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ABSTRACT

Interracial differences in the educational attainment process between whites and blacks were examined, using Joreskog and Sorbom's (1981) general method for the analysis of covariance structures. The basic model of educational attainment considers education to be a function of father's occupational status and education, mother's education, respondent's ability, and high school curriculum and grades. Study data were drawn from the National Longitudinal Study of the High School Class of 1972. Information was available for the 13 study variables for 6,825 whites and 433 blacks. It was found that the process of educational attainment is not different for blacks and whites. Study results indicate that social background plays an equal role for blacks and whites. For both races, the process of educational attainment appears to depend modestly on social background; children of higher status parents are more likely to enter an academic track in school. The influence of academic ability, curriculum, and grades on attainment do not differ for blacks and whites. Student ability is the most important determinant of placement in an academic program, and curriculum differentiation in high school also plays a major role. An explanation of the measurement model and a bibliography are appended. (SW)

POSTSECONDARY EDUCATIONAL ATTAINMENT AMONG WHITES AND BLACKS

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ABSTRACT

Previous research has indicated that social background variables are more important determinants of educational attainment among whites than among blacks. The present study, based on more recent data and upon methods that control for known measurement error structures, finds that social background plays an equal role for both whites and blacks. Increments in background social status variables lead to exactly the same increases in education for whites as for blacks, within sampling error limits. Moreover, the effects of personal characteristic variables (ability, curriculum, grades) of whites and blacks as they influence educational attainment are also equal for both groups.

POSTSECONDARY EDUCATIONAL ATTAINMENT AMONG WHITES AND BLACKS

The attainment of education is one of our society's most highly placed values. Not only is it a value unto itself, it plays an instrumental role in subsequent occupational and economic achievement. It is also the area to which the greatest commitment to equality of opportunity has been made., Despite this commitment, however, equality of educational outcomes remains an allusive goal. In 1979, the U.S. Bureau of the Census (1980) estimated that the median school years completed by whites age 25 and over was 12.5; in comparison, blacks attained 11.9 years. This difference results from differential access to education, and there are two fundamental ways to explain such differences. Either the process of educational attainment varies across racial groups, or if the process is invariant, whites start on the average with social advantages not shared by blacks. The main issue addressed in this paper is whether the process of educational attainment is the same for whites and blacks, or whether it is different.

This paper is not the first to ask whether the process of educational attainment differs between racial groups. The seminal work of Blau and Duncan (1967) gave birth to a number of analyses of interracial (e.g., Duncan, 1969; Jencks, et al., 1972) and interethnic (e.g., Duncan and Duncan, 1968; Featherman and Hauser, 1978) examinations of differences in socioeconomic achievement. While a great deal of attention has been paid to occupational achievement, differences

in the process of educational attainment have also received their share of attention. For example, based on the Wisconsin social-psychological model of status attainment (Sewell, Haller and Portes, 1969; Sewell and Hauser, 1975), Porter (1974), Portes and Wilson (1976), and Kerckhoff and Campbell (1977) concluded that the educational attainment process is different for blacks and whites. All three of these studies yielded evidence that social background variables are more important determinants of educational attainment among whites than among blacks.

The previous research literature would thus lead us to conclude that whites with higher socioeconomic origins possess an inflated opportunity for the successful completion of additional years of schooling in contrast to their white peers of lower status. Among blacks, however, the process of educational attainment relegates to them the same, equal (and comparatively low) opportunity for success regardless of their status origins.

While the available evidence would thus lead to the conclusion that educational outcome differences between blacks and whites exist in part because the process of educational attainment is different, there are at least two reasons to suspect that this proposition needs to be reexamined. On substantive grounds, it may be as W. Wilson (1978) argues that class differences have become more important than racial differences in determining access to positions of higher status. If so, status differences within races may be more important determinants of educational attainment than racial differences at the same status levels. One consequence of the social changes implied by W. Wilson's (1978)

argument may be that the process of educational attainment is invariant between whites and blacks.

On methodological grounds, the proposition may need to be reexamined because most of the previous studies have been based on the implicit assumption that there were no measurement errors among the variables included in the several analyses. Ignoring measurement error, however, can result in systematic bias in parameter estimates, and when levels of measurement error differ between groups, interracial comparisons of parameter estimates may exaggerate or understate interracial differences. Bowles (1972) has argued that using respondents' reports of parental socioeconomic status underestimates to a serious degree the influence of origin variables. And there is evidence that blacks report status variables with greater random error than do whites (Mason, et al., 1976; Bielby, et al., 1977; Wolfle and Robertshaw, 1983). There is also some evidence to indicate that nonrandom errors exist among variables usually included in models of educational attainment (Bielby, et al., 1977; Mare and Mason, 1980; Wolfle and Robertshaw, 1983; Wolfle, 1983; Hauser, et al., 1983). As a result of these apparent differences in measurement structures between whites and blacks, "we are even more inclined than in the past to discourage comparative analyses that are not based upon well-calibrated measurements with known error structures" (Hauser, et al., 1983, p. 36).

Moreover, Gottfredson (1981) has shown that previous analyses of black-white differences in the educational attainment process have failed to produce consistent results. Previous conclusions that black-white

differences exist in regression slopes have apparently been influenced by variations in sampling, by inappropriate statistical criteria used to identify cross-group differences in coefficients, and by differences across groups in measurement reliabilities. Gottfredson's (1981) own analysis goes on to suggest that substantive conclusions about race differences in the educational attainment process may not be warranted.

The present paper therefore reexamines interracial differences in the educational attainment process between whites and blacks using Joreskog and Sorbom's (1981) general method for the analysis of covariance structures, a statistical procedure that allows for the control of differential measurement errors in the estimation of structural parameters.

THE MODEL

The basic model of educational attainment used in this analysis considers education to be a function of father's occupational status, father's education, mother's education, respondent's ability, high-school curriculum, and high-school grades. Similar models have been employed by Heyns (1974) in her analysis of high school effects on educational aspirations, and by Thomas, et al. (1979) in their analysis of the college attendance process. The model is shown diagrammatically in Figure 1; the theoretical, latent variables of interest are shown within ellipses.

Insert Figure 1 About Here

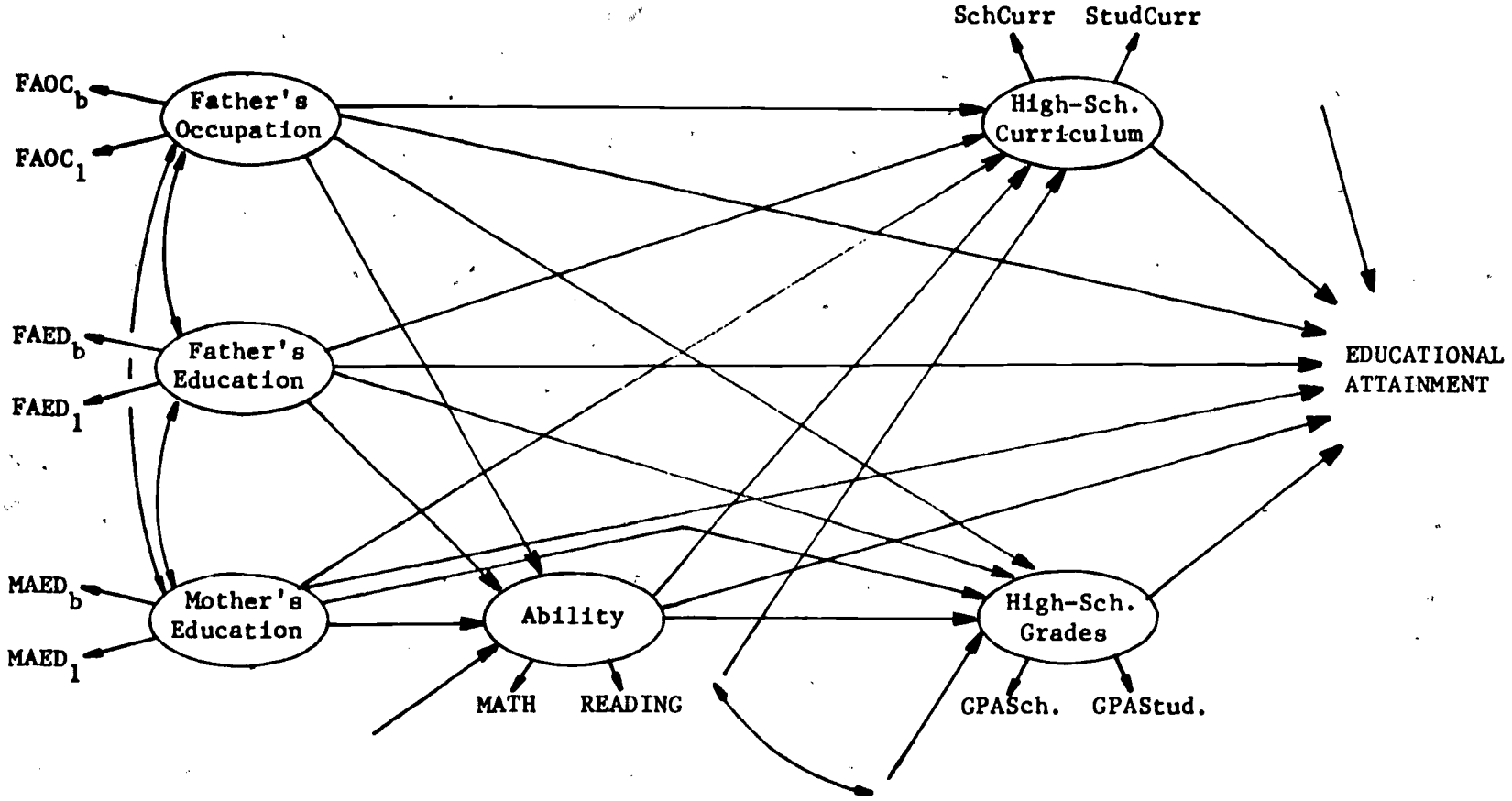

Figure 1. Structural Equation and Measurement Models of Educational Attainment Among White and Black 1972 High School Graduates

The latent ability variable is considered to depend on father's occupational status, father's education, mother's education, and a residual disturbance term that represents all of the variation in ability not explained by the three latent, exogenous variables. The disturbance term is assumed to be statistically independent of the three exogenous variables, and is also assumed to be independent of the disturbance terms attached to high-school curriculum, high-school grades, and educational attainment. The three parental status variables are expected to have positive effects on ability. While these relationships may in part be causally spurious due to the omission from this model of measures of parental ability, they are in any event expected to be positive (Scarr and Weinberg, 1978).

Previous studies (e.g. Heyns, 1974; Alexander and McDill, 1976) have considered curriculum placement to be a major mechanism by which secondary schools function to separate students into tracks that ultimately differentiate their adult roles. In particular, students in college preparatory tracks complete a greater number of courses in academic subject matter, and thus develop the prerequisite skills and credentials necessary for postsecondary matriculation. Moreover, students in college preparatory tracks interact with other students with similar interests, and these interactions seem to have an influence on subsequent educational attainment (Sewell and Hauser, 1975; Hauser, et al. 1983). The high-school curriculum variable is considered to be causally determined by the three exogenous variables plus ability. It is expected that students with parents of higher socioeconomic status are

more likely to be members of the academic curriculum track than are students with parents of lower status. Higher ability students are also expected more likely to be members of the academic track.

High-school grades are also specified to depend on the three exogenous variables, ability, and a residual disturbance term. These effects are also expected to be positive; that is, students whose parents hold higher status are expected to achieve higher grades in high school, and higher ability students are expected to receive higher grades. While the disturbance terms for both high-school curriculum and high-school grades are specified to be independent of their mutual causes, they are allowed in this model to covary since no causal nexus is specified to exist between their respective latent variables.

Finally, educational attainment is considered to be dependent upon all of the preceding latent variables. Positive effects are expected from the three measures of parental status. Positive effects are also expected from ability, high-school curriculum, and high-school grades. Given Parsons's (1959) thesis that curriculum differentiation is the major mechanism by which secondary schools function to select and allocate youths to adult roles, it is hypothesized that this variable will assume a dominant role in the explanation of educational attainment. (Alexander and Cook's [1982] recent study suggests that the formulation of the model in the way described here may overstate the importance of curriculum's influence by neglecting within-school criteria that select students into an academic curriculum.)

THE DATA

Data for this study were drawn from the National Longitudinal Study (NLS) of the High School Class of 1972 (see Riccobono, et al., 1981). The NLS was designed to provide data on the development of educational, vocational, and personal aspects of the lives of adolescents as they made the transition from high school to the adult world. The total sample as it evolved consisted of 22,652 students selected from 1318 schools sampled from across the United States. The respondents were initially surveyed in the spring of 1972, their senior year of high school. Subsequent follow-up surveys were conducted in the fall of 1973, 1974, 1976, and 1979. Logistical problems with the initial data collection effort prevented the inclusion of base-year information on nearly 6000 students; as a result, some important base-year responses are missing and the following analyses are based on the remaining students. The sample was further restricted to subjects whose racial identification was either white or black; other ethnic groups such as Mexican-American or Oriental were omitted. As with most survey data, item nonresponses have further reduced the number of cases; the following analyses were based on 6,825 whites and 433 blacks for whom complete information was available for the 13 variables included in these analyses. The source and coding of each variable included in the model are described in the Appendix, along with the variances, covariances, and means.

Bear in mind that the NLS sample is representative of high-school seniors in 1972; it is therefore not necessarily representative of all youths of equivalent age. A number of youths dropped out of school

prior to their senior year, and it is likely that the dropouts differed systematically from those who remained to graduate. In 1977, for example, among people age 25-29, 86.8 percent of whites completed high school, but only 74.5 percent of blacks (National Center for Education Statistics, 1979, p. 224). These data are therefore representative of high-school seniors, and the analysis of educational attainment reported in this paper relates to years of schooling attained after high school.

FITTING THE MODEL

Estimates of parameters implied by the model shown in Figure 1 were obtained by using LISREL (Joreskog and Sorbom, 1981). The steps followed in the analysis were dictated by the need first to establish the measurement properties of the model, and only then to estimate and compare the structural parameters of the model. The first step in the analysis was to test for the possibility of correlated response errors. If, for example, respondents have reported their father's and mother's education with greater consistency than warranted in fact, then the covariance between their respective latent factors will be greater than warranted; consequently, their effects upon endogenous variables will be attenuated. There is ample evidence to indicate that just these variables have been measured with such correlated errors (Wolfle and Robertshaw, 1983; Wolfle, 1983).

The test for correlated errors was conducted by first estimating a LISREL model in which all latent variables were specified to be exogenous variables, and the latent factors free to covary. Users of LISREL will recognize that the LISREL model does not permit error covariances

between exogenous and endogenous manifest variables; this first model bypasses this problem by not specifying initially any structural order among the latent factors beyond their mutual covariation. This baseline model specified that none of the response errors covaried. For whites, the likelihood-ratio chi-square statistic for this model was 367.96 with 45 degress of freedom; for blacks the chi-square statistic was 74.70 with 45 degrees of freedom (see Table 1). Chi-square values this large relative to their degrees of freedom indicate a poor fit between the estimated and actual covariance matrices. Since the "structural" portion of the model was completely identified, the lack of fit must be found in the measurement portion of the model. The modification indices in the latest version of LISREL provide a powerful tool for detecting model parameters, which if set free will improve the fit of a model. An examination of the modification indices for both whites and blacks indicated that the covariance between the reporting errors for father's and mother's education in the first follow-up survey should be set free. This was done for both groups and resulted in significant improvements in the fit of the model. For whites the chi-square statistic with a nonzero covariance between the reporting errors of father's and mother's education was 179.58 with 44 degrees of freedom; for blacks the chi-square statistic was 55.28.

A new examination of modification indices revealed that the covariance between the response errors for the school's report of the student's grade point average and the student's report of their curriculum could be set free to improve the fit of the model. The "fit"

of any model, however, is also measured by the plausibility of its estimates, and I can think of no plausible social mechanism that would explain why these reporting errors should be correlated. Consequently, for both blacks and whites a plausible measurement model was adopted in which most response errors were found not to covary with other response errors; the single exception was between the reports of mother's and father's education in the first NLS follow-up.

Insert Table 1 About Here

For both blacks and whites, but particularly the latter, the chi-square values for model B are sufficiently large to indicate that the differences between the estimated and actual covariance matrices could not have occurred by chance. With large sample sizes, however, the chi-square goodness-of-fit test may easily lead to the statistical rejection of a theoretical useful model (Bentler and Bonett, 1980; Hoelter, 1983). Based on their experience, Wheaton, et al. (1977, p. 99) suggest as one criterion of fit that when the ratio of chi-square to its degrees of freedom is five or less, the model estimates may be considered a reasonable fit to the actual data. All of the retained models represented in Table 1 meet this criteria.

The next step in the analysis was to combine the two groups and test whether the factor patterns were the same for whites and blacks. If the factor pattern coefficients were to be the same, it would indicate that unit increases in true scores led to the same increments in manifest

Table 1. Hierarchy of Models of Educational Attainment: 1972 High School Graduates, Whites (N = 6,825) and Blacks (N = 433)

	Model or Contrast	L^2	df	L^2/df	$P(L^2)$
A.	No error covariances for whites	367.96	45	8.18	.000
A'.	No error covariances for blacks	74.70	45	1.66	.004
B.	Covariance between errors of father's and mother's education, 1st follow-up, whites	179.58	44	4.08	.000
	B vs. A	188.38	1	188.38	.000
B'.	Covariance between errors of father's and mother's education, 1st follow-up, blacks	55.28	44	1.26	.118
	B' vs. A'	19.42	1	19.42	.000
C.	Fully recursive model with unconstrained factor patterns, whites and blacks	234.87	88	2.67	.000
D.	Fully recursive model with invariant factor patterns	237.62	94	2.53	.000
	D vs. C	2.75	6	.46	.840
E.	Fully recursive model with invariant slopes from exogenous factors	245.13	106	2.31	.000
	E vs. D	7.51	12	.63	.822
F.	Fully recursive model with invariant slopes from all factors	254.87	112	2.28	.000
	F vs. E	9.74	6	1.62	.136

variables for blacks as for whites. This test was conducted by constraining the LISREL lambda coefficients for whites and blacks to be equal; if these constraints do not seriously erode the fit of the model estimates to the actual data, one may conclude that whites and blacks have a common factor pattern.

Model C in Table 1 shows the likelihood-ratio chi-square statistic for the two groups in which the lambda coefficients have been permitted to vary as they will between whites and blacks. Model D represents a constrained model that resulted from specifying each previously free lambda coefficient as invariant between whites and blacks. The difference in chi-square statistics between Model C and Model D indicates that no serious deterioration in fit has resulted from specifying equal factor patterns between whites and blacks. Indeed, the reduction in chi-square was not as large as the reduction in the degrees of freedom, which indicates in all likelihood that differences between factor pattern coefficients for whites and blacks resulted by chance. The resulting measurement model parameter estimates for whites and blacks are shown in Table 2.

Insert Table 2 About Here

That whites and blacks have a common factor pattern has important consequences for the rest of the analysis. As K. Wilson (1981) has pointed out, latent factors are created with arbitrary metrics, and unless some limiting conditions are either found empirically or imposed by

Table 2. Measurement Model Parameter Estimates for White 1972 High School Graduates (N = 6,825 listwise present)

Variables		True Score Variance	Error Variance	Slope	Reliability
True	Observed	ϕ	Θ	λ	$\lambda^2\phi/(\lambda^2\phi+\theta)$
Father's Occupation	FaOcBase	448.06	149.43	1.00	.75
	FaOcl		144.57	.93	.73
Father's Education	FaEdBase	1.53	.12	1.00	.93
	FaEdl		.15	.98	.91
Mother's Education	MaEdBase	.95	.15	1.00	.86
	MaEdl		.10	.96	.90
Ability	Reading	9.88	10.27	1.00	.49
	Math		14.06	1.71	.67
High-Sch. Curriculum	School	.18	.07	1.00	.71
	Student		.10	.91	.58
High-Sch. Grades	School	6.87	1.65	1.00	.81
	Student		.53	.45	.72

Covariance between errors of FaEdl and MaEdl is .039

Table 2 (continued). Measurement Model Parameter Estimates for Black 1972 High School Graduates (N = 433 listwise present)

Variables		True Score Variance ϕ	Error Variance Θ	Slope λ	Reliability $\lambda^2\phi/(\lambda^2\phi+\theta)$
True	Observed				
Father's Occupation	FaOcBase	303.80	180.68	1.00	.63
	FaOcl		201.04	.93	.57
Father's Education	FaEdBase	.86	.16	1.00	.85
	FaEdl		.24	.98	.78
Mother's Education	MaEdBase	.94	.14	1.00	.87
	MaEdl		.27	.96	.77
Ability	Reading	8.80	11.26	1.00	.44
	Math		13.65	1.71	.65
High-Sch. Curriculum	School	.14	.10	1.00	.58
	Student		.12	.91	.49
High-Sch. Grades	School	6.06	3.67	1.00	.63
	Student		.65	.45	.65

Covariance between errors of FaEdl and MaEdl is .085

specification, comparisons of structural coefficients across populations may not be meaningful. Comparative analyses would clearly be possible if one could assume that all of the variances of the latent factors were identical across the populations, but this is an assumption rarely found in practice. A more plausible, minimal condition for the comparison of structural coefficients is that all of the lambda coefficients are identical across the populations. Since this restriction has been empirically satisfied, the comparison of structural coefficients between blacks and whites may proceed.

COMPARISONS OF STRUCTURAL COEFFICIENTS

Having established that whites and blacks have a common factor pattern, we may now turn to the cross-group comparisons of structural coefficients. To accomplish this, we start with the structural model implied by the relationships shown in Figure 1 without any cross-group restrictions on any structural coefficients. These coefficients are shown in Table 3. Cross-group equality constraints were then imposed on the model one at a time, beginning with the effect of father's occupation on ability, and proceeding sequentially through the model. At each step the likelihood-ratio chi-square statistic was compared to that from the previous, less constrained model. Where the equality constraint resulted in a significant deterioration in the fit of the model, one would conclude that the structural coefficients were not equal. Where the equality constraint did not result in a significant change in chi-square, one would conclude the structural coefficients are the same for whites and blacks.

Insert Table 3 About Here

It would be unnecessarily tedious to present each of the intermediate models as eighteen equality constraints were sequentially specified. Two models, however, are of substantive interest, and their likelihood-ratio chi-square statistics are shown above in Table 1. The first of these, Model E, is a model in which equality constraints have been applied to all coefficients emanating from the exogenous latent variables, which measure the influence of socioeconomic background. Comparison of the likelihood-ratio chi-square statistic from this model to that of Model D indicates that the fit of the model has not significantly deteriorated as a result of these constraints. In other words, all of the effects of the background variables in this model are the same for whites and blacks within sampling error limits.

Model F in Table 1 represents a model in which every structural coefficient (including all gamma coefficients from exogenous variables, all beta coefficients, and the psi-matrix covariance between the residuals of high-school curriculum and high-school grades) has been constrained to be equal between whites and blacks. As can be seen by comparing the chi-square statistics between Model F and Model E, these last constraints have not resulted in any further significant changes in the fit of the model. (Note that only two of eighteen hierarchically constrained models have been reported here. None of the eighteen slope equality constraints produced significant changes in the likelihood-ratio chi-square statistics.)

Table 3. Structural Coefficients in Metric Form for Model of Educational Attainment, Unconstrained Estimates for Whites and Blacks

Predetermined Variables	Dependent Variables							
	Whites				Blacks			
	Ability	High-Sch. Curriculum	High-Sch. Grades	Educ. Attain.	Ability	High-Sch. Curriculum	High-Sch. Grades	Educ. Attain.
Father's Occupation	.020*	.001*	-.011*	.002	.036	.000	-.003	.011
Father's Education	.342*	.024*	.036	.143*	-.174	.032	-.268	.048
Mother's Education	.553*	.021*	-.065	.192*	.537*	.014	.003	.128
Ability		.091*	.593*	.058*		.083*	.525*	.106*
High-Sch. Curriculum				1.741*				1.543*
High-Sch. Grades				.090*				.007
Coef. of Determination	.035	.469	.404	.484	.185	.586	.451	.493

*Coefficient is at least twice its standard error.

The bottom row of Table 3 shows the squared multiple correlation coefficients for the four equations in the model of educational attainment. Unlike previous studies (e.g., Portes and Wilson, 1976), these show that the model explains educational process variables and educational attainment for blacks as well as the model does for whites. Previous studies have concluded that straightforward models of educational attainment are not appropriate for blacks, whose educational achievements apparently depend on variables not considered by current theory. The present findings suggest in contrast that a single theory of educational attainment may be appropriate for both racial groups.

Moving to the individual predictive equations, we see that the partial coefficients from ability to grades are .59 for whites and .53 for blacks, which as indicated above are equal within sampling error limits. These results do not support the findings of Portes and Wilson (1976), who reported distinctly different slopes from ability to academic performance (grades). They found that these slopes were substantially larger for whites than for blacks. The present results suggest that ability produces the same increments in academic performance for blacks as for whites. Furthermore, academic performance results in nearly equal postsecondary educational achievements for both groups.

Heyns (1974) found that curriculum placement is responsive to the influences of social background, but that the single variable of greatest importance is ability. In contrast; Alexander and McDill (1976) found that the combined effect of social background variables was more important than ability. The present findings suggest for both blacks

and whites that ability is by far the best predictor of placement in an academic curriculum and that background social status pales in comparison. The standardized coefficients for both blacks and whites are shown in Table 4, and indicate that the effect of ability on curriculum placement is over nine times as great as that of its nearest competitor.

Insert Table 4 About Here

Contrary to expectations, the present results indicate negative effects from father's occupation and mother's education to academic performance, but these anomolous effects are probably due to the strong influence of ability on grades and the high intercorrelations of the true-score background status variables.

For the regression of educational attainment on the predetermined variables in the model, the results clearly indicate that the net effect of membership in an academic track in high school is the best predictor of postsecondary educational attainment for both whites and blacks. Inclusion in an academic curriculum in high school leads on the average to nearly two more years of schooling after high-school graduation. In contrast, the direct effect of social background on postsecondary educational attainment is fairly weak, but of course the total effect of social background is greater due to its generally positive influence on ability and placement in an academic track in high school. The point is, however, that the process is the same for both whites and blacks, and

Table 4. Structural Coefficients in Standard Form for Model of Educational Attainment, Unconstrained Estimates for Whites and Blacks

Predetermined Variables	Dependent Variables							
	Whites				Blacks			
	Ability	High-Sch. Curriculum	High-Sch. Grades	Educ. Attain.	Ability	High-Sch. Curriculum	High-Sch. Grades	Educ. Attain.
Father's Occupation	.134	.065	-.085	.027	.243	.019	-.024	.146
Father's Education	.133	.072	.017	.107	-.068	.093	-.125	.036
Mother's Education	.172	.050	-.024	.115	.167	.033	.001	.077
Ability		.684	.712	.111		.625	.630	.204
High-Sch. Curriculum				.445				.395
High-Sch. Grades				.145				.011

equal changes in either social background variables or within school variables lead to the same outcome.

CONCLUSION

The present analysis of postsecondary educational attainment has yielded one major finding. The process of educational attainment is not different for blacks and whites. This conclusion contrasts sharply with that of Kerckhoff and Campbell (1977), who reached exactly the opposite conclusion, and similarly contrasts with Porter (1974) and Portes and Wilson (1976). Whether these different findings are due to the use here of a different causal model, of a different sample, of a more recent cohort of high school graduates, or of a more adequate methodology for comparing slopes across populations, I do not know. I do know that there is less evidence now than before that the process of educational attainment works differently for whites and blacks.

Previous studies of interracial differences in educational attainment have suggested multiple social theories to explain the differences between whites and blacks. Porter (1974) suggested that whites operate in a contest-oriented mobility system, whereas the mobility of blacks could be better explained as a sponsored mobility system. Portes and Wilson (1976) suggested that educational achievement for whites could be explained by individual differences in ability and the routinized acquisition of school credentials, whereas black achievement depended more on personal self-reliance and ambition.

The present study suggests a more simplified theory of social mobility. The process of educational attainment depends modestly on

social background; children of higher status parents are more likely to enter an academic track in school school. By far the most important determinant of placement in an academic program, however, is the ability of the student. In turn, curriculum differentiation in high school plays a major role in subsequent educational attainment by allocating to the selected the prerequisite skills and credentials necessary for postsecondary matriculation. Moreover, this process seems to work about the same for both whites and blacks.

This characterization of the process of educational achievement sets aside the more theoretically complex explanations of racial differences invoked in one instance by Porter (1974) and in another by Portes and Wilson (1976). Instead, these results suggest the existence of a common process of educational attainment that operates for blacks the same way it does for whites.

APPENDIX

The measurement model used in the estimation of postsecondary educational attainment for whites and blacks included two indicators of every variable in the structural model except for educational attainment. Multiple indicators of most variables in the model permit the estimation of true-score variances and covariances among the theoretical variables of interest. In the case of educational attainment, only a single manifest indicator was incorporated into the model. Provided its response errors are random, the slope estimates of the regression of educational attainment on other variables in the model will be unbiased, and the only information lost by not including multiple measures of educational attainment is the separation of the structural disturbance from the measurement disturbance in the regression, which is of little import.

Father's Occupation. Father's occupational status was ascertained from reports of students in the base-year survey in 1972 (Var #3496. [where the variable number corresponds to that used in Riccobono, et al., 1981]), and repeated in the first follow-up in 1973 (Var #2393). These variables were scaled with Duncan's (1961) socioeconomic index, as amended to match the census bureau's 1970 categorization of detailed occupations (Hauser and Featherman, 1977).

The typical measurement assumptions used in the model are illustrated by father's occupation, which are discussed here as representative of the other variables in the model. Both manifest indicators of father's occupational status are considered dependent upon father's true occupational status, weighted with a relative slope coefficient, plus an error term. The metric of father's true occupational status is undetermined, and it is specified by the normalizing restriction that the slope from true occupational status to the base-year indicator is unity. (A similar restriction is made on each pair of measurement equations.) It is assumed that the errors are uncorrelated with the underlying true-score factor.

The two manifest indicators of father's occupational status were obtained about one year apart, and any change in father's occupational status in that period will be reflected in this model as errors of reporting. This problem, however, is not as serious as the inability to estimate the correlation of errors with which these variables have been reported. Since the two measures were obtained from the same individuals, presumably a positive correlation exists between the errors of their reports. This correlation, and other within-variable, between-occasion error correlations, are not identified in the present model. To the extent that such correlations exist, the consistency of the respondents' reports have been overestimated.

Father's Education. Father's education was also measured with two manifest indicators obtained in the base-year and first follow-up

surveys. The response categories used in the two panels varied somewhat; accordingly, the two variables were recoded to provide matching scales in which 1 = less than high-school education, 2 = finished high school; 3 = completed some college, 4 = finished college, and 5 = attended or completed graduate school.

Mother's Education. Mother's education was measured in exactly the same way that father's education was measured. When both parents are considered together, another possibility for correlated error arises, and as indicated in the text there are strong empirical reasons to believe that father's and mother's education in the NLS have been reported with greater consistency than the true association between their educational levels would indicate. One possibility is that the construction of the questionnaire itself encouraged respondents to make these kind of overconsistency errors, for the questions were presented side-by-side in a columnar format, but similar correlations have been found with the High School and Beyond data (Wolfle, 1983), which asked these educational attainment questions separately. Apparently high school students resolve uncertainties about one parent's education by guessing with reference to the educational attainment of the other parent.

Ability. The latent variable of ability was measured with two manifest indicators of achievement, a reading test and a mathematics test administered to the respondents during the spring of their senior year in high school. The reading test was based on short passages with questions focused on straightforward comprehension. There were 20 items on the test, and the students were given 15 minutes to complete it. The mathematics test was based on quantitative comparisons in which the student was asked which of two quantities was greater or to assert their equality. There were 25 items on the test, and the students were given 15 minutes to complete it. On both tests students were told they would be penalized for guessing, and the scores used here are the NLS corrected formula scores for reading (Var. #27) and for mathematics (Var. #29).

In the original administration of the NLS test battery there were six tests administered to the students. An exploratory factor analysis of these tests, as reported by Riccobono, et al., (1981), indicated that only four of the tests (reading, letter groups, vocabulary, and mathematics) loaded on a first principal component; consequently, only these four tests were used by NCES to construct an ability scale, and only these four were used here initially as indicators of ability. However, few researchers have found the letter group test very useful (Heyns and Hilton, 1982), and in preliminary analyses of these data the covariances of the letter group variable with other variables in the model were not well estimated with any plausible reconfiguration of the model. As with the High School and Beyond longitudinal study (Heyns and Hilton, 1982), it was decided to drop the letter group test from the model.

It was also decided to drop the vocabulary test for related reasons. In none of our preliminary analyses were we able plausibly to find an adequate configuration of the model that would reproduce the covariances of vocabulary with other variables in the model. Indeed, we were led to believe that the manifest vocabulary test score was more plausibly considered not as an indicator of ability alone, but also of the social background of the parents. This would make sense if one considers vocabulary to develop both as a function of one's own ability and as a function of the richness of language experienced in one's home (as indexed here by parent's level of education). Because we could not consider the vocabulary test to be a unique indicator of ability, it was dropped from the model.

High-School Curriculum. High-school curriculum was measured with reports from both the school (Var. #196) and the student (Var. #209). These variables were recoded such that 1 = academic curriculum, 0 = other. These variables are obviously dichotomous, but the LISREL program obtains maximum likelihood estimates under the assumption of multivariate normality. While no one yet knows how robust LISREL estimates are in the face of violation of distributional assumptions, the problem has been ignored here. Neither of the two variables is distributionally skewed, however, so the LISREL estimation procedures probably have not underestimated the validity and reliability of these variables to an extent that would affect the substantive conclusions.

High-School Grades. A latent variable for high-school grades was also indexed with two manifest measures, one reported by the school (Var. #632), the other by the student (Var. