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Samuel Bowles; Valerie I. Nelson

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THE "INHERITANCE OF IQ" AND THE INTERGENERATIONAL REPRODUCTION OF ECONOMIC INEQUALITY

Samuel Bowles and Valerie I. Nelson*

I. Introduction

THE growing disillusionment with compensatory education and other anti-poverty programs has given new life to an old theme in United States social theory: the poor are poor because they lack mental skills. Their poverty is particularly intractable because it is rooted in the genetic structure inherited from their parents who were also poor and "mentally deficient."¹ An explanation of transmission of economic status from one generation to the next is thus found in the heritability of IQ. The idea is not new: an earlier wave of genetic interpretations of economic and ethnic inequality followed in the wake of the failures of the purportedly egalitarian educational reforms of the early 20th century Progressive Era.² The liberal environmentalist counterattack against these interpretations was highly successful; among social scientists, and in the public eye, the genetic position was largely discredited.³ Since the late 1960's, however, public disillusionment with egalitarian social programs has

been enhanced by the dissemination of the heritability research of Burt, Jensen, and others, supporting the scientific claims of the genetic interpretation of racial inequality and intergenerational immobility.⁴ Further evidence has been found in studies such as the Coleman Report which seemed to indicate that scholastic achievement in schools is not greatly influenced by the level of educational inputs and that differences among children prior to school entry explained most of the nonrandom variance in test scores.⁵

The version of the genetic argument to which we will address ourselves may be summarized by two propositions: First, that IQ, as measured on standard so-called intelligence tests, is highly heritable, and second, that IQ is a major determinant of income, occupational status, and other dimensions of economic success. If both propositions were correct, it could easily be shown that intergenerational immobility, as measured by the correlation between the economic status of parents and their (adult) children, is attributable in large measure to the genetic inheritance of IQ and its role in determining economic position.

The first proposition—concerning the heritability of IQ—has received careful scrutiny; in fact, the current debate on IQ has been dominated by a concern with IQ's heritability, virtually to the exclusion of questions concerning its economic importance.⁶ In this paper we

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¹ Jensen (1969) begins his article on the heritability of IQ with: "Compensatory education has been tried, and apparently it has failed." The most explicit statement of the genetic interpretation of intergenerational immobility is Herrnstein (1971). For a critical review of Herrnstein's interpretation, see Bowles and Gintis (1973).

² Michael Katz notes the historical tendency of genetic interpretations of social inequality to gain popularity following the failure of educational reform movements (Katz, 1968). On the rise of the genetic interpretation of inequality towards the end of the Progressive Era, see Karier (1972).

³ See, for example Hunt (1961).

⁴ See Jensen (1969) and Burt (1958). For a critical review of Jensen's and Burt's estimates, see Light and Smith (1969), Jencks et al. (1972), and Kamin (1973).

⁵ Coleman et al. (1966). A critique of statistical bases of the Coleman Report can be found in Bowles and Levin (1968 and 1969). See also Mosteller and Moynihan (1972).

⁶ Information on the economic success or failure of individuals at either extreme of the IQ distribution—such as the data invoked by Herrnstein—tells us virtually nothing about the overall economic importance of IQ as a determinant of an individual's place in the distribution of income or stratification system.

will turn to the second proposition and investigate the role of IQ as a determinant of educational attainment, occupational status and personal income. In the next section we will develop a simple model which will allow us to isolate the role of IQ in the process of intergenerational status transmission. We will stress the importance of adopting a correct treatment of the problems of measurement error and misspecification of the fundamental equations. In section III we will estimate this model using data from samples of white adult male workers. In section IV we will note some particularly troublesome deficiencies of the data used, and attempt a number of checks on our results. The conclusions are summarized in the last section.

Limitations of both a conceptual and empirical nature are unavoidable in a study of this type. The estimates presented below should therefore be viewed with circumspection. However, the following three propositions appear to be reasonably well established. First, independently of socio-economic background, childhood IQ appears to exercise a substantial direct impact upon years of schooling attained but not on income or occupational status. Second, considering both direct and indirect effects, variations in inherited IQ are less important than variations in socio-economic background as a determinant of educational level, occupational status, or income. Third, even without questioning the purportedly high heritability of IQ, our results imply that the genetic inheritance of IQ plays a minor role in the process of intergenerational educational and economic status transmission; intergenerational correlations of educational and economic status appear to be attributable primarily to the direct impact of socio-economic background and its indirect impact operating via unequal educational attainments.

At this point, we should stress the limited nature of our inquiry. We seek to estimate the role of genetic inheritance of IQ — not all types of genetic inheritance — in the intergenerational reproduction of economic inequality. It may well be that other highly heritable characteristics — height, for example — have a significant effect upon educational or economic success, and thus contribute to the parent-offspring similarity in economic status. While

an interesting possibility, and one which cannot be ruled out a priori, this notion has not stirred the social concern nor the attempts at empirical substantiation aroused by the IQ controversy. In any case, it lies beyond the scope of our investigation.⁷

II. A Statistical Model of the Role of IQ in Intergenerational Inequality

We will concentrate here on three measures of intergenerational status transmission: the three simple correlation coefficients between an index of parental socio-economic background (*SEB*) on the one hand, and the individual's years of schooling attained (*S*), the respondent's income (*I*), and the respondent's occupational status (*O*). Socio-economic background (*SEB*) will be measured by three variables: parents' income (*PI*), father's years of schooling attained (*FS*), and father's occupational status (*FO*).⁸ The occupational status of both the father and the respondent is measured by the Duncan socio-economic status index, which approximates the social prestige of an occupation by the distribution of educational attainments and mean income of individuals holding such jobs.⁹

In order to determine the importance of the genetic inheritance of IQ in the process of intergenerational status transmission, we will estimate a model of the following process. Socio-economic background (*SEB*) and genotypic IQ (*G*) are the exogenous variables. Childhood IQ (*CIQ*) measured at the age of school entry (the earliest age at which mea-

⁷ If inherited traits which affect income, schooling or occupational status are also correlated with childhood IQ or socio-economic background, their exclusion from our analysis will bias our coefficients. In the absence of comparable evidence on *both* the heritability and the economic effects of other traits *and* their intercorrelations with childhood IQ and socio-economic background, however, no empirical assessment of the direction and magnitude of this bias can be attempted.

