualified high school graduates is through low tuition and student financial aid. While low tuition reduces the barriers generally, lower income students will be able to attend only if they obtain financial aid to help offset the out-of-pocket costs of college. The available financial aid is, however, inadequate to meet the amount of student financial need; total financial aid in the form of grants, work and loans, meets less than forty percent of financial need as it is conventionally measured.

How levels of achievement differ among various classes of college students is something about which we know very little.

We do, however, have some evidence on the distribution of subsidies. For California we have found that undergraduate subsidies go to above average families, and that among them, the largest subsidies go to students from institutions which enrolled on average students from higher income families.[8] In Wisconsin, by contrast, there is no direct relationship between the size of the subsidies offered in the three systems of higher education and the average family incomes of the students enrolled in those systems.[9] Yet when account is taken of the fact that in institutions which enroll students who on average come from higher income families, these students are more likely to complete their undergraduate program, then the actual distribution of subsidies favors students enrolled in institutions with higher average family incomes.[10]

Whether or not education speeds up the process of income mobility to any great degree is not known with any great degree of accuracy. It is known that college-going of children is associated with college attendance of parents; it is also known that the educational attainments of children on average exceed those of their parents. But the extent to which the rankings of students and their parents by either years of schooling or income differs from generation to generation is not at all clear.

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8. W. Lee Hansen and Burton A. Weisbrod, "The Distribution of Costs and Direct Benefits of Public Higher Education: The Case of California," Journal of Human Resources (Spring, 1969), pp. 176-191; and W. Lee Hansen, "Income Redistribution Effects of Higher Education," American Economic Review, LX (May, 1970), pp. 335-340.

9. Hansen and Weisbrod, "The Distribution of Costs . . .".

10. This observation is based upon unpublished 1970 data for Wisconsin, and also

This brief review of the evidence indicates that while we may have some criteria by which to judge the equity of the system, the data are for the most part not adequate to permit any extensive analysis. Yet by pushing the data already mentioned on enrollments and on subsidies, we come to the interesting conclusion that actions designed to achieve greater equity, in some cases at least, hold out the promise of also being more efficient. First, consider the Project Talent data.[11] On the assumption that higher achievement in high school is more likely than higher parental income to be correlated with high productivity (or income) subsequent to college attendance, resource allocation would be improved by effecting a shift in the composition of the college student body. Lower ability but affluent students would be dropped in place of higher ability but financially poor students.

Second, if financial aid is viewed as also inducing the student subsidies now provided through below-cost tuition, and if financial need is calculated on the assumption that tuition is set at full instructional cost, then total financial aid somewhat exceeds financial need. If we allow for expected increases in enrollment that such financial aid would generate, total financial aid would meet anywhere between 70 and over 90 percent of financial need, depending upon the assumed enrollment response.[12] By simply reallocating the public resources already used to support undergraduate education, the existing financial barriers could be largely offset. Once again, a change designed to produce greater equity would also be more efficient.

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11. See Hansen, "Financial Barriers . . ."

12. Ibid.

These interesting results should alert us to the fact that proposals for financing undergraduate education are likely to have both equity and efficiency effects. And it also suggests that whereas the objectives of equity and efficiency are often in conflict, this need not always be the case.

A Catalog of Proposals

Proposals for promoting greater equity in higher education -- and that is what most of them appear to emphasize -- can be classified into two broad categories. One category involves the extent to which there are to be intergenerational transfers of resources: from taxpayers, and private doners to students and their parents, and from taxpayers, donors, and parents to college students. The other category involves the extent to which there are intragenerational transfers which take direct account of the investment nature of college expenditures. No attempt is made here to be exhaustive. Readers who prefer to see the entire gamut of financing plans are directed to the references below.[13]

Proposals from the first category take several forms. One is to provide equal treatment for all so as to promote greater equity. By equal treatment for all we mean that students are not explicitly differentiated in the treatments they receive. There are several variants of this form, among them (a) zero tuition charges, (b) full instructional cost tuition charges, (c) full student grants to cover all institutional and student costs of

13. See. M. D. Orwig (ed.), Financing Higher Education: Alternatives for the Federal Government (Iowa City, American College Testing, 1971); Ronald A. Wolls, Alternative Methods of Federal Funding for Higher Education (Berkeley, California: Carnegie Commission on Higher Education, 1968).

attendance, and (d) a fixed grant of the "GI Bill" variety for education and training but not restricted to college students.

Common to all of these proposals is the provision of approximately equal-sized subsidies (equal to zero in b) to all eligibles even though their family resources may vary widely. As a consequence subsidies as a proportion of income steadily decrease as family income increases. To the extent, however, that the subsidy level falls substantially short of the private costs of obtaining education or training, then the percentages of lower income students availing themselves of the subsidies will fall. This means that average subsidies will rise with income level, though whether the rate of increase exceeds, equals, or falls short of the rate of increase in income depends upon the income elasticity of demand.

These proposals ignore the different initial circumstances in which students and their families find themselves. Students from higher income families have access to more resources to help pay for the costs of college; many of them would attend even were there no subsidy. Lower income students, by contrast, find themselves unable to afford college even with substantial subsidies. Thus, there is strong support for proposals (a) and (c) because they minimize the importance of differential ability to pay on attendance, as is the case for elementary and secondary education.

These proposals differ widely in the extent of cost sharing. With full student grants (c) undergraduate education costs are shifted almost fully onto taxpayers and donors, with little or none of the cost borne by students and their parents. At the other extreme we have full instructional cost tuition charges (b) under which taxpayers and donors make a zero contribution while students and their parents share the instructional costs and the income foregone during attendance. Zero tuition (a) is an intermediate proposal, one which differs only in degree from below-cost (but not zero) tuition system which now prevails. Fixed grants (d), by covering a much larger group of individuals, become more expensive unless the amount of the grant is scaled down; depending upon the size of the grant and the cost of the education or training program, students and their parents might or might not have to share in the costs.

These proposals will have differing incentive effects. The larger the size of the subsidy, the greater will be the private rate of return to investing in undergraduate education; this will stimulate an increase in enrollments, thereby increasing the cost of the proposal to taxpayers. The sensitivity of the private rate of return to alternative tuition policies can be illustrated with some recent calculations for Wisconsin. In 1968 the private rate of return for males to a 2-year degree program in the Wisconsin State Universities was about 11.5 percent; the student pays approximately 30 percent of total instructional costs. Charging a zero tuition would increase that rate of return to 12.0 ; charging the full instructional cost would decrease the rate of return to 10.3 . These changes of from 5 to 10 percent give some notion of the sensitivity of private rates of return to alternative tuition policies. In the short-run the rate of return on total resource costs will not change, of course, unless the additional students attracted into college are qualitatively different from those already in attendance. Over the longer period we would expect the private rate of return to decline as additional graduates flow into the labor market, and similarly a decline in the rate of return on total resource costs.

The key question then becomes one of determining what is the appropriate level of public subsidy. One can use the "external benefits" criterion. Beyond that, subsidy increases will gain more students but will still provide unequal treatment for people of comparable ability but with different family circumstances.

Another form of the first category of proposals calls for equalizing treatment for all students, that is, treatment which by differentiating among students places them on an equal financial footing in overcoming the financial barriers to college attendance.[14] The variants on this form involve (a) financial aid grants based on student financial need, and (b) financial aid grants and work opportunities which are based on student financial need. Financial need is measured in the standard fashion, being based heavily on parental income level. The principal difference between these two plans is in the extent to which students must work to help earn their college expenses and which students it is that must allocate some of their time to work effort.

Under these plans student grants which might cover any amount ranging from tuition, or some part of it, to the full out-of-pocket costs of college attendance, and with possibly even some allowance for foregone income, would vary inversely with family income. Because the grants offset the financial barriers, then, we would expect them, depending upon their level, to result in smaller differences in the proportions of eligible students enrolling from families at different income levels.

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14. The following paragraphs draw heavily upon Hansen and Weisbrod, "A New Approach . . ."

The cost-sharing effects of these proposals bear mention. The higher the student grant maximum, and the lower the tuition, the greater will be the cost of the program. But if we assume, for example, that there is full-cost tuition and that grants cannot exceed this amount, then for students not demonstrating financial need all of the costs of college will be borne by them and their parents. For those students demonstrating full financial need, their instructional costs (tuition) will be borne by taxpayers, with the students and their parents sharing the remaining costs. By a judicious setting of the grant schedule whose maximums slightly exceed the full instructional cost of tuition, it is possible to design a program that will not result in any increase in the cost to taxpayers of undergraduate education.

The incentive effects of these proposals are strikingly different from those discussed earlier. While the rate of return to total resource costs will behave as mentioned above, the private rates of return will change. With unchanged tuition the rate of return will increase for students with financial need and remain the same for those without financial need. But if full-cost tuition is charged, the rate of return will rise even more for students with financial need while falling for those without financial need. The shifts in rates of return made possible by direct grants or subsidies to students will stimulate greater enrollment by qualified students with financial need and though possibly reducing somewhat the enrollment by students without financial need. (Actually, the response is not fully clear in as much as students with no financial need are viewed as "financially able" to pay the costs of college; hence, they might be expected to continue enrolling at the same rate.)

Under these proposals, then, it would appear that the optimal structure of student grants would be that which insures equal opportunities for students of comparable ability, but with different family circumstances, in overcoming the financial barriers to attendance.

Proposals in the second broad category recognize that expenditures on undergraduate education represent an investment which is highly likely to result in greater earning capacity, and hence young people should have equal access to investment funds which they can repay later in life. Becker and Chiswick proposed this as a criterion for assessing the equity, and possibly the efficiency as well, of the market for higher education.[15]

The task becomes one of improving the capital market for educational loans. Some proposals are national in scope -- The Zacharias plan[16] -- while others are very limited -- Yale's new tuition postponement option.[17] The effects of loan schemes have been analyzed by Hartman,[18] and so there is no need to describe these plans in any detail here.

What kinds of equity effects are likely to result under a loan plan? We would expect a continuation of intergenerational transfers of resources from parents to children, depending upon a family's ability to pay. The higher the family income, the more likely it is that the student will not

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15. Gary S. Becker and Bary R. Chiswick, "Education and the Distribution of Earnings," American Economic Review LVI (May, 1966), pp. 358-369.

16. Educational Opportunity Bank

17. James Tobin and James Pugash, "The Economics of the Tuition Postponement Option," Yale Daily News, February 10, 1971.

18. Robert W. Hartman, Credit for College: Public Policy for Student Loans (New York: McGraw-Hill, 1971 forthcoming). A part of this study, prepared for the Carnegie Commission on Higher Education, appears as Student Loans for Higher Education," in M. D. Orwig (ed.) Financing Higher Education...

have to incur any debt. Lower income students, by contrast, will be more likely to borrow because of the inability of the family to transfer any large amounts of resources to them. And so what we are likely to observe is that even though the subsequent incomes of students from higher and lower income families may be approximately the same, their net incomes after allowance for annual interest and principle will differ.

What these plans mean for incentives is difficult to say. Undoubtedly larger numbers of qualified lower income students will wish to make use of loan funds. How sensitive they will be to the amount of the loan they must take out and the interest charges they must pay, particularly as tuition rises toward full instructional cost (a likely occurence, I would guess), is much more difficult to say. One reason for this uncertainty is that whatever the private rate of return, the perceived net benefits may differ appreciably depending upon whether the out-of-pocket costs of education are financed largely through transfers from parents versus student borrowing that requires future repayment.

The cost sharing effects are clear. To the extent that tuition is still subsidized, the only additional cost will be that of the interest subsidy -- if there is one -- and that cost should not be great. More likely, as noted above, tuition will increase such that the costs of undergraduate education to the public will decline. Students and in part their parents will absorb the cost.

Additional Considerations

When alternative methods of financing higher education are discussed, particularly those which move far toward offsetting the financial barriers confronting qualified, lower income young people, there is considerable concern about who will pay the costs. If additional resources are required, this will mean an increase in taxes or a reduction in expenditures on other programs. Rarely, however, is there any discussion of the incidence of the additional taxes or of which other programs would have to be cut. While someone will have to pay, who that will be and how much they will have to pay is unclear. On the other hand, if existing resources are to be reallocated, as in the full cost-grant scheme proposed by Weisbrod and myself for Wisconsin, then it is quite clear who will bear the brunt of the costs and how much they will have to pay. It will be student-families in the middle and upper income groups. And we can expect objections.

There are several types of responses. One is to view the added costs as a kind of tax surcharge (or special user charge) which continues only as long as a child is in college; after that the normal tax schedule again prevails. Inasmuch as parental contributions reflect a 30 percent marginal tax rate, there is a sharp increase in the progressivity of the "total" tax structure beginning where the "ability to pay" schedule cuts in; after that the rate stabilizes and then becomes regressive. Inasmuch as tax experts have given us no way for determining what is an excessive tax rate, we can only note the effect, not pass judgment on it.

Another view is to consider how the plan changes the implicit tax rate. One might well argue that a higher implicit tax rate is imposed on middle and upper income groups, while at the same time the implicit taxes on lower income groups are reduced. Put another way, the higher implicit tax on more affluent families will replace the implicit tax that now falls on qualified, lower income families, who because of financial barriers to college attendance receive lower lifetime earnings than they might otherwise earn.

The objections to shifting the financing also fail to recognize that current family income is not the sole measure of a family's ability to pay its children's educational costs. Families also have recourse to their net worth, at least some portion of which was probably accumulated specifically for purposes of college financing.[19] This reserve of net worth, whose ratio to income rises as income increases, means that the ability to pay out of some combination of current income and net worth rises more sharply than is indicated by looking at family income alone.[20]

The role of wealth in affecting college-going is an intriguing one, because it has important implications for the extent to which different financing schemes will bring about changes in the distribution of income from one generation to the next. Parental financing of undergraduate education can be viewed as one of several .thods for transferring wealth from generation to generation; the other two methods are via cash gifts and inheritance. Inheritance is a chancy method in that the donor has little control over the way in which the transferred wealth is used; the recipient ordinarily obtains the inheritance too late to use it effectively to enhance his own earning power; and because the donor may live longer than he expected, or incur greater than anticipated, whatever is left is largely a matter of accident. Cash gifts can be provided at most any time by parent, and indeed many cash gifts are made. But they tend to be rather small because of a reluctance to give wealth to their children for unrestricted use.

Educational purchases appear to be the preferred form of transfer,[21] and upon reflection, the reasons are apparent. Foremost is the parental view that education becomes embodied in the child and hence cannot be taken away or easily destroyed or lost; hence, by this purchase parents exert a permanent influence on the child and help to insure the child's continued livelihood through the earning power the education will generate. In addition, supporting a child through college yields some tax saving through the exemptions for dependents permitted under the tax laws. More important, perhaps, is the leverage that such expenditures provide in helping parents achieve their wishes for the future lifestyle of their children. By providing tuition and other out-of-pocket costs, parents can easily tap into the public subsidy that accompanies enrollment in, at least, public colleges. If a parent is wise, he also enlists the efforts of the child who can offset some of the out-of-pocket costs through working while in school. All of these forces combine to strengthen the desire to transfer wealth via education investment.

The ability to transfer wealth in this way is facilitated by the structure of education, with its relatively weak emphasis on ability standards as a condition for admission to college. As some have remarked, there is a college

19. John B. Lansing, et al., How People Pay for College (Ann Arbor: Institute for Social Research, 1960).

20. W. Lee Hansen and Burton A. Weisbrod, "Measuring Economic Welfare," American Economic Review, LVIII (December, 1968), pp. 1315-1329.

21. For some evidence, see Harold W. Guthrie, "Intergenerational Transfers of Wealth and the Theory of Saving," Journal of Business, XXXVI (January, 1963), pp. 97-108.

for everyone, i.e., almost anyone can be admitted to a college somewhere -- the only difficulty is in finding the college! Because of this phenomenon, wealthy families can much more easily effect wealth transfers to their children through education purchases than in most other nations.

Taking account, then, of the desirability as well as the ability to transfer wealth from generation to generation via educational purchases, we would not expect the present method of financing higher education to do much to alter the shape of the income distribution from one generation to the next or to affect the relative income position of the successive generations.

This tendency is no doubt reinforced by the effect of college-going itself on lifetime incomes. We know that on average the incomes of college graduates exceed those of high school graduates, and gi en the assumption (for which there is some evidence) that the ratio of wealth to income is higher for the college-educated, then the ability to pass on to children higher levels of education increases with the educational attainment of parents. And so we find that educational attainment, through its effect on income and, in turn, its effect on wealth, all work to limit the way in which the distribution of income from generation to generation is altered.

What can we now say about the several major types of financing proposals advanced earlier? If across-the-board subsidies are increased, the intergenerational distribution of income would change only insofar as the subsidies covered the full cost of education, thus permitting lower income students to attend. If a system of grants which met student financial need were implemented, the chances for qualified lower income students to rise in the distribution would increase. If at the same time tuition were set at full cost with grants increased commensurately, there would be an even more substantial effect; not only would lower income students find reduced financial barriers but higher income students would find the barriers raised somewhat. If a system of loans were introduced, opportunities for lower income students to rise would be increased. But the change might be illusory; what is important is not gross but net income -- gross income less debt repayment -- and this for college students who had to borrow most of the costs might not be too much greater than the gross income of high school graduates.

Conclusion

Much remains undiscussed in this paper, including such topics as evasive responses that students and their parents (not to mention educational institutions) can take to offset what they regard as undesirable effects of new financing systems. Nor has much been said about the effect of making subsidies available only for formal instruction of the kind now designated as "higher education." There are certainly other important human investment options that lie open to people but which are not now subsidized -- proprietary training, on-the-job training, apprenticeship, and the like. Why these activities do not qualify for the same kinds of student subsidies requires fuller exploration.

The concept of equity is an elusive one, certainly as contrasted to efficiency. The growing interest in equity -- whether in the financing of higher education or of other programs -- is forcing us to address this topic even though many of the tools for this task remain to be fashioned.

PRELIMINARY -- FOR DISCUSSION PURPOSES ONLY

STATE TUITION POLICY AND STUDENT LOANS: AN EXPLORATION INTO THEIR EFFECTS ON EDUCATIONAL ATTAINMENT, MOBILITY, AND THE DISTRIBUTION OF INCOME

by

Robert W. Hartman

As we survey the recent literature on higher education finance and read the newspapers about new policy initiatives, we see two predominant themes, perhaps linked by some grand design. One is a growing interest in, and dissatisfaction with, the way states provide subsidies for higher education. Sparked by the Hansen-Weisbrod analysis of California's policy of low tuition in higher education,_/

_/ W. Lee Hansen and Burton A. Weisbrod, "The Distribution of Costs and Direct Benefits of Public Higher Education: The Case of California," Journal of Human Resources (Spring 1969); and W. Lee Hansen and Burton A. Weisbrod, Benefits, Costs and Finance of Higher Education (Chicago: Markham Publishing Company, 1969).

a mammoth controversy and literature is growing over the issue of the distribution of net benefits of publicly-supported higher education._/

_/ See, for example, Elchanan Cohn, Adam Gifford and Ira Sharkansky, "Communications," Journal of Human Resources, Vol. 5, No. 2 (Spring 1970), pp. 222-36; Joseph A. Pechman, "The Distributional

Effects of Public Higher Education in California," Journal of Human Resources (Summer 1970), pp. 361-70; Robert W. Hartman, "A Comment on the Pechman-Hansen-Weisbrod Controversy," Journal of Human Resources (Fall 1970), pp. 519-23.

The controversy has to some extent been superceded by real events. In the last few years, tuition and fees at state-supported institutions have risen dramatically.

At the same time, we notice a growing interest in student loan programs. From the 1967 report of the Zacharias Panel,_/

_/ Panel on Educational Innovations, Educational Opportunity Bank, to the U.S. Commissioner of Education, the Director of the National Science Foundation, and the Special Assistant to the President for Science and Technology (Government Printing Office, 1967).

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which brought loan finance to the attention of the general public, there has been an outpouring of research on student loan proposals. Karl Shell's two papers,_/ Roger Bolton's essay,_/_/ André Danière's

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_/ Karl Shell, et al., "The Educational Opportunity Bank: An Economic Analysis of a Contingent Repayment Loan Program for Higher Education," National Tax Journal, Vol. 21, No. 1 (March 1968), pp. 2-45; Karl Shell, "Notes on the Educational Opportunity Bank," National Tax Journal, Vol. 23, No. 2 (June 1970), pp. 219-20.

_/_/ Roger E. Bolton, "The Economics and Public Financing of Higher Education: An Overview," in The Economics and Financing of Higher Education in the United States, A Compendium of Papers submitted to the Joint Economic Committee, 91 Cong., 1 sess. (1969), pp. 11-104.

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report,_/ the work of Cook and Stager,_/_/ and the forthcoming works

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_/ André Danière, "The Benefits and Costs of Alternative Federal Programs of Financial Aid to College Students," in The Economics and Financing of Higher Education in the United States, A Compendium of Papers submitted to the Joint Economic Committee, 91 Cong., 1 sess. (1969).

_/_/ Gail C. A. Cook and David A. A. Stager, Student Financial Assistance Programs, with special reference to the Province of Ontario, Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto (1969).

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of Robert Hartman_/ and Stephen Dresch and Robert Goldberg_/_/

_/ Credit for College: Public Policy for Student Loans (New York: McGraw-Hill, 1971).

_/_/ Stephen P. Dresch and Robert D. Goldberg, "Variable Term Loans for Higher Education -- Analytics and Empirics" (New York: National Bureau of Economic Research, 1971).

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have all made it possible for economists and policymakers to point to more than the few words of Milton Friedman as a literature on student loans._/

_/ Milton Friedman, "The Higher Schooling in America," The Public Interest, Vol. 11, No. 108 (Spring 1968).

Here again the real world may be overtaking the analysts. The two major federal loan programs (the National Defense Student Loan Program and the Guaranteed Loan Program) have been growing rapidly in recent years.

Moreover, the non-federal sectors of the higher education economy have begun to awaken to loan finance for higher education. Earlier this year, Yale University announced a "tuition postponement option" under which a tuition increase could be financed by students through long-term loans._/ The Ford Foundation followed this announcement with a plan of research to test the possibility of long-term loans "for a variety of institutions."_/ And most recently, proposals

_/ See M. A. Farber, "Yale Weighs Pay-as-You-Earn Tuition Financing," New York Times, December 11, 1970; and Stuart Rosow, "Yale Offers Partial Pay-Later Plan," Washington Post, February 6, 1971.

_/ Eric Wentworth, "Ford Fund Weighs 'Pay As You Earn' Student Loan Plan," Washington Post, January 2, 1971.

for student loans have been made public in Ohio and other states._/

_/ See John A. Crowl, "'Ohio Plan' Creates a Storm; Would Require Students to Repay State for Education in Public Colleges," The Chronicle of Higher Education, Vol. 5, No. 25 (March 29, 1971).

The growing trend toward loans for students and toward elimination or reduction of low-tuition policies in state-supported institutions suggested a useful topic for exploration for this conference. Given the conference theme, I decided to probe into the effects on personal income distribution of changes in state tuition policy and in the availability of student loans. Specifically, I am interested in tracing through what it is one would need to know to quantify the long-run effects of a large increase in tuition charges at state institutions of higher education on educational attainment, on the distribution of income and on social mobility, when such policies are accompanied by greater access to capital markets on the part of students.

Two apologies and caveats are in order before getting into our subject. First, there are very few useable data or well-established behavioral parameters, and thus the estimates of various program impacts is intended to be _illustrative_ only. Second, I realized that there was a danger of encroaching on the turf of other participants in the conference at every stage of the investigation. Many shortcuts were taken to keep the problem manageable; I could not approach the level of richness that participants whose topics were narrower could attain. (And besides, I didn't know what they were going to say!)

The plan of the paper is the following. Part I provides an illustrative example of what the system of state support that has prevailed in the past might be expected to produce in the future. Part II describes a format for illustrating the gross effects of an increase in tuitions at state institutions on the future income distribution and discusses the magnitude of changes in distribution occasioned by offsetting some of the losses of higher tuition through expanded loan programs. Part III is a discussion of how the tax system used to support low tuition and how the repayment system used for student loans might be evaluated and compared on equity grounds.

PART I

Future Implications of Low State Tuitions

The objective in this part of the paper is to spell out the income distribution effects of the continuation of low-tuition policies at publicly supported colleges, as a basis for discussion of changes in that policy. For this purpose, we have developed a grossly oversimplified model of the income-generating process. In essence, our model takes a census survey of high school seniors in 1965, and traces the cohort through college entry, completion, and incomes in the future based on various sources._/

_/ The model and data are described more fully in the Appendix. The text covers the major assumptions and data sources.

All of our data is standardized to a cohort of 100,000 high school seniors in 1965, whose rates of high school completion were estimated by the U.S. Census in 1967._/ Then the high school

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_/ The final income distribution estimates reported later in this section are based on the experience of "all males," but our education attainment estimates are for "all students," including females.

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graduates, grouped into seven family (parental) income classes, were allocated into two postsecondary attendance categories -- do / do not attend college -- on the basis of census data. For the "do attend" college category, students were allocated to four types: public two-year, private two-year, private four-year, and public four-year on the basis of estimates made by Folger, Bayer and Astin./

/ John K. Folger, Helen S. Astin and Alan E. Bayer, Human Resources and Higher Education, Staff Report of the Commission on Human Resources and Advanced Education (New York: Russell Sage Foundation, 1970).

Students from each family income class differed in the mix of institutional types attended with a larger proportion of low family income students attending public and two-year institutions.

The college attendants were then assigned educational attainments, by applying to each institutional type a completion rate. For example, the sub-group of students who attend four-year public colleges were allocated among the classes: 1) did not complete one year; 2) completed one to three years; 3) completed four or more years of college./ Different allocations were made for two-year colleges

/ These rates were also derived from Folger, Bayer and Astin.

and for four-year private schools. (It should be noted that these completion rates were entirely based on institutional type and not on family income or ability within institutional type. This is clearly an assumption for later refinement.) Students who did not complete one year of college were reassigned to the category "high school graduate."

This process of assignment of the cohort of 100,000 students to high school graduation, college attendance, institutional type, and completion paths allowed me to identify, for each parental income class, four final education attainment categories:

1) not high school graduate;
2) high school graduate;
3) one to three years college;
4) four or more years college.

To estimate the future income distribution implications of existing patterns of educational attainments by parental income class, I applied the census distributions of total money income in 1967_/

_/ U.S. Bureau of the Census, Current Population Reports, Series P-60, No. 60, "Income in 1967 of Persons in the United States" (1969).

by education and age using the "years of school completed" census categories corresponding to the four educational attainment groups just listed._/ The census tables for "all males" were employed in the

_/ For the "not high school graduate" group, I used "1 to 3 years of high school" in the census tables.

age brackets 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 years and over to generate income distributions over time for the 100,000 person cohort.

Thus, the distribution of income for the cohort depends on:

a) The initial mix of high school seniors by family income class.

b) High school graduation rates in each class.

c) College attendance rates in each class.

d) Type of college attended by college entrants.

e) Completion rates by type of college attended. All of the above yields educational attainment by family income class.

f) Income distribution by educational attainment and age.

The result of this exercise is summarized in the following tables. Table 1 shows the college attendance patterns of the 100,000 high school seniors. The well-established result that college attendance rates are greater for the rich than for the poor can be easily seen by comparing the last column of the table with the first: over 80% of the high school seniors from the highest family income class attend college while less than 20% of the lowest income class enroll. A less publicized fact that emerges from this table is that the probability of attendance at a public institution is greatest for the middle and upper income classes. The probability of attending a public school is over three times as great for a student from the highest family income category as for the lowest, although the concentration of private school attendance in the upper income class is shown by the fact that the probability of attending any college is five times greater in the highest class than in the lowest.

TABLE 1. College Attendance of Cohort of 100,000 High School Seniors in October 1965 by Class of Family Income
(Number of students)

Family Income	Total	Do not Attend College. H.S. Grad.	Do not Attend College. Not H.S. Grad.	Attend College Public 2-yr.	Attend College Public 4-yr.	Attend College Private 2-yr.	Attend College Private 4-yr.	Total
Under $3,000	11,812	8,223	1,559	440	983	52	556	2,050
3,000 - 3,999	7,339	4,323	954	456	1,116	53	437	2,062
4,000 - 5,999	20,031	11,767	1,382	1,460	3,563	171	1,687	6,881
6,000 - 7,499	15,023	8,256	1,007	1,222	2,983	143	1,412	5,761
7,500 - 9,999	19,916	9,183	1,175	1,993	5,033	234	2,290	9,558
10,000 - 14,999	19,419	7,042	1,223	1,597	5,459	187	3,910	11,154
15,000 and over	6,460	814	342	498	2,297	58	2,450	5,304
Total	100,000	49,607	7,643	7,666	21,435	899	12,750	42,750

Tables 2 and 3 summarize the final educational attainments of our cohort of students. Once again the contrasts among the seven family income classes are pronounced. Only 14 percent of the high school seniors from the lowest income bracket complete one or more years of college while two-thirds of the children from the uppermost bracket complete that much schooling. Put another way, the probability of earning a B.A. degree is six times greater for the children of the rich than for the progeny of the poor. This last statistic can be used to summarize how the educational attainment model works. The 8% B.A. completion rate for the lowest income group is the product of three proportions:

1) The probability of high school graduation (0.87).
2) The probability of attending college, given high school graduation (0.20).
3) The probability of four or more years completed, given college attendance (0.49). This proportion, in turn, is the weighted average of completion rates in two-year institutions, four-year publics, and four-year privates.

The corresponding probabilities that result in a 48% B.A. rate for the highest family income class are 0.95, 0.87, and 0.59 respectively. The last entry is higher for the wealthy because of their heavier concentration in private institutions.

From the educational attainments just presented, income distributions at age 30 (equals the census category 25-34 years), 40, 50, 60, and 65 were computed for the 100,000 person cohort, by assuming that the 1967 census distribution of income by education and age applied equally well to all family income subgroups, given their educational attainment.

TABLE 2. Educational Attainment of Cohort by Class of Family Income (No. of Students)

Family income	Total	Not H.S. Grad.	H.S.Grad.	1-3 yrs. college	4 or more college
Under $3,000	11,812	1,559	8,568	683	1,002
3,001 - 3,999	7,339	954	4,673	730	982
4,000 - 5,999	20,031	1,382	12,937	2,354	3,357
6,000 - 7,499	15,023	1,007	9,235	1,971	2,811
7,500 - 9,999	19,916	1,175	10,808	3,269	4,664
10,000 - 14,999	19,419	1,223	8,938	3,235	6,023
15,000 and over	6,460	342	1,715	1,292	3,111
Total	100,000	7,643	56,874	13,534	21,949

TABLE 3. Educational Attainment of Cohort by Class of Family Income (Percent)

Family income	Total	Not H.S. Grad.	H.S. Grad.	1-3 yrs. college	4 or more yrs. college
Under 3,000	100	13	73	6	8
3,001 - 3,999	100	13	64	10	13
4,000 - 5,999	100	7	65	12	17
6,000 - 7,499	100	7	61	13	19
7,500 - 9,999	100	6	54	16	23
10,000 - 14,999	100	6	46	17	31
15,000 and over	100	5	27	26	43
Total	100	8	57	14	2[illegible]

As the reader is aware, seven original family income categories times sixteen census income categories times five age brackets generates a lot of numbers to juggle at one time. So I have tried to summarize the results here in three main ways.

First, Table 4 gives an overview of the income distribution over the lifetime of our cohort. It shows the familiar increase in incomes up to age 50 (read 45-54) and decline thereafter. The low absolute level of the mean incomes are, of course, a reflection of the fact that we are using cross-section data and have not, therefore, accounted for the effects of price inflation or the productivity-induced upward shift in age-education income profiles. Two kinds of summary measures of the income distribution are given in Table 4. First, a conventional Gini coefficient was calculated at each age. Not surprisingly, the Gini coefficient rises as the cohort ages, reflecting the greater variation in income at later stages of careers. In addition, the table shows the proportion of the entire cohort falling in the top two future income categories. The probability of earning over $15,000 (about 50% above mean income between 40-60) peaks at age 50 where the ratio stands at 15 percent.

What we are most interested in, of course, is how the high school senior cohort broken into original family income categories compare to each other. To illustrate the findings, a similar set of measures to those just presented was calculated for the various original family income groups at age 50. Hereafter, all distributions will be for the original cohort at age 50; perusal of the data indicate that all results would be true at other ages as well.

TABLE 4. Income of Cohort Reaching Specified Ages

Age	Mean	Gini coefficient	% over $15,000	% over $25,000
30	$7,571	.268	3.6	0.7
40	9,538	.287	11.1	2.6
50	9,942	.322	15.1	3.9
60	9,059	.371	13.1	4.2
65	5,245	.500	6.4	2.1

Table 5 shows the results at age 50. The table indicates that the average member of the low parental income group earns about 10% less than the average member of the entire cohort and that the average member of the wealthiest original bracket earns about 15% more than the cohort average.

More interestingly, for the question of social mobility is the finding that the chance of earning $15,000 or more (read "moving to a high status position") is only 10.1% for children of the poor, and 23.8% for children of the rich -- more than a 2:1 advantage in status mobility for the privileged classes._/

_/ The 2:1 advantage arises in spite of the fact that children of wealthy families have a 6:1 advantage in college graduation for the following reason. At age 50, the 1967 census reports a 39% chance of earning over $15,000 for college graduates and an 8% chance for high school graduates. Children (males) from the wealthiest income class have a 48% chance of graduating college and a 27% chance of being high school graduates, producing a chance of earning $15,000 or more of 0.39 (0.48) + 0.08 (0.27) ≈ 21%. Children from under $3,000 homes have corresponding estimates of 0.39 (0.08) + 0.08 (0.73) = 9%.

For reasons that will become clearer in later sections, Table 5 shows the proportion of the members of each family income class who will fall (at age 50) into the four income quartiles (quartiles are computed from data on the whole cohort at age 50). Although less dramatic than the differences in chances to earn $15,000 income, the

TABLE 5. Income Distribution of Cohort by Original Family Income at Age 50.

	Original family income categories							
	$0- $3,000	$3,000- $3,999	$4,000- $5,999	$6,000- $7,499	$7,500- $9,999	$10,000- $14,999	$15,000 and over	Total
Mean at age 50	$9,034	$9,256	$9,654	$9,780	$10,090	$10,488	$11,460	$9,942
Gini	.307	.314	.317	.319	.322	.326	.328	.322
Proportions:								
Over $15,000	10.1	11.9	13.4	14.0	15.9	18.2	23.8	15.1
Over $25,000	2.7	3.1	3.5	3.6	4.1	4.7	6.1	3.9
In 1st quarter	28.3	27.3	25.8	25.4	24.4	23.2	20.1	25.0
In 2nd quarter	28.0	26.8	26.0	25.6	24.5	23.2	19.9	25.0
In 3rd quarter	24.6	24.7	25.0	25.1	25.2	25.1	25.0	25.0
In 4th quarter	19.1	21.2	23.1	23.9	26.0	28.6	35.0	25.0

quartile distribution is nonetheless revealing. It shows that the child of a poor family falls six percentage points below what an egalitarian educational system would produce in the upper quartile: his chance of being in that quartile is only 19%. By contrast, the student from the highest income class has a 10 percentage point advantage produced by education; his chance at a top quartile position is 35%.

Overall, this is not the picture of an educational system producing anything like egalitarian results. Moreover, the model that generated these results almost certainly understates the actual inequalities that the real-world of higher education will actually produce. The major glaring omissions that would have made the resulting distributions more disparate by income class are:

(1) The absence, in the cohort, of any student who dropped out before senior year of high school -- surely concentrated in low parental income classes.

(2) The assumption of a common dropout rate in a particular type of college. It is certain that students from low-income homes are more likely to fail completion within a given category of school.

(3) The assumption that anyone who reaches a given educational attainment level is equally likely to earn over $X as anyone else. Surely, children from high-income-homes-with-a-B.A. will, in fact, earn more than other B.A.'s.

So, the <u>status quo</u> is surely inegalitarian. We now ask what will happen if public institutions raise tuition.

PART II

The Effect of Tuition Increases on Attainment, Distribution, and Mobility

A substantial increase in tuition at public institutions could be expected to affect the future incomes of the cohort of high school seniors in the following ways:

(1) Reduce the rate of high school graduation, since the option value of high school completion is lowered.

(2) Lower the entry rate into public institutions through the operation of both an income and price effect.

(3) Offsetting this might be some diversion into private institutions owing to their lowered relative price.

(4) A reduction in completion rates at public institutions due to the higher annual cost of attendance.

(5) A smaller reduction in completion rates among entrants into private institutions, since some of these students would have transferred to public institutions.

There is very little existing empirical evidence on the size of any of these effects that could be expected if tuitions at public institutions were raised by a large sum, such as $1,500 per annum. (A tuition increase of this magnitude for public institutions would cover full costs_/ and would represent a cost increase of between

_/ see Earl F. Cheit, The New Depression in Higher Education: A Study of Financial Conditions at 41 Colleges and Universities, (New York: McGraw-Hill Book Company, 1971) p. 32.

25 percent and 50 percent to the student, counting both opportunity earnings and existing student charges in the base.)

I am in the midst of exploring the implications of several variations in responses of students to a tuition increase of $1,500. At the time of writing only one variation has survived the computer. The results are reported here, although in later revisions, computer willing, the reader will be offered a menu of possible outcomes.

In the successful experiment, it was assumed that the tuition increase of $1,500 had no effect on high school graduation rates. Second, the percentage reduction in number of entrants to public institutions was assumed to be an inverse function of original family income. _/ Third, it was assumed that, of the gross loss of public

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_/ The equation in the program reads: $E_i = b[\frac{\Delta T}{Y_i}]$ where E_i is the percent reduction in public school entrants of income class i, ΔT= tuition increase = $1,500 and Y_i is the mean income of class i. The program is constrained so that E_i cannot exceed 98 percent.

For a similar approach see Roy Radner and L.S. Miller, "Demand and Supply in U.S. Higher Education: a Progress Report," American Economic Review Papers and Proceedings, Vol. 60, (May, 1970) pp. 326-34.

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school entrants in each income class, one-fifth would "reenter" the system in private institutions. Finally, the completion rate for four or more years of college was assumed to be reduced by 20 percent in public institutions and by 2 percent in private institutions.

The educational attainment results of this experiment are shown in Table 6. The first two lines repeat data from Tables 2 and 3. Lines 3, 4 and 5 show the levels and changes in the level of attainment of four or more years of college in each original family income class. (Similar results obtain for 1-3 years of college.) The experiment was so structured that the percentage reduction in B.A. or more attainment rates would be greater in low-income classes, and the range of variation in this particular run is shown in line 5: 38 percent fewer low-income children eventually graduate, while only 12 percent fewer wealthy off-spring fail to complete college./ The

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/ The percent reduction in public school entrants in the trial reported in the text was found by setting the percent reduction in public entrants in the 3rd parental income class at 51%. The percent reduction in public entrants in the lowest class was 98% and was 72% in the second lowest parental income class.

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implied elasticity of completion of college with respect to a cost increase of 50 percent is shown in the last line of Table 6. It shows a range of -0.75 for the lowest income groups, -0.42 for the whole cohort, and -0.25 for the wealthiest class. The elasticity of public school entrants with respect to a cost increase is about 2 for the lowest income class, unity for the 3rd income class, and less than .5 for the high income group.

TABLE 6. Changes in Educational Attainment of Cohort Resulting from Tuition Increase of $1,500[a]

	Original family income class							
	Under $3,000	$3,000-3,999	$4,000-5,999	$6,000-7,499	$7,500-9,999	$10,000-14,999	$15,000 and over	Tot[illegible]
Original number with B.A.	1,002	982	3,357	2,811	4,664	6,023	3,111	21,9[illegible]
Original percentage with B.A.	8%	13%	17%	19%	23%	31%	48%	2[illegible]
Final number	~~262~~ 626	631	2,440	2,153	3,668	5,072	2,754	17,3[illegible]
Final percentage	5%	9%	12%	14%	18%	26%	43%	1[illegible]
Percentage change	-38	-36	-27	-23	-21	-16	-12	-[illegible]
Implied elasticity	.75						.25	.[illegible]

a/ See text for explanation of assumptions used in these calculations.

A strong believer in the public benefits of higher education would presumably stop here. Table 6 shows 22 percent fewer college graduates (and about 18 percent fewer people completing 1-3 years of college -- not shown in the table). These results would lead to a reduction of social benefits of the following type: The likelihood that your neighbor understands that people with long hair have written symphonies may be reduced by almost a half. The likelihood that one's fellow citizens will be conned by demagogues promising law and order is reduced. Maybe even the likelihood that a checking account holder is aware that a reduction in the relative value of the U.S. dollar versus marks does not imply that he should bury currency in the back yard -- the likelihood of all these is reduced by lower education attainment. How much we value these and other effects of higher education, per se, would be one determinant of our willingness to engage in social experimentation with higher tuitions.

What are the effects of the changes in educational attainment on the distribution of income and mobility?

Table 7 shows the income redistributional implications of the state-institution tuition increase. In a nutshell, the effects on the distribution of income at age 50 are negligible. The gini coefficient for the incomes of the entire cohort is unchanged from the low-tuition situation. Similarly, the change in the proportions of the children (sons) of each original family income group falling into the various quartiles of the income distribution, at age 50, are very small indeed (compared to Table 5); the strongest effect seems

TABLE 7. Changes in Income Distribution and Mobility of Cohort Resulting from Tuition Increase of $1,500

	Under $3,000	$3,000-3,999	$4,000-5,999	$6,000-7,499	$7,500-9,999	$10,000-14,999	$15,000 and over	Total
Mean income at age 50	8,796	9,022	9,353	9,511	9,800	10,229	11,199	9,664
Gini	.301	.307	.311	.314	.318	.324	~~.327~~ .328	.318
Proportions:								
Over 15,000[a]	8.7(-13)	10.0(-14)	11.7(-11)	12.6(-10)	14.1(-10)	16.7(-8)	22.3(-6)	13.5(-10
25,000[a]	2.4(-11)	2.7(-14)	3.1(-12)	3.3(-10)	3.6(-10)	4.3(-9)	5.7(-7)	3.5(-10
In 1st quarter	28.1	27.4	25.9	25.4	24.4	23.2	20.2	25.0
2nd quarter	27.4	27.1	26.1	25.6	24.5	23.1	19.8	25.0
3rd quarter	24.8	24.8	25.1	25.1	25.1	24.9	24.7	25.0
4th quarter	19.1	20.7	22.9	24.0	25.9	28.8	35.4	25.0

[a] Parentheses enclose the percentage change from Table 5.

to be in the $3,000-$3,999 class whose probability of attaining fourth quartile status is reduced by .5 of one percentage point.

The absolute levels of earnings disclose somewhat more significant differences among the parental family income groups. The proportion of progeny of families with incomes below $6,000 who will receive over $15,000 income is reduced about 13 percent, while the proportion of the highest family income class earning that much would be reduced by about 6 percent. (See line 3 of Table 7.) Both of these results straddle the average reduction in high earners of the whole cohort of 10 percent. These are significant differentials in terms of social mobility of the low income classes, but they mask an important fact. While it is important that low-income children's chances of earning high status incomes are reduced twice as much as high income children, it is true that high income family's children start with such an advantage that the absolute gap is hardly changed at all. (That is, the lowest family income group's chance to earn $15,000 drops from 10.1 percent to 8.7 percent while the highest income group's chance to earn $15,000 falls from 23.8 percent to 22.3 percent; the percentage point gap between the two groups is hardly changed at all as a result of the reduced educational attainment.) _/

_/ In fact, the implication of the arithmetic in the long footnote on page 17 , suggest that it is impossible to worsen the relative chance for future high income by the poor very much. If every low parental income completer of 1 or more years college were pushed back to high school graduation status, the reduction in the proportion earning $15,000 would be from 10.1 percent to about 7 percent.

For those who think that higher public institution tuitions and attendant changes in higher education attainments will significantly affect the overall distribution of income, our model suggests that this is not the case. Enrollment and completion of college among children of the poor is so small (see Table 3) that even large reductions in that small number do not affect the distributions of the low parental income cohort much. At the same time, high income groups which do participate heavily in public institutions, are little affected by the tuition increase (by assumption, to be sure)._/

_/ Middle income groups, whose descendents are destined to middle income status, would suffer the largest losses. But this group so dominates the income distribution of the population that the relative distribution of income, which depends so heavily on their incomes, is hardly budged by the changes noted.

Social mobility, defined as the chance of a low-income student rising to high income levels, is significantly affected by a large rise in public tuitions, but not by enough to change relative life chances, compared to wealthy kids, very much.

What stands out from the exercise reported here is that if one were interested in significantly affecting the distribution of income via higher education, changes in low-tuition policy at state institutions do not really matter very much. What does matter much -- and jumps out of the data -- is how to induce a massive increase in enrollments and completions of the poor. To accomplish this purpose it is necessary to reduce the price of college attendance to the poor. If additional grants will do the trick, there is no need to increase tuition generally. But if higher public institution tuitions are a necessary price to pay for more-than-offsetting grants to the poor and for enlightened open admission policies, my judgment is that the price would buy an improvement in future income distributions. It is the increase in participation of low-income students that counts here, not the method of finance. (More on this subject at the end of the paper.) _/

_/ I plan to describe other computer runs to complete this section.

Increased access to loan programs is sometimes suggested as a perfect substitute for subsidized low tuitions, if the goal is a better future income distribution. It is difficult to understand even the <u>a priori</u> reasoning underlying this contention, given the kinds of loan programs that have been seriously proposed as substitutes. Suppose, for example, that tuitions were raised by $1,500 and all students were guaranteed access to $1,500 loans at market interest rates. _/ The change in net cost to the student must be

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/ Suppose that market interest rates were what would ensue under a government guaranteed (against default) loan plan.

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equal to $1,500 plus the difference between the discounted present value of the future repayments as valued by the student and $1,500. Only if the student's discount rate is infinity can this difference be equal to $1,500. (In other words, if the student treats the loan as a grant, a "loan" will offset an equal rise in price.) The same condition holds even if the interest rate on the loan is subsidized at below-market rates: the tuition rise raises the net cost to the student by less than its nominal total, but by a positive sum unless the student's discount rate is infinite.

In the case of income-contingent loans, where repayments are based on a contracted fraction of gross income, the net change in cost to the student must be positive unless expected income is zero. /

/ An exception to this is the case where low income levels are exempt from any repayment requirement as in the Ohio Plan. This plan is discussed in the next section.

Naturally, the net cost increase would be relatively less for those whose income expectations are low under income-contingent loans. So, in general, access to loan programs complementing a rise in tuition, increases the net cost to the student, but by less than the nominal rise in tuition. Loans <u>fully offset</u> tuition increases only in improbable cases.

Increased tuitions coupled with loan programs that offered students access to loan amounts in excess of the tuition increase could reduce the perceived net cost of attending college under certain circumstances. For example, if tuition were to increase by $1,500 and all students were offered $3,000 loans, the net price of college to the student would decline if he valued his repayments at less than $1,500. Such a valuation could occur, if market rates of interest were charged, only if the student's discount rate were much higher than the market rate of interest (and the loan were long-term) or if the student loans featured heavily subsidized rates of interest. (In this last case, it might be noted, we would have achieved precisely the kind of effect subsidized tuitions produce: a subsidy for everyone regardless of need.)

Income contingent loans in per capita amounts considerably in excess of tuition increases could reduce net costs of higher education to those students whose expected repayments fall short of the amount borrowed by a large sum. This possibility will be realized only if students are permitted to borrow substantially more than the tuition increase and if considerable progressiveness is built into the income-contingent repayment schedule. For example, Yale's recently announced tuition increase of $500 coupled with the option of borrowing up to $800 will have resulted in a net decrease in cost only to those students who value the expected repayments on an $800 loan at less than $300. Yale's repayment terms are sufficiently liberal to low future earners that it is conceivable that some students will have enjoyed a net drop in costs (as they see it) as a result of the new program./

/ But this set-up raises the prospect that high earners won't participate -- see the next section.

On balance, the impact of increased access to loan programs coupled with a tuition increase of $X can best be analyzed by treating the loan program as reducing $X by some fraction. An attractive loan program coupled with an increase of tuition of $1,500 might be equivalent to a tuition increase of only $800; a less attractive loan program would imply a perceived tuition rise of $1,100 and so on. Under these assumptions, the introduction of better loan opportunities on the distribution of income (given a tuition rise) would result in income distribution effects somewhere between the original model and the uncompensated tuition increase of $1,500 discussed above. Since the uncompensated rise in tuition caused a negligible change in income distribution, the introduction of loans would produce results on the order of the square root of negligibility. This conclusion would need to be modified only if there were some reason to expect increased access to loans to have substantially different effects among family income groups, but evidence of such impact differences is non-existent.

PART III

Paying for Higher Education through Taxes or Loan Repayments

Previous sections have discussed the behavioral parameters on which tax or loan support depend and how they work through entry and continuation rates to educational attainment and income. In this section, the results are modified to take into account the tax or repayment burden of the method of financing higher education.

Imagine that the cohort of high school seniors described earlier in this paper is responsible for paying for its own higher education throughout its lifetime. If you like, assume that the cohort "imports" educational services while going to school and then finances "exports" to the outsiders during its working lifetime. Exports are financed through compulsory taxation or amortization of loans.

We can distinguish several differences between tax burdens and loan repayment burdens and evaluate the equitability and redistributiveness of each.

1. The Timing of Payments: Intertemporal Distribution of Income

The cohort of high school seniors are assumed to arrange themselves in states as is today's population. Ignoring in this section interpersonal comparisons of tax burdens, the first question to ask is what will be the time pattern of the cohort's exports under tax finance vs. loan finance?

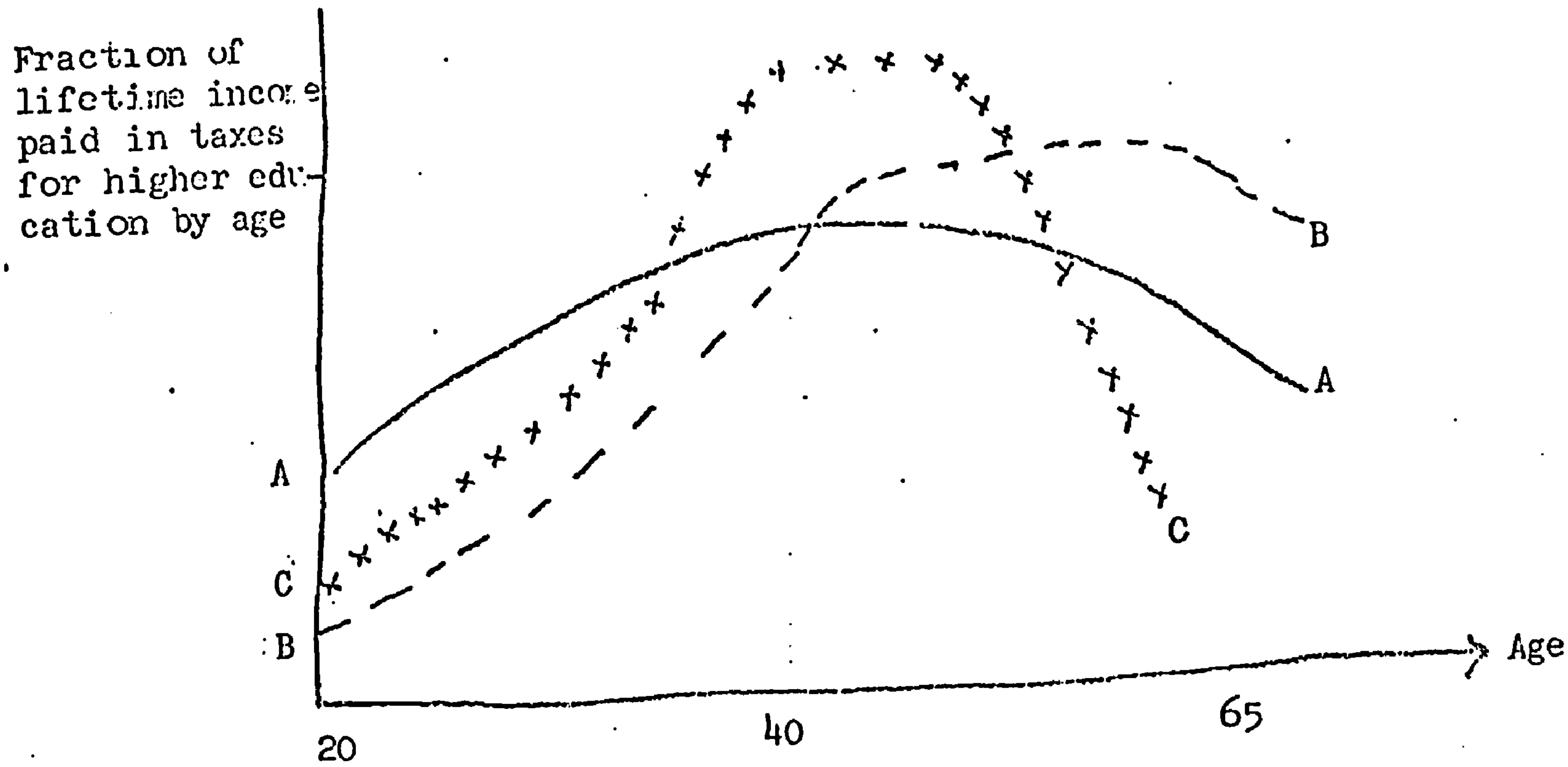
It is a characteristic of public financing of investment that if the polity agrees to it, the financial burden can be spread over the lifetime of the assets acquired. In our example, the imports of education services are paid for over the taxpaying (post-school) years. If the cohort of high school seniors had complete control of the taxation process it would schedule a pattern of tax revenues over time that minimized the welfare loss to the group, subject only to the constraint that the providers of educational services be willing to accept such a time pattern of remittances. It is more realistic, however, to imagine that some given fraction of the cohort's annual state tax payments are set aside for payment to outsiders. In that event, the optimality of the time structure of tax payments will depend on 1) the income elasticity of the state tax system (which determines the time pattern of dollar sums of tax-financed "exports"); 2) the marginal utility of income; and 3) the community rate of time preference.

We don't know enough about any of these welfare components to make any hard and fast guesses about the intertemporal goodness of tax financing. The income elasticity of most state tax systems would suggest, however, that the time pattern of tax-financed exports would be approximately the same as the temporal pattern of cohort income; i.e., the income elasticity is near unity. Moreover, some research _/

_/ Lester C. Thurow, "The Optimum Lifetime Distribution of Consumption Expenditures," American Economic Review, Vol. 59 (June 1969), p. 329.

would seem to indicate that either for marginal utility of income or time preference reasons, people would like to consume more in their younger (up to age 40-45) years, and are willing to consume less when they are of more advanced age. If these findings can be made to apply to the temporal pattern of taxes, a case can be made that tax burdens are too high in the cohort's 20s and 30s. A more income-elastic state tax system (or a pattern of ag -specific tax rates suggested by Thurow) would be preferable.

All this can be illustrated in a diagram as follows.



AA is the time pattern of actual taxes paid for higher education assuming the cohort spends a constant fraction of its state taxes on higher education and that the income elasticity of state taxes over time is unity.

BB is the optimal temporal pattern based on the observation that the cohort would like higher consumption up to age 40.

CC is the pattern of state tax payment if a constant fraction of state taxes were allocated to higher education, but the income elasticity, over time, of state taxes were greater than unity.

Turning now to loan programs, it is useful first to describe existing federal student loan program repayment features.

1) The guaranteed loan program. This program provides for repayment installments, commencing about a year after the borrower is no longer a student, over a period of "not less than five years (unless sooner repaid) nor more than ten years." —/ Moreover, the legislation

—/ Higher Education Act, Public Law 89-329 (1965), 79 Stat. 1239.

governing this program stipulates that the annual repayment of any borrower must be at least $360. As a practical matter, this means that all borrowers whose aggregate debt is less than $2,500 must pay $360,—/ and

—/ The ceiling interest rate for students on which most repayment schedules are based is 7 percent per annum. The constant annual sum repayment for a 10-year schedule is $142 per $1,000 borrowed.

will have repayment cycles of less than 10 years. Borrowers with larger debt most commonly pay the equivalent of a constant annual sum in repayment of their loan./

/ See Robert Hartman, Credit for College: Public Policy for Student Loans (New York: McGraw-Hill, 1971), p. 23.

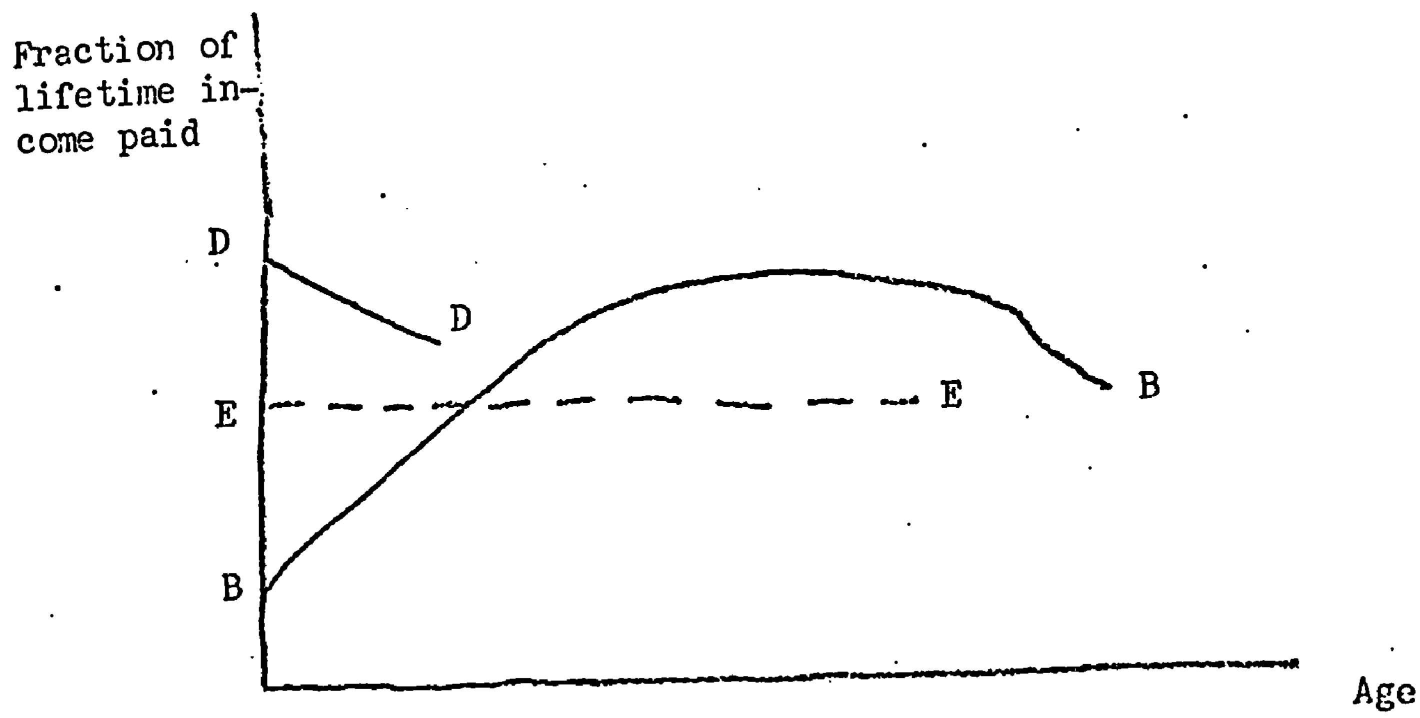
2) National Defense Loans. These are 10-year loans, with repayments commencing a little less than a year after student status is terminated. The legislation contains one of those mind-breaking clauses: "provides for repayment of the principal amount, together with interest thereon, in equal annual installments" / that allow almost any interpretation. In this case, there are administrative reasons, relating to teacher cancellation provisions of the loans / that have impelled many institutions to write repayment schedules such that a constant amount of principal is repaid each year plus the interest on the outstanding balance: the first repayment is therefore the largest. Moreover, the law governing this program also stipulates a minimum annual

/ National Defense Education Act, Public Law 85-864 (1958), 72 Stat. 1585.

/ Hartman, op. cit.

repayment of $180; implying that borrowers whose debts aggregate less than about $1,500 will have to pay the minimum.

It does not take much to see that virtually all of the repayment provisions in these loan programs run counter to our best guess as to the welfare maximizing temporal pattern of repayments. All the costs are concentrated in the youngest age bracket in both loan programs. Small borrowers, who are most likely to be dropouts, and to face the lowest lifetime incomes, are forced to accept the most concentrated repayment periods. In the National Defense Loan program, the highest repayments occur in the first years after repayment commences. In the diagram below, DD shows what the current National Defense Loan repayment pattern might look like compared to the preferred BB locus previously discussed.



Proposed loan programs usually have features designed to mitigate the worst temporal aspects of existing federal programs. First, such proposals usually provide for greatly lengthened repayment periods of 30-40 years _/ or at least 15-20 years._/_/ The effect of such term-

_/ Karl Shell, et al., op. cit.; U.S. Department of Health, Education and Welfare, Toward a Long-Range Plan for Federal Financial Support for Higher Education, A Report to the President, Office of the Assistant Secretary for Planning and Evaluation, January, 1969 (The "Rivlin Report"); Carnegie Commission on Higher Education, Quality and Equality; Revised Recommendations New Levels of Federal Responsibility for Higher Education (New York: McGraw-Hill, 1970).

_/_/ Danière, op. cit.; Nixon Administration proposal, contained in Higher Education Opportunity Act of 1971, H.R. 5191, 91 Cong. 1 sess. (1971), section 408, p. 36.

lengthening combined with constant annual payments would be to convert DD into something like EE in the diagram. Second, many of the proposed loan programs stipulate a repayment scheme in which each borrower's repayment would be proportional to his income (i.e., a fixed "tax rate" on gross income; see Shell, for example). Under such a scheme, the cohort's repayments would be very similar to the curve AA which we used to describe a typical state tax pattern. Recently, the Governor of Ohio has promulgated the "Ohio Plan," which would require that students who attend public universities pay a special tax to "repay" the state,_/ at a mildly graduated tax schedule for incomes

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/ Repayment ceases when the state subsidy is repaid without interest. Taxpayers would still be heavy subsidizers of the program.

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above $7,000. Incomes below $7,000 would be exempt./ The temporal

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/ The formula for annual repayments is 2 percent of adjusted gross income minus $100, provided that the annual payment exceeds $40. There is a maximum lifetime repayment of $2,000. This sum and the exempted $7,000 income are stated in real terms: both rise with the cost of living index.

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distribution of receipts from this tax would conform to the optimal pattern up to age 35: a large fraction of the cohort of borrowers would be exempt from any tax under that age. However, Ohio Plan payments would peak very strongly at the ages between 35-54, probably a decade sooner than Thurow's estimates suggest would be optimal.

In summary, as far as the welfare effects of temporal payment patterns are concerned:

1) Present federal loan programs almost certainly are unattractive to the student. They concentrate repayments in the earliest, lowest-income years. Any cohort of borrowers would probably reject such a payment scheme if it had a choice.

2) To the extent that the state tax system can be viewed as spreading payments over a working lifetime, more or less in keeping with

the pattern of cohort income, the major weakness (in temporal welfare) would seem to be the tax burden at ages up to 45. The more income elastic the tax system, the less would be this problem, especially in immediate post-graduate years.

3) Long-term loans, especially those based on income, would have temporal characteristics similar to a state tax system. The Ohio Plan has the merit of lessening repayment burdens in immediate post-graduate years.

2. Users vs. Non-Users

No equity issue has raised more attention than the transfer of resources through the state tax system from non-users to users of public higher education. (Note that I do not equate "users" with "gainers"; if there are public benefits to higher education, non-users will also be gainers.) A tuition increase, coupled with extending capital markets, goes a long way toward rectifying this alleged inequity. The price of correcting the inequity is, of course, the changes in social mobility described in earlier sections.

In this section, an attempt will be made to clarify the nature of the transfer from non-users to users, an issue which has been submerged in all the studies of state tax support for higher education. To illustrate the point, suppose that as of tomorrow (and forever after) all youth of college-going age entered a public college and completed a B.A. degree. Suppose that in 50 years we decided to construct a table showing the "income of all families" and lined it up against "income of families with students in public colleges and universities." By hypothesis, all families in both groups would be users (either before our computation date, during our date, or after our date). But they would differ in age. In fact, if the cross-section in 50 years were the same as the cross-section of male incomes in 1967, and if all families with students in public college are aged 45-54, the table would look like this:

	Incomes of All Families (4 Years of College, Age 25 and over) (Percent)	Incomes of Families with Students in Public Colleges (4 Years of College, Age 45-54) (Percent)
Under $6,000	16.7	11.4
$6,000 - $ 7,499	12.0	7.9
$7,500 - $10,000	20.6	17.3
Over $10,000	50.5	63.5
Median	$10,090	$12,267

It would look as if there is a substantial amount of redistribution from the poor (taxpayer) class to the rich (college-going) class, from non-users to users. In fact, there is no intergroup redistribution at all: everyone in this table is, by construction, a user of public education.

Our method of looking at one cohort through life avoids this pitfall. We can identify the fraction of total tax liabilities levied to finance public higher education under the present tax system for users and non-users for any given age group, by income classes. This distribution of tax liabilities can be interpreted as the "tax repayment" by that age group for the cost of public higher education received by its members when they went to college. (It could also represent the taxes paid by that age group for members of a younger cohort group that goes to college when the older age group is earning income. The two approaches are equivalent for a stable population with no increases in productivity.)

Estimates for age 50 of the cohort of high school seniors will be incorporated in the final version of this paper. These estimates will assume that 1/25th of total lifetime public education costs are paid by 50-year olds —/ and that the distribution by income classes

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_/ This guess is based on the further assumption that each individual in the population works 40 years and that he reaches his peak earnings around the age of 50. If earnings were constant throughout a lifetime of work, each age group would pay 1/40th of total public higher education costs. To allow for the fact that earnings reach their peak near 50, we arbitrarily assumed that the 50-year olds pay 1/25th of the costs.

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follows the average (regressive) tax incidence of state-local taxes.—/

_/ The tax burden distribution used in this illustration was taken from the estimates prepared by David Ott for a chart in the Economic Report of the President, January 1969, p. 161. The actual data underlying this chart are given in Joseph A. Pechman, "The Rich, The Poor, and the Taxes They Pay," Public Interest, Fall 1969 (Brookings Reprint 168).

When completed, the table will show the tax liability, and the fraction of total income paid, by users and non-users in each future income class.

Even this method of separating users and non-users may miss part of the intergenerational transfer. See the note by Joseph A. Pechman on this question appended to this paper.

[This section will be completed later]

3. Interpersonal Redistribution Through Taxes or Loan Repayments

There is nothing particularly unique to say about the incidence of state tax systems used to subsidize low tuition in higher education.

See discussion in Joseph A. Pechman, "The Distributional Effects of Public Higher Education in California," Journal of Human Resources, Summer 1970, and Douglas M. Windham, "The Redistributional Effects of Public Higher Education in Florida" (Monograph Series F, No. 1, Department of Economics and Business Administration, University of North Carolina at Greensboro, September 1969).

To the extent that such systems are regressive, they tend to increase the inequality of pre-tax incomes. Similarly, if state subsidies to higher education were to be reduced by the repeal of regressive taxes, the primary redistributive benefits would accrue to the poor. On the other hand, a reduction in state-subsidized tuition might be offset in any number of regressive ways, e.g.,

1) reduction of progressive corporate taxes designed to attract industry;

2) expansion of state services designed to help the middle- or upper-income classes.

There is no way of reliably predicting the uses of tax savings from a tuition increase at public universities. If Director's Law, as produced by Stigler,[1] is correct, the most likely starring role would be played by public services "for the primary benefit of the middle classes."

[1] George J. Stigler, "Director's Law of Public Income Redistribution," Journal of Law and Economics, Vol. 13 (April 1970), pp. 1-10.

Redistribution under loan financing is an almost undiscussed topic; all we have to rely on are various assertions that income-contingent loan programs would have "good" redistributive effects. Before taking a closer look at that contention, it might be useful to summarize the distributive effects of present federal programs.

Table 8 presents some relevant data on how well the principal federal loan programs accomplish the goal of providing capital market access to students from various parental income classes. The data on loan volume (second column) in 1967-68 indicate that compared to all families with college-aged children, recipients were somewhat more likely to be from the upper-half of the income distribution. In comparison to the distribution of *students*, however, the loan programs

TABLE 8. Redistribution Under Guaranteed Loan and National Defense Loan Programs 1967-68 (Percent)

Gross Income Class	All U.S. Families with College-Age Children (1969)	Dollar Volume of Guaranteed and National Defense Loans	Implicit Subsidies in Loan Programs
Under $ 3,000	10.6	13.1	13.2
3,000 - 5,999	23.0	15.0	15.1
6,000 - 7,499	13.0	11.8	11.9
7,500 - 8,999	11.7	10.8	10.9
9,000 - 11,999	16.6	19.0	19.1
12,000 - 14,999	13.1	15.3	15.4
15,000 and over	11.9	15.1	14.4

Source: Hartman, Credit for College, Tables 12 and 13, pp. 49-51.

(especially National Defense Loans) are somewhat targeted toward lower income groups. Similarly, the implicit subsidies_/ that were

_/ Implicit subsidies here mean only the dollar value of the difference between the market interest rate (taken as 6% in 1967-68) and the rate paid by students on the federal programs in that year (zero during enrollment and 3% in repayment period for both programs). Teacher cancellation subsidies are not included and this omission probably understates the subsidy to poorer income classes. On the other hand, the in school period in which no interest is paid is assumed the same for all income classes and this assumption probably understates the subsidy to the wealthier students.

provided in these programs in 1967-68 show some tendency toward being directed to the more well-off parental income groups. By 1968-69, the reduction in the interest subsidy_/ under the Guaranteed Loan

_/ Beginning in 1968-69, students were required to pay a ceiling of 7% interest during the repayment period, a level that still governs the program today.

Program, which serves a higher income clientele than National Defense Loans, shifted the pattern of subsidies toward lower-income groups, but not enough to offset the previous conclusions.

In short, when redistribution of benefits of existing loan programs is looked at by the parental income distribution, the conclusions are very similar to those reached on low state tuitions: a disproportionate share of the benefits accrue to higher income classes.

Repayments of federal loans will affect the interpersonal income distribution depending on the amounts borrowed by future income class. To determine the rate of repayment by future income class, data showing the average annual amount borrowed and the frequency of borrowing (the product of which is "debt") by future income class would be needed. To my knowledge, no such data exist. There is evidence that the average federal loan rises somewhat by parental income class,_/ and coupled with the greater education

_/ But not very much. In 1968-69, the average borrower from below-$6,000 income families borrowed about $700, while the average borrower from the $15,000 and over class borrowed about $900. See Hartman, op. cit., Appendix D.

attainment of students from higher income families, one could expect to observe higher repayment obligations in the upper end of future income cross-sections.

The repayment format under long-term income-contingent loans has been taken by some people to be self-evidently pro-poor. By their nature, income-contingent repayment loans mean that families with no income make no repayments while families with high earnings pay substantial sums. In fact, it is self-evidently true that, if a fixed repayment tax rate is applied per $1,000 borrowed, if everyone borrows the same amount, and if everyone participates, the repayment tax will be strictly proportional among users of higher education.

But, in fact, all potentially practical income-contingent loan schemes involve some provision for borrowers who realize very high incomes to "opt-out," that is, to treat their repayments as if they were based on a conventional loan. When repayments (based on income) just requite the conventional loan at the "opt-out interest rate," further repayments are excused. The opt-out provision has been written into loan proposals to insure that high income expecters participate and generate the "profits" that provide the cushion necessary for the lender to subsidize the low-income attainers whose repayments will not be sufficient to repay their loans.

The provision of a maximum interest rate introduces a regressive element into the income-contingent loan repayment pattern. To illustrate this point, consider a variable-term loan program with the following provisions. Students may borrow $1,000 if they promise to repay 1% of their annual income for up to 30 years. If, prior to 30 years, the sum of their repayments are sufficient to repay a conventional $1,000 loan at 9% interest ("opt-out" rate), their repayments will cease. If at the end of 30 years, their repayments have been insufficient to requite a 9% loan, any remaining balance is forgiven. Suppose finally, that the lending agency raises its funds at 7% interest cost; the 2 percentage point gap between the lending agency's borrowing rate and the opt-out rate finances the unpaid balances of those who reach the 30-year maximum term. (It should be noted that these parameters sufficient to repay a 9% loan. The fourth column shows the present value of repayments, calculated at a 7% discount rate,_/ in order to

_/ We use 7%, the borrowing rate of the lender, rather than 9%, the opt-out rate, for the following reason. Nine percent represents a charge that includes both a pure interest rate and an "income insurance premium." It is the excess over the borrowing rate of the lender that makes it possible to insure that borrowers whose incomes are small (or whose lives are short) will not have to pay off their loan in full. (A's "gift" of $628 is paid by the excess payments of B, C, D, and E.) In calculating present values, we are interested in the rate at which consumers convert income flows of different periods, and that rate has nothing to do with income insurance. For this reason, the appropriate consumer discount rate is less than the opt-out rate. Whether 7% or some interest rate between 7% and 9% is appropriate depends on whether the lender's borrowing rate is lower or the same as the consumer's borrowing rate over his lifetime. Seven percent implicitly assumes they are the same.

make the streams of repayments of the different students comparable. According to this column, Student A is, in fact, subsidized under the income-contingent loan program. Only 37% of his loan is paid off; the remaining $628 is a (deferred) gift or insurance benefit. Students B, C, D, and E all pay an excess amount for their loans over and above what they would pay for a conventional 7% loan. Student B's excess payment, however, is the greatest of the "taxed" students.

We can make our loan repayment data comparable to the standard tax incidence studies by computing the ratio of the present value of loan repayments to the "permanent incomes" of the five students. This is done in the fifth column of the table. It is clear from these data that the repayment scheme under an income-contingent loan program is like a proportional tax at all incomes up to that of Student B,_/ and is regressive at all higher income levels. In fact,

_/ Student B is one whose repayments just repay his loan at the opt-out rate at the end of the full contractual payment period. He is the marginal opter-out.

the resemblence between this incidence pattern and that of the Social Security tax is striking: proportionality up to a maximum wage base, and regressivity thereafter.

Yale's loan program has overcome part of the regressivity problem by, in effect, raising the maximum wage base. Under Yale's repayment program, a very low tax rate was selected: 0.4 of one percent of income per $1,000 borrowed. This low tax rate (and the lengthy, 35-year repayment period in the program) is compensated for in Yale's plan by the imposition of a very high "opt-out" interest rate._/

_/ For a discussion of profit trade-offs of tax rates, interest rates and repayment periods, see Dresch and Goldberg, op. cit.

Yale's repayment scheme requires that a borrower repay 150% of his original loan plus the accumulated opt-out interest rate on this sum. If 9% is taken as the opt-out rate,_/ the actual interest rate paid,

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_/ Yale loan contracts specify a contract interest rate that depends on Yale's cost of borrowing up to a 9% maximum.

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based on the original sum borrowed, will vary from borrower to borrower, and will be greatly in excess of 9% for many whose loans terminate before 35 years. For example, a student who borrows $1,000 and whose repayments terminate in one year would repay $1,635 ($1,500 times 1.09) in that year. The actual interest rate paid on the loan is about 63.5 percent! (Before reacting too strongly to the loan shark rate, it should be noted that such a student would have to earn $408,750 in that first year in order for his tax to automatically reach a level of $1,635.) Students whose repayments terminate in longer periods would pay progressively lower true implicit interest rates. For example, the borrower whose repayments just meet Yale's termination condition in 35 years (Student D_1, in the next table) pays an implicit interest rate of about 14%.

The effect of the positive association of opt-out interest rates and high income in the Yale Plan is illustrated in Table 10 where six illustrations of student borrowers are given. The primary effect of Yale's program is to extend the range over which the repayment scheme is proportional to a permanent annual income level of about $35,000._/ After that, it is regressive.

TABLE 10. Illustrative Annual Repayments for Student Loans Under the Yale Plan and Under a 25-Year Conventional Loan

	Permanent Income (1)	Annual Payment (2)	Years to Pay (3)	Present Value of Repayments (4)	(4) ÷ (1) (Percent) (5)
		Yale Plan			
Student A	$ 3,000	$ 12.00	35	$ 155	5.2
Student B	9,734	38.94	35	504	5.2
Student C	15,583	62.33	35	807	5.2
Student D_1	35,488	141.95	35	1,838	5.2
Student D_2	58,433	233.73	10	1,642	2.8
Student E_1	408,750	1,635.00	1	1,528	0.4
		Conventional 25-Year, 7% Loan			
Student A	$ 3,000	$85.81	25	$1,000	33.3
Student B	9,734	85.81	25	1,000	10.3
Student C	15,583	85.81	25	1,000	6.4
Student D_1	35,488	85.81	25	1,000	2.8
Student D_2	58,433	85.81	25	1,000	1.7

_/ The reader should note that the parameters of loan plans in this part were based on projections of student incomes including inflation and real growth. Thus, $35,000 permanent income is not as high as it looks. For example, if prices and real growth equal 4% per annum, $35,000 in income 17 years from today is equal to about $17,500 today.

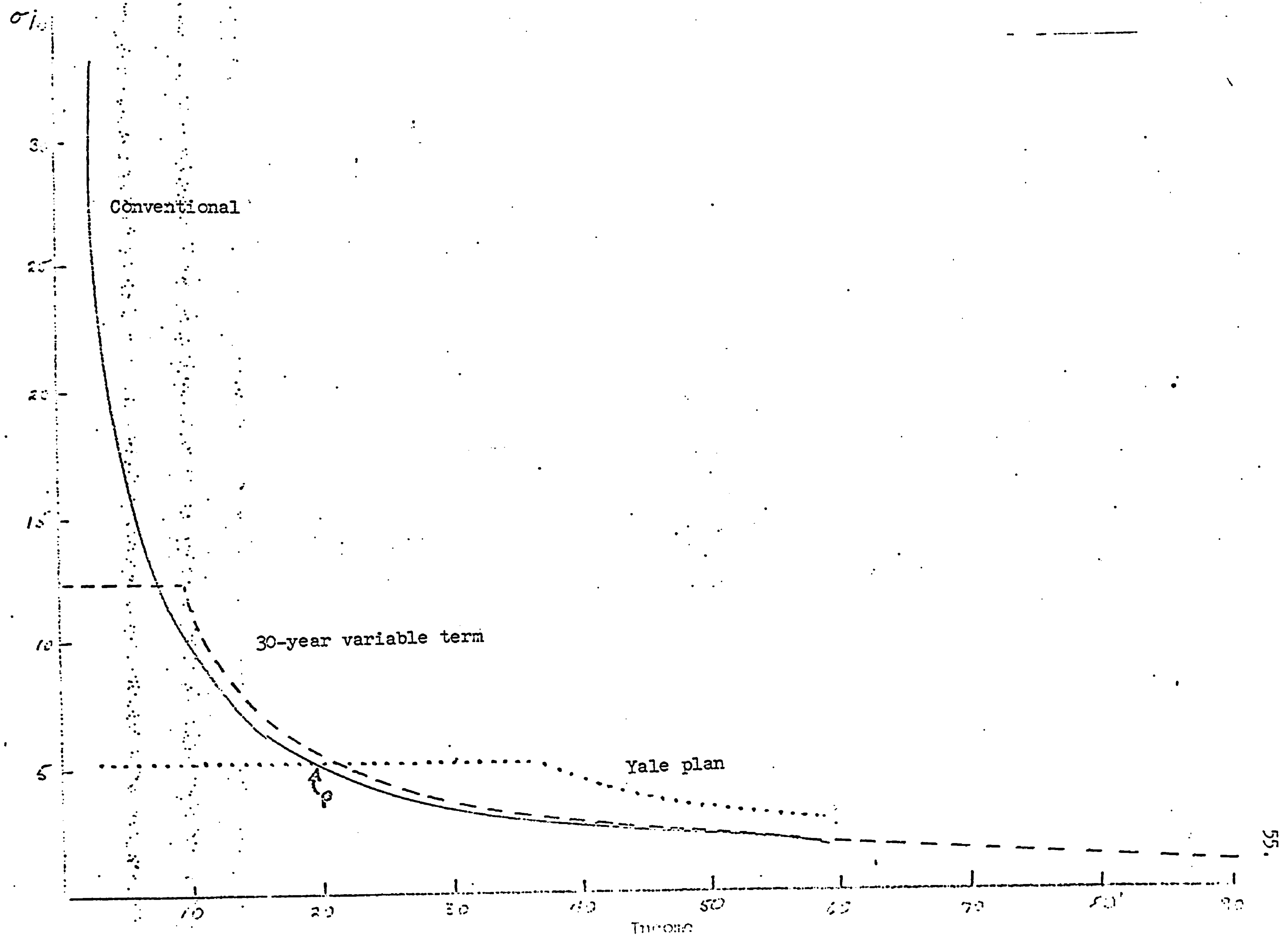
The redistributional "goodness" of Yale's program in contrast to the variable term loan and to a conventional 25-year loan at 7% interest can best be seen in Figure A. Here, I have plotted the ratio of the Present Value of Repayments discounted at 7% to Permanent Income for each loan program._/

_/ The Yale Plan was based on income projections different from those used in the variable term loan case. Thus, part of the reason that the "Yale Plan" curve is low is that the repayment profiles were richer than in the variable term program described above. A "Yale Plan" -- low tax rate, high opt-out, long term applied to a lower income cohort would have a similar shape to the curve in Figure A, but it would be displaced upward by a few percentage points.

The figure makes clear that a conventional long-term loan is the most regressive repayment plan and is probably more regressive than existing state-local tax structures as well. The mildly

Figure A

Repayment Incidence of 30-Year Variable Term, Conventional 25-Year 7%, and Yale Plan Loans



redistributive variable-term loan is less regressive (proportional) at low incomes, but is regressive over the broad range of incomes that college graduates are likely to find themselves in in future years. This loan program imposes a fairly minor penalty on higher income persons relative to what they would pay under a conventional loan and therefore it is likely to attract a broad spectrum of students: it is a feasible program, with mildly favorable repayment incidence at low incomes. Yale's plan is far and away the least regressive program of those so far delineated. Both in terms of minimizing burdens on the future poor and on socking it to the future rich, the Yale plan looks least bad. In contrast to a typical incidence pattern for state-local taxes, the Yale Plan favors both low and very high incomes and imposes higher burdens on a broad spectrum of "middle incomes."

The unfortunate thing about Yale's program is that Yale is not the government and cannot compel participation. A prospective borrower at Yale must ask whether participation in Yale's plan is superior to alternative methods of finance that are open to him. Although there are not now available 7%, 25-year loans for students, we shall use that as an alternative simply because it is a likely option open to most Yale parents (e.g., refinancing a mortgage). A Yale parent counseling his child could, in effect, reason as follows from the last chart: "If our best guess as to the future income (in future dollars!) of the Yale student amounts to over about $20,000,_/ we would be better off refinancing our mortgage,

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_/ $20,000 annual income seventeen years from now is equivalent to about $10,000 today.

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unless we place very heavy negative values on the possible shortfall of income below that level, compared to the possible earnings above that level." In short, the only students who are likely to participate in Yale's program are --

a) those who confidently expect low incomes;
b) those with average expectations but strong aversion to risk;
c) those with no alternatives or decidedly inferior ones._/

_/ In addition, of course, some people will be willing to pay for the more convenient time pattern of repayments that would exist under income-contingent programs. Our discussion implicitly assumes that that effect would be overwhelmed by the repayment comparisons discussed here.

The Yale Plan is hardly likely to attract really wealthy students, and if a program with these characteristics were introduced in place of low-tuition policies at state institutions, the same non-participation of the rich could be expected. From a redistributive point of view, the major significance of this result is that whatever state taxes are collected now from the rich would be lost as far as the support of others in higher education is concerned._/

_/ For an estimate that these taxes are not insignificant, see Pechman's review article in Journal of Human Resources (Summer 1970).

There are two obvious ways to keep the rich in the program, contributing some substantial sum to the education costs of future low-income students.

First, it is possible to conceive of a repayment format that would essentially follow the incidence pattern of Yale up to point P in Figure A and follow the conventional loan repayment schedule thereafter. Under these circumstances, no one would be worse off under the income-contingent loan program than under a conventional loan and all would presumably sign up for the plan. The implication of this repayment schedule is that somebody has to be willing to subsidize it for the insufficient payments of the low-earners are not in this case made up for by a tax on the well-to-do borrowers. If public funds are to be used for the purpose, the policy question is:

> Is the subsidy better used here to improve the redistributiveness of the repayment plan or would it be better used in the first place to keep tuitions low?

From an equity point of view, the answer to that question depends on the responsiveness of students to the higher tuition charge versus the responsiveness to the generous subsidization of those who earn low incomes.

The second avenue of improvement in the equitability of repayment schemes is to get voluntarism out of the picture altogether and compel high-income users of public higher education to contribute toward the education of their low-earning colleagues. This would be the result of the Ohio Plan as we understand it. All students who use public higher education would be required to pay a tax on all incomes above $7,000. The exemption of below-$7,000 income is certainly a progressive feature of the program. The Ohio Plan would be more progressive than the Yale Plan at all income levels. It would, in addition, be more progressive than any existing state tax system now extant. The only drawback to the Ohio Plan is on the benefits side: will the rate of social mobility be significantly lessened by the repayment requirement? We take note here of the companion bill introduced by Governor Gilligan that would supply grants to low (parental) income students along with the new Ohio Plan tax. On pure equity grounds it would be hard to beat this proposal. If we were to imagine a four-cell matrix based on low-high parental income and low-high future income, the Ohio Plan would aid all students in any "low" cell. The only omitted cell would be high parental-high future income. Perhaps that is why the proposal was greeted by the executive director of the American Association of State Colleges and Universities with the statement that the Ohio Plan would be "a reversal of what public higher education has stood for for more than 100 years."/

/ *Chronicle of Higher Education*, Vol. 5 (March 29, 1971), p. 1.

Final Comments

The principal conclusions reached in this paper are:

1. Under seemingly plausible assumptions as to the responsiveness of students to a substantial rise in state-institution tuition levels, there is a significant reduction in educational attainment of children from under-$6,000 families and some reduction in social mobility.

2. Greater access to loan programs could be expected to modify this result, but it would probably not offset it.

3. The distribution of pre-tax income, in any global sense, would not be overwhelmingly changed by a shift from low-tuition to loan financing.

4. Present federal loan programs are almost certainly inferior to state tax-finance in the temporal allocation of burdens of paying for higher education.

5. State-supported low tuitions transfer resources from non-users to users. When measured in a consistent manner, however, this transfer is smaller than previous studies would have led one to believe. [To be verified.]

6. State-tax systems are regressive. Conventional loan repayments are even more regressive. Variable term loans, with small internal redistributions, are superior to state-tax systems on equity grounds, especially at low incomes. At high incomes they may be worse than state-tax systems. The Yale Plan would be a superior money-raiser on equity grounds if one could feel confident that high earners would participate. I can't feel confident.

Many readers must have long since wondered why low tuitions supported through state taxes have been compared only to loan substitutes. Specifically, one might ask whether there is any reason, in the economics of the case, why the replacement of low-tuition by (parental) income-conditioned grants would not be a superior policy for financing higher education. It is true that, if tuitions were increased substantially and if revenues were used to restore, say, all students from below-median incomes to their former net price position, there would be (a) no loss in mobility and (b) state tax money left over, useable for even larger grants to the poor. The defense for ignoring this alternative is that the likelihood of its enactment is very small. If the federal government is any test of legislators' sentiments, the prospects for broad-scale grant programs are slim, despite the urging of some excellent high-level commissions and Task Forces._/

_/ Carnegie Commission, Quality and Equality..., op. cit.; Toward a Long-Range Plan..., op. cit.; "Report on Higher Education to the Secretary of Health, Education, and Welfare by a Task Force.

That loans are more popular than grants in Congress should be evident from Table 11, which contrasts administration proposals and enacted levels of the federal Educational Opportunity Grant program versus the National Defense Loan program in the last few years. Perhaps the states can do better._/

_/ There is some evidence that state-supported student grant programs are growing. In The Capitol and the Campus: State Responsibility for Postsecondary Education (New York; McGraw-Hill, 1971), the Carnegie Commission reports almost $200 million expended by states in 1969-70 for "comprehensive undergraduate grant programs." Many of these programs, however, base entitlements on scholastic ability or achievement rather than need. See Edward F. Denison, "An Aspect of Inequality of Opportunity," Journal of Political Economy, Vol. 78, No. 5 (September/October 1970), pp. 1195-1202, for the equity effects of such a basis.

TABLE 11. Obligational Authority for Educational Opportunity Grants and National Defense Loans, Fiscal Years 1970-72
(Millions of dollars)

	Educational Opportunity Grants		National Defense Loans	
	Proposed	Enacted	Proposed	Enacted
FY 1970	$175.6	$164.6	$181.8	$194.2 - 229.0 a/
FY 1971	185.6	167.7	141.9	243.0
FY 1972	317.0 c/	165.3 b/	5.0 c/	293.0 b/

Sources: The Budget of the United States Government, Appendix, Fiscal Year 1972, p. 447, Fiscal Year 1971, p. 426; Chronicle of Higher Education, vol. 5, No. 33 (May 24, 1971), p. 2; U.S. House of Representatives, Committee on Appropriations, Office of Education and Related Agencies Appropriation Bill, 1972, Report No. 92, 92 Cong. 1 sess., p. 7.

a/ In FY 1970, Congress voted $229.0 million for National Defense Loans, but HEW was instructed to cut 2% from the total Office of Education budget. They cut National Defense Loans to $194.2 million.

b/ House action; Senate is pending.

c/ For FY 1972, the President proposed combining the grant program with the work-study program. Using past ratios of grants to work-study and making some adjustments to correct the President's proposal to a comparable fiscal year basis, the implicit request for grants was $317 million. At the same time, the President proposed phasing out NDEA loan direct capital contributions and its replacement by an interest-subsidy program. $5 million is the request for direct capital contributions only; it does not reflect the loan volume of the interest-subsidy replacement.

APPENDIX

Note on the Intergenerational Transfer of the Benefits of Public Higher Education

by

Joseph A. Pechman

The traditional way of looking at the burdens and benefits of higher education is to distribute the net benefits received by students by the income classes of parents (i.e., taxpayers). But this sweeps the problem created by the intergenerational nature of the benefit transfer under the rug. One way of keeping track of the burdens and benefits would be to distinguish between those who benefitted from public higher education as parents and those who benefit as children. The matrix of possibilities is as follows:

	Parents	
Children	Users	Nonusers
Users	A	C
Nonusers	B	D

Obviously, Group A receives the maximum benefit from public higher education and Group D receives no benefit at all; Groups B and C, which have either a parent or a child, but not both, going to a public college, fall somewhere in between. To distribute the burdens of two generation's worth of benefits shown in the matrix, it would presumably be necessary to discount taxes to some fixed point in time; and the same applies to benefits. I do not find this way of looking at the problem very helpful, but those who wish to think in these terms should at least disaggregate their results into the four groups shown above, as well as by income classes within these groups, and then somehow try to compare the relative net benefits and burdens among all of the income-user class groups.

It seems to me that a more useful way of looking at the problem is to acknowledge that the benefits of public higher education are received by one generation while the costs are paid by another, and that there is no way of merging benefits and costs in one distribution to evaluate the equity of the system. The benefits are received by the students who attend college (although their parents may also feel better knowing that their children are being educated). The costs are shared by the parents who pay for most of the out-of-pocket costs (tuition, room and board), the taxpayer who pays for the subsidy to public higher education, and the student who bears the cost of foregone earnings. Let us omit foregone earnings for the moment. The remainder of the costs are borne by a generation of people (either parents or taxpayers) who are, in effect, making a gift to those who are going to a public college or university. Of course, there is an understanding that each generation of earners will pay for the higher education of the succeeding generation. But there is no practical way of obtaining a distribution of net benefits (or net burdens) by income classes, since the persons who receive the benefits are not the same persons who pay the costs._/

_/ This problem is exactly analogous to the problem of estimating the net benefits of the social security system. The benefits are received by the aged, while the costs of the system are paid by those who are earners. See Joseph A. Pechman, Henry J. Aaron, Michael K. Taussig, Social Security: Perspectives for Reform (Brookings Institution, 1968), pp. 180-81. In this study, distribution by income classes of the burdens and the benefits of social security are shown separately for the earners and the aged, respectively, and no attempt is made to net out one against the other.

On this reasoning, the "fairness" of the method used to pay public higher education cannot be judged by comparing the taxes and tuition paid by parents with the benefits received by college students. If society decides that higher education should be a public activity, the costs of that activity should be allocated in accordance with the tax system it judges to be best or fairest. If that tax system happens to be regressive, the fault is not that students (or their parents) are paying too little for their education. Society always has the option to improve its tax system to pay for public services of all sorts, including higher education.

Whatever the verdict on the tax side, there is a real question whether the benefit side of the system is equitable. If it is observed, as is the case, that children from low income families either do not go to college or go to inferior schools, the system of distributing the benefits of public higher education is clearly inequitable. There is no reason why individuals who happen to be born into poor families should receive less from this public service than children who are born into middle- and high-income families. To correct this inequity, it is necessary to change enrollment practices and other discriminatory techniques now used against those who come from poor families/ so that they will have the

/ Not the least of these needed changes is a method of compensating for the deficient education given to these individuals in these individuals in the nation's elementary and secondary schools.

same opportunity to go to college as those coming from higher income families.

Given the fact that pre-college education is unequal, the equalization of educational opportunity at the college level would involve a number of steps. First, it would be necessary to invest heavily in compensatory education for those with deficient elementary and secondary education. Such education is now provided in a few schools, but it is clearly inadequate both as to numbers, quality, and scope. To overcome the educational handicap of poor children of college age in this country would require a staggering investment in compensatory education as compared with present programs. Second, youngsters from poor families cannot rely on their families to pay <u>any</u> out-of-pocket expenses and, in any case, they should not work much, given their academic preparation. They should be given grants that would be sufficient to pay these costs as well as instructional costs. Third, the earnings foregone by poor students may be a real burden for their families. To offset this cost, it might be necessary to supplement the incomes of the poor families to alleviate this burden. Finally, since not all children will be able, or will wish, to go to college, it would be inequitable to confine the education subsidy to those among the 18-year olds who choose college. The only way to handle this problem is to establish a one-time grant or drawing account for all individuals reaching the age of 18, to be used only for educational purposes. Those who go to college will apply their grant to college costs; the others would be allowed to use these grants for vocational or other types of training any time after 18 year of age.[/]

[/] This is a proposal by James Tobin. See his "Raising the Incomes of the Poor," Agenda for the Nation, Kermit Gordon, editor (Brookings Institution, 1968).

So far, nothing has been said about tuition charges. (It is assumed that, whatever the tuition policy, students from poor families will be given grants that would be sufficient to pay tuition as well as other costs.) Whether or not tuition should be charged and, if so, how much of total instructional costs should such charges cover depend on the degree to which higher education generates public benefits (in the Samuelson sense). Ideally, foregone earnings, plus tuition, plus out-of-pocket costs should pay for the private benefits of higher education and the remainder should be paid out of taxes. Estimates of the total higher education costs privately paid differ, but they are clearly well in excess of 50 percent if foregone earnings are counted as a cost. Those who would charge full cost tuition assume that higher education generates only private benefits; those who argue for free tuition assume that other costs (foregone earnings and out-of-pocket costs) are roughly proportional to private benefits. There is clearly no way to settle this issue empirically. My own view is that the public benefits of higher education are significant and that a policy of full-cost tuition would grossly distort the allocation of costs between taxpayers, on the one hand, and students (and their families) on the other.

There remains the question of public versus private higher education. Many (but not all) of the private colleges in this country provide the same type of education as is provided in the public colleges. Thus, the two types of schools probably generate the same types of benefits, both public and private, and in roughly the same proportions. A good case can be made, therefore, for subsidizing private as well as public higher education. Private institutions already receive a major subsidy in the form of their own income tax exemption and the deduction and exemption of charitable gifts and bequests to colleges and universities under the income and estate taxes, respectively. (The same tax benefits are available to public institutions, but they are not as important for them as they are for the private institutions.) Part of the difference in costs between public and private institutions is due to the relatively more expensive type of education provided by the private institutions (smaller classes, better facilities, etc.). It is doubtful that this difference should be subsidized by the public. But for the "non-quality" related costs, if anyone could measure them, some move toward parity of treatment of public and private institutions of higher learning is warranted.

Robert Hartman

STATE TUITION POLICY AND STUDENT LOANS: AN EXPLORATION IN THEIR EFFECTS ON EDUCATIONAL ATTAINMENT, MOBILITY, AND THE DISTRIBUTION OF INCOME

Addendum

The simulation reported in the text of the paper (pp. 22-26) assumed that 20 percent of the gross reduction in entrants to public institutions in each income class "reentered" the higher education system in private institutions. Perhaps a more plausible assumption would be that the percentage of discouraged public institution entrants who reenter private institutions would be positively correlated with family income. A test of this alternative was performed, by assuming that 5 percent of the discouraged public institution entrants would enter private schools in the lowest family income category, 10 percent in the second lowest category, 15 percent in the next, and 20 percent for all family income classes above $6,000.

Table entries comparable to Table 6 (p. 23) and Table 7 (p. 25) are given below. Table 6A indicates that the college completion rates in the lowest 3 income classes are quite sensitive to the reentry assumptions. Completion of 4 or more years drops by 52, 44 and 30 percent, compared to Table 6's 38, 36, 27 percent declines for the three lowest family income groups, respectively. College completion for the entire cohort is barely affected since there were so few completers to begin with in the low family income groups.

All of the summary income measures on Table 7A are very little changed by the stepped reentry assumption. The gini coefficient for the entire cohort changes only in the third decimal place, and the quartile proportions change by no more than .3 of one percent. The mobility - proportion earning $15,000 at age 50 - measures show an increased tendency to spread out under the new assumptions. The relative reduction in the chance to earn $15,000 between the two extreme family income classes rises from a little over 2:1 to almost 3:1, but the percentage point gap between extreme income classes is still about the same as it was before the assumed tuition rise.

TABLE 6A. Changes in Educational Attainment of Cohort Resulting from Tuition Increase of $1,500[a]

	Original family income class							
	Under $3,000	$3,000-3,999	$4,000-5,999	$6,000-7,499	$7,500-9,999	$10,000-14,999	$15,000 and over	To[illegible]
Final number	481	554	2,351	2,153	3,668	5,072	2,754	17,[illegible]
Final percentage	4%	8%	12%	14%	18%	26%	13%	1[illegible]
Percentage change	-52	-44	-30	-23	-21	-16	-12	-[illegible]

a/ Assuming stepped reentry described in text.

TABLE 7A. Changes in Income Distribution and Mobility of Cohort Resulting from Tuition Increase of $1,500[a]

	Original Family Income Class							
	Under $3,000	$3,000-3,999	$4,000-5,999	$6,000-7,499	$7,500-9,999	$10,000-14,999	$15,000 and over	Tot
Mean income at age 50	8,728	8,963	9,329	9,511	9,800	10,229	11,199	9,64
Gini	.299	.306	.311	.314	.318	.324	.328	.31
Proportions:								
Over $15,000	8.3(-17)	9.6(-19)	11.5(-14)	12.6(-11)	14.1(-10)	16.7(-8)	22.3(-6)	13.4(
25,000	2.3(-15)	2.6(-17)	3.0(-13)	3.3(-10)	3.6(-10)	4.3(-8)	5.7(-7)	3.5(
In 1st quarter	28.3	27.5	25.9	25.3	24.4	23.1	20.1	25
2nd quarter	28.1	27.2	26.2	25.5	24.5	23.0	19.1	25
3rd quarter	24.9	24.9	25.1	25.1	25.1	24.9	24.6	25
4th quarter	18.8	20.4	22.8	24.1	26.1	29.0	35.5	25

[a] Assuming stepped reentry described in text.

The Role of Ability and Schooling in Determining the Lifetime Earnings Profile

by John C. Hause
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"Ability: the natural equipment to accomplish some small part of the meaner ambitions distinguishing able men from dead ones." Ambrose Bierce

I. Introduction

The roles of ability, schooling, and their interaction in determining earnings are currently not well understood. For empirical economic study, even Bierce's sweeping definition of ability is unsatisfactory. Whether we are concerned with highly specific ability (e.g., the highly esteemed, but rare capacity to extract all rent in salary and consulting negotiations) or with general ability (e.g., IQ), measured ability is the product of genetic, environmental, and experience factors that are difficult to measure, much less disentangle. For many important problems, it is probably unnecessary to decompose ability into its components as the following model illustrates. Suppose that the prospective earnings of an individual can be expressed as a function of measured ability at time t_o, a set of other personal characteristics at t_o, additional schooling (or some other investment to increase future earnings), and time for $t \geq t_o$:

(1) $$E(t) = f(A_o, P_o, S, t).$$

A_o and P_o specify the initial state of the person at t_o. Although P_o and A_o may include simple, easily measured elements (such as race or sex) as well as complicated functionals of factors operating before t_o, it may be that A_0 and P_o adequately summarize the initial state for analyzing how S affects the earnings profile E(t). If this condition is satisfied, then it is feasible to carry out a value added analysis of the schooling investment S. This "aggregation by initial conditions" is common in economics. In studying the returns from additional investment in physical capital, theoretical and empirical work invariably assumes that an arbitrary initial state can be summarized by the initial stock of capital, and does not require full information on the previous investment stream that determines this stock. In the case of investments in humans, it is less clear precisely what information should be included in A_o and P_o, and the experimentation with certain "socio-economic" variables is one way of partially answering this question.[1]

This study takes a slightly less agnostic view about the role that ability plays in determining the earnings stream E(t). The measure of A_o is a test score (or set of test scores) about which loose hypotheses can readily be developed on how A_o is related to E(t) for additional schooling after t_o (including S = 0). The main interest in these hypotheses stems largely from our ignorance of <u>how</u> schooling affects the earnings stream. If we reason that many people regard schooling as an important way of increasing their prospective earnings, we expect to find (and observe) a significant tendency for earnings to rise with the level of schooling attainment. This discovery throws little light on the "technology" by which schooling augments subsequent earnings. The analysis of the role of ability gives some insights into this black box.

The next section discusses some hypotheses on the roles of ability and schooling, as they affect earnings. The third considers several cohorts of individuals for which data are available on ability, achievement, other personal and background characteristics, and earnings, and tests some of these hypotheses.

II. Some Hypotheses on Ability, Schooling, the Earnings Profile, and Lifetime Earnings

"Ability" is usually defined as the power to do something. Many of the tests designed to measure ability have been developed in an educational context in which the relevant power is the capacity to learn and to master cognitive tools. Learning through formal schooling and learning those things that increase a person's economic productivity are not identical, although one would expect an empirically significant positive correlation between these two capacities. Beyond this plausibility argument suggesting a positive relationship between earnings and measured ability, there are several well-documented empirical relationships that also lead one to expect a positive association. An empirically significant positive relationship exists both between level of schooling attainment and earnings after people have been working for a few years (e.g., Tables 1, 7, 9) and between measured ability and level of schooling attainment (e.g. Tables 1, 5, 7, 9). Our knowledge of the technological relationship between schooling and earnings is meager, but this lack hasn't impeded sweeping conjectures. Several output components of schooling which may affect earnings have been suggested (or asserted). A casual catalog includes (1) specific skills to perform well-defined tasks, (2) general cognitive skills that enable people to locate and handle information more efficiently, (3) "social skills" that increase the capacity to deal with (or manipulate) others, (4) development of greater rational foresight and self-discipline, and (5) conditioning to certain attitudes (e.g., obeying orders, punctuality) and to routine tasks that increase personal productivity in modern economic organizations. From this list it seems likely that measured ability is primarily associated with general cognitive skills and with the capacity to acquire some of the more complex specific mental skills. Since these skills (and skill levels) depend upon both schooling and measured ability, one expects a positive interaction of schooling and ability on earnings unless these skills do not affect earnings.[1a]

To mv knowledge, neither learning theory nor economic theory have been developed to a point where a powerful theory of the earnings profile can emerge. Even so, interpreting ability broadly as "learning power" immediately suggests several simple hypotheses. Consider the earnings profiles of a cohort of people with the same schooling attainment. If people with greater ability learn the same job skills as others, but more quickly, their earnings profiles will rise more rapidly than those with less ability as long as their economic productivity is increasing more rapidly. If full job competence is attainable by people of lower and higher ability, the influence of ability disappears after a period long enough to allow those with less ability to attain full productivity. On the other hand, differential ability may limit the complexity of skills that people are able to master. In this case, an ability effect on earnings can persist over time as long as more complex skills yield higher earnings. If one considers different schooling levels, it seems plausible that persistent ability differentials in earnings should become more important at higher levels of schooling. At the lowest levels of schooling attainment, jobs consist largely of well-defined tasks in which output is easily measured and which do not require great cognitive ability. At high levels of education, more jobs have no obvious upper limit, in terms of the degree of skill that is economically productive. The efficiency with which people can find and assemble economically relevant information depends significantly on cognitive capacity and skills. There is no reason why the marginal returns to such skills should become negligible in many "high level" jobs.

Turning next to the relative slope of the logarithm of the earnings profile of high and low ability people, a priori arguments do not carry one far. Initial earnings of people first entering the labor force could have a positive, zero, or negative simple correlation with ability. A positive correlation could indicate that those with higher ability are immediately more productive and that employers can observe this fact at the time of hiring. In this case, there is no guarantee that the percentage rate at which high ability people acquire specific job skills exceeds the rate for less skilled people. A low positive or zero simple correlation between initial earnings and ability could reflect imprecise information by employers about the current and future productivity of new members of the labor force at the time they are hired. The reassessment of employee productivity gained through experience and the higher speed with which the more able workers acquire specific job skills should combine in this case so that the percentage rate of increase in earnings is higher for those with more ability (at least initially). A negative simple correlation between initial earnings and ability could arise if ability is a strong complement of on-the-job training which may be paid for by reduced initial earnings. In this case, at some point in time the relative earnings of high ability people would have to rise more rapidly than those of less able people to make worthwhile the greater investment financed by reduced initial earnings.

In addition to determining the relationship between earnings, schooling, and ability at different points on the earnings profile, it is also useful to consider how these factors are related to lifetime (discounted) earnings. Even if people have identical ability and schooling, the growth of individual productivity over time may differ between jobs. In the absence of nonpecuniary occupational tastes, there would be a tendency for entry rates to different occupations to be governed by the condition that they lead to the same (net) present value of earnings. Thus significant dispersion of earnings at different points along the earnings profile is in principle compatible with relatively little dispersion in the net present values. Since people presumably take into account prospective profiles of earnings over time and not merely the earnings for a single year when they make decisions about schooling and occupation, the attempt to establish statistically the determinants of the present value of earnings (or closely related functions of the earnings profile) plays an important part for understanding these decisions. The preceding remarks on ability and how it may affect the earnings profile also imply that there is likely to be a positive correlation between ability and discounted earnings.

We consider next the relationship between ability and discounted earnings for different levels of schooling. A number of expository and statistical models express earnings (usually for a single year after earnings profiles have flattened out) as a linear function of schooling, ability, and an uncorrelated random variable:

(2) $$Y = \beta_0 + \beta_1 S + \beta_2 A + u.$$

(See, e.g., W. Lee Hansen, Burton A. Weisbrod, and William Scanlon or Orley Ashenfelter and Joseph D. Mooney.) This relationship does not seem plausible. It implies that schooling and ability are perfect substitutes in determining earnings (because of the linear form). More important, it implies that the marginal product of additional schooling is independent of ability (because of separability). The latter assumption is implausible because of two well-known facts. First, there is the systematic tendency for higher ability people (measured by IQ or other tests) to acquire more schooling than others. Second, the opportunity cost of foregone earnings is a large part (more than half) of the cost of obtaining higher levels of schooling for most people (e.g., see Theodore W. Schultz). Equation (2) implies that the opportunity cost of acquiring additional schooling is greater for more able people, yet this schooling yields the same increment to earnings to people independently of ability. Thus the economic incentive to acquire additional schooling implied by this model is greater for those with less ability, and their expected rate of return would be higher.

An alternative specification that captures the opportunity cost of acquiring schooling in a more plausible way replaces the level of earnings Y by log (Y) in equation (2). In this formulation, the level of earnings for people with different ability increases equiproportionally with schooling. Even this specification provides no economic rationale for the strong tendency for people with greater ability to acquire more formal education. Tables 1, 5, 7, and 9 all demonstrate the strength of this tendency of higher ability people to acquire more schooling in the samples that are analyzed in Part III of this study.

A simple model in which education is acquired solely to increase earnings, and in which perfect foresight and a perfect capital market for funds to support schooling are assumed implies an equilibrium when the flows of different ability people to different terminal levels of schooling leads to relative wages such that net present values of earnings are the same for people with the same ability but different schooling attainment. In such a world, within schooling class regressions of the logarithm of earnings on ability would result in the coefficient of ability being roughly the same for different schooling levels. However, the very imperfect market for educational loans (and perhaps uncertainty) might well result in the coefficients of ability rising with education. The hypotheses of this section are examined empirically in Part III.

III. Empirical Tests of Ability and Schooling Hypotheses

Four samples of cohort data are examined to study the ability-schooling earnings relationship and are described in detail in the appendix. The samples differ substantially in size, populations from which they are drawn, and supplementary variables. The small sample of Rogers has been studied more thoroughly than the others. The main results obtained from it are reported in subsection A. Parallel calculations with the other samples to confirm, qualify, and/or extend these results are then discussed. A brief final summary is given in section E.

A. Results from Rogers' Data

The calculations from the important sample obtained by Daniel C. Rogers are based on 343 white males, primarily from Connecticut who were eighth graders in 1935 when tested for IQ. Table 1 shows the means of the logarithm of earnings at five year intervals from 1950 through 1965, ability, and background variables (and standard deviations of non-dichotomous variables) by level of schooling. The five schooling levels are: E_1 high school nongraduates; E_2 high school graduates; E_3 college nongraduates; E_4 college graduates with one degree (and perhaps additional study); and E_5 graduate degree holders. The intervention of World War II for this cohort may make the E_3 group atypically heterogeneous. E_3 includes men who started college shortly before the war, entered the military, and didn't return to college. It also includes those college dropouts who initially entered college after completing military service, attracted in part by the relatively low out-of-pocket costs of college attendance due to GI Bill subsidies.

Table 1 - Means and Standard Deviations* of Log Earnings, IQ, and Background Variables by Education Level (Rogers)

Education Level	Sample Size N	LE65	LE60	LE55	LE50	LDE4%	IQ	SCH	SCL	RC	RJ	PS	NM
E_1	60	8.857 (.326)	8.708 (.281)	8.664 (.279)	8.569 (.335)	11.836 (.221)	95.9 (11.8)	.033	.917	.750	-	.033	.050
E_2	117	9.001 (.392)	8.764 (.336)	8.662 (.320)	8.550 (.338)	11.872 (.324)	102.3 (11.1)	.034	.829	.650	.017	.094	.077
E_3	51	9.262 (.557)	9.057 (.439)	8.900 (.428)	8.668 (.478)	12.070 (.429)	107.8 (9.59)	.196	.529	.431	.039	.235	.039
E_4	68	9.456 (.539)	9.253 (.479)	9.008 (.432)	8.689 (.535)	12.211 (.519)	115.8 (11.00)	.412	.427	.325	.059	.470	.059
E_5	47	9.640 (.574)	9.414 (.607)	9.061 (.502)	8.525 (.624)	12.262 (.445)	117.3 (10.0)	.446	.319	.298	.170	.383	.042

*Numbers in parentheses are standard deviations. Source: Data tape of D.C. Rogers.

The motivations leading men to enter college but not graduate are diverse in any period, and they are probably unusually mixed in this sample. One should therefore interpret with caution the results for this subgroup.

The background variables used in this analysis of Rogers' data are subpopulation dummy variables for social class (SCH=1 for the highest two social classes [out of five], SCL=1 for the lowest two), religion (RC=1 for Catholic background, RJ=1 for Jewish background), private school attendance (PS=1 for precollege private schooling), and marital status (NM=1 if not married in 1965). No attempt will be made in this paper to rationalize the precise role played by these variables in the earnings function. None of them were highly correlated with measured ability (IQ). They help to prevent exaggerating the role of ability in the regressions and help to eliminate some sources of differential earnings that make difficult the estimation of an ability effect from the small samples that are available.

In Table 1 the earnings means all increase with schooling except in 1950 when the E_5 group has very little post-school job experience and several trivial reversals in other classes. The standard deviations of the log of earnings are substantially lower for E_1 and E_2 levels, which suggests in principle that weighted regression should be used if all schooling classes are pooled in one regression. The table shows the positive association of IQ and schooling attainment, a relationship that suggests the possibility that schooling and IQ have a positive interaction on earnings, a hypothesis proposed in section II. Marital status is not systematically related to schooling attainment, but is included in the empirical work because of the strong tendency for unmarried men to have substantially lower earnings than married males. The entire set of background variables is frequently used in regressions in this paper based on Rogers' data and is denoted by X* in the following discussion and tables.

The size of the schooling subgroups in this sample are unpleasantly small, which leads to large standard errors in many of the parameter estimates. Even so, there are some suggestive patterns that broadly conform to some of the hypotheses in section II although they cannot be confirmed with high statistical significance.

Several theoretical and empirical arguments in the preceding section explain why schooling and ability are unlikely to be perfect substitutes in producing earnings. Table 2 provides some evidence on this point by showing the linear regressions of 1965 earnings and discounted lifetime earnings (at 4 per cent) on IQ and the background variables X*.

To facilitate comparisons with other samples in which different tests are used to measure ability, the bracketed figures in the 1965 column are the product of the IQ coefficient and one standard deviation of the test score for each schooling cohort. Since the dependent variable is the natural logarithm of earnings and the product is usually small, this product can be interpreted as approximately the relative increase in earnings associated with a one standard deviation change in IQ.

The pattern of IQ coefficients (except in E_3) is broadly consistent with the belief that the coefficient of ability increases with education level in linear regressions. IQ is only trivially related to earnings for the lowest schooling level, but appears to make a moderate empirical

TABLE 2--LINEAR REGRESSIONS OF EARNINGS ON IQ AND X*

Education Level	Sample Size N	1965 Earnings		Discounted Lifetime Earnings (4%)	
		β_{IQ}	R^2	β_{IQ}	R^2
E_1	60	-3.5 (26.9)	.16	-115 (367)	.19
E_2	117	74.6 (35.8)	.19	756 (592)	.09
E_3	51	-2.2 (127.2)	.34	-589 (1606)	.23
E_4	68	186.4 (94.7)	.29	1668 (2625)	.21
E_5	47	223.0 (154.5)	.19	1968 (1754)	.19

difference in earnings as the schooling level rises. An approximate chi-square test of the statistical hypothesis that the 1965 IQ coefficients are equal across education classes (excluding the peculiar E_3 class) indicates the probability of the null hypothesis is less than .05.[2] This result and the array of IQ coefficients in Table 2 suggests that there is positive interaction between IQ and education level and that the linear model is misspecified by not allowing for the interaction if education levels are pooled in one regression equation.

The low coefficient for the E_3 group (some college) is anomalous. This result may be sample-specific for historical reasons already mentioned or there may be some unobservable factor that leads to self-selection by those who terminate their school at this level. Still it is unclear why the effect of IQ on carnings should be eliminated.

Table 3 contains some regressions of the logarithm of earnings on IQ and the other variables X* to observe whether IQ differentials affect earnings at all educational levels equiproportionally. As before, IQ continues to have a very weak association with earnings of high school nongraduates. Aside from the contained anomaly of the small coefficient for E_3, the pattern of IQ coefficients in 1965 and for discounted lifetime earnings across schooling levels is consistent with the argument in Section II that ability should tend to increase earnings at least proportionally for increasing levels of schooling. Indeed, the IQ coefficient on 1965 earnings and discounted earnings appears to jump substantially for the highest education level, a suggestive result, although in this small sample the difference in the E_4 and E_5 coefficients is not statistically significant.

There appears to be a pervasive tendency for IQ to become relatively more important as labor force experience is acquired. The increase is largest for the highest schooling group, but occurs at each level except for the lowest group. These results suggest that the cognitive factor plays an increasingly important (though modest) role in determining differentials over time particularly at higher levels of schooling.[2a] At the E_5 level (two or more college degrees), the pronounced trend might be due in part to substantial earnings by high ability professional men whose earnings increase rapidly after their lengthy training is completed. The initial small negative correlations of IQ with earnings for this group in 1950 and 1955 may also be partly due to the late labor market entry of these

Table 3 -- Coefficients* on IQ from Regressions of Log Earnings on IQ and Other Variables (X*). (Rogers' Sample)

Education Level	Sample Size N	1965	1960	1955	1950	4%	Other Variables
		Year or Discount Rate					
E_1	60	.024 (.35) [.0026]	.14 (.29)	.20 (.29)	-.27 (.36)	-.01 (.24)	X*
E_2	117	.70 (.32) [.078]	.36 (.29)	.32 (.28)	.28 (.30)	.45 (.27)	"
E_3	51	.36 (.78) [.035]	.17 (.66)	.32 (.62)	.04 (.68)	.00 (.63)	"
E_4	68	.92 (.63) [.101]	.70 (.55)	.53 (.51)	.74 (.69)	.42 (.61)	"
E_5	47	1.32 (.90) [.132]	1.01 (.99)	-.18 (.97)	-.17 (1.11)	.78 (.75)	"
Pooled	345 =	.49 (.23)	.46 (.20)	.29 (.20)	.15 (.22)	.35 (.19)	X* and education level dummies

*Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the IQ coefficient and one standard deviation of IQ from Table 1. It has not been multiplied by the 100 factor of the other lines in the table. The 1965 IQ coefficient for E_5, for example, implies a 1.32% rise in earnings with a one-point rise in IQ and since the standard deviation of IQ is 10 for E_5, this magnitude of IQ change implies approximately a 13.2% change in earnings.

professionals. However, occupational information is not readily available to verify these conjectures.

An alternative specification is convenient for testing the role of measured ability in the growth of earnings over the fifteen-year segment of the earnings profile covered by Rogers' data. For each schooling level, the logarithm of 1965 earnings is regressed on the logarithm of 1950 earnings. The residuals from these regressions are then regressed on two sets of variables, IQ by itself, and IQ and X* (the variables used in the regressions of Table 3). The purpose of this test is to determine whether the earnings in an early year of the life cycle captures most of the effect of IQ and the background variables so that these variables have negligible effect on later earnings, once the effect of early earnings are netted out by the first regression. The coefficients on IQ from this second round of regressions are shown in Table 4.

The small samples and relatively low significance of most of the individual IQ coefficients suggests pooling the results in a single test of the null hypothesis that IQ does not have an increasing effect on earnings as labor force experience increases. Using a procedure developed by Fisher rejects the null hypothesis at the .01 level.[26] (This result is based on the simple regressions of the residuals on IQ.) This test confirms the impression of the increasing importance of IQ suggested by Table 3.

On the basis of Rogers' sample, what conclusions can be drawn about the important problem of bias in the returns from education if ability is ignored? It seems to be well-established that mean IQ increases the

Table 4 - Coefficients* from Regressions of the Residuals from Regressions (log earnings (1965) = $\beta_o + \beta_1$ log earnings (1950) + u) on (1) IQ and (2) IQ and X*

Education Level	Sample Size N	(1) β_{IQ}	(1) F	(2) β_{IQ}	(2) F
E_1	60	.13 (.35)	.145	.09 (.34)	2.89[a]
E_2	117	.82 (.30)	7.29[a]	.74 (.31)	1.97
E_3	51	.41 (.58)	.494	.37 (.60)	1.15
E_4	68	.75 (.48)	2.41	.57 (.52)	3.23[a]
E_5	47	.79 (.82)	.924	1.17 (.95)	1.29

*Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100.

[a]Significant at 5 per cent level.

higher the school level. If IQ is positively correlated with earnings at each level, then it is clear that the apparent increase in earnings by taking the difference in the mean earnings at each level exaggerates the potential gain for a person of a given ability in acquiring more schooling. For the Rogers sample, Table 1 indicates that mean IQ of college graduates is about 13 points higher than IQ of high school graduates, the corresponding differential in IQ for college graduates with two degrees over high school graduates is 15 points. The coefficients on IQ for levels E_4 and E_5 in Table 3 multiplied by the corresponding differentials imply that lifetime earnings (discounted at 4 per cent) of the mean high school graduate would be about 6 per cent and 8 per cent less than the corresponding means of those who attained the E_4 and E_5 levels. A similar calculation based on the 1965 earnings IQ coefficients implies that the mean high school graduate (who terminated his education with high school) would earn 13 per cent and 18 per cent less than the mean E_4 and E_5 individuals, respectively. Thus this sample indicates an empirically significant bias exists that overstates the apparent increase in earnings for high school graduates who subsequently take one or more college degrees. Because the IQ-earnings relationship is negligible for high school nongraduates, there is no overstatement of the increased earnings obtained by those who actually completed high school (although there would be an overstatement of the gains to a person whose ability is that of the mean high school nongraduate).

The sample provides a modest, but positive rationalization of the strong association between schooling attainment and IQ. The discounted lifetime earnings coefficient for those with two or more degrees is larger in magnitude than the high school coefficient. The product of the difference in the coefficients and the difference in the mean IQ's indicates that lifetime discounted earnings increase 5.4 per cent more for a person with IQ 117 than for a person with IQ 102, if they both have two degrees.[3]

The IQ coefficients for high school graduates and college graduates with one degree are almost identical for discounted earnings. However, the 1950 IQ coefficient for high school graduates is quite small, while it is relativ ly much larger for college graduates with one degree. The small IQ coefficient for high school graduates suggests that the opportunity cost of earnings while attending college differ little over a wide range of ability, while ability makes a larger relative difference promptly in the earnings career of college graduates. Clearly this provides some incentive for those with higher IQ to attend college than others.

B. Results from Project Talent Data

The results from Project Talent data discussed here are based on a sample of about 11,000 high school juniors (white males) who had full-time employment in 1966, who took ability and achievement tests and provided background information in 1959, and who responded to a mail questionnaire in 1966. Although most of the college graduates have not had more than one year of post-college work experience and later points along the earnings profile are not yet available, it is interesting to compare this large sample with the Rogers evidence. Table 5 is analogous to Table 1, and provides data on earnings, weeks worked and background variables by schooling level. The five schooling levels are: E_1', high school non-graduates; E_2', high school graduates; E_3', college dropouts (with 1-2 years college); E_4', college dropouts (with 3-4 years college); and E_5', college graduates. A number of ability and achievement variables are available for this sample. The tests included in the table are C001 (a composite test score which is reported to be highly correlated with IQ), C004 (a quantitative test-composite score), R410 (arithmetic computation), and R430 (clerical checking). The background variables include high and low "social class" (SCH' and SCL', obtained from a composite socio-economic status variable, P*801, developed by Project Talent), religion (RC=1 for Catholic background, RJ=1 for Jewish background), nonpublic school attendance (PARS=1 for parochial, PRVS=1 for private

ɔility and Achievement Variables,
ɛct Talent)

ι- ɜ ιte)	R410 (Arithmetic Computation)	R430 (Clerical checking)	SCL'	SCH'	RC	RJ	NM	S	PARS	PRVS
	38 (13)	39 (18)	.399	.279	.328	.016	.284	.137	.022	.011
	40 (10)	40 (16)	.314	.283	.331	.015	.398	.165	.061	.012
	42 (9)	41 (15)	.173	.469	.313	.042	.498	.162	.099	.028
	44 (9)	41 (14)	.107	.597	.259	.068	.562	.154	.096	.038
	47 (9)	42 (13)	.113	.621	.266	.078	.502	.157	.102	.044

ata tape on high school junior subsample, Project Talent.

and 332.

school attendance in 1959), not married in 1966 (NM), and a variable for region of school in 1959 (S=1 for U.S. Office of Education, Region 5 [southeast]).[4]

The logarithmic mean earnings for 1966 are irregularly ordered with respect to schooling attainment. The mean for high school nongraduates is slightly larger than the mean for high school graduates. This may reflect a differential response bias favoring nongraduates with high earnings, although direct evidence is not available on this point. The differences in the mean of log weeks worked is partly responsible for the lower earnings means of the E_4' and E_5' schooling levels. If we assume that earnings per week are unaffected by the number of weeks worked, and standardize all 1966 earnings to the 3.90 mean of log weeks worked for the E_1' class, the five (log) earnings figures for E_1' through E_5' are 8.54, 8.47, 8.40, 8.30, and 8.56, respectively.[5] This adjustment substantially reduces the differentials between log earnings of the schooling levels, although only the rank of college graduate earnings is changed. The ranking is probably influenced significantly by the productivity gains that have already been achieved by those in the lower levels of schooling attainment, and behavior of similar samples suggest that the ranking will be altered in favor of those with more schooling in the future.

The significant tendency of abstract ability (C001 and C004) to rise with level of schooling parallels the Rogers' data. The more specific skills (R410 and R430) also tend to rise with schooling, but the within schooling level standard deviations for these variables are relatively much larger than the mean differences between schooling levels. The inverse relation between fraction married and level of schooling in these data are consistent with the young age of this cohort in 1966. The association (or lack of association) between the remaining background variables and schooling are also similar to Rogers.

Regressions are reported with the logarithm of 1966 earnings as the dependent variable, with one of the ability or skill variables and X'* = (SCH', SCL', RC, RJ, PARS, PRVS, NM, S, LNWK) as independent variables.[6] Table 6 shows the coefficients of the different ability and skill measures, standard error, and (selectively) the product of the ability or skill coefficient and one standard deviation of the corresponding test measure for the appropriate schooling level. The C001 coefficient (general ability composite) is very weak in its effect at all levels (and in fact, is negative and significant for college dropouts with 1 or 2 years of college). The C004 (quantitative composite) is significant and positive for high school and college graduates (and significant and negative for college dropouts with 3 or 4 years of college). This pattern seems broadly consistent with the 1950 results from Rogers data. The ability variables have a very weak relationship with earnings for high school dropouts. Their influence rises for high school graduates, declines for college dropouts, and rises again for college graduates. For all schooling levels, the quantitative effect of ability differentials on earnings seems to be quite small at early points along the earnings profile. These results also suggest that college dropouts differ in some way from high school graduates and college graduates, and the earnings-ability relationship for them cannot simply be

Table 6 - Coefficients* on Ability and Skill Measures from Regressions of Log Earnings (1966) on an Ability or Skill and Other Variables (X'*). (Project Talent Sample)

Education Level	Sample Size N	Ability or Skill Variable				
		C001	C004	R410	R430	C004[a]
E'_1	212	.04 (.059) [.012]	.02 (.125) [.006]	-.06 (.222)	.00 (.30)	.06 (.088)
E'_2	4319	.02 (.013) [.009]	.06 (.018) [.022]	.11 (.073) [.011]	.12 (.044) [.019]	.09 (.019)
E'_3	2486	-.04 (.022)	-.01 (.021)	.06 (.105) [.0001]	.25 (.067) [.038]	.00 (.10)
E'_4	1551	-.04 (.035)	-.07 (.033)	.36 (.154) [.033]	.28 (.104) [.043]	-.05 (.032)
E'_5	2534	-.01 (.030)	.06 (.027) [.024]	.47 (.117) [.041]	.19 (.080) [.025]	.06 (.027)

*Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the ability or skill coefficients and are standard deviations of the corresponding test by schooling level. It has not been multiplied by the 100 factor of the other lines in the table.

[a]In this column, the other independent variables were LNWK, RC, RJ, NM. Other variables more highly correlated with C004 are omitted.

interpolated from results for high school and college graduates. Perhaps dropping out reflects differences in motivation, or perhaps specific job skills for the jobs dropouts take are less complementary with general cognitive ability than the jobs taken by the high school graduates. This problem is not pursued further in this paper. The last column in Table 6 shows the regression coefficient of C004 when the other independent variables are LNWK, RC, RJ, and NM. By leaving out other independent variables that have greater correlation with ability, this column indicates the maximum effect that C004 could plausibly exert on earnings. The size of the effect remains small at all schooling levels.

Consider next the more specific skills R410 (arithmetic computation) and R430 (clerical checking). It is not surprising that these variables have a stronger effect on earnings than the broader abilities at an early point in earning careers, since they are probably better indicators of differences in current productivity than the ability measures (before people have acquired highly job specific skills from job experience). These measured skills probably increase personal productivity in a number of occupations, but not in all. Differences in the distribution of jobs, by education level, may explain why the skill coefficients tend to be smaller for the E_1' and E_2' cohorts.

Although these skills appear to be associated with modest earnings differentials, omitting them is unlikely to be a significant source of bias in estimating the returns from schooling, since they are not highly correlated with schooling attainment.

C. Results from NBER-Thorndike Data

The NBER-Thorndike sample includes white males who took and passed, a battery of tests given to potential American pilots and navigators during World War II. Earnings data and additional information were obtained from questionnaires in 1955 and 1969. The results discussed here eliminate proprietors, teachers, pilots, and farmers, and restricts attention to those born in the period 1921-25 (which overlaps the Rogers' sample).

Assuming the chaos of the Columbia computer center diminishes, results from these calculations may soon be available.

D. Results from Husén's Data

The Husen sample reported here includes some 450 Swedish males who were third graders in Malmö when they were originally tested. They answered a questionnaire in 1964 and earnings data were obtained by searching records of past income tax returns.

Table 9 summarizes the available earnings data and background variables by schooling attainment. The seven schooling levels are: E_1'', folkskola not completed (folkskola is the Swedish elementary school); E_2'', folkskola completed (usually at age 14); E_3'' some realskola (secondary school); E_4'', realexamen (realskola completed usually at age 16 or 17) and technical school graduate; E_5'', studentexamen (completion of the gymnasium, roughly junior college, at ages 19-21); E_6'', university degree (excluding E_7''); and E_7'', doctor or dentist. The ability measure TST 38 is the total score from four subtests and is highly similar in

Table 9 - Means and Standard Deviations* of Log Earnings, Ability, and Background Variables by Education Level (Husén-Swedish)

Education Level	Sample Size N**	LE68	LE64	LE59	LE54	LE49	TST38	SCH"	SCL"	PS	NM"	PHLTH
E"$_1$	18	9.494 (.278)	9.249 (.223)	8.833[a] (.267)	8.986 (.232)	8.154[b] (.458)	34.1 (12.7)		.428		.111	.056
E"$_2$	235	9.455 (.318)	9.208 (.305)	8.996 (.229)	9.033 (.182)	8.225 (.349)	44.3 (13.5)	.017	.404		.089	.127
E"$_3$	59	9.515 (.380)	9.328 (.266)	9.058 (.239)	9.035 (.259)	8.234 (.450)	50.9 (13.9)	.068	.203	.017	.068	.051
E"$_4$	66	9.849 (.393)	9.562 (.322)	9.191 (.283)	9.042 (.245)	8.133 (.393)	56.3 (12.5)	.152	.136	.030	.106	.091
E"$_5$	51	10.061 (.346)	9.574 (491)	9.260[c] (.376)			59.6 (11.8)	.294	.156	.059	.098	.078
E"$_6$	21	10.223 (.282)					57.4 (16.0)	.619	.048	.238	.048	.095
E"$_7$	5	10.529 (.167)										

*Earnings means are deflated by the Swedish Consumer Price Index (1949=100). Numbers in parentheses are standard deviations.

**N is for 1968 earnings and all other nonearnings variables. Number of observations decline for earlier years. Cells with very few observations are indicated.

[a]120 observations. [b]7 observations. [c]20 observations.

content to IQ tests. The background variables include dummy variables for social class (SCH"=1 for the highest of four classes of a discrete social class variable, SCL"=1 for the lowest), private school attendance in 1938 (PS=1), never married (NM=1), and serious prolonged illness during late teens or thereafter (PHLTH=1).

As Table 9 indicates, by 1968 (mean age 40) there are large differentials in earnings between some of the education levels, with the more highly educated obtaining greater earnings. The table includes only those who responded to the 1964 questionnaire, and response bias may be partially responsible for the slightly higher mean of log earnings for E_1'' over E_2''. An earlier calculation not limited to questionnaire respondents revealed that E_2'' had earnings .31 larger than E_1'' in 1968. At the time members of this sample were in school, the Swedish educational system was organized strongly in the continental tradition under which relatively few people obtain high levels of education. Most children terminated their formal academic study with the completion of the <u>folkskola</u> (elementary school) at the age of 14. The attrition rate of those starting the <u>realskola</u> is high, and only a little over half obtained the secondary <u>realexamen</u> degree (or equivalent degree from more vocationally oriented alternatives). This difference in educational systems probably explains why there is such a limited tendency for the 1938 test score to rise after E_4'' (<u>realexamen</u>) is achieved in this sample (except for the small E_7'' group, highly trained doctors and dentists). There is a very strong tendency for the highest socio-economic class to become an increasingly important source of students attaining schooling beyond E_4''.

Direct schooling costs at the university level were completely absorbed by the Swedish government, and university admission was limited almost entirely to people who passed the studentexamen (i.e., attained level E''_5). In this sample, slightly over a third of those passing studentexamen achieved a university degree (E''_6 and E''_7). These facts indicate that a relatively small proportion of those with middle and low socio-economic backgrounds found it worthwhile getting a university degree even if they passed the studentexamen. In turn, this result suggests that these people did not believe that the higher earnings of university graduates were enough to offset the out-of-pocket living costs while studying at the university and opportunity cost of foregone earnings. Thus it may be that the investment motive for higher earnings played a less important role in Sweden than in the U.S. in determining university attendance during this period.

Table 10 shows the pattern of the ability (TST38) coefficient by schooling attainment over time. Other independent variables are (X"*) = (SCH", SCL", PS, NM", PHLTH). All ability coefficients are positive for 1968, although statistical significance of the individual coefficients is low. The pattern of coefficients over time and across schooling levels is much less regular than the comparable calculations from Rogers' data. This irregularity may be partly due to the very small samples (especially for E''_1 and E''_6) and to the fact that the earnings statistics are based on actual annual earnings instead of the full-time annual equivalent earnings (or controls for weeks worked) available in the other samples. It appears that measured ability plays a more

Table 10 - Coefficients* on 1938 Ability from Regressions of Log Earnings on TST38 and Other Variables (X"*). (Husén Swedish Sample)

Education Level	Sample Size N	Year 1968	1964	1959	1954	1949
E''_1	18	.39 (.61) [.049]	-.23 (.78)	-.86[a] (.68)		
E''_2	235	.05 (.80)	.13 (.16)	.14 (.14)	.19 (.12)	.12 (.27)
E''_3	59	.22 (.38) [.031]	.32 (.29)	.11 (.27)	-.54 (.33)	.04 (.71)
E''_4	66	.43 (.39) [.054]	.46 (.38)	.35 (.36)	.62 (.51)	-.84[b] (.81)
E''_5	51	.58 (.41) [.068]	1.19 (.86)	1.09 (.83)		
E''_6	21	.39 (.46) [.062]				

*Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the TST38 coefficient and one standard deviation of TST38 by schooling level. It has not been multiplied by the 100 factor of the other lines in the table.

[a]Sample size 12.

[b]Sample size 22.

important role for E_4'' and E_5'' than for the lower E_2'' and E_3'' levels. The size of the ability coefficient is surprisingly large for E_5'' in 1964 and 1959, where a standard deviation change in the test score is associated with a change in earnings exceeding 13 per cent. The peculiar apparent drop in this coefficient in 1968 is a small puzzle not yet resolved. Further examination of the E_6'' group with the drop in the ability coefficient and the large standard deviation of the test score is also in order.

The modal E_2'' class (folkskola graduate) deserves serious attention because of the relatively large sample size of 235 (in 1968). Both the empirical magnitude and statistical significance of the ability coefficients are trivial for all years indicating the small role played by measured cognitive capacity in determining earnings for these people. Vocational training, trade schools, and the like are more important in Sweden than in the U.S. for teaching market relevant skills. It is conceivable that there is a wide distribution of investment in such training not highly correlated with cognitive ability that tends to mask the ability variable, a hypothesis that will be tested soon with these data. The apparent decline in the ability coefficient in 1968, if genuine and maintained in subsequent years is compatible with the conjecture that at this modest level of formal schooling job performance can be mastered with experience to the point where marginal returns to measured ability is negligible.

E. Summary of Empirical Results

The brief summary in this preliminary version is tentative, pending the availability of the Thorndike material and a bit of further experimentation with the Husén sample. It appears that measures of cognitive ability are associated with an empirically significant, but modest increase in annual earnings for those with relatively high levels of education. In 1965, one standard deviation of measured ability was associated with an increase in earnings exceeding 10 per cent for those with one or two college degrees in Rogers' data. Earnings for two years for Swedish males terminating their education with the <u>studentexamen</u> also suggested an increase well exceeding 10 per cent with a one standard deviation change in measured ability. Measures of cognitive ability have a weaker association with earnings at lower levels of schooling attainment, and this tends to reduce although not eliminate bias in rates of return measures in which no control is available for ability. The Rogers' sample suggests a strong tendency for the association of cognitive ability and earnings to increase with earnings experience, while the Swedish data are less clear on this point.

Estimated lifetime (discounted) earnings are available only for the Rogers' sample. The association of ability with discounted earnings is somewhat weaker, and the tendency to increase with schooling level is less pronounced, although still present at the highest and lowest schooling levels.

*University of Minnesota and National Bureau of Economic Research. This paper significantly extends (and heavily cannibalizes) an earlier version published in the May 1971 Supplement to the AER. The empirical portion of this study would have been impossible without the generous cooperation of those assembling the important primary data. I am indebted to Dr. D.C. Rogers for allowing me to use his basic data tape. I am also indebted to Professor Torsten Husén for allowing me to use the remarkable data on Swedish males from Malmö and to Ingemar Fägerlind for coordinating the collection of the Swedish earnings data. The American Institutes of Research prepared the Project Talent data tape. And Professor Robert Thorndike was most cooperative in making available to the NBER his massive collection of data from 1955.

Comments by Finis Welch on the original version were perceptive and valuable. Computations were carried out by J. Sanguinetty, M. Sternfeld, and A.L. Norman. Norman also developed a very useful program for estimating missing observations that greatly facilitated the Project Talent calculations. Margareta Forselius and Karlis Goppers provided much assistance with the Swedish data. The groundwork and much of the research was carried out with the support of National Science Foundation Grant GS-1797.

FOOTNOTES

[1] If important components of A_o or P_o can be affected significantly by decisions made before t_o, then we may wish to determine the value added from these earlier decisions. The main point is that if data are not available for studying earlier investments, or if we wish to study the returns from a specific investment S (after t_o), we can probably investigate and understand parts of the life-cycle earnings and investment process adequately without attacking the problem as a whole.

[1a] It is beyond the scope of this paper to investigate the other hypotheses on schooling outputs and earnings. Some of them appear to be difficult to evaluate, because available data preclude observing marginal changes. For example, children have been exposed to substantial experience in school related to (5) before reaching the legal age permitting them to leave school. If further schooling has little effect in this dimension, then it will not be easy to measure directly the impact of schooling on earnings from this source.

[2] For this test, a weighted mean was constructed from the IQ coefficients of the 1965 regressions in Table 2. Let $w_i = (1/\sigma_{\beta_i})/(\Sigma_j (1/\sigma_{\beta_j}))$; where σ_{β_i} is the estimated standard error of β_i, the IQ coefficient of schooling group E_i. Let the weighted mean $\beta_w = \Sigma w_i \beta_i$. Then $\Sigma[(\beta_i - \beta_w)/\sigma_{\beta_i}]^2$ is approximately chi-square with three d.f. (for the four education classes). In this case, the chi-square value is 9.5.

FOOTNOTES (continued)

2a It is not necessarily true that the increase in the IQ coefficient should be attributed solely to the increasing role of ability. Mincer's work has suggested that ability and postschool on the job training may be complements. Since no variable in the regression controls for post-school investment, the IQ could include the effect of such investment over time if the complementarity is strong.

2b Fisher's test (see Hald), is used in the following way. Let P_i be the significance level of the i^{th} schooling level IQ coefficient, based on a one-tail t test (for positive effect). Then $\sum_i^n \log(P_i)^2$ has a chi-square distribution with 2n degrees of freedom, where n is the number of schooling levels. (Natural logarithms are required in this formula.) When IQ is the only independent variable in the regression of the residuals, Table 4 yields a chi-square value of 24.2 with 10 df.

3 This magnitude of interaction between IQ and schooling is considerably larger than the 1 per cent increase obtained by Rogers (Table 9, p. 115). The difference arises in part because Rogers uses an age-in-school variable that is correlated with IQ and because of other differences in formulating a statistical model and handling the data. As explained in Appendix A, Rogers sample of 364 was reduced by 21 observations to eliminate individuals with extreme

FOOTNOTES (continued)

personal characteristics. This procedure could lead to some modification of the IQ coefficients. Rogers measured social class by a four-valued single variable, whereas I trichotomized the sample by dummy variables. Finally my results are based on coefficients from individual regressions by schooling level to allow for full interactions with the other variables. Rogers pooled his observations in a single regression in which the IQ-schooling interaction was allowed (but no other schooling level differences).

[4] The Project Talent data bank did not code where questionnaire respondents lived in 1966, and the only geographic information readily available is region of 1959 schooling.

[5] In fact, this adjustment appears to be too large. Within schooling class regressions have coefficients on log weeks worked which are about .7. I will not burden this footnote with ad hoc conjectures rationalizing this result.

[6] The variable LNWK (log of weeks worked) is included as an independent variable for two reasons. First, including it makes the results more comparable with the 1950 calculations from Rogers' data and the Thorndike sample (both of these give earnings on a full-time equivalent basis). Second, many individuals with E_4' and E_5' schooling attainment were relatively new to the labor force and worked less than a full year

FOOTNOTES (concluded)

(as suggested by the considerably lower mean value of LNWK for these two groups). As far as this study is concerned, this source of variation of the log of earnings is largely "noise" at the higher educational levels.

Including LNWK reduces the magnitude of the ability and skill coefficients for the three lowest education levels, but not by enough to change very much the statistical or empirical significance of the coefficients shown in Table 6.

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APPENDIX A

Description of the Samples Included in the Study

Brief descriptions are given in the main text of the four samples used in Part III of the study. This appendix describes the samples and procedures used in greater detail so that the reader can judge for himself the role of population differences in the results. More thorough discussions of the data are in the original sources by Flanagan, Husén, Rogers, and original sources cited in the bibliography.

A. Rogers' Data

The Rogers' sample is based on respondents to a 1966 questionnaire survey designed and carried out by D.C. Rogers. The modal group consists of Connecticut eighth graders in 1935, tested for IQ in the eighth grade. Age has a tight distribution with a standard deviation of 1.2 years. All earnings data are retrospective, obtained from the questionnaire. The 1965 figure is intended to be a reasonably precise measure of total earnings for the year. The 1960, 1955, and 1950 figures are full-time equivalent earnings based on inflated salary or wage rate recall information.

The original sample contained 364 observations. By eliminating those reporting zero salary or wage for any year, those not working full-time in 1965, those with a severe handicap, and three extreme observations (which were more than 3.75 standard deviations from the corresponding schooling means), the final sample size in this paper is reduced to 343. The purpose in rejecting these observations is to reduce the extreme heteroscedasticity of individual earnings data which makes estimation of parameters of interest difficult in small samples.

Rogers' measure of socio-economic status is based on a two factor index of social position devised by A. B. Hollingshead. This index assigns scores to father's occupation and father's schooling attainment. Rogers then allocated total scores to five social classes. The high and low social class dummy variables used in this study assigned the top two and bottom two classes of Rogers, respectively.

B. Project Talent Data

The Project Talent subsample is based on some 14,000 male high school juniors who took the Project Talent battery of tests in 1960, and who indicated positive earnings in 1966. For the calculations in this paper, all still attending school, all indicating part-time work in 1966, all farmers and men in the military, and all those reporting poor health in 1960 were rejected. Nonwhites were also removed for separate analysis. For each of the five education levels for the remaining observations, the mean and standard deviation of the log of 1966 earnings was computed, and observations lying more than 2.75 standard deviations beyond the mean were discarded. The first group of criteria removes individuals not full-time members of the civilian labor force and specific groups with heteroscedastic or difficult to interpret earnings. The second criterion was imposed to eliminate observations in the extreme tails of the log-earnings distribution. This brutal treatment of the data further reduces heteroscedasticity, and is probably a low cost way of improving the efficiency of the estimates (relative to no adjustments). This procedure left 11,425 observations.

Missing independent variables are obtained either by assignment of modal class for discrete, non-ordered variables or by estimation from subregressions using a flexible program written by A.L. Norman. No observation with more than five missing independent variables is used in subsequent calculations.

The dummy variables for "high and low" socio-economic status (SCH' and SCL') are obtained from the Project Talent variable, P*801, which is an index weighting breadwinner's income, parents education, and a number of other items on family background from the original 1960 questionnaire. A person is assigned to the higher status SCH' if P*801 > 111, and to the lower status SCL' if P*801 < 91.

C. NBER-Thorndike Data

This sample is based on male air force volunteering for pilot, navigator, and bombadier programs who had passed an initial screening test, and were given an additional set of 17 tests to measure various abilities in the last half of 1943. Thorndike and Hagen sent a questionnaire to a sample of 17,000 of these people in 1955, which included a question on 1955 earnings. The NBER sent a subsequent questionnaire in 1969. From useable coded responses, the sample was reduced to exclude independent proprietors, doctors, lawyers, and teachers (occupational groups raising particular problems that will be studied separately). The grossly overrepresented pilots are also eliminated from the sample. Heterogeneity is reduced by restricting the sample to the central group between ages 44 and 47 in 1969. Heteroscedacticity in earnings is reduced by eliminating those in poor health. Those reporting earnings less than $500 are eliminated, and the earnings figures are truncated at $99,999. A three-standard deviation rejection criterion from the empirical log of earnings distribution for each education level was then imposed. Original 1955 earnings were obtained by inflating monthly salary to an annual basis. Earnings for other years were reported on an "annual full-time basis salary."

D. Husén Sample

The Husén data is based on all (male) third graders in Malmö in the third grade who were given a series of four tests in 1938. Additional information was obtained from school and social records and a 1964 questionnaire (to which the response rate exceeded 80 per cent). Information on earnings were obtained for 1968, 1964, 1959, 1954, and 1949 directly from archives containing a summary of data from individual income taxes. Thus these earnings are realized earnings rather than full-time equivalent reported in most of the other samples. No information was available on weeks worked per year or hours per week except for a questionnaire item that distinguished part-time and full-time workers in 1964. A 2.75 rejection criterion for log of earnings exceeding 2.75 standard deviations of the corresponding mean (by schooling level) was applied and iterated once. Only questionnaire respondents are included in this paper. The sample size of those with 1968 earnings passing these criteria is 455.

The high and low socio-economic class variables SCH" and SCL" are obtained from the highest and lowest of four "classes" developed in 1939 by Hallgren. Criteria include father's income, occupation and social welfare status.

The "continental schooling system" in which relatively few attain high levels of formal schooling prevailed when the Malmo cohorts were third graders.

APPENDIX B

Summary of Full Regression Equations of Log Earnings by Schooling Level on Measured Ability and Other Variables

Table 11 summarizes for the different samples and different schooling levels regressions of the log of earnings for a single year on some ability measure and a more or less standard set of background variables. The educational levels are not directly comparable for the different samples, and the coding should be checked in the main text. The scaling of the different ability tests makes direct comparison between samples meaningless, and the tests themselves would not be perfectly correlated. However, since earnings are expressed in logarithms, multiplying the ability coefficients by the standard deviation of the ability measure indicates the proportion (approximately) by which earnings are altered by this size of change in measured ability. This information is included in a number of tables in the main text.

The scaling and criteria used to produce dummy variables for high and low socio-economic status differ greatly between samples, and make comparison of coefficient magnitudes in the four samples meaningless.

hm of Earnings on an Ability Measure, and Background Variables

RC igion olic)	RJ (Religion Jewish)	NM (Not married)	S Southern U.S.	PHLTH (Serious illness since mid-teens)	PS (Private school)		R^2
(Dependent variable: log of 1960 earnings)							
202		-.473			-.057		.240
99)		(.180)			(.298)		
067	.679	-.045			.072		.165
81)	(.275)	(.132)			(.134)		
040	.696	-.744			.556		.296
53)	(.376)	(.390)			(.238)		
114	.170	-.843			.338		.212
39)	(.270)	(.251)			(.162)		
566	.636	-.695			.063		.339
10)	(.245)	(.386)			(.245)		
nt: (Dependent variable: log 1966 earnings)							
					Pars.	Prvs.	
042	.203	-.166	-.236		.023	.026	.136
57)	(.88)	(2.53)	(2.74)		(.11)	(.09)	
041	.050	-.298	-.068		-.030	.224	.149
57)	(.91)	(21.3)	(3.57)		(.99)	(3.59)	
083	.101	-.331	-.091		-.042	-.023	.239
23)	(1.97)	(16.0)	(3.21)		(1.10)	(.37)	

(continued)

B - 2

C gion lic)	RJ (Religion Jewish)	NM (Not married	S Southern U.S.	PHLTH (Serious illness since mid-teens)	PS (Private school) Pars.	Prvs.	R^2
Dependent variable: log 1966 earnings) (continued)							
66	.036	-.281	-.081		-.048	.056	.390
3)	(.62)	(9.53)	(2.00)		(.86)	(.75)	
55	.027	-.105	.038		-.069	-.031	.376
2)	(.67)	(4.98)	(1.28)		(1.71)	(.62)	
Sample: (Dependent variable: log 1968 earnings)							
		-.112		-.061			.098
		(.241)		(.349)			
		-.163		-.025			.030
		(.072)		(.062)			
		-.121		-.116			.042
		(.394)		(.237)			
		-.277		-.238			.117
		(.157)		(.166)			
		-.071		-.098			.199
		(.161)		(.176)			
				-.049			.056
				(.239)			

Footnotes to Table 11

*Standard errors are in parentheses except for Project Talent, where the regression program gives t-values.

[a] Different ability tests are used for each major sample cohort. These are: Rogers, IQ test scores; Project Talent, C004 (quantitative composite); NBER-Thorndike (a general ability factor from Air Force test battery); and Husén, TST38 (total test score 1938).

Hans Andersson / addendum

Table 9 - Means and Standard Deviations* of Log Earnings, Ability, and Background Variables by Education Level (Husén-Swedish)

Education Level	Sample Size N**	LE68	LE64	LE59	LE54	LE49	TST38	SCH"	SCL"	PS	NM"	PHLTH
E"$_1$	18	9.494 (.278)	9.249 (.223)	8.833[a] (.267)	8.986 (.232)	8.154[b] (.458)	34.1 (12.7)		.428		.111	.056
E"$_2$	235	9.455 (.318)	9.208 (.305)	8.996 (.229)	9.033 (.182)	8.223 (.349)	44.3 (13.5)	.017	.404		.089	.127
E"$_3$	59	9.515 (.380)	9.328 (.266)	9.058 (.239)	9.035 (.259)	8.234 (.450)	50.9 (13.9)	.068	.203	.017	.068	.051
E"$_4$	66	9.849 (.393)	9.562 (.322)	9.191 (.283)	9.042 (.245)	8.133 (.393)	56.3 (12.5)	.152	.136	.030	.106	.091
E"$_5$	51	10.061 (.346)	9.574 (491)	9.260[c] (.376)			59.6 (11.8)	.294	.156	.059	.098	.078
E"$_6$	26	10.236 (.286)					60.6 (9.2)	.539	.039	.238	.077	.077
E"$_7$	5	10.529 (.167)					66.8[d] (4.6)					

*Earnings means are deflated by the Swedish Consumer Price Index (1949=100). Numbers in parentheses are standard deviations.

**N is for 1968 earnings and all other nonearnings variables. Number of observations decline for earlier years. Cells with very few observations are indicated.

[a]120 observations. [b]7 observations. [c]20 observations. [d]8 observations.

Table 10 - Coefficients* on 1938 Ability from Regressions of Log Earnings on TST38 and Other Variables (X"*). (Husén Swedish Sample)

Education Level	Sample Size N	Year 1968	1964	1959	1954	1949	1968**
E''_1	18	.39	-.23	-.86[a]			
		(.61)	(.78)	(.68)			
		[.049]					
E''_2	235	.05	.13	.14	.19	.12	.32
		(.80)	(.16)	(.14)	(.12)	(.27)	(.19)
E''_3	59	.22	.32	.11	-.54	.04	[.037]
		(.38)	(.29)	(.27)	(.33)	(.71)	.40
		[.031]					
E''_4	66	.43	.46	.35	.62	-.84[b]	(.47)
		(.39)	(.38)	(.36)	(.51)	(.81)	[.050]
		[.054]					
E''_5	51	.58	1.19	1.09			1.03
		(.41)	(.86)	(.83)			(.58)
		[.068]					[.105]
E''_6	26	.22					1.06
		(.66)					(.78)
		[.010]					[.106]

*Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the TST38 coefficient and one standard deviation of TST38 by schooling level. It has not been multiplied by the 100 factor of the other lines in the table.

**This column gives regression coefficients on IQ measured in 1948 ten years after the original tests. The scaling is different from the 1938 tests so the coefficients are not strictly comparable, although the bracketed products are.

[a] Sample size 12.

[b] Sample size 22.

C. Results from NBER-Thorndike Data

The NBER-Thorndike sample includes white males who took and passed, a battery of tests given to potential American pilots and navigators during World War II. Earnings data and additional information were obtained from questionnaires in 1955 and 1969. The results discussed here eliminate proprietors, teachers, pilots, and farmers, and restricts attention to those born in the period 1921-25 (which overlaps the Rogers' sample).

The means and standard deviations of earnings for three years and standard background variables in Table 7 follow patterns by schooling level that resemble the Rogers and Project Talent data. The six schooling classes are: E_1^+, high school graduate; E_2^+, some college; E_3^+, college graduate with one degree; E_4^+, college graduate with two or more degrees; E_5^+, lawyer; and E_6^+, doctor. The last three classes are mutually exclusive. Because of the higher investment required by the lawyers and doctors in professional training, these two occupations are distinguished for separate analysis. The ability measure TST43 is a composite of 17 Air Force tests taken in 1943. These statistics are from a subsample of people born between 1922 and 1925. Consequently, virtually all in this subsample had completed high school when ability was measured, while relatively few had higher schooling attainment at that time. In turn, this means that measured ability differentials in this sample cannot be attributed to schooling differentials prior to the testing in 1943.

The background variables include father's education (FEDH=1 if father has at least a college degree; FEDL=1 if father did not graduate from high school),

Table 7 - Means and Standard Deviations* of Log Earnings, Ability, and Background Variables by Education Level (NBER-Thorndike)

Education Level	Sample Size N[a]	LE69	LE64	LE66	TST43	FEDL (Father's Education, Low)	FEDH (Father's Education, High)	RC	RJ	NM	S
E_1^+	489	9.128 (.362)		8.645 (.292)	-.62 (1.57)	.760	.035	.309	.022	.045	.121
E_2^+	535	9.301 (.403)		8.743 (.312)	-.31 (1.56)	.600	.077	.230	.034	.047	.151
E_3^+	900	9.517 (.376)		8.849 (.419)	.45 (1.83)	.536	.133	.231	.040	.044	.174
E_4^+	211	9.600 (.436)		8.842 (.337)	.94 (1.91)	.530	.137	.180	.081	.047	.114
E_5^+	128	9.885 (.494)		8.872 (.328)	.38 (1.83)	.515	.250	.266	.094	.047	.227
E_6^+	53	10.061 (.387)		9.094 (.694)	.51 (1.62)	.472	.245	.264	.057	.057	.151

*Numbers in parentheses are standard deviations. Source: NBER-Thorndike data tape.

[a]Sample size is for 1969 earnings. Sample size for the original 1955 earnings for the six education classes are: 475, 520, 873, 209, 105, and 36.

religion (RC=1 if Catholic, RJ=1 if Jewish), marital status (NM=1 if not married in 1969), and region (S=1 if from U.S. Office of Education Region 5 [southeast]).

In 1969, the logarithmic mean earnings for E_1^+ through the E_4^+ schooling attainment levels rise consistently, and continue to rise for the two professions of lawyers and doctors. One minor reversal of this pattern occurs in the original earnings means in 1955, where those with two or more college degrees (E_4^+) earned about 7 per cent less than those with one college degree. This irregularity may well reflect the relatively limited earnings experience in 1955 by those with high levels of formal education. The ability measure TST43 rises significantly with schooling attainment over the first four schooling classes. It does not separate the schooling levels (in terms of the extent to which one standard deviation of the test score overlaps the mean score from adjacent levels) as strongly as the Rogers and Talent samples because initial screening had already been imposed before these men were given the battery of Air Force tests. More specifically, this factor makes the high school graduates in this sample have atypically high measured ability.

Table 8 shows the ability variable coefficients from regressions of the logarithm of earnings on TST43 and background variables X^{+*} = (FEDH, FEDL, RC, RJ, NM, S). There are several patterns in these coefficients strikingly similar to the results from Rogers' data in Table 3. In 1969, the coefficient of the some college group is less than the coefficient for either high school graduates or college graduates, and

Table 8 - Coefficients* on 1943 Ability from Regressions of Log Earnings on TST43 and Other Variables ($X^{+}*$) (NBER-Thorndike Sample)

Education Level	Sample Size N*	Year 1969	1964	1955
E_1^+	489	.0267 (.0102) [.042]		.0061 (.0085)
E_2^+	535	.0213 (.0110) [.033]		.0206 (.0086)
E_3^+	900	.0265 (.0067) [.048]		.0274 (.0053)
E_4^+	211	.0715 (.0144) [.137]		.0600 (.0113)
E_5^+	128	.0441 (.0242) [.080]		.0252 (.0177)
E_6^+	53	.0303 (.0336) [.049]		-.064 (.104)

*Numbers in parentheses are standard errors. The bracketed figures are the product of the TST43 coefficient and standard deviation of the test score at the corresponding schooling level.

has lower statistical significance. The coefficient increases substantially for those with two or more college degrees over those with a single degree. This increase is much more dramatic in the Thorndike sample, and is statistically highly significant. The two professional groups are small samples, which yield coefficients between the one-degree and two-degree college graduates, although the coefficients are closer to the one-degree level. The tendency for ability coefficients to increase over time within schooling level is another common characteristic of the Thorndike and Rogers' samples. (Compare the 1955 to 1965 increase in Table 3 with the 1955 to 1969 change in Table 8). A substantial increase in the ability coefficient of high school graduates is observed in both samples. The substantial increases for lawyers and doctors resemble more closely the Rogers' E_5 class (which includes doctors and lawyers) than the Thorndike E_4^+ classes (which excludes them). The 1955 coefficient for the Thorndike college graduates with two or more degrees seems surprisingly large. For comparable schooling levels, the Thorndike sample implies in most cases a smaller earnings differential associated with one standard deviation of measured ability (within schooling level) than the Rogers data. However, at the two-or-more college degree level, both samples suggest a 13 or 14 per cent earnings differential with this much variation in ability.

Taking the sample means of TST43 for the E_1^+, E_3^+, and E_4^+ individuals and multiplying them by the ability coefficients for college graduates with one and two-or-more degrees leads to the conclusion that neglecting ability differences would lead one to overstate the potential gains to (average) terminal high school graduates by 2.8 and 11.1 per cent, respectively, from these increments to their schooling. This is a substantial understatement of the bias for the population, since the Thorndike high school graduates have unusually high ability because of Air Force prescreening.

D. Results from Husén's Data

The Husén sample reported here includes some 450 Swedish males who were third graders in Malmö when they were originally tested. They answered a questionnaire in 1964 and earnings data were obtained by searching records of past income tax returns.

Table 9 summarizes the available earnings data and background variables by schooling attainment. The seven schooling levels are: E''_1, folkskola not completed (folkskola is the Swedish elementary school); E''_2, folkskola completed (usually at age 14); E''_3 some realskola (secondary school); E''_4, realexamen (realskola completed usually at age 16 or 17) and technical school graduate; E''_5, studentexamen (completion of the gymnasium, roughly junior college, at ages 19-21); E''_6, university degree (excluding E''_7); and E''_7, doctor or dentist. The ability measure TST38 is the total score from four subtests and is highly similar in

al s)	SCL (Social class low)	RC (Religion Catholic)	RJ (Religion Jewish)	NM (Not married	S Southern U.S.	PHLTH (Serious illness since mid-teens)	PS (Private school)		R^2
							Pars.	Prvs.	
Project Talent: (Dependent variable: log 1966 earnings) (continued)									
:	.010 (.15)	.066 (1.38)	.132 (1.64)	-.330 (8.06)	-.082 (1.58)	...	-.052 (.76)	.165 (1.73)	.263
	-.006 (.172)	.055 (1.92)	.027 (.67)	-.105 (4.98)	.038 (1.28)		-.069 (1.71)	-.031 (.62)	.376
NBER-Thorndike: (Dependent variable: log 1969 earnings)									
	-.034 (.040)	-.039 (.035)	.564 (.101)	-.180 (.077)	-.024 (.049)				.077
	-.118 (.038)	.003 (.042)	.291 (.096)	-.058 (.081)	-.022 (.048)				.050
3	-.082 (.027)	.002 (.029)	.372 (.062)	-.167 (.059)	-.084 (.032)				.086
L)	-.217 (.060)	.182 (.073)	.274 (.102)	-.176 (.128)	-.060 (.086)				.233
7)	-.233 (.112)	.037 (.112)	.122 (.157)	.118 (.208)	-.065 (.106)				.084
5)	-.207 (.123)	.122 (.126)	.040 (.225)	-.420 (.230)	.129 (.159)				.216

(continu)

ion 1	Sample Size N	Ability Test[a]	LNWK (Log of weeks worked)	SCH (Social class high)	SCL (Social class low)	RC (Religion Catholic)	RJ (Religion Jewish)	NM (Not married	S Southern U.S.	PHLTH (Serious illness since mid-teens)	PS (Private school)	
											Pars.	Prvs.
		Project Talent: (Dependent variable: log 1966 earnings) (continued)										
	793	−.03	.702	.062	.010	.066	.132	−.330	−.082		−.052	.165
		(.56)	(12.0)	(1.49)	(.15)	(1.38)	(1.64)	(8.06)	(1.58)		(.76)	(1.73)
	2534	.06	.719	.038	−.006	.055	.027	−.105	.038		−.069	−.031
		(2.24)	(34.3)	(1.57)	(.172)	(1.92)	(.67)	(4.98)	(1.28)		(1.71)	(.62)
		NBER-Thorndike: (Dependent variable: log 1969 earnings)										
	489	.0267		−.059	−.034	−.039	.564	−.180	−.024			
		(.0102)		(.092)	(.040)	(.035)	(.101)	(.077)	(.049)			
	535	.021		−.039	−.118	.003	.291	−.058	−.022			
		(.011)		(.069)	(.038)	(.042)	(.096)	(.081)	(.048)			
	900	.026		.003	−.082	.002	.372	−.167	−.084			
		(.007)		(.039)	(.027)	(.029)	(.062)	(.059)	(.032)			
	211	.072		−.011	−.217	.182	.274	−.176	−.060			
		(.014)		(.086)	(.060)	(.073)	(.102)	(.128)	(.086)			
	128	.044		−.237	−.233	.037	.122	.118	−.065			
		(.024)		(.126)	(.112)	(.112)	(.157)	(.208)	(.106)			
	53	.030		−.356	−.207	.122	.040	−.420	.129			
		(.034)		(.148)	(.123)	(.126)	(.225)	(.230)	(.159)			

E. Summary of Empirical Results

The data examined in this study imply that measures of cognitive ability are associated with an empirically significant, but modest increase in annual earnings for those with high levels of schooling. In the three samples with earnings data for people with fifteen or twenty years of earnings experience, ability coefficients are found at some high schooling level in which one standard deviation of measured ability (within schooling level) is associated with a 13 per cent earnings differential. Measures of cognitive ability have a weaker association with earnings at lower levels of schooling attainment, becoming completely negligible for high school non-graduates (or who have not obtained some training at the secondary (realskola) level in the Swedish sample).

In the three American samples there appears to be a distinct tendency for the ability coefficents in earnings regressions to increase with labor force experience. The temporal pattern for the high school coefficients is especially relevant in considering possible bias in the opportunity cost (foreign earnings) of getting a college degree. For early years in the earnings profile, the ability coefficient is very small, and in most cases not statistically significant. This result implies that bias from this source is negligible. For those with fifteen or more years of earnings experience, there is a more significant bias if ability differences are disregarded. Taking the product of the differences between the sample means of ability for two schooling levels and the regression coefficient on ability for the higher of the levels yields the bias in predicting the expected increase in earnings from the schooling increment to a person with the mean ability of those terminating schooling at the lower level. This calculation indicates a positive bias of 13 and 18 per cent for average high school graduates obtaining one or several college degrees (Rogers sample); the corresponding biases implied by the Thorndike data are (at least) 2.8 and 11.1 per cent.

The modest contribution of measured ability in explaining the differences in earnings in contrast with the strong association of measured ability and final schooling attainment is not very surprising, since most of the ability measures considered here are designed to forecast academic potential and achievement. The coefficients of determination of the within schooling class regressions are low and (more important) the standard deviation of the residuals continue to be embarrassingly large despite the homogeneity imposed by narrow age range, criteria for omitting observations, and the sets of background variables included in the regressions. In no regression of annual log earnings does it fall below .24. The task of identifying the main determinants of this residual variation remains a major challenge to students of the distribution of earnings.

THE ALTERNATIVES BEFORE US

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The function of this paper is presumably to pull together the detailed discussions that have taken place over the four days of the conference sessions. These discussions have ranged widely over many issues both of philosophy and of economic theory and of the proper way to extract the maximum of information from the minimum amount of statistically usable data. From them, however, should emerge a set of issues that we can shape into some sort of rough agenda for future research and theorizing, before returning to our individual institutions.

I begin with some fairly elementary but I hope relevant comments on the motivation of the conference, which has been concerned with higher education and the personal distribution of income. There are two quite different themes that have motivated the large and long-standing literature of social concern and social reformism with respect to the personal distribution of income.

One has been the concern with what has been variously termed "the need for a social minimum" and "the poverty problem." Those who have expressed this concern, and thought about it, have shared the general philosophical position that inequalities of income and wealth resulting from differences in productive input into the economic system of society are necessary and justified by their contribution to the efficiency and the dynamic progress of the economy and hence to the general well-being; but nevertheless that those who are more fortunately placed by reason of their superior productive power have an obligation to ensure that their less fortunate fellow citizens do not fall below some socially-determined standard of decency, in terms of level of consumption of goods and services. This position, at its less sophisticated, leads to the recommendation of income redistribution through the fiscal process and the provision of social services and security designed to ensure a "social minimum" for every citizen by virtue of his being a citizen. At its more sophisticated, the approach leads to uneasiness about the extent to which the prospects of innocent children are determined by the accidents of their parentages, and to consequent recommendation of policies designed on the one hand to prevent children of a particular generation from obtaining too great a head start over their peer group and on the other hand to prevent others suffering too much disadvantage because their parents were economically unsuccessful. Specifically, this has in the past involved considerable interest in progressive inheritance taxation, and more recently concern about "equality of opportunity" in the education system. Whether unsophisticated or sophisticated, this approach soon gets itself involved in conflicts between its belief in the necessity of economic incentives to motivate economic contributions and accumulation, and its recognition that completely free play for economic incentives produces results that it considers humanly and socially and even morally unjustifiable.

The other approach has been concerned with "equality" rather than with the "social minimum". The two of course do not necessarily overlap: a society could have no poverty, but great inequality; or it could have equality for the majority, and so satisfy most statistical definitions of equality, while still being characterized by widespread poverty. But they tend to overlap, and become confused with one another, because poverty only becomes noticeable and apparently remediable when a sufficiently small proportion of the population (Roosevelt's one third, Johnson's one fifth, of the nation) is subject to it, while inequality only becomes a source of serious social concern when its existence leads to a significant proportion of the population-- who may themselves be either "poor" or "rich"-- believing that the existing degree of inequality is unjust. Philosophically, concern with inequality involves as intractable problems as concern with poverty,,and perhaps more so. For it rests on the a priori proposition that all men are in some sense either equal or potentially equal-- and while this proposition can be satisfied fairly cheaply in the political sphere by giving each person one vote, and not inquiring too closely into how they choose to spend their votes, the achievement of economic equality raises far more difficult problems, especially of cost. Moreover, just as concern about poverty has both a less and a more sophisticated version-- reallocation of existing income versus reallocation of existing opportunity towards the poor-- so concern about equality has both a less and a more sophisticated version-- equalization of existing incomes through fiscal transfers, and equalization of income-earning opportunities through rearrangement of the availability of opportunities. And just as concern about poverty faces a conflict between a social judgment of "fairness" o r "decency" and an economic understanding of the laws of economic incentives, so concern about equality faces a conflict between a social judgment of fairness in the provision of opportunities and an economic judgment of the adequacy of the responses of differently-situated individuals to these opportunities.

Further, there is in both cases the problem of the intergenerational dimension of the question. Is poverty in the sense of some indecently low income receivers tolerable if it is not passed on to the second generation, as part of the economic incentive system, or must no poverty be tolerated anywhere at any time? Is "from shirt-sleeves to shirt-sleeves in three generations" a satisfactory definition of an equalitarian system-- as it used to be considered in nineteenth-century America, as applied to those who were lucky in their own generation-- or should it be rewritten into" no shirt-sleeves for anyone, ever! "

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Economics used to be a branch of moral philosophy before it became independent and emerged through the title of "political economy" into the status of a self-styled social science.At least in the hands of its best practitioners in the intervening years, it sought to temper economic logic and the doctrines of laissez-faire by an understanding of how these economic forces impinged on society as it was actually organized-- namely not by unfettered free enterprise but by families which, for good or ill, arrived from generation to generation by a process of inheritance which involved a triad of material property, genetically-determined innate ability, or perhaps more cautiously expressed potential ability, and something occasionally referred to as "family character." Frank Knight used scornfully to dismiss equalitarianism with the argument that it was impossible by public policy to equalize the non-material family backgrounds of children. I would venture the thought that compulsory conscription of children into state-run orphanages might do the trick-- and this has sometimes been suggested, and even practiced in small communities, by utopian socialists, though the proposal has few modern proponents among social philosophers-- but every time I use this assumption to set up a simple model of a human-capital-oriented society (I cannot use a slave society to exemplify the principles of rationality with respect to human capital in this day and age) the laughter of my students reminds me of how unrealistic politically the suggestion is.

I should add that one of Knight's major points in this connection, and one I have never forgotten, is that the inegalitarian economic consequences of unequal inheritance of genetically-determined ability or of family character are just as morally indefensible as the inegalitarian economic consequences of unequal inheritance of material property. Yet one of the basic problems of our conference proceedings in the policy area has been that our society discriminates sharply in favour of both genetical inheritance and the capacity of well-to-do parents to give their children an inheritance of culture, time, patience, and travel in substitution for an inheritance of material property-- a substitution possibility that continues to frustrate inheritance taxation designed to increase equality among the next generation. And as academics we typically lack either the reasoning power or the intellectual frigidity to pursue that point to its logical conclusion. In particular, a point to which I shall return, we are typically unwilling to contemplate the thought that, regardless of whether poverty or inequality is our focus of concern, material capital can be substituted for ~~material~~ human capital, and if we want to equalize opportunities for income-earning among children of different inheritances (with respect to both total, and compositimn) we should in all honesty consider the possibility of giving them money instead of education, rather than seeking only to use money to buy them educational equality.

As a digression before proceeding, let me remark that the work that has been presented at this conference, or at least much of it, appears to have been slowly fumbling its way back to insights into the social aspects of higher education that the older-style economists-- Admm Smith and Alfred Marshall on the one side of the Atlantic, Thorstein Veblén and Frank Knight on the other-- already had-- though one has to interpret them with insight and modernize their language for oneself. The concepts of different supply and demand curves for education by upper and lower income groups, of different search costs and risks, of differing entrepreneurial requirements, of differences between innate and acquired capacity for education on the part of children from richer and poorer families, of ability and motivation as opposing forces governing the ultimate performance of the educated, are all concepts that one could acquire if one tried by reading a few novels by Jane Austen or Charles Dickens-- or for that matter by Horatio Alger. I do not say that these economic concepts are uninformative or unenlightening when applied to the problems of the relation between education and income distribution-- quite the contrary. But I would say that the need to develop and emphasize them is the consequence on the one side of an excessively naive view of the democratic, equalitarian, and other characteristics that American society likes to attribute to itself-- a view emphasized during the postwar II period by the assumed threat to the American way of life posed by what every European immigrant to America had been taught to regard as the monster threat to European civilization-- the barbarous Russian empire, the Byzantine deviant from the true Catholic religion-- and a view only gradually dispelled by the recognition that the Russians are really failed Europeans like ourselves and that the real threat to our civilization now comes from the mysterious east. ON the other hand, the need for the new concepts has been created by our own conception, developed since the 1930's, of our subject as a "science", philosophically, socially, and ethically neutral and requiring mathematical theorizing for its intellectual base and econometric testing to furnish plausibility and what Veblen called "ceremonial adequacy". Science demands the submergence of social conscience in a welter of statistical squabbles. Economists with a feel for society have had both to learn a different language and to adapt its grammar and semantics to cover situations excluded from consideration by the triumphant simplicity of the scientific core of the subject, in order to return to the discussion of things thatcconcern them as human beings and as members of society.

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I have dwelt so long on these preliminaries as a prelude to reminding you that since the early 1960s we have moved very rapidly-- and mostly in response to the social and intellectual dynamics of this country rather than to any inner logic of the unfolding of the scientific development of our subject-- from supreme self-confidence in the power of economics to solve all conceivable problems to considerable self-questioning about how much it really has to say about important problems, and to sometimes near-desperate efforts to make it say something about problems that are of the utmost social concern but about which we may not be able to say very much, no matter how hard we try-- though we may be able to hide that fact successfully from ourselves and our colleagues by juggling with the semantics of our subject and deploying the full set of our hard-won statistical techniques. In the early sixties, for reasons I will not discuss in detail but which in my judgment had a lot to do on the one hand with the United States overreaching itself in its assumed responsibilities to the rest of the world, and particularly for setting Europe straight on American melting-pot lines and defending it from the Russian threat, and on the other hand with the change in the immigration laws in the nineteen-twenties. The latter change in my view had tremendous long-run social consequences: it protected the average U.S. citizen from competitive pressures to conform with the melting-pot tradition in order to survive in the United States; and at the same time it made other countries an easier haven for refugees grateful to have escaped an oppressive regime and culture. Americans who were capable of observing reality and testing social hypotheses against it began to proclaim, and not merely suspect, that all was not well with American democracy and the American free enterprise system-- and indeed that American society might instead itself be an unduly oppressive regime.

Initially, the criticism was that, while the United States was still the greatest country in the world-- even obscenely disgusting for its affluence-- it was flawed by the fact that a substantial number of its citizens unaccountably failed to share in the affluence that had been assumed to be every citizen's right. Hence the launching of the war on poverty, to whose infra-structure in economic research many people present at this conference contributed at the time.

But concern about the prevalence of poverty is only a superficial symptom of malaise-- and one highly correlated with the business cycle. A society with a small minority of poor and a vast majority of presumably non-poor can cure its ills with a relatively small expenditure of conscience money-- though the rich are always grudging in spending money if it will actually succeed in removing the occasion for their charity, or render their clients genuinely independent.

The American social conscience, however, has moved on rapidly, largely under the impact of military reverses abroad and related social discontent and intellectual ferment at home, to a far more sweeping condemnation of the economy and the society, one which concentrates on inequality among citizens in general rather than on poverty among a minority of them. Concern about this problem has indirectly motivated the calling of this conference; and one of its major problems has been to work back from the known territories of welfare economics and human capital theory on the one hand, and of the techniques and limitations of regression analysis on the other, to the real but ambiguously and poorly defined concerns of the wider intellectual community of the country with emotionally strongly felt but operationally opaque ideas about what the problem of inqquality in American society is. It is easy to think of theoretically and even statistically meaningful aggregative definitions of inequality in the personal distribution of income. It is much harder to relate these to the real subjects of public concern about the income distribution.

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In the papers for the conference-- leaving aside all the matters of technical debate, which have been discussed in great detail-- there have been in my judgment two central questions in dispute.

First, what is inequality? Most of us would I think agree on two basic points. One comes from the theory of human capital, and is by now familiar: inequality is to be measured, not in the labour incomes of individuals undifferentiated by age and education, but by the lifetime earnings (or with greater theoretical accuracy, consumption) profiles of these individuals. The other is a rather newer and more slippery point: real and socially important inequality is associated with the differences among children of differentially situated parents in the degree of access to opportunities to acquire such life-time income streams.

Such differences in opportunity raise two different kinds of problems. The first is that to define a standard for a tolerable degree of inequality of opportunity facing individuals of the same age-cohort, it is necessary to refer to the life-history of a family over more than one generation. The difficulties we have with the welfare economics of this problem are associated with the fact that our basic theory of welfare economics ignores the fundamental realities of parental choice and parental ambitions-- or lack of them-- for the children; and also the realities of childrens' appreciation of the limitations of their parents and their own ppportunities to exploit their parents' useful qualities while escaping from their parents' limitations.

The intergenerational utility function that defines familial welfare, moreover, is not a constant; it shifts over time and always involves the problem of social choice that welfare economists have been studying intensively but without clear and simple results.

In a largely immigrant America, parents' ambitions typically were both to offer opportunities to their children and to force compliance with the costs of those opportunities; and the children typically saw those costs as externally imposed and their parents as qualified by their position in society to be paternalistic decision-takers. In a stable second or third generation America, however, the costs of compliance appear on both sides to be internally imposed by the family, and necessary to parental self-respect but not necessary to the childrens' survival and prosperity in the society-- nor do the children even feel the immigrant's self-chosen obligation to accept the society. The problems involved cannot really be solved satisfactorily purely by juggling with the pricing system for education-- though that pricing system creates a host of unnecessary and confusing problems, to an important extent because it places such a heavy emphasis on the exercise of paternalism not by parents but by the educators themselves.

The second problem about differences in opportunities for acquiring lifetime consumption streams is again associated with certain important characteristics of American society as set by past history-- and particularly the crucial role that education has played in American society, earlier as a way of keeping together, civilized, and cohesive a colonial population forced to cope with a barbarizing environment and needful of both replacement of the intellectual tools of superiority over the surrounding savagery and reminder of the religious beliefs that justified their own responsive barbarism; and later as a way of integrating into an English-speaking and English-cultured community the first and second generation refugees from non-English-speaking fellow-European countries that for a historically short period the United States welcomed to its Atlantic shore. As a result of this tradition-- together with a set of ideas on the social value of education held in common with most European countries and derived in part from the recruitment needs of the monastic celibacy of the middle ages-- American public opinion has always accorded a special place to education as a solvent for social problems. On the one hand the educated person-- even though when employed as a teacher he was frequently criticized and persecuted for rising above his station as a mere baby-sitter for the potential pioneers who would eventually do the real work of American society-- always enjoyed residual respect as the former and preserver of the society's human capital. On the other hand, the educational system was the filter through which the heterogeneous raw human material provided by immigration was assigned to its proper place in society-- as determined by its potential productive contribution.

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It is therefore natural enough that American society, and particularly American intellectuals, should look to the putative defects of the American [illegible] system as the root source of the flaws in American society they see, and to reform of the educational system as the solution to these problems. And if one so looks one can easily find serious flaws, whether one looks primarily as a social critic or primarily as an economist.

To the social critic, a system that selects the future recipients of income streams from human capital according to their success in passing tests devised and imposed by its educators is both selecting in large part on the basis of parental resources, culture, effort, and familial ambition, and relying on a selection process that may be neither socially nor economically effective. The process may be appropriate to a society welcoming immigrants and then sorting them out into the useful and the non-useful according to an agreed concept of what the society needs in the way of useful citizens and also agreed on the qualifications of the selectors-- an essentially self-confident imperialist society bent on political and economic expansion, regardless of its rhetoric of freedom. It is much more questionable for a mature society that protects its wealth by the exclusion of immigrants and purports to guarantee every citizen a due share in its riches. (Incidentally, one of the most ominous characteristics of contemporary American society, and particularly of its radical intellectuals, is a general unawareness that what the citizenry would like to spend for social purposes or radical ones is a product of past effort and current monopoly that could be easily either squandered or eroded by international competition, or both.)

It is equally easy to look at the pure economics of a system in which at least minimum-quality education at every level is provided nominally free or nearly free to all candidates suitably qualified-- though without regard to the foregone earnings to which human capital theory has quite rightly called attention-- and to point out that the combined results of the inevitable fiscal limitation on the total quantity provided, the equally inevitable dependence on rationing by the educators who control admissions, and the availability of privately-provided education at an extra price, are

nonsense in almost every dimension of economic theory that one can think of.

The direction of the final outcome of economically nonsensical financial arrangements for higher education, however, is more difficult to determine than appears at first sight. As Anne Krueger pointed out in her commonts on T.W. Schultz's introductory paper for the conference, we have generally been trying to find third-and-a-half-best but politically feasible solutions to a fourth-or-fifth-best problem, and it is not easy to tell where we stand. Let me illustrate some of the difficulties by reference to the British higher education system. Weisbrod and Hansen have shown that the Californian education system redistributes real resources in California from the lower to the higher income groups in that State. Krueger argued, using a model that allowed for the presence of private universities which have to be paid for by parents in addition to the taxes they pay for state universities that they do not patronize with their children because quality is too low, that the income redistribution might go the other way and that there might, in consequence, be either over-allocation or under-allocation of resources to higher education as a whole.

In the United Kingdom there are no really private universities which support themselves by fees plus private endowments; most of the funds come from the Government. There are two kinds of over-allocation of resources and students to these universities. On the one hand middle-class parents probably over-spend on pre-university supplementary education aimed at getting their children into the "free" state university places by buying them an edge in passing the requisite examinations. Over-spending in this connection includes not only direct costs of private schools or supplementary coaching, but choice of work location and type of job to maximize chances of obtaining university scholarships, the number of which per eligible student varies among localities. On the other hand, children of all classes faced with the choice between going to work on completion of high school and going to

... are faced with the choice between working for wages, paying taxes, and escaping from paternalism into freedom, and paying the price of university paternalism in order to live for three years at public expense in an environment in which university teachers regard it as a failure on their part to flunk out a student they have once admitted. Everything encourages cleverness at yearly examinations, idleness between them, and the postponement of a career decision . As against these incentives to over-allocation of the supply of trainable students, there is a severe restraint imposed on the total number of university places by the immense budgetary cost of the system--a restraint which operates not only to restrict numbers but to adulterate educational quality through the imposition of standard rules governing such disparate matters as office sizes and ratios of junior to senior staff. Whether the net result of these conflicting pressures is too much or too little higher education is an open and unresolved question; inefficient the system certainly is from an economic and I would judge also from a social point of view.

The point I would like to stress in this connection, however, is not so much the many problems of inefficiency raised by the present system of finance of higher education in the United States, but the limitations of the American assumption that the key to the solution of social problems like poverty or inequality or the just society is to be looked for in reforms of the financial or administrative aspects of the university system. The educational system, and especially the university system, obviously has inherently inefficient and generally conservative biases. One could reduce these biases by putting the whole apparatus on a price system basis. But if one argues for this one must go the whole hog: and here I would disagree with T.W. Schultz, who is I think wrong to concede an argument for providing educational subsidies to the children of poor parents. By the time they get to the stage of university admission they are probably already out of the poverty or deplorably unequal class. If poverty or inequality is considered a problem, ... the one most deserving of help from his fellow men, is the one that nature forgot to endow with brains-- and that the way to make it up to him is not to exclude him form school and tax him to pay part of the cost of educating his intellectually well-endowed and no longer poor peer-group among the children of poor parents, but to give him money in lieu of the brains he lacks? Superior intelligence or skill is undoubtedly more economically useful than the absence of it; but discriminating in favour of it by fiscal subsidization will not necessarily produce a more democratic and poverty-free or egalitarian society.

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This paper has not sought explicitly to produce a neat list or "menu" of the alternatives before us, as they emerge from the state of the art of economic analysis of higher education. The technical questions of measurement are extremely difficult, and I have refrained from discussing them. As I see it, the really tough questions are three. First, how far do we really believe in the ability of economic analysis to set up socially relevant standards of inequality in the educational field, standards which correspond to what the public is really worried about?-- and if ~~not~~ So, how could we improve the situation. Second, how far can we insist on a competitive cost-oriented system for the finance of higher education? This raises a question I have not dealt with, because I can see no way to grapple with it, the vexed issue of whether or not higher education produces significant social and economic externalities that are worth subsidization, even indiscriminate subsidization? Third, if we insist on applying competitive principles to higher education, are we prepared to recommend cash redistributions of income to solve the poverty or the inequality problem, and insist on that too? If not, as Sam Bowles has argued, we may implicitly be accepting a retrogression from a fourth-best to a fifth-best performance with respect to a widely-accepted social goal.

These points, I hope, though presented in a somewhat rhetorical and ... [illegible] alternatives for discussion that

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Optimal Investment in College Instruction: The Efficiency-Equity Quandary

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The argument of this paper is that the allocation of resources to provide the instructional services of higher education is neither socially efficient nor equitable. In advancing this argument I shall approach the performance of this part of higher education under the dynamic conditions of economic growth. I shall treat college students as firms, who behave as entrepreneurs in allocating their own time and their other resources in investing in themselves. I shall appeal to the considerable evidence that college students are privately fairly efficient in investing in themselves. They respond with relatively short lags to changes in costs that they bear in acquiring an education and to changes in job opportunities that may be available to them upon graduation. On the other hand, the allocation of resources to colleges and universities is not as efficient socially as students are privately. I shall present evidence to show that an inordinate part of the subsidies to higher education is used to provide these educational services below cost to the growing proportion of students who come from families who have the income and wealth to pay the full cost. The rise in personal incomes in the United States associated with economic growth

* This paper benefitted and I gained assurance from the cogent criticism of Gary S. Becker, Richard B. Freeman, and W. Lee Hansen.

is making the traditional financing, pricing, and supplying of these instructional services ever more obsolete. The purpose of this paper is to present the logic and the evidence in support of the argument that our system of higher education is socially inefficient and inequitable.

It could be argued, however, that higher education as it has developed in the United States is a model of competition and welfare inasmuch as college students have many/subsidized options and no college or university has a monopoly of the supply of these educational services. There are more than 2500 institutions[1] competing for faculty and students, and they compete not only with each other, but also with other sectors of the economy for talent and materials. They acquire virtually all their instructional inputs in competitive markets. Moreover, to the extent that growth enhances competition, higher education has been a growth sector par excellence with enrollment rising from 1.5 million in 1940 to over 7 million since then.

With respect to welfare, there is no comparable standard to that of competition in attaining economic efficiency. It is noteworthy, however, that in terms of career choices, higher education in the United States not only offers students many options, but it also subsidizes them in part directly and nearly all of them indirectly in large amounts. Financial aid granted to students is equal to about 4 percent of total direct educational cost that is incurred by public institutions and about 8 percent of such cost incurred by private institutions. But the major subsidies are indirect because tuition and

[1] See, Digest of Educational Statistics, 1970, Table 113. It reports 2525 institutions, fall 1969.

fees paid by students in public institutions cover only 15 percent of the total educational cost and 46 percent of such cost incurred by private institutions. (See top panel of Table 1.) (Indirect subsidies are also appreciable in providing room and board for students.) But unlike the implications of competition for efficiency, the welfare implications of this vast subsidization of students is far from obvious.

Seeing that most of the direct costs of higher education in the United States are not paid for by tuition and student fees, there is a strong presumption that the economic organization of higher education has a built-in tendency to spend too much on it socially unless the benefits that accrue to society, which the students cannot capture personally during their life time, are large. This presumption is warranted despite the competition referred to above. In view of the fact that most of the direct costs of higher education are not paid for by the students, I find it hard to believe that the allocation of resources is socially efficient. It is certainly true that the social rates of return and private rates of return are not proportional in all higher education activities.

There is a tendency to transfer wealth in the form of human capital to a particular class of people without regard to their incomes. To the extent that these tendencies prevail, the first implies economic efficiency, and the second implies social inequity. Moreover, both tendencies arise from the same general sources, namely, from the disparities between costs and

Table I. U.S. Higher Education 1940 and 1968, Some Per Student Expenditures

	Public			Private		
	1940 (1)	1968 (2)	68/40 (3) =(2)÷(1)	1940 (4)	1968 (5)	68/40 (6) =(5)÷(4)
a. Number of institutions	600	940	1.6	1150	1440	1.3
b. Enrollment (000)	800	4850	6.1	700	2110	3.0
c. Direct total instr. costs (000,000)	300	7900	26.5	340	4800	14.3
d. Net instr. expenditures (000,000)	230	6710	30.0	250	4070	16.6
e. Implicit interest, deprec. (000,000)	71	1190	16.7	90	730	8.1
f. Tuition and fees (000,000)	55	1210	22.0	150	2180	15.0
g. Student aid expenditures (000,000)	7	330	47.4	22	390	17.6
h. Enrollment per institution	1320	5170	3.9	610	1460	2.4
i. Per student direct total instr. costs	370	1630	4.4	480	2270	4.7
j. Per student net instr. expenditures	280	1380	4.9	350	1930	5.5
k. Per student interest and deprec.	89	240	2.8	130	350	2.7
l. Per student tuition and fees	69	250	3.6	210	1030	4.9
Per student financial aid	9	69	7.6	32	180	5.7

	Total			Public/Private		
	1940 (7)	1968 (8)	68/40 (9) =(8)÷(7)	1940 (10) =(1)÷(4)	1968 (11) =(2)÷(5)	68/40 (12) =(11)÷(10)
a. Number of institutions	1750	2380	1.4	.5	.6	1.2
b. Enrollment (000)	1490	6960	4.7	1.1	2.3	2.0
c. Direct total instr. costs (000,000)	630	12700	20.0	.9	1.6	1.9
d. Net instr. expenditures (000,000)	470	10780	22.8	.9	1.6	1.8
e. Implicit interest & deprec. (000,000)	160	1920	11.9	.8	1.6	2.1
f. Tuition and fees (000,000)	200	3390	16.9	.4	.6	1.5
g. Student aid expenditures (000,000)	29	720	24.8	.3	.9	2.7
h. Enrollment per institution	1170	2920	24.5	2.2	3.5	1.6
i. Per student direct total instr. costs	420	1820	4.3	.8	.7	.9
j. Per student net instr. expenditures	320	1550	4.9	.8	.7	.9
k. Per student interest and deprec.	110	270	2.5	.7	.7	1.0
l. Per student tuition and fees	140	490	3.6	.3	.2	.7
m. Per student financial aid	19	100	5.4	.3	.4	1.3

Notes and Sources

Totals may not add due to rounding. Data for 1940 are for the Continental United States only. Data for 1968 are for the Aggregate U.S., i.e., U.S. (The 50 states, District of Columbia), and outlying areas (Canal Zone, Guam, Puerto Rico, Virgin Islands). Data are for the school year ending in the given date, thus 1939-40 and 1967-68.

a. Number of institutions:

1940 (columns 1, 4, 7): Source is (3) Vol. II, Chapter I, "Statistical Summary of Education, 1939-40," Table 2, page 3.

1968 (columns 2, 5, 8): Source is (1) Table 9, page 7.

b. Enrollment (opening fall enrollment):

1940 (columns 1, 4, 7): Resident Degree-credit enrollment. Source is (4), Table 146.

1968 (columns 2, 5, 8): Degree-credit enrollment includes both resident and extension students. Degree credit enrollment is available for the U. S. (50 states and D. C.) in (2), Table 6, page 23. Total enrollment is available for the U.S. and outlying areas in (1), Table 84. Degree credit enrollment for Aggregate U.S. is estimating by applying the U.S. degree-credit to total enrollment ratio to total enrollment in outlying areas.

Enrollment (,000)	Total	Public	Private
(1) U.S., Degree-credit	6390	4350	2040
(2) U.S. total	6910	4820	2100
(3) Degree-credit/Total ratio = (1)÷(2)	.9	.9	.9
(4) Outlying areas total	52	34	18
(5) Outlying Degree-credit = (4)x(3)	48	31	18
(6) Agg. U.S. Degree-credit = (1)+(5)	6960	4850	2110

c. Direct total instructional costs:

Sum of d and e

d. Net instructional expenditures:

Educational and general costs excluding extensions and public service, other sponsored activities, and 50 percent of organized research.

1940 (columns 1, 4, 7): Source is (3), Vol. II, Chapter IV, "Statistics of Higher Education," Table 16.

1968 (columns 2, 5, 8): Source is (1), Table 129.

e. Implicit Interest and Depreciation:

Calculated as 8 percent of value of physical property, multiplied by ratio of net instructional expenditures to sum of educational and general expenditures and expenditures on auxiliary enterprises.

	Total		Public		Private	
	1940	1968	1940	1968	1940	1968
1. Value (000,000)	2750	34590	1260	21180	1490	13410
2. 8 percent of Line 1	220	2770	100	1690	120	1070
3. Ratio of net instructional to educational & general & auxiliary enterprises	.7	.7	.8	.7	.7	.7
4. Implicit interest & depreciation chargeable to instruction = line 2 times line 3	160	1920	71	1190	90	730

1940: Source is (3), Volume II, Chapter IV, Table 17, page 93.
1968: Source is (1), Table 133.

f. Tuition and fees:

1940 (columns 1, 4, 7): Source is (3), Vol. II, Chapter IV, "Statistics of Higher Education," Table 13.
1968 (columns 2, 5, 8): Source is (1), Table 126.

g. Student aid expenditures:

1940 (columns 1, 4, 7): Data are actually for "other non-educational activities," from (3), Vol. II, Chapter IV, Table 16. But the same figures are given as "Scholarships, Fellowships and Prizes" in (4), Table 191.

1968 (columns 2, 5, 8): Source is (1), Table 129.

h. Enrollment per institution. Calculated as (b) (a).

i. Per student direct total instruction costs. Calculated as (c) (b).

j. Per student net instructional expenditures. Calculated as (d) (b).

k. Per student interest and depreciation. Calculated as (e) (b).

l. Per student tuition and fees. Calculated as (f) (b).

m. Per student financial aid. Calculated as (g) (b).

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Sources

(1) U.S. Office of Education, National Center for Educational Statistics, Digest of Educational Statistics, 1970 Edition, OE 10024-70, L111 .N25 1970.

(2) ________, Projections of Educational Statistics to 1978-79, OE 10030-69, L111 .N28 1978/79.

(3) U.S. Office of Education, Biennial Survey of Education in the United States 1938-40.

(4) U.S. Bureau of the Census, Statistical Abstract 1970.

benefits as they are revealed in private and social rates of return.

There is some evidence which shows that in general private educational choices are privately efficient in the sense that the private rate of return to higher education tends to be comparable to the private rates of return to other private investments. Whether there are long standing disparities among private rates of return among the various educational opportunities requires disaggregation and analysis. The dynamics of the economy implies that certain disparities are inevitable. Richard Freeman's (1971) study, however, shows that as these disparities occur the lags in adjustment are relatively short. The efficiency with which public resources are allocated to the many part of higher education is another story. When it comes to equity consequences, the evidence is fragmentary; it is inconceivable, however, that they are neutral in their effects on the distribution of personal income.

The classical economists divided on the question of efficiency with respect to alternative ways of providing education (West, 1964). This long standing controversy is still with us (Beales, etal. 1967). Nor have the proponents of "equal educational opportunities" settled the problem of equity in distributing the benefits of education; like the proverbial needle, it is lost in the welfare haystack. disagreements, so it seems to me, suggest that we have not been asking the right questions. With respect to the United States, I have become convinced that the efficiency problem and the equity problem of higher education, especially so as they come to the forefront during recent decades are in large part the consequences of the dynamics of modern growth. This view implies the following question: Under the dynamic conditions that characterize our economy, how efficient are we in allocating private and public resources to higher education and in using these resources in producing educational services? The equity question, so it seems to me, should be formulated along similar lines.

Although it is obvious that these problems consist of disparities in the distribution of private and social cost and benefits, it is not obvious that these disparities are in part related to the developments that characterize modern growth. The central argument of this paper is that when an economy has arrived at an equilibrium that persists over an extended period, the efficiency disparities tend to become small. Whereas under conditions of modern growth, disequilibria are the order of the day and, although adjustments are made, new disparities emerge and dominate. Approaching growth via the process of investment, what is required ideally is a generalized optimal investment model that encompasses both human and nonhuman capital and that accounts for all of the nonmarket benefits including the personal satisfactions that accrue to students from their investment in higher education. But we will have to settle for less because of the limitations of the state of economic knowledge. What I shall attempt, in view of these limitations, is to develop an approach to these problems that treats them mainly as growth problems. My plan is to examine the following four interrelated issues: (1) three economic growth-education puzzles; (2) the rise in the student's opportunity cost and in his allocative benefits associated with growth; (3) the growth related enlargement of the student's capacity to finance and to benefit from education; and (4) the equity-efficiency quandary in a growing economy.

I. Investment in Education and Growth: Three Puzzles

Growth is not an equilibrium state. For the purpose at hand, growth implies responses to investment opportunities in acquiring additional income streams at a price that is lower than the equilibrium price. In terms of investment decisions, growth is a consequence of the allocation of investment resources in accordance with the priorities set by the relative rates of return on alternative investment opportunities. The reciprocal of the highest rate of return option is in theory and in fact the lowest price of additional growth. Investment in human capital by means of higher education occurs on the one hand as a response to the demand derived from growth, and on the other, it is a contributor to the growth of an economy. The particular high levels of ability associated with higher education are in all probability complementary with the new, superior material inputs that have their origin in the advances in the sciences and the associated developments in technology. Then, too, modern research and development activities are dependent upon particular subsets of these high levels of abilities.

Thus, a satisfactory theory of economic growth should explain the mechanism that determines the formation of human and nonhuman capital including the accumulation of knowledge.[2] Razin's study (1969) is an extension of growth theory along these lines. Growth theory, however, should also explain the sources of the investment opportunities that maintain the growth process; sources that keep it from settling into a stationary long run equilibrium. It is the more difficult part of growth theory and it is lacking.

In thinking about the economics of education, I find it instructive to distinguish between the investment mechanism that determines the formation of capital and the sources of the new investment opportunities that account for growth. The mechanism appears to be sufficient in explaining various puzzles pertaining to the interactions between growth and education. In retrospect, taking the long view, there are three puzzles: (1) Why has the accumulation of human capital represented by education occurred at a higher rate than that of non-human capital? (2) Why has the difference in relative earnings between workers who have little education and those who have much of it decreased? (3) Why is it that as growth proceeds the inequality in the distribution of personal income shows signs of decreasing?

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[2] Useful knowledge that is appropriated, can be treated as capital, but knowledge that enters the public domain and is available to anyone is another matter (Schultz, 1971, Chapter 12).

There is some evidence. Human capital consisting mainly of education accounts for a smaller part of the production (income) in the less developed than in countries classified as developed. This fact implies that as growth proceeds/the complementarity and substitution among factors are such that the role of human capital becomes increasingly more important. Krueger's study (1968) is most telling on this point. In explaining the large absolute difference in per capita income between poor and rich countries in terms of factor endowments Krueger concludes, "that the difference in human resources between the United States and the less-developed countries accounts for more of the difference in *per capita* income than all the other factors combined." The attribute of human resources that matters most in her study is education. My estimates of the average annual rates of increase of different stocks of capital between 1929 and 1957 in the United States provide some additional evidence. (Schultz, 1971, Table 5.1.)

	Annual Rate in Percent
1. Reproducible tangible wealth	2.01
2. Educational capital in the labor force	4.09

For the period from 1900 to 1957 a related set of estimates show that the educational capital in the labor force rose sharply relative to the stock of reproducible nonhuman capital; it was 22 percent as large as the nonhuman capital in 1900 and by 1957 it had risen to 42 percent (Schultz, 1971, Table 8.5). Here the implication is that the rate of return to education was sufficiently higher than the rate of return to reproducible n..human capital to have induced this pattern of investment. Although there are no clues in this evidence of the sources of this favorable rate of return to the investment in education, it supports the presumption that investments were responding to opportunities that imply disequilibrium, and the further presumption that there have been continuing sources of new opportunities that have kept the rates of return from settling into a long run equilibrium state.

Turning to the next puzzle, what is it about growth that reduces the relative earnings between workers who have little and those who have much education? The extent and the sources of the disparities in earnings in Bombay City (India) and the United States have been investigated by Kothari (1970). His data by occupations and education appear in Table 2. His summary of the income ratios with the earnings of unskilled workers as the base (equal to 1.0) is as follows:

> . . . the relative income ratios for skilled manual occupations in Bombay as well as the United States were 1·4. The Bombay ratio for clerical personnel was 2·1, as against 1·5 for the United states, i.e., nearly 50% higher. For lower professions the Bombay ratio was 25% higher than the United States ratio. For Higher Professions the ratio in Bombay was 7·8 as against the United States ratio of 3, i.e., nearly 2 1/2 times as high. The differences in ratios in case of business and government executives in higher posts were even sharper. The Bombay ratio was 11·2, as against the United States ratio of 2·4. This contrast is all the more striking in the light of the educational content of different occupations. In Bombay City an unskilled worker had only 2 years of schooling while the clerical workers had 10·3 years of schooling. The corresponding figures for the United States were 8·2 years and 11·6 years. For the skilled manual occupations the years of schooling were 3·7 in Bombay and 9·5 in the United States.

The real puzzle, however, is the very much higher relative income ratio in Bombay for the higher professions and the higher posts in business and government although relatively to the clerical personnel the additional schooling was of a very similar duration in Bombay and the United States.

I see four inferences with respect to growth and education that are supported by Kothari's study: (1) As growth increases the general level of earnings, the absolute differences in earnings by education increase, and it is well known that the returns to education depend not on the relative differences but on the absolute differences in earnings. In Bombay, although college graduates were earning twice as much as matriculates, this difference was only 323 rupees (per month), whereas in the United States college graduates were earning $4,158 (per year) more than high school graduates (Kothari's data); and his estimates of the private rates of return are about the same, i.e., 12 percent for the United States and 14 percent for Bombay. (2) Restrictions on entry into the "Higher Professions" are more telling in a less developed country such as India than in the United States. Among the college graduates in Bombay, those who had managed to enter the "Higher Professions" were enjoying a 33 percent private rate of return presumably because of an array of restrictions to entry including barriers associated with the caste system and the lack of facilities for engineering and medical education. (3) Higher education in the less developed countries tends to be more elite oriented and less subject to competition than that in the United States where higher education has become more and more mass oriented.

TABLE II. Mean Income, Relative Income Ratio and Education in Bombay City (1955, 1956) and the United States (1959) (Males) by Broad Groups of Occupations.

Occupation	Mean income Rupees per mo.	Mean income $ per year	Relative income ratio		Years of Schooling	
	Bombay City	U.S.	Bombay City	U.S.	Bombay City	U.S.
Higher professions	622	9,890	7·78	3·00	15·1	15·7
Business & government executives in higher posts	897	7,831	11·21	2·37	13·0	12·7
Lower professions	207	6,628	2·59	2·01	10·0	13·0
Subordinate officers in business & government	261	6,935	3·26	2·10	10·6	11·6
Clerical personnel	168	4,902	2·10	1·49	10·3	11·6
Skilled manual occupations	110	4,627	1·38	1·40	3·7	9·5
Unskilled manual labor	80	3,301	1·00	1·00	2·0	8·2

Source: V.N. Kothari, "Disparities in Relative Earnings Among Different Countries," Economic Journal, 80, September, 1970, Table II, p. 609.

(4) In adjusting education to the dynamics of growth, competition in providing educational services is an important institutional requirement.

Kuznets devoted his American Economic Association presidential address to growth and income inequality pointing out that there are long-term trends toward less inequality and noting that the reduction in this "inequality in the secular income structure is a puzzle." (1955). His 1963 study advances the quantitative analysis of these trends, and then in his Modern Economic Growth (1966) the explanations that are advanced emphasize the relative decline in income from property accompanied by a compensatory relative rise in income from the "greater investment in training and education" (p. 218). Thus, presumably, growth alters the functional distribution in a manner that reduces the inequality in the personal distribution of income. Mincer (1958, 1970) and Chiswick (1967, 1971) provide both theory and evidence in explaining this process.

In summarizing my interpretations of the role of growth in the above three puzzles, the conclusion is that as growth proceeds investment in education occurs at a higher rate than investment in nonhuman capital, in response to the investment mechanism with rates of return that tend to be favorable to investment in education, that the rise in the general level of earnings is accompanied by sufficiently large absolute differences in earnings to make the investment opportunities in education relatively attractive, even though the difference in relative earnings between unskilled and skilled workers declines, and that one of the long-term effects of this growth, as rates of return tend toward equality, is to reduce the income inequality within countries. Furthermore, as growth proceeds, education becomes less elite and more mass oriented and the organization of education, especially that of higher education, acquires increasingly the attributes of competition.

Although each part of this conclusion is derived from the investment mechanism of growth, the mechanism by itself tells us nothing about the sources of the investment opportunities that have maintained the growth process. Despite the vast accumulation of capital from the long continuing, ever more investments, diminishing returns to investment have not prevailed in bringing about a long run general equilibrium as traditional theory would imply. The critical unanswered question about growth is, what are the sources of the new investment opportunities that have counteracted the theoretically expected tendency toward diminishing returns to investment? Let me advance the following hypothesis: The acquisition of additional knowledge that becomes useful in reducing the cost of production and in enlarging consumer choice accounts in large part for the continuation of growth. Since the "production" of knowledge also requires scarce resources, it has the attributes of an investment.[3] Research oriented universities are among the major contributors to the advances in knowledge (Schultz, 1971).

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[3] (See page 12 a.)

[3] My critics have urged me to extend my comments on this issue. I shall, however, forego this opportunity because it would require a major paper to develop the analysis and because I have in Chapters 1, 2, and 12 (Schultz, 1971) examined some aspects of this issue. Suffice it say here, that the argument that has been underway in Science among scientists beginning with Bentley Glass on "Science Education-Process or Content?," March 5, 1971, is not helpful. While it is obviously true that the acquisition of additional knowledge is in some ultimate sense subject to diminishing returns to argue that the "exponential growth (of science) is self-limiting" is rather pointless in clarifying the funding of science in a world of scarce resources.

II. The Rise in Opportunity Cost and in Allocative Benefits Associated with Growth

One of the attributes of economic growth is that it increases the value of time and the earnings foregone by students tend to rise. Another attribute of growth is that it affords new production and consumption opportunities and, as a result, there are benefits to be had by responding promptly to these opportunities. Education is not organized to take account of earnings foregone and our studies of the returns to education tend to omit the particular class of benefits here under consideration. Moreover, both of these components have efficiency and equity implications.

With respect to cost, although most economists in analyzing the rates of return to education include earnings foregone as a cost, they are not taken into account in educational planning. Earnings foregone do not appear in official educational statistics. It is fair to say that in determining educational policy, in authorizing programs, and in allocating resources to finance education, we go merely on not reckoning earnings foregone although they are well over half of the real cost of higher education. Despite the marked upward trend in the value of the time of students, there appears to be virtually no awareness on the part of educational administrators and faculties of the economic implications of this development. There is no search for ways of economizing on the time of students; instead, there is a waste of the time of students. The traditional standard of four years for a bachelor's degree that is enforced regardless of the differences in the rates at which students can perform because of differences in their capacity to learn and regardless of the increases in value of the time of students, is an inefficient standard.

Among the benefits of education there is an allocative benefit that is determined by the ability to respond to the opportunities afforded by growth. This particular benefit increases with the rise in the level of education; that is, the response to the new opportunities is slowest for the least educated persons and it increases with education. In production the allocative benefit accrues initially to those persons who are among the first to respond; then, under competition, it is transferred and accrues to consumers sooner than had the production response occurred more slowly. Economists in their studies of education, with a few exceptions, have put this class of benefits aside although they are of major economic importance. The approach has been in estimating the life-time earnings function from cross-sectional earnings data associated with education to adjust this function downward for growth over time on the assumption that the rate of growth is wholly independent of the allocative behavior of educated people.

The main argument of the first section of this paper is that growth favors the investment in education. The converse is also plausible, namely, that if the economy were to experience no growth for an extended period, the benefits from education would decline. The reason is that less education would suffice as economic life becomes more placid. The disequilibria that are the result of growth would diminish and fewer economic adjustments would be required because the domain of economic activity would become more routine in character. It follows that the economic value of one of the abilities developed by education is not only dependent upon growth, but it also contributes to growth. It is the ability to discern the new opportunities, evaluate them, and to act promptly and effectively in taking advantage of them. These are opportunities that are inherent in the disequilibria associated with growth. It is my contention that the contribution of this particular ability to growth is omitted in reckoning the benefits of education.

The discovery of the allocative benefit here under consideration owes much to the perceptive treatment of the "allocative effects" of education by Welch (1970). His conceptual distinction between the worker effect and the allocative effect of education in production is clear and cogent. To the extent that increases in "education enhance a worker's ability to acquire and decode information about costs and productive characteristics of other inputs," there is an allocative effect. His argument is that in a technically dynamic economy, educated persons are more adept at critically evaluating new opportunities and that they can distinguish more quickly between the systematic and random elements in such an economy, and for these reasons they are more productive than uneducated persons. In addition to Welch's evidence in support of the allocative effects hypothesis drawn from U.S. agriculture, there is the evidence provided by Chaudhri in his studies of education and the productivity of agriculture in India (1968, 1969).

The allocative benefits from this particular ability developed by education is not restricted to farmers in the modernization of agriculture. There are reasons for believing, and there is some evidence that they are pervasive under the dynamic conditions of growth. Schwartz (1968) found that differentials in life-time earnings provide a better explanation of migration than do the differentials in current earnings and that the response to the differences in life-time earnings is lowest for the least educated persons and it increases monotonically with education. His findings are consistent with the hypothesis that one of the effects of education is to reduce the cost of obtaining information about job opportunities. The O'Neill study (1969) confirms Schwartz's results with respect to responses to job opportunities. She also found that the effects of consumption opportunities upon migration show a comparable pattern of response by education.

My interpretation of the results obtained by Freeman (1971) showing relatively short lags by college students in adjusting to changes in job opportunities among the fields in which they specialize, is that these results also support the argument that there are allocative benefits associated with education.

Turning to the household and the effects of the education upon the management of the household, Michael's study(1969) shows that the efficiency is lowest for the heads of households with the least education and it increases with their education. Here, too, in responding to new consumer opportunities that come with growth, one of the effects of education would appear to be a reduction in the cost of acquiring information about these opportunities. At every turn in the application of the new micro (household) approach to fertility (population), the woman's education appears to be a strong explanatory factor in connection with the wage effect, the efficiency effect in the household, and the contraception effect.

What then are the efficiency and equity (income distribution) implications of these allocative benefits? In production, as better production possibilities become available, the allocative benefits are the sum of two parts: (1) the benefits that accrue to the educated person as a reward for his expeditious response to the opportunity, and (2) the benefit that accrues to the consumer sooner than it would have had the production response occurred with a longer lag. The logic of economics implies that under the assumption of competition, the opportunities that arise as a result of growth disequilibria will be fully realized when equilibrium is attained. The educated person who is capable of exploiting such opportunities first (fastest) stands to gain relative to those who respond less expeditiously. Then as these opportunities are realized under competition the gains, for example, from a set of better production possibilities, are transferred to intermediate and through them to the final product where they become consumer surpluses. The consumer acquires these surpluses soonest where the responses in production occur with the shortest lag. Herein lie the consumer's part of the gain from the allocative benefit attributed to the education of producers.

Welch's (1970) study provides a useful framework by way of summary. In production the distribution of the allocative benefits among producers depends on the differences in their ability to respond. Welch found that the more educated farmers have an advantage compared to the less educated farmers in responding to the dynamics of growth. The sooner the better production possibilities are attained, the sooner the additional efficiency from them is added to the real income of the economy. The resulting reductions in real factor cost are thus transferred to consumers in terms of lower food prices, and as a special case, when this occurs in agriculture it tends to improve the income position of low income non-farm families relatively more than that of higher income families. Thus, to some extent, in the case of agriculture, this process under competition reduces the inequality in the distribution of personal income in general, although it tends to widen the inequality among farm families.

III. Enlarging the Student's Capacity to Finance and Benefit

Turning to the investment by college students in their own human capital, I shall examine a set of attributes of economic growth with a view of determining their effects upon the capacity of students to finance and to benefit from higher education. I shall treat the student (family) as a firm, his capacity to finance as the supply and his capacity to benefit as the demand. Although institutions and policy are also altered by growth, I shall abstract from these alterations. I shall concentrate on the investment decisions of college students (families) in acquiring human capital by means of some form of higher education for which they incur costs and from which they obtain benefits. The primary growth attributes to be examined are (1) the rise in the personal income of families, (2) the enlargment of the capacity of students to learn, (3) the increase in the value of time, and (4) the improvements in the entrepreneurial ability of students including the allocative benefits they obtain in managing their investment decisions.

The connection between the value of the student's time and his earnings foregone has been examined briefly in part II. Likewise, the importance of the allocative benefits that increase with education under conditions of growth is formally clear and consistent with a growing body of evidence. Earlier in this paper, in accounting for the higher rate of investment in education than that in nonhuman capital, we found that economic growth favors the investment in education. In solving the puzzle of the narrowing of relative earnings between those with little and those with much education, we were led to reaffirm the fact that it is the difference in absolute earnings, not the relative difference, that accounts for the investment opportunities in successive levels of education.

My approach to the changing pattern of the supply curve and demand curve here under consideration is basically the optimal investment in human capital model developed by Becker (1967). The demand curve represents the marginal benefit measured by the rate of return to the student on each additional dollar of investment, and the supply curve the marginal financing cost measured by the rate of interest on each additional dollar invested. I shall extend the Becker model somewhat in treating the attributes of economic growth.

The rise in the personal income of families is the key attribute of growth that alters these supply and demand curves over time. The number of students and their respective marginal financing cost accounts for the aggregate supply curve and their respective marginal benefits account for the aggregate demand curve. The general direction of the changes in supply and demand as income rises can be inferred. If institutions and policy remain constant and if the distribution of personal income remains unchanged, or becomes less unequal, it follows that as incomes rise, the marginal financing cost declines, and the per student[2] supply curve shifts down and becomes

[2] I shall focus on the supply or demand curve of the average per student of a composite of students and thus leave aside the increases in the number of students that occur over time.

more elastic. More important, however, in determining the increases in investment in higher education associated with growth, is that the rise in income under these conditions increases the marginal benefits from higher education and the per student demand curve shifts up.[4] The inference with respect to the supply as personal incomes rise is fairly evident, but that pertaining to the demand is far from obvious and it is in general neglected in examining the economics of higher education.

Changing Supply Curves

These supply curves, following Becker, do not reveal the cost of producing college education. They represent the marginal cost borne by students (families) in financing additional units of education. To simplify the analysis, I shall treat the distribution of personal income as a dichotomy consisting of families who are rich and those who are not rich. Thinking in terms of U.S. incomes, I shall arbitrarily classify all families who have had over a period of years a permanent income of $15,000 or more as being rich, and all of the families with less income than this as not rich.[5] I take it to be obvious that the

[4] The logic and evidence on this shift will be presented shortly.

[5] A fourth of the full time college students as of October, 1969, were dependents of families with $15,000 and over of family income during the preceding 12 months. Over half of them are accounted for by the families with $10,000 and over of family income. For a more detailed specification of concepts and characteristics of the sample, see Special Studies, Series P-23, No. 34, February 1, 1971, Current Population Reports, Bureau of Census, U.S. Department of Commerce. In considering policy choices, families with incomes between $10,000 and $15,000 may be viewed as "comfortably" rich in terms of their ability to finance the education of their dependents.

income and wealth of families who are that rich have sufficient resources to finance their students and that their own capital is the cheapest source. Moreover, the financial resources of these families are sufficient even if higher education were not subsidized, that is, if college students from these families were to pay the full cost of providing the education with no scholarships or fellowships and with no subsidized student loans. The characteristics of the per student supply curve of this set of families are as follows: (1) it is below that of families who are not rich, (2) it is relatively elastic, and (3) it is not segmented.

In the case of the families who are not rich, it is evident that many of them lack sufficient income and wealth to finance from their own resources the full cost of this education and that they accordingly are dependent for a part of the capital required on borrowed funds that entail relatively high transaction cost because of legal restrictions on lending to acquire funds to invest in human capital. It is for these reasons that the per student supply curve of students from families who are not rich is segmented and less elastic and above that of students of rich families.

The increase in the value of the time of students, as earnings rise with growth, obviously increases the student's cost of acquiring a college education. Thus, even though the cost of producing a unit of education by universities and colleges were to remain constant, the total cost that the student would have to finance would rise, and in the case of students from families who are not rich, for many of them the supply implications of the rise in earnings foregone are real and harsh.

Although the value of the time of students rises with growth, actual earnings foregone are held in check by more part time work on the part of students as they have during recent years in the United States which may however impair their education (Schultz, 1971, Chapter 7). Thus, the dominant factors that are shifting the per student supply curve down and making it more elastic are: (1) the increase in the proportion of all families who become rich with growth and (2) the rise in the personal incomes of the rest of the families which reduces the marginal cost of financing the education of their students.

Changing Demand Curves

The interactions between economic growth and the marginal benefits measured by the rate of return to students on each additional dollar of investment in higher education are complex and they have received all too little analytical attention. The key to the analysis is in the enlargement of the capacities of potential and actual students made possible by the rise in personal incomes. In examining this process with respect to changes in demand, I shall again appeal to the simplified dichotomy of rich and not rich families.

Two types of capacity come into play; they are the students' capacity to learn in benefitting from college work, and their entrepreneurial capacity in combining their own time with the services of teachers and that of other resources. I shall contend that the rise in personal incomes associated with growth results in additional expenditures by parents on behalf of their children that enlarge these capacities, and as this occurs the per student demand curve shifts up.

Presumably it is the task of geneticists, psychologists, and students of education to explain the changes and the differences among students in their capacity to learn. While it is exceedingly hard for economists to interpret their findings, it would be naive to treat the capacity to learn as if it were identical with innate ability. To do so can only lead to a serious misspecification of the factors that account for the observed differences in the capacity of the youth of college age to learn. A convenient framework albeit a much oversimplified one, is to treat this capacity as a product of both the innate ability and the acquired ability of the youth here under consideration. The amount of acquired ability is obviously dependent not only upon the years of schooling, but importantly upon the quality of the elementary and secondary schooling. Equally, if not more important, is the pre-school home environment and experience of the child which is in no small part determined by the education of the mother. It is nevertheless true that the rate at which these acquired abilities are accumulated depends in substantial part on the innate ability that each child inherits.

The proposition is here advanced that the proportion of the youth of college age who have this capacity to learn increases as relatively more of the members of this age group benefit from pre-college investments that adds to their acquired ability. At some point, however, as this process continues, the innate abilities that are required to benefit from college work will become exhausted. But it is hard to believe that we are close to this point, even though high schools have improved and most teenagers complete high school, preceded by improvements in elementary schooling and in the pre-school training and experience of children as the schooling of mothers moves up. All things considered, my interpretation of the available evidence is that the supply of this relatively high level of innate ability that is distributed among the college age population is as yet less scarce than the supply of acquired abilities that is necessary in providing a capacity that is sufficient to learn enough to warrant the investment in college work.

In supporting the above proposition, it is not necessary to assume that the distribution of innate ability of students from rich families is the same as that of students from families who are not rich. There has undoubtedly been some genetic drift in favor of the first of these two classes of families. But a conservative interpretation of the fragmentary evidence known to me is that this genetic drift accounts for only a small part of the observed differences in the capacity to learn between the youth from these two classes of families. This interpretation by no means implies that all or even most youth of college age, or that all who now enter college, have enough innate ability to benefit from college work measured in terms of the going rate of return to undertake the investment compared to alternative investment opportunities. On this score, my view of the facts is that the lack of sufficient innate ability is somewhat greater in the United States among college students from rich families than among students from families who are not rich. This difference between them is concealed, however, by the fact that the students from rich families are long on acquired ability whereas those from the other set tend to be short on the necessary acquired abilities. As of October, 1969, U.S. families with dependent members 18 to 24 years old, with dependents in college full time ranged from 66 percent for the rich families down to 16 percent for the very poor families. Surely no one would argue that this difference of 4 to 1 implies that the genetic difference between them is equally wide. The complete classification of families by income follows: [6]

[6] U.S. Department of Commerce, Bureau of Census, Special Studies, Series P-23, No. 34, February 1, 1971, Table 17.

Family income (in dollars)	Number of families with dependent members 18 to 24 years old (in thousands)	Families with dependents in college full time (in per cent)
Under $3,000	690	16
$3,000 to $4,999	940	24
$5,000 to $7,499	1,440	33
$7,500 to $9,999	1,470	42
$10,000 to $14,999	2,100	49
$15,000 and over	1,410	66
Not reporting	720	39
Total	8,770	42

Becker, in his perceptive and cogent argument on why the demand curves for human capital are negatively inclined and not horizontal (1967, pp. 5-9), digresses to suggest that persons investing in human capital are "firms." Since entrepreneurial time is required by students in combining their learning time with the services of teachers and that of other resources, the differences among students in their entrepreneurial capacities alters their respective demand curves. A part of the "profit" attributed to this capacity is an allocative benefit of the type presented in part II. This particular benefit increases for the same reasons advanced earlier, namely, from improvements in the quality and quantity of the schooling and pre-school investment of students because they enlarge this part of their entrepreneurial capacity. But the primary attribute of entrepreneurship is the capacity to cope with risk and uncertainty and the source of it is far from settled. It is probably true that in general students from poor families who have managed despite all manner of difficulties to acquire a college capacity to learn, possess more entrepreneurial capacity than students from rich families who have had at their disposal without stint or effort the best facilities and instruction in acquiring this capacity to learn.

In summary, the first conclusion of part III is that the per student supply curve that represents the financing cost of students who come from rich families is not altered appreciably by additional increases in their personal income resulting from economic growth. Their supply curve remains low, unsegmented, and relatively elastic. Since relatively more families, however, become rich to that extent the general per student supply curve is altered. The important change in the supply curve occurs as a consequence of the rise in the personal income of families who are not rich. For this class of families the supply curve shifts down, becomes less segmented and more elastic as growth proceeds. The general per student supply curve accordingly changes with growth in a similar manner to that of the class of families who are classified as not rich, especially so since they are the predominate class in the arbitrary $15,000 dividing line that I have imposed. (This figure is undoubtedly too high in considering the policy implications of this analysis.) It should be noted, once again, that this analysis rests on the assumptions that institutions and policies remain constant and that the distribution of personal income does not become more unequal with growth.

The second conclusion is that the demand curve representing the marginal benefits measured by the rate of return to students on each additional dollar of investment depends on their capacity to learn and on the entrepreneurial capacity of students. The sources of the capacity to learn are the innate abilities coupled with the acquired abilities; the supply of the first component is presently in our college age population less restrictive than the supply of the second component.

Here, too, the per student demand curve of dependents from rich families is not altered appreciably by additional increases in their personal incomes that come to them from growth. Their demand curve remains high and relatively inelastic. Since relatively more families become rich as growth proceeds, to this extent the general per student demand curve shifts up. The larger change in the demand curve takes place, however, as a consequence of the rise in the personal incomes of families who are not rich. The per student demand curve of this class rises and it probably becomes less elastic. The allocative benefits arising from the entrepreneurial capacities of students in managing their college affairs suggest a similar pattern of effects on the demand. But the sources and the consequences of the entrepreneurial capacity required to cope with risk and uncertainty are not clear.

IV. The Equity-Efficiency Quandary

Are we, because of our commitment to economics, not seeing the beauty of the higher education rainbow? Our concern about allocative efficiency and the welfare implications of the distribution of personal income serves us in choosing those issues that are amenable to our analytical skills. But this convenience would not make economics the right forum if the issues are matters of taste in appreciating beauty. It is undoubtedly true that the perplexities of higher education reach far beyond the economic calculus; higher education is an involved state of affairs that has become embodied in a large number of public and private institutions strongly rooted both socially and politically.

Although higher education has long been institutionalized in our society, there is much disagreement on the essentials of an ideal model of higher education. This lack of consensus arises primarily out of basic inconsistencies associated with the attributes that are deemed to be essential for higher education. The view that it should be free of any manner of government control and that public bodies should appropriate most of the funds for higher education are inconsistent views because government cannot abdicate its responsibility in accounting for the uses that are made of public funds. The view that ideally the services of higher education should be free to all qualified students is inconsistent with the will and capacity of private donors and public bodies to pay the bill. The incompatibility between "free" and "scarcity" is paramount in understanding this lack of agreement. It is little wonder that a major controversy is underway with regard to the goals of higher education that are appropriate to our democracy with its strong equalitarian values. The two goals at the center of the controversy may best be identified as "equal opportunity" and that of "optimal investment in higher education." The proponents of equal opportunity still dominate public discussions mainly because the investment approach has emerged out of economics only fairly recently. The proponents of equal opportunity appeal to the political process as the means for attaining their goal, primarily to the legislatures for appropriations and secondarily to the courts for legal standards and their enforcement. They overlook the limits of the enforcement powers of the courts and of the taxing and spending powers of the legislatures. As these limits become increasingly evident, the optimal investment goal has been on the ascendency in this controversy. While it is clear (to economists) that this shift with respect to goals sets the stage for more allocative efficiency, it is still a matter of doubt that it could also serve to reduce the inequality in the distribution of personal incomes.

I shall first comment on the argument that is made on behalf of the goal of equal opportunity in higher education. The basic postulate on which it rests is advanced as a "social principle"; i.e., equal opportunity in higher education is an established preference of society revealed by widely held and consistent social values of our people.[7]. The political process is the means by which equal opportunity in higher education is to be attained and the issues of allocative efficiency and those pertaining to the distribution of personal income are of secondary importance in this process. This argument, therefore, appeals to the legislative bodies and to the courts for remedies.

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[7]The prestigious reports of The Carnegie Commission on Higher Education are most explicit in propounding this social principle. See the report, "A Chance to Learn. An Action Agenda for Equal Opportunity in Higher Education," March, 1970.

I shall not belabor the weakness of the foundation of the "social principle" on which this argument rests. Suffice it to say that it is built on shifting sand for the simple reason that our social values as they are in fact revealed by the political process are not only far from consistent, but they fluctuate and change over time. The critical reason, however, why this argument leads to false conclusions arises out of the fact that it fails to take account of the limits of the judicial process in enforcing equality and of the legislatures in financing and administering equality of opportunity in higher education.

In Brown vs The Board of Education, the court in one its rare unanimous decisions argued that education today is perhaps the most important function of state and local governments and that success in life depends on the opportunity of an education. It said:

> Such an opportunity, where the state has undertaken to provide it, is a right which must be made available to all on equal terms.[8]

The lucid and cogent analysis of Kurland (1968) when applied to higher education in the United States leaves little room for doubt that "the Supreme Court is the wrong forum for providing a solution" for the problem of inequality in higher education opportunities. A part

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[8] The School Desegregation Case, 347 U.S. at 493 (1955) emphasis added, as cited by Kurland.

of the legal argument presented by Kurland is that there are three necessary conditions for the success of any fundamental decision of the Court. The constitutional standard must be a simple one, as it is in The Reapportionment Case: One man--one vote. The second condition is that the public acquiesce and clearly in the reapportionment cases, there has been an "unwillingness of any large segment of the population to do battle with it." The third condition is that "the judiciary must have adequate control over the means of effectuating enforcement." In satisfying this condition, the problem of enforcement of the "one man--one vote" principle has thus far not arisen, although should a case arise that applied this principle to the U.S. Senate, the Court would be in difficulty. Turning to equal opportunity in higher education, there is no simple standard. Universities are made to resist governmental authority and it is inconceivable that the judiciary could enforce such a fundamental decision in the area of higher education.

I take it to be obvious that the judiciary does not have the means of effectuating the enforcement of the principle, for example, as a part of it that all public colleges and universities provide the <u>same quality</u> of educational services. If the courts could enforce all public colleges and universitics throughout the United States to be the same in this respect, the results would be absurd. Moreover, if this principle could be enforced, students (families) who want the higher quality can escape by retreating to private colleges and universities and the courts would be incapable of preventing it. The powers of the courts are essentially negative and not affirmative. Kurland's quotation from Hamilton is indeed pertinent in considering the possibilities of attaining equal opportunity in higher education via the decisions of the judiciary: "The judiciary . . . has no influence over either the sword or the purse; no direction either of the strength or the wealth of society."[9] Herein lies the limits of the judiciary.

The legislatures hold the power of the public purse which consists of two parts: taxing power and spending power. The reports of the Carnegie Commission on Higher Education are oblivious of the limits of both of these powers. It is all very simple: the state and local authorities should increase their appropriation for higher education tc $7 billion by 1976-77 and that the federal government should jump its contribution from $3.5 billions (1967-68) to $13 billions by 1976-77-- as if there were no limits to the taxing powers of the respective legislatures. Nor is there any analysis of the effects of this financing proposal upon the control by the federal authority over the affairs of higher education. The current confusion over the sharing of federal revenue brings to the fore the problem of developing politically acceptable standards of control along with the problem of the federal

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9 From The Federalist, No. 78, as cited by Kurland (1968).

government administering, over the whole of the United States, the spending of vast federal funds in accordance with such standards. Clearly, the spending power of the government also has its limits. Since these limits arise out of the scarcity of resources, their allocation and the uses to which they are put, economics is to this extent not the wrong forum for providing solutions for the problems here under consideration.

Returning to the quandary, surely the instructional service of higher education embodied in the student is not a public good inasmuch as a "pure public good is one for which enjoyment by one individual does not in any degree exclude the enjoyment" by others (Johnson, 1969). With somewhat less assurance, I would contend that a college graduate generates only a few externalities that accrue as benefits to other persons, with one major exception, namely the education of the woman gives her children an important benefit in terms of pre-school training and experience. It is internalized in the family, however, as I shall point out below. I take it to be self-evident that the differences in the quality of educational services among colleges and universities are inconsistent with the "principle" of equality of opportunity, and more important, that preferential treatment of qualified students who are in need has a priority over the equal treatment of all students. If these conditions and propositions are granted, a good deal of progress can be made in clarifying the underlying perplexities of higher education that account for the existing inequities and inefficiencies.

Higher education is not organized to bring about an optimal investment in its instructional services. The source of the difficulty is in the financing, pricing, and supplying of these services. The financing tends to subsidize the wrong educational activities, the pricing bears no meaningful relation to the differences in the costs of producing the services, and the suppliers of these services are therefore substantially sheltered from the disciple of competition, notwithstanding the large number of colleges and universities in the United States. Current endeavors to cope with the financial adversities arising out of the pause in the educational boom of the sixties are efforts to "save" the existing organization. They are not seeking solutions for the basic underlying difficulty that has become increasingly acute, especially so since World War II as a consequence of economic growth which is revealed in the fact that personal per capita disposal income in 1958 prices has doubled since 1940.

The reasons for the failure to comprehend the sources of organizational difficulties confronting higher education can be put quite simply. Although it is obvious that most families in the United States, who have members (students) enrolled in higher education, now have the income and wealth to pay the full cost of the education, it is not obvious that the allocation of public revenue (even if all of it were collected by means of progressive income taxes) to subsidize all publicly supported college and university instruction is bound to be socially inefficient, that the optimal investment in this form of human capital is basically dependent upon the micro decisions of students functioning as firms which are as efficient as any other large set of private firms, that the underpricing of the instructional services to all students in supplying them with these services thwarts the possibility of the privately efficient investment decisions of students in bringing this sector of the economy into a socially efficient state, and that in the area of instruction the proper function of private gifts and public funds is in financing and subsidizing in accordance with some socially agreed upon standards the qualified students from low income families (and of on-campus research).

In support of the proposition that private educational choices of college students are privately efficient, there is a growing body of evidence which shows that the private rates of return tend to be equal among educational options and that they tend to be comparable to the private rates of return to other private investment, ranging in general between 10-15 percent since 1939 (Becker, 1964; Schultz, 1971). The widely-held belief of the critics of this interpretation who maintain that college-oriented students are too immature to be informed with respect to the economic value of the fields in which they might best specialize is far from valid. The short lags in their responses to changes in job opportunities for the various specialized skills leave little room for doubt that college students become informed about these opportunities and respond to them fairly promptly as Freeman's study clearly shows (1971). The large shifts during the sixties on the part of Negro college students with respect to the fields in which they specialize, away from teaching and toward business, law and engineering where this option is available, as Freeman's ongoing work reveals, strongly support the responsiveness of these students to changes in job opportunities.

In citing this evidence, I am not implying that all of the youth of college age, who have the necessary innate ability, have had the opportunity in their pre-college schooling to have accumulated the necessary acquired ability to qualify for college, or that all who have the necessary capacity to learn at that age can finance the cost of a college education, or that those who enter college can obtain adequate information to determine fully the differences in the quality of the educational services among fields and among the institutions that provide these services.

To see more clearly the extent to which our system of higher education is socially inefficient in terms of optimal investment, it may be helpful to compare it with a hypothetical system[10] designed

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[10] I am prompted in suggesting this hypothetical system by the example of higher education in Turkey. A.O. Krueger's study (1971) informs us that in Turkey "the costs of a university education borne by the student are probably negative." Tuition charges in public universities are nominal, and there "are a host of special concessions available to students; special low fares on intracity bus transportation; subsidized lunches, and sometimes even highly subsidized housing; half-price cinema tickets, etc. Scholarships average about 50 percent of foregone income." Thus it comes as no surprise that "the disparity between the private return and the social return is remarkable. . . . While it does not pay, socially, . . . it is privately very profitable to attend college."

to be perfectly inefficient socially. The requirement would be free tuition, free board and room, free transportation, and a monthly payment to each student to compensate him fully for his earnings foregone adjusted, of course, for the difference between the free board and room and the cost of living were he to take a job. On-campus living would become a way of life for students and it would have life-time possibilities once terminal dates were abolished and free child care centers for the children of students were assured. Unless some social purpose were served by maintaining college students in this privileged manner, the rate of return on the cost borne by society would be zero.

Compared to Turkey, higher education in the United States must be grossly antisocial! Tuitions and fees charged by private institutions have risen from \$210 in 1940 to \$ 1030 in 1968 per student.[11] Even the cherished free tuition banner of public institutions

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[11] Not all private institutions charge anywhere near this much. At Berea College, for example, there are upper income limits on the admission of students and there are no tuition charges. The income limits start at \$4,000 for a family of one child and go up to \$8,500 for a family with seven children--with two exceptions: children of the faculty at Berea attend tuition free as do the students who are admitted from families in the small town of Berea, which has a population of 6,000. Thirty-six percent of the students come from families with less than \$4,000 income, another 31 percent with incomes between \$4,000 and \$6,000, 19 percent from families between the \$6,000 and \$8,000 range and then 10 percent from families with incomes between \$8,000 and \$10,000. Thus 96 percent of the enrollment is accounted for. Berea's enrollment is concentrated at the lower tail of the income distribution whereas higher education is in general heavily weighted towards the middle and upper range of family incomes.

has become slightly tattered; for their tuitions and fees have risen from \$ 69 to \$ 250 per student during this period. (Four state universities, however, still charge no tuition.) Tuition and fees minus financial aids per student in 1968 were \$ 850 in private and \$ 182 in public institutions. Board and room are generally subsidized, more so at public than at private institutions, but the amount of the subsidization is a well kept secret. But all told, what students pay the colleges and universities is the smaller part of the direct educational costs per student. (See Table I.)

Although it may not be obvious, the logic of economics clearly implies that the solution of the inefficiencies and inequities here under consideration is not in simply allocating more state and federal funds in support of higher education even though all such funds were collected by highly progressive taxation.[12] The problem to be solved is in the choice of educational activities that are to be subsidized by such funds. For example, since university research that is primarily "basic" in character is indeed a public good, it must be subsidized if it is to be undertaken. In supporting needy students, subsidies are required. But for the subsidization of such students to be allocatively efficient, it must go directly to the students and not into the funds of colleges and universities, leaving it to them to distribute the financial aid to students by all manner of standards. Until the choice of educational activities that require subsidization are identified and the amounts

[12] Surely economists would agree that the economic inefficiencies and gross inequities associated with the several billion dollars of federal funds that are allocated annually to U.S. farmers cannot be remedies by increasing the progressivity of federal taxation. The same logic applies here to higher education.

required determined, to simply proceed in allocating even more funds to subsidize all students is not only socially inefficient but grossly inequitable.

One of the necessary conditions in developing a socially efficient system of higher education is full cost pricing of each of the different classes of instructional services, modified (reduced) in the amount of known social benefits if, and only if, the social benefits are ascertainable and worthwhile in terms of the going rate of return on alternative investment opportunities (Hansen and Weisbrod, 1970).

Yet, for all manner of reasons, it is widely held that the economic logic of full cost pricing, as modified above, is impractical, unrealistic and contrary to all historical experience. It is deemed to be wrong by the proponents of equal opportunity in higher education. It is viewed with suspicion by the rank and file of faculty, by college and university administrators and probably by many of the members of legislative bodies. The students self-serving interests, however rich they may be, in demanding that everything they want be free, is understandable, not seeing that it would be at the expense of other persons in society.

It may be true that virtually all colleges and universities have always been subsidized and that there may have been good and sufficient reasons for this traditional practice having become institutionalized. But it is also true that institutions that perform economic functions, as I have attempted to show in "Institutions and the Rising Economic

Value of Man," become obsolete (Schultz, 1971, Chapter 13). Higher education clearly is not an exception. Another strongly-held view is that it is impossible to determine the real costs of each of the many classes of the services (educational) that students receive from the university. It is true that the economic accounting within a university is not designed for this purpose. But it is no more impossible than it is for firms that are producing a complex set of different products, many of which are joint products of many different production activities within such firms. Necessity imposed by competition makes it possible.

There is then the argument that full cost pricing of the instructional services would reduce the supply of college graduates far below the demand for persons with these particular high skills. Recent graduates who specialized in the sciences may now be entertaining the thought that the supply is all too large; but these ex post thoughts in view of the present depressed market for these particular skills have no bearing on the argument. The full cost implications of the direct educational expenditures per students in 1968 (assume that students from rich families paid it) are that tuition and fees per student would be increased from $490 to $1820 (see second panel of Table 1). When earnings foregone are taken into account it would increase the cost to these students about two-fifths. Meanwhile, the approach taken here is that more students from low income families would be subsidized. Even so the supply may be reduced somewhat, sufficiently to bring the intercept up along the demand curve where the returns to the investment would again assure the going rate of return on alternative investment opportunities. The adjustments would take place with a relatively short lag in view of the known responsiveness of students to changes in the economic value of these forms of human capital.

As a last resort, there is always the argument that the social benefits of higher education are not only ever present, but that they are large and all-pervasive in bringing about gains in productivity from which the non-college population benefits and in improving the quality of life. Although these claims have been with us for ever so long, they continue to remain vague and unsubstantiated. They have the ring of special pleading for more funds to maintain the existing system of higher education as it is. The class of social benefits, to which I referred earlier, is not among those that are commonly advanced. It has come to the fore only recently as a result of the extension of economic theory to analyze the micro economics of the household which has lead to some preliminary empirical work that strongly suggests that the rise in the education of women results in their becoming more efficient in the start that they give their children during their early years. But even this important "social" benefit accrues in large part to the parents in terms of satisfactions. Moreover, and to repeat, most families have sufficient income and wealth to pay for this particular value added to the female members of their families. But the existence of this class of "social" benefits argues for the subsidization of needy students whether they are males or females.

Concluding Remarks

My analysis implies that the rise in personal incomes associated with economic growth, which has doubled real personal incomes in the United States since 1940, makes the traditional financing, pricing, and supplying of the instructional services of higher education ever more obsolete. The general conclusion is that the instructional part, especially undergraduate instruction, has become increasingly less efficient socially and that an inordinate part of the subsidies to higher education are used to provide these educational services below cost to students from families who have the income and wealth to pay the full cost. Thus, in providing instruction, higher education is in general both socially inefficient and inequitable.

I am aware that my analysis at a number of points rest on evidence that is still fragmentary. A critical point throughout the analysis is the interpretation of the evidence at hand that college students are privately fairly efficient in investing in themselves. Then, too, if the personal distribution of income, as per capita income has risen, has become in fact more unequal it would undermine a part of my argument. If colleges and universities were allocating a substantial and an increasing part of the funds they receive from public and private sources to provide college instruction in subsidizing needy students, it would impair my conclusions with respect to social inequities. If the supply curves, i.e., the capacity of students to finance the cost of the education, were becoming more segmented, less elastic and were moving upward over time, despite the rise in personal incomes, it would weaken my argument appreciably. Similarly, with respect to the demand curves, i.e., the capacity of students to benefit sufficiently from the education to warrant the investment, if these demand curves were not moving upward as personal incomes rose, the argument would lose some of its strength. Although the allocative benefits associated with education imply that there are gains from them that are transferred to consumers, I have not treated these particular gains as social benefits because in the process of adjusting to the dynamics of a growing economy, less educated persons may become less well off in competing with the more educated persons. If this were not true, there would be a part of these allocative benefits that should be treated as one of the social benefits of education. In closing, the point with which I started this paragraph rests squarely on the concept that students behave as economic firms. The validity of the underlying assumption of this concept implies an hypothesis that awaits more complete testing.

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