⁸ For purposes of exposition we have defined an index, *SEB*, as the equally weighted normalized sum of parents' income, father's occupation, and father's years of schooling. Reasonable alternative weighting schemes for *PI*, *FO*, and *FS* yield virtually identical results.

⁹ A more complete description of this index is found in Blau and Duncan (1967). Though our methods and results differ in important ways from those of Duncan and his associates, our intellectual debt to them will be obvious to anyone familiar with the literature.

sured IQ shows a stable relationship with IQ at later dates), is determined by the respondent's genotypic IQ (G), as well as his socio-economic background (SEB) and a random term (u_1). The respondent's years of schooling attained (S) is determined by CIQ and SEB , plus a random term, (u_2). The respondent's income (I) or occupational status (O) is then determined by CIQ , S , and SEB as well as the random terms (u_3 and u_4), respectively. The individual's level of adult cognitive capacity (AIQ) could be explicitly included in the equation system (adding another equation, and an additional variable to equations (3) and (4)). However, by postulating that the effect of genetic inheritance of IQ operates solely via CIQ the need for explicit consideration of this variable is avoided.¹⁰

This model, composed of the following set of recursive equations, is summarized in figure 1.¹¹

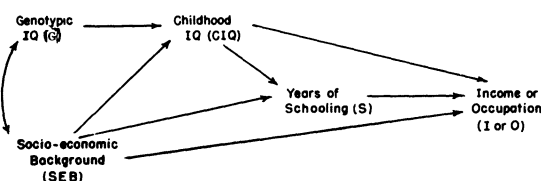
$$CIQ = f_1(G, SEB, u_1) \tag{1}$$

$$S = f_2(CIQ, SEB, u_2) \tag{2}$$

$$O = f_3(CIQ, S, SEB, u_3) \tag{3}$$

$$I = f_4(CIQ, S, SEB, u_4) \tag{4}$$

FIGURE 1.—RECURSIVE MODEL OF INTERGENERATIONAL EFFECTS ON INCOME OR OCCUPATION



The measures of intergenerational status transmission — $r_{s,seb}$, $r_{i,seb}$, and $r_{o,seb}$ — may be decomposed into a part due to the genetic inheritance of IQ and parts due to other mechanisms. Thus, letting \hat{p}_{jk} represent the normalized regression coefficient of variable k in an equation predicting variable j , we can write¹²

¹⁰ The adult IQ variable, AIQ , is used in constructing some of the correlation coefficients not available in our sample. Its explicit introduction into the system of equations does not alter the results.

¹¹ In figure 1, single-headed arrows represent causal relations. The double-headed arrow represents a simple correlation.

Equation (4) can be interpreted as a hedonic price index for individual characteristics when sold on the labor market as part of a package embodied in a worker.

¹² This decomposition of a correlation coefficient can be

$$r_{s,seb} = \hat{p}_{s,seb} + \hat{p}_{s,ciq} r_{ciq,seb}. \tag{5}$$

The correlation of socio-economic background and years of schooling attained is thus composed of a direct effect of SEB on schooling attainment, plus an indirect effect operating through the correlation of childhood IQ with SEB . It is the last term which will interest us here. Notice that $r_{ciq,seb}$, can itself be decomposed

$$r_{ciq,seb} = \hat{p}_{ciq,seb} + \hat{p}_{ciq,g} r_{seb,g}. \tag{6}$$

Again, it is the last term which interests us. Inserting equation (6) into equation (5), the contribution of genetic inheritance of IQ to the intergenerational transmission of schooling status, $r_{s,seb}^g$, can be isolated as

$$r_{s,seb}^g = \hat{p}_{s,ciq} \hat{p}_{ciq,g} r_{seb,g}. \tag{7}$$

By analogous reasoning the "genetic component" in the other intergenerational status correlations, $r_{o,seb}$, and $r_{i,seb}$, can be isolated. In those cases, of course, there will be an additional genetic term capturing the effect of childhood IQ on the level of schooling attained and thereby upon income or occupational status. Thus, $r_{o,seb}^g$, the full genetic component of the correlation $r_{o,seb}$, will be composed of a direct and an indirect effect

$$r_{o,seb}^g = \hat{p}_{o,ciq} \hat{p}_{ciq,g} r_{seb,g} + \hat{p}_{o,s} \hat{p}_{s,ciq} \hat{p}_{ciq,g} r_{seb,g}. \tag{8}$$

And similarly

$$r_{i,seb}^g = \hat{p}_{i,ciq} \hat{p}_{ciq,g} r_{seb,g} + \hat{p}_{i,s} \hat{p}_{s,ciq} \hat{p}_{ciq,g} r_{seb,g}. \tag{9}$$

The correct estimation of the genetic component in intergenerational status transmission requires, of course, that the coefficients of equations (1)–(4) be unbiased estimates. The system is estimated recursively, by ordinary least squares techniques. Unbiased estimation in this case requires that the error terms u_j in each equation be uncorrelated. One of us has demonstrated elsewhere (Bowles 1972) that positively correlated error terms and resulting biases are likely to arise in such a recursive system because of: (a) the omission of important measures of parental status and; (b) the erroneous measurement of those variables which are

derived from the normal equations of the linear regression model. See Malinvaud (1966), p. 27.

included. We will consider each problem in turn.

The primary source of data for this study is a 1962 Current Population Survey in which the standard questions concerning years of schooling, occupation and income were asked, along with a special questionnaire eliciting information on parental status (father's occupation and father's years of schooling completed). The data resulting from this Occupational Changes in a Generation (OCG) Survey is described in detail in Blau and Duncan (1967).

The range of variables available in this survey is seriously deficient. First, it contains only two relatively limited measures of socio-economic background (father's occupation and father's education). The omission of other important measures of parental background (wealth, income, mother's education, various characteristics of their jobs as distinct from job status) would, if uncorrected, lead to a significant underestimate of the overall role of socio-economic background. In particular, parents' income has been shown in other studies (Hauser, Lutterman and Sewell, 1971) to have important effects upon adult status (S , I , O) independent of the background measures available in the OCG survey.

We have attempted to rectify this deficiency by using independent data on the relationship of parental income to our other variables to construct a column and row of the product moment matrix for the variable parents' income (PI). The methods and data employed are described in Bowles (1972) and summarized in the notes to appendix table A.1.

Our data on IQ are also drawn from other sources. The observed correlation of adult IQ with CIQ and the other variables used in the model, as well as the correlation of CIQ with PI and S , have been used to infer the remaining (unknown) correlations between CIQ , O , FO , FS and I . Where possible we have corrected the correlations for the restricted variance in the independent data sources used. See the appendix for methods of estimation.

Errors in measurement are likely to arise from survey response errors (conscious and unconscious) and from the inevitable discrepancy between the variables required by the underlying theoretical model (e.g., permanent income)

and the empirical measures used to approximate them (e.g., annual income). In order to obtain more nearly unbiased estimates, we have used the standard approach to measurement error proposed by Johnston (1963) and others. Specifically, we have used independent information to estimate the correlations between the observed and true variables, and adjusted the product moment matrix of the observed variables to approximate that of the true variables.¹³ (The methods used are fully described in Bowles (1972) and are summarized in the appendix.)

Technically speaking, IQ is a relatively accurately measured variable; test-retest reliabilities for the tests used considerably exceed reliabilities for all the independent variables in the system, except possibly years of schooling. Because of the more adequate measurement of this variable, its role in the process of inter-generational status transmission is likely to be overestimated.¹⁴

Because the data on parental status are largely from surveys requiring retrospective recall of the respondents, the error in these variables is substantial, and the difference between the observed and adjusted values in the product moment matrix for these variables is particularly great. Substantial adjustments in the income variables reflect the sizeable discrepancy between observed annual income and true permanent income (the correct measure for this model). Evidence of erroneous measurement of IQ (both childhood and adult) and years of schooling required a similar, though quantitatively less great, adjustment of the relevant elements of the product moment matrix.

Matrices of the estimated true correlations for four age cohorts of "non-Negro" males from non-farm backgrounds are presented in

¹³ In order to generate a true product moment matrix from the observed one, we were forced to assume that the relation between the observed variables, x' , and true variables, x , is as follows: $x' = x + u$ where u is an error term, uncorrelated with the true values of the variable x or with other variables in the system.

¹⁴ Indeed, failure to treat the errors in measurement and specification bias problems adequately (or in some cases, at all) is our main critique of the related literature. See for example Duncan (1968), and Duncan, Featherman and Duncan (1968). For a more complete discussion see Bowles (1972).

appendix table A.1. The reliability coefficients used for the correction of the observed correlations are also presented in table A.1. We regret that available data do not allow estimation of our model for women and blacks. No inferences concerning these groups can be drawn from our data.

III. Results

Estimates of equations (2)–(4) using our summary variable, *SEB*, appear in table 1.

(Estimates of these equations using the disaggregated measures of *SEB* (*FO*, *FS*, and *PI*) are available from the authors in a mimeographed appendix. Estimates of equation (1) will be presented below.) The following results are particularly noteworthy.

First, for all four age groups, childhood IQ appears to exert a substantial direct effect on the number of years of schooling attained. This is hardly surprising in view of the fact that IQ tests are used in counselling students about

TABLE 1. — CHILDHOOD IQ AND SOCIO-ECONOMIC BACKGROUND AS DETERMINANTS OF YEARS OF SCHOOLING, OCCUPATIONAL STATUS AND INCOME^a

Dependent Variable	Age	Normalized Regression Coefficients of ^b			Coefficient of Determination R^2
		Childhood IQ	Socio-economic Background	Years of Schooling	
Schooling	25–34	.253 (198.8)	.536 (890.6)		.463
	35–44	.256 (208.7)	.544 (941.5)		.473
	45–54	.253 (198.4)	.536 (888.2)		.463
	55–64	.268 (199.8)	.482 (649.6)		.414
Occupational Status	25–34	1) .163 (67.2)	.497 (620.9)		.340
		2) ^c	.152 (62.3)	.643 (1109.0)	.561
	35–44	1) .180 (95.2)	.562 (927.8)		.429
		2) .042 (6.5)	.270 (197.8)	.537 (725.7)	.581
	45–54	1) .216 (116.4)	.453 (509.4)		.332
		2) .082 (19.7)	.168 (63.0)	.530 (583.4)	.483
	55–64	1) .221 (118.8)	.444 (479.6)		.329
		2) .100 (26.8)	.225 (113.7)	.452 (434.3)	.449
Income	25–34	1) .180 (61.9)	.251 (120.3)		.132
		2) .140 (34.5)	.166 (37.0)	.158 (31.4)	.146
	35–44	1) .122 (31.2)	.384 (309.3)		.200
		2) .048 (4.5)	.226 (76.9)	.291 (118.0)	.244
	45–54	1) .125 (33.7)	.413 (366.5)		.228
		2) .068 (9.4)	.292 (131.8)	.225 (72.5)	.255
	55–64	1) .171 (53.9)	.235 (102.3)		.118
		2) .101 (17.9)	.109 (17.4)	.261 (94.8)	.158

^a The sample consists of "non-Negro" males of non-farm backgrounds who in 1962 were in the experienced labor force.

^b F -statistics in parentheses.

^c In a prior estimate this coefficient was not significantly different from zero. The equation presented here was estimated without this variable.

TABLE 2. — NORMALIZED EFFECTS UPON OCCUPATIONAL STATUS, INCOME, AND YEARS OF SCHOOLING OF A STANDARD DEVIATION DIFFERENCE IN SOCIO-ECONOMIC BACKGROUND, CHILDHOOD IQ, AND GENOTYPIC IQ^a

Estimated Effects	Dependent Variables												
	Age	Years of Schooling				Occupational Status				Income			
		25-34	35-44	45-54	55-64	25-34	35-44	45-54	55-64	25-34	35-44	45-54	55-64
1. Childhood IQ													
(a) total <i>CIQ</i> effect ^b	.253	.256	.253	.268	.163	.180	.216	.221	.180	.122	.125	.171	
(b) genotypic IQ effect ^c	.228	.230	.228	.241	.147	.162	.194	.199	.162	.110	.113	.154	
(c) <i>SEB</i> effect via <i>CIQ</i> ^d	.051	.051	.051	.054	.033	.036	.043	.044	.036	.024	.025	.034	
2. Socio-economic Background													
(a) <i>SEB</i> effect net of <i>CIQ</i> effect (1c) ^e	.536	.544	.536	.482	.497	.562	.453	.444	.251	.384	.413	.235	
(b) total <i>SEB</i> effect (1c + 2a) ^f	.587	.595	.587	.536	.530	.598	.496	.488	.287	.408	.438	.269	
3. Ratio of Socio-economic Background Effects to Genotypic IQ Effects (2b/1b)	2.57	2.59	2.57	2.22	3.61	3.69	2.56	2.45	1.77	3.71	3.88	1.75	

^a Refers to "non-Negro" males, with non-farm backgrounds in the experienced labor force in 1962.

^b From table 1.

^c This figure is the normalized regression coefficient in row 1a multiplied by 0.9, the assumed normalized regression coefficient of genotypic IQ on *CIQ*. See text.

^d This figure is the entry in row 1a multiplied by 0.2, the assumed normalized regression coefficient of *SEB* on *CIQ*. See text.

^e From table 1.

^f Calculated from: $\partial s/\partial seb = p_{s,seb} + p_{s,ciq} p_{ciq,seb}$ and similarly for the variables *I* and *O*.

further education and in allocating financial aid.

Second, the direct effect of childhood IQ upon income and occupational status is considerably less than on years of schooling; the total effect of early IQ upon income and occupational status operates in large part indirectly via the effect of childhood IQ upon years of schooling.

Third, the effect of socio-economic background on each of the three adult status variables — schooling, income, and occupational status — is greater than the effect of childhood IQ. Table 2 presents summary estimates of the relative size of the combined direct and indirect effects of these background factors.¹⁵

¹⁵ These results may be contrasted with similar estimates for roughly the same data reported in Duncan (1968). He corrected for measurement error only in the relationship between the childhood and adult IQ variables, and did not use the hypothetical variable parents' income. He also based his calculations in part on the NORC veterans data, but used the correlation of AFQT (Armed Forces Qualification Test) with "expected" income which was slightly higher than that with actual income. He found the effects (in standard deviation units) of *CIQ* (measured about age 12) on all three adult status variables (*S*, *I*, *O*) to be greater than the effects of the parental status variables combined.

The observation that the effect of the *SEB* variables is greatest for the middle age cohorts may help to place in perspective the rather limited importance of *SEB* variables in some samples of young workers.¹⁶

Table 2 must be interpreted with care, for it would be inadmissible to attribute all of the impact of the childhood IQ variable to the effects of genotypic (inherited) IQ. Some portion of the variance of IQ at ages 6–8 is explained not by genotype, but by the socio-economic environment of the home, and other environmental influences. To take account of the influence of socio-economic background on childhood IQ, we have included in table 2 a row indicating the relative effects of *CIQ* and the *SEB* variables making use of the parameters of equation (1).

If, following Jensen, we assume the heritability of IQ (h^2) to be 0.81, $p_{ciq,s}$ is 0.9 (h itself) and the coefficients of *CIQ* in table 2 may simply be multiplied by this value to yield the normalized estimate of the partial relationship between *G* and the adult status variables *S*, *I*,

¹⁶ See for example Hauser, Lutterman, and Sewall (1971).

and O .¹⁷ To adjust the coefficients of the *SEB* variables upwards requires an assumption regarding the extent to which the influences of environment (E) on *CIQ* are *SEB*-related. The Jensen heritability estimates imply that the magnitude of the effect of environment on childhood IQ, $p_{ciq,e}$, is between 0.4 and 0.5.¹⁸ Recognizing that not all environmental effects are related to socio-economic background, and wishing to select a conservative estimate of the effect of *SEB* on *CIQ*, we will choose a value for $p_{ciq,seb}$ of half of the lower figure so that our estimate of equation (1) is

$$CIQ = .9G + .2 SEB + u_1.$$

A lower estimate of the heritability of IQ (following Jencks et al. (1972)) or a larger role of socio-economic background in the environmental effects on *CIQ* would, of course, lower the apparent effects of genetic inheritance on one's adult status, and correspondingly raise the apparent socio-economic background effects.¹⁹

What do these results tell us about the role of the inheritance of IQ in the intergenerational transmission of socio-economic status? In order to decompose the intergenerational status correlations into a part due to the influences of the inheritance of IQ and a part due to other influences, we need an estimate of $r_{seb,g}$, the correlation between *SEB* and genotype IQ. This value we can infer from the estimate of the *CIQ* equation. We know $r_{ciq,seb}$, and can express the value

$$r_{ciq,seb} = p_{ciq,seb} + p_{ciq,g} r_{seb,g}. \quad (10)$$

This procedure yields values of $r_{g,seb}$ of .233, .221, .234, and .251, respectively, for the four age cohorts. Using these values of $r_{seb,g}$, along with the assumption that $h = .9$, we get the

¹⁷ h is the normalized partial relation between G and *CIQ*, or $p_{ciq,g}$. Thus, $p_{s,g} = p_{s,ciq} p_{ciq,g}$ and similarly for the other variables, I and O .

¹⁸ The correlation of IQ's of unrelated individuals reared in the same home — about 0.25 — suggests the higher figure. The correlation of IQ's of identical twins reared in the same home — about 0.97 — along with $h^2 = .81$ implies the lower figure. See Jensen (1968).

¹⁹ Although we have used Jensen's estimate of the heritability of IQ, we find serious deficiencies in both his data and methods. See for example Jencks et al. (1972) and the unpublished work of Leo Kamin. We have decided not to use a more reasonable (lower) estimate simply to stress the fact that our results are substantially independent of the choice of any particular heritability estimate.

estimates of table 3. Depending on the age group, between 8% and 11% of the correlation between years of schooling and socio-economic background is attributable to the genetic inheritance of IQ. Analogous ranges for income and occupational status are 5% to 13% and 5% to 10%, respectively.

IV. Caveats

Before proceeding to draw some possible inferences from these results let us pause to consider the quality of the data and the soundness of the methods used. In view of the following shortcomings — both of data and method — we recommend that the estimates be treated with caution. The data bases for the estimates are not strictly comparable, and the correction for the known non-comparabilities (e.g., restricted variance in the NORC sample) can at best be approximate. Some of the corrections for errors in measurement and one correlation ($r_{o,pi}$) are based on conjecture. Wherever possible, we have made internal checks on the procedures used (see Bowles 1972). Yet some of the methods used cannot be adequately checked. Particularly important here is the assumption that the errors in measurement are uncorrelated with the true values of the variables.

Moreover, the model as it stands is probably mis-specified through the inadequate measurement of the socio-economic background of the respondent. Data on the parents' wealth, their position in the social hierarchy of the work place, and the mother's educational level might significantly revise the estimates reported here. While no precise quantitative estimates will be offered, the direction of bias introduced by the exclusion of these variables is predictable.²⁰ The inadequate measurement of socio-economic background lowers the intergenerational status correlations and (because of the likely positive correlations with *CIQ* of these omitted influences on S , I , and O), raises the apparent absolute and relative importance of the inheri-

²⁰ Bowles (1972) attempts to estimate the likely effects of including a measure of parental net worth in a similar set of equations, and discusses the problem of omitted variables in more detail. For an empirical demonstration of the importance of the parents' position in the social hierarchy of the work place independent of other *SEB* measures see Kohn (1969).

TABLE 3. — THE GENOTYPIC IQ COMPONENT IN INTERGENERATIONAL STATUS CORRELATIONS^a

Correlation of Socio-economic Background with:	Age	Total Correlation (1)	Correlation Due to Genetic Inheritance of IQ ^b			Genetic Component as a Percentage of the Total Intergenerational Status Correlation (5)
			Effects via Childhood IQ (2)	Indirect Effects via Childhood IQ and Years of Schooling (3)	Total Genotypic IQ Component ^c (4)	
Years of Schooling	25-34	.640	.055	...	.055	8.6
	35-44	.646	.052	...	.052	8.0
	45-54	.640	.056	...	.056	8.8
	55-64	.597	.063	...	.063	10.6
Income	25-34	.324	.029	.008	.037	11.4
	35-44	.433	.010	.015	.025	5.8
	45-54	.464	.016	.009	.025	5.4
	55-64	.308	.023	.016	.039	12.7
Occupational Status	25-34	.564	...	.035	.035	6.2
	35-44	.634	.008	.027	.035	5.5
	45-54	.541	.018	.027	.045	8.3
	55-64	.538	.023	.028	.051	9.5

^a For "non-Negro" males with non-farm backgrounds, in the experienced labor force in 1962. Calculations based on equations in table 1 and correlations in table A.1.

^b As derived in equations (7), (8), and (9).

^c Column 2 + column 3.

tance of IQ. Although the respondents are grouped by ten year age cohorts, a more precise measure of age and job experience would have been desirable.

Because the raw data were not available to us, we were unable to experiment with interactive structures and nonlinear forms of the variables (a particularly serious drawback in the case of years of schooling).²¹ Lastly, our measure of education, years of schooling, fails to capture educational quality differences.

In the absence of a more adequate data base, two methods of checking these results are possible: evaluating their consistency with other data from the same sample and comparing our results with those from other samples. First, we will test the consistency of the observed correlation between brothers' levels of education observed in our sample with that predicted by our years of schooling equation. Because brothers (ordinarily) share a common socio-economic background as well as a similar (but not identical) genetic endowment, we should be able to use equation (2) to predict the correlation between years of schooling attained by brothers. Thus, where the superscript prime (') refers to the eldest brother of the respondent and the p 's refer to normalized regression

coefficients in an equation predicting the educational attainment of the respondent, S , we have

$$r_{s,s'} = p_{s,seb} r_{s',seb} + p_{s,ciaq} r_{s',ciaq}. \quad (11)$$

The term $r_{s',ciaq}$ is estimated from²²

$$r_{s',ciaq} = p_{s,ciaq} r_{ciaq,ciaq'} + p_{s,seb} r_{ciaq,seb}. \quad (12)$$

Further, the correlation between the two brothers' childhood IQ's is estimated as 0.5.²³ Using our figures from tables 1 and A.1, we arrive at the estimates of the correlation between the two brothers' education presented in table 4. The fact that the predictions based on our model fall short of the estimated true correlation is to be expected, given the incomplete specification of the socio-economic background of the respondents and the possibility that there is some positive direct relationship between the educational level of brothers. Nonetheless, the fact that the predicted value is closer to the estimated true value than that based on other studies (see, e.g., Duncan, Featherman and Duncan (1968)) and yet does not exceed the estimated true value, lends some

²² The p 's in the equation refer to the normalized regression coefficients in an equation predicting brother's educational level, s' . Here and above, it is assumed that the p 's and r 's are identical for the brothers, and that there is no direct causal relationship between the brothers' educational levels.

²³ Duncan (1968).

²¹ The occupational status index may be considered an ordinal measure. Experiments with various transformations of this index might have yielded interesting results.

TABLE 4.—PREDICTED AND ACTUAL CORRELATION BETWEEN BROTHERS' YEARS OF SCHOOLING^a

Age	Predicted Correlation	Actual Correlation ^b
25-34	.431	.584
35-44	.440	.551
45-54	.431	.591
55-64	.380	.587

^a The sample consists of "non-Negro" males of non-farm backgrounds who were in 1962 in the experienced labor force.

^b Corrected for errors in reporting.

credibility to our estimates and to the model upon which they are based.

As a second check on our estimates we have used a sample which though limited in size contains measurements of most of the crucial variables in our model: FS , PI , I , S , and CIQ . Thus, we have not been forced to augment the product moment matrix through the addition of variables available from other samples, though we have made corrections for likely errors in measurement.

The data are from the California Guidance Study sample of children born in Berkeley, California in the years 1927-1928. The variables measuring the respondent's socio-economic background were recorded directly from the parents about the time of birth of the respondent. The respondent's IQ was measured at various ages from 1 to 18 years. Years of schooling, occupation and income as of age 30 were ascertained in follow-up surveys.²⁴ These data do not provide the basis for a completely adequate check on the equations presented in table 1. First, the sample is severely limited in size and in geographical range. Second, we have used some of these data to construct correlations used in the previous estimates ($r_{s, pi}$, $r_{ciq, s}$, and $r_{ciq, pi}$), so the estimates are not entirely independent. Nonetheless, we believe that this sample sheds some light on our earlier esti-

²⁴ We are grateful to Marjorie Honzik and John Conlisk for making these data available. The data and sample are more fully described in Honzik (1957). The income variable which we use is constructed by assigning to each occupation the mean income (from the 1960 Census). This transformation of the data — by Conlisk — probably accounts for the unusually high coefficient of determination in the income equation. Individual income data could not be used because of the very limited number of individuals who responded to the income question on the follow-up survey. The sample size for the calculations reported below is 70.

mates. The normalized equations based on these data (with F statistics in parentheses) are

$$S = .474 PI + .332 CIQ \quad R^2 = .428 \\ (23.9) \quad (11.7) \quad (13)$$

$$I = .181 PI + .595 S \quad R^2 = .510 \\ (3.0) \quad (32.5) \quad (14)$$

As in the earlier estimates, CIQ plays an important role in the determination of years of schooling. Its importance in income determination appears to operate primarily via its effect on years of schooling. (The coefficient of CIQ in equation 14 is not significantly different from zero.) The contribution of the genetic inheritance of CIQ to the intergenerational status correlation is even less than that estimated from our larger sample: 6% of the correlation for years of schooling and 4% for income.

V. Conclusions

Though the two checks on the original estimates did not contradict our basic results, one must still consider the figures as subject to error. Nonetheless, the major empirical propositions which we have sought to demonstrate would not be falsified by even quite substantial changes in the estimated coefficients. We are confident then in concluding that the genetic inheritance of IQ is a relatively minor mechanism for the intergenerational transmission of economic and social status. The estimates in table 3 yield the following implication: if *either* IQ were not at all inherited ($p_{ciq, s} = 0$), *or* if IQ had no direct influence on years of schooling attained, income or occupation ($p_{s, ciq}$, $p_{o, ciq}$, $p_{i, ciq}$ all = 0), that is, if CIQ were totally unimportant in the process of intergenerational status transmission, the degree of intergenerational immobility (as measured by the intergenerational status correlations) would be lowered by at most 13%. Alternatively, and equally hypothetically, if all direct socio-economic background influences on educational attainments, income and occupational status, were eliminated, leaving the genetic inheritance of IQ as the only mechanism by which a family could pass its level of social and economic privilege on to its offspring, the degree of intergenera-

tional status transmission would fall to such an extent that at most one half of one per cent of the variance of educational attainments, income or occupational status could be "explained" by socio-economic background.

Evidently, the genetic inheritance of IQ is not the mechanism which reproduces the structure of social status and economic privilege from generation to generation. Though our estimates provide no alternative explanation, they do suggest that an explanation of intergenerational

immobility may well be found in aspects of family life related to socio-economic status and in the effects of socio-economic background operating both directly on economic success, and indirectly via the medium of inequalities in educational attainments.²⁵

²⁵ For an attempt to explain the intergenerational reproduction of economic inequality along these lines and to evaluate the crucial role of *beliefs* about IQ and meritocracy in legitimizing economic inequality, see Bowles and Gintis (1973).

APPENDIX

Methods, Sources, and Data

I. Method²⁶

The equations reported in table 1 were estimated from the product moment matrix of the normalized variables, the matrix of simple correlation coefficients presented in table A.1. The coefficients in table A.1 represent the correlations among the "true" values of the variables, and have been constructed from the observed correlations (reported in the sources to table A.1) in the following way. (Particular attention will be given below to the IQ variables and to the hypothetical variable representing parents' income.)

If we assume that the errors, u , are uncorrelated with the true values, x , then we can write the variance of the observed variable, x' , as²⁷

$$\text{var}(x') = \text{var}(x) + \text{var}(u). \quad (\text{a})$$

Now define r_j , the correlation of the true value of x_j with its observed value. It can easily be seen that

$$r_j = \sqrt{\frac{\text{var } x_j}{\text{var } x'_j}} \quad (\text{b})$$

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. 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}

$$r'_{kj} = r_{kj} r_k r_j + r_{ukj} \sqrt{1 - r_k^2} \sqrt{1 - r_j^2}. \quad (\text{c})$$

The r_j 's appear on the main diagonal of table A.1. The estimation of the r_j 's is described in detail in Bowles (1972). However, two of the reliability estimates used here differ from those based on the 1950 Post Enumeration Survey of the United States Census reported in Bowles (1972). We have used the data

²⁶ This method is formally equivalent to that suggested by Johnston (1963) and others. See Bowles (1972).

²⁷ To adopt a more realistic assumption would greatly complicate the task of calculating corrected correlation coefficients, and would require data which are not available.

from a match of the 1960 Census with the Current Population Survey (CPS) (see Hodge and Siegel 1968). Assuming that the error variance of the CPS is half as great as that of the Census, and assuming further that the correlation of errors in reporting a given value to these two different surveys is 0.5, we estimate a reliability of 0.958 for respondent's years of schooling and 0.910 for respondent's occupational status.²⁸ (These compare with 0.91 and 0.92, respectively, based on the 1950 Post Enumeration Survey.)

Together with estimates of the reliability of the respondent's retrospective recall of father's occupational status based on Blau and Duncan (1967), and using procedures described in Bowles (1972), these estimates imply that the correlation of the errors in reporting occupational status and level of schooling is 0.04.²⁹ We have assumed that this estimate approximates the correlation of errors in reporting income and education level, and income and occupational status as well.

II. Introduction of Variables Measuring IQ and Parents' Income

The correlation coefficients for the parents' income (PI) variable were taken from two main sources, indicated in the notes to table A.1.

²⁸ The correlation of the Census returns with the matched CPS returns is for years of schooling and for occupation. The assumptions used here are identical to those used in Bowles (1972). Hodge and Siegel adopt an assumption with respect to the relative accuracy of the two surveys which approximates Bowles', but curiously assume that the errors in reporting the same variable to two different sources are uncorrelated. Their estimates of r_e and r_o are 0.98 and 0.95, respectively.

²⁹ We have used the revised reliability estimates in equations A.10 and A.11 of the appendix of Bowles (1972) to generate this estimate of the degree of correlation of errors.

The crucial additional assumptions used in calculating the correlation are (a) that there has been no secular trend in the correlation of occupational status and educational attainment and (b) that the degree of correlation in errors for reporting parental status variables is the same as that in reporting one's own status. The evidence for assumption (a) is presented in Bowles (1972). Assumption (b) is unsupported; however, it appears reasonable, and in any case alternative assumptions within a broad range would not substantially alter the results.

TABLE A.1. — ESTIMATED "TRUE" ZERO ORDER CORRELATIONS AMONG THE VARIABLES FOR NON-NEGRO MALES WITH NON-FARM BACKGROUNDS IN EXPERIENCED LABOR FORCE, 1962

	A. Age Groups 25-34 and 35-44								
	1	2	3	4	5	6	7	8	9
1. Income	.840	.429 ^d	.300 ^a	.330 ^d	.283 ^b	.228	.300	.312 ^c	.324
2. Occupation	.566	.910	.485 ^a	.740 ^d	.367 ^e	.470	.485	.470 ^c	.564
3. Parents' Income	.385	.580	.840	.573 ^f	.299 ^f	.459 ^{d,g}	.566 ^{d,g}	.228 ^f	
4. Years of Schooling	.459	.732	.573	.958	.473 ^k	.524	.539	.618 ^c	.640
5. Childhood IQ ^l	.275	.404	.299	.473	.900	.348 ^h	.400 ⁱ	.850 ^j	.410
6. Father's Education	.347	.475	.459	.528	.346	.800	.740 ^d	.362 ^c	
7. Father's Occupation	.385	.580	.566	.566	.385	.806	.800	.383 ^c	
8. Adult IQ ^l	.312	.470	.228	.619	.850	.362	.383	.950	
9. Socio-economic Background ^m	.433	.634		.646	.399				
	B. Age Groups 45-54 and 55-64								
	1	2	3	4	5	6	7	8	9
1. Income		.561	.451	.444	.294	.283	.451	.312	.464
2. Occupation	.485		.519	.677	.402	.346	.519	.470	.541
3. Parents' Income	.278	.487		.573	.299	.459	.566	.228	
4. Years of Schooling	.374	.634	.573		.473	.481	.581	.619	.640
5. Childhood IQ ^l	.271	.410	.299	.473		.372	.377	.850	.410
6. Father's Education	.237	.415	.459	.461	.383		.737	.362	
7. Father's Occupation	.278	.487	.566	.506	.419	.808		.383	
8. Adult IQ ^l	.312	.470	.228	.619	.850	.362	.383		
9. Socio-economic Background ^m	.308	.538		.597	.426				

Note: Coefficients above the diagonal in Panel A and B are for the 25-34 and 45-54 age groups, respectively. Coefficients below the diagonal are for the 35-44 and 55-64 age groups. The numbers on the diagonal of Panel A are the estimated correlations between the true and observed variables.

Sources: Unless otherwise indicated, the original data are from Duncan, Featherman, and Duncan (1968), p. 51. Sample sizes for each correlation vary as the correlations are based on those respondents who responded to both of each pair of questionnaire items. One hundred per cent response for the four age groups is, respectively, 3,141; 3,214; 2,596; and 1,482.

^a Corrected correlations for these cells are assumed to be equal to the corrected correlations of father's occupation with respondent's income and occupation, respectively.

^b The correlation between *I* and *CIQ* is estimated from the correlations of *CIQ* with those variables (including *AIQ*) which influence *I*, and the normalized regression coefficients of these variables on *I*. It is assumed that *CIQ* influences *I* only indirectly, through its impact on *S* and *AIQ*. Thus, $r_{i,ciq} = \rho_{i,pi} r_{ciq,pi} + \rho_{i,s} r_{s,ciq} + \rho_{i,aiq} r_{aiq,ciq}$. The equations used in the construction of this and other correlations with *CIQ* are available in a mimeographed appendix available to the interested reader from the authors.

^c From National Opinion Research Center's 1966 Veterans Sample as reported in Griliches and Mason (1972). Corrected for restricted variance.

^d Correlations calculated using appendix equation (c) with $r_{ukj} = .0404$. For all other correlations $r_{ukj} = 0$.

^e Following the method indicated in footnote b, $r_{o,ciq} = \rho_{o,pi} r_{ciq,pi} + \rho_{o,s} r_{s,ciq} + \rho_{o,fs} r_{ciq,fs} + \rho_{o,fo} r_{ciq,fo}$.

^f Data provided by the California Guidance Study.

^g These figures are the actual correlations for 35-44-year-old respondents' own earnings, education and occupation.

^h Using an equation predicting *AIQ*, we can write

$$r_{aiq,fs} = \rho_{aiq,pi} r_{pi,fs} + \rho_{aiq,s} r_{s,fs} + \rho_{aiq,ciq} r_{ciq,fs} \text{ or } r_{ciq,fs} = (r_{aiq,fs} - \rho_{aiq,pi} r_{pi,fs} - \rho_{aiq,s} r_{s,fs}) / \rho_{aiq,ciq}$$

The corrected correlation based on the California Guidance Study data is 0.285. The Equality of Educational Opportunity Survey (Coleman, et al., 1966) reports a simple correlation of 0.280 between white northern sixth graders' verbal test scores and parents' educational level. Correcting this correlation for measurement error might raise the figure to 0.35. Jencks, et al. (1972) report a range of figures between 0.20 and 0.40.

ⁱ Using a derivation analogous to that in the previous footnote $r_{ciq,fo} = (r_{aiq,fo} - \rho_{aiq,pi} r_{pi,fo} - \rho_{aiq,s} r_{s,fo}) / \rho_{aiq,ciq}$.

Bayley (1964) reports an uncorrected correlation of 0.40. Smith found an uncorrected correlation of 0.278 between verbal scores of white urban northern sixth graders and their fathers' occupational level (scored simply white collar/blue collar). (Reported in Jencks, et al. (1972).) Correction for errors in reporting would probably raise this coefficient considerably though we cannot say how much without adequate data on the reliability of the dichotomously coded occupational responses.

^j Bloom (1964), chapter 3.

^k Based on data from the California Guidance Study, adjusted by the estimated correlation between the true and observed values of years of schooling (.958) and the intelligence test (.90). Other studies give the following (uncorrected) correlations for years of educational attainment and IQ at particular grade levels: Bajema (1968) .58 (grade 6); Bensen (1942) .54 (grade 6); Thorndike (1934) .42 (grade 8). The simple average of these coefficients is 0.51. Correcting these figures for measurement error would raise the estimated correlation somewhat. However, there is a far from perfect correlation between IQ scores in grades 6-8 and grades 1-3 (the years relevant to our *CIQ* variable). Adjusting the above correlations downward to take account of the discrepancy in scores between grades 6-8 and 1-3 would thus lower the correlations considerably. All of the coefficients (including that based on the California Guidance Study) are for a single locality, in which a relatively uniform availability of schooling (admission standards, continuation pressures from schooling authorities, financial aid for higher education, and geographical proximity to higher education) might render childhood IQ a relatively more important determinant of years of educational attainment than in the nation as a whole.

^l The corrections of the adult and childhood IQ measures for erroneous measurement are based on the test-retest reliabilities of the relevant tests. See Personnel Research Section (1945). The reliability of the IQ tests used by the California Guidance Study for children aged 6-8 is assumed to be 0.9. See Jencks, et al. (1972).

^m It follows from the definition of socio-economic background (footnote 1) that

$$r_{sed,j} = \frac{\sum_i r_{ij}}{\sqrt{3 + 2 \sum_i r_{ik}}} \quad \begin{matrix} \text{for } i = 3, 6, 7 \\ k = 3, 6, 7 \text{ and} \\ k \neq i \\ j = 1, 2, 4, 5 \end{matrix}$$

(The numbers refer to the variables listed in table A.1.)

The crucial assumption used is that

$$r_{i,pi} = r_{i,fo} \text{ and } r_{o,pi} = r_{o,fo}.$$

The California Guidance study's small sample yields an uncorrected value for $r_{i,pi}$ of 0.258, or slightly higher than the uncorrected value on which this estimate is based. Other studies (see for example, Hauser, Lutterman, and Sewell (1971)) have found higher correlations of adult status with parents' income than with the other parental status variables used here. Thus, we doubt that we have overestimated the correlation of adult status with parental income.

A column and row of the same matrix was similarly constructed for the measure of adult IQ, using data from a 1966 survey of veterans by the National Opinion Research Center (NORC).³⁰ Because of the restricted variance of the population of veterans compared to the population surveyed by the Occupational Changes in a Generation Survey, the correlation coefficients from the NORC study were adjusted (upwards) using a method suggested by Gulliksen (1950).³¹

Introduction of the last excluded variable, childhood IQ, proved to be more complicated. Data for childhood IQ, as well as our other variables for a large representative sample simply do not exist. As a distinctly inferior alternative, forced upon us by the absence of the appropriate data, we constructed the relevant terms in a product moment matrix for a synthetic sample using various sources, and filling in missing cells on the basis of quantitative inferences from the available correlations.³² This method involves adding to the correlation

³⁰ We are indebted to Zvi Griliches for making these data available. For a description of the sample and an analysis of the data bearing closely on the concerns of this paper, see Griliches and Mason (1972).

³¹ Our procedure required generalization to all four cohorts of data from a single cohort on the interrelationship of *AIQ* with the other variables. Some biases are undoubtedly introduced by this process, as Taubman and Wales (forthcoming) have demonstrated that these relations are not stable across cohorts. Although we have done no rigorous sensitivity analysis on this point, we doubt that the biases are significant enough to alter our main conclusions.

We corrected the NORC veterans sample correlations for the restricted variance of this population relative to the OCG sample of non-Negro, non-farm background males using the following expression (Gulliksen 1950):

$$r_{kj} = \frac{r^*_{kj} S_j}{\sqrt{S_j^2 r^2_{kj} + s_j^2 - s_j^2 r^2_{kj}}}$$

Where the correlation r^*_{kj} has been corrected, as above, for errors in reporting (but not for restricted range) and the S_j and s_j indicate the standard deviation of variable j (in this case AFQT score) in the larger (OCG) and restricted (NORC) samples. In the absence of data on S_j , we have assumed that the AFQT score is as relatively restricted in the NORC sample as is the years of schooling variable, yielding a value for S_j of 0.2903.

These corrections for restricted variance bring about a substantial increase in all correlations involving the variable *AIQ* and (by implication) of *CIQ* as well.

Corrections using an assumed value for S_j of 0.33 (which

matrix of the variables on which observations are available, a column and a row representing the correlations of *CIQ* with our already measured variables. 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 noncomparability of samples, errors in measurement, and specification bias.

Our method is based on direct estimates of the correlations of childhood IQ to adult IQ, parental income and years of schooling attained. These, along with correlations of adult IQ scores with the other variables in the model, are used to infer the values of the correlations between childhood IQ and the occupation and income of the respondent, as well as the educational and occupational attainments of his parents.³³ The vectors of correlation coefficients for the childhood and adult IQ variables are presented in table A.1. A description of the estimation of these coefficients and a number of alternative estimates are provided in the notes to that table.

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³² This is the method used by Duncan (1968).

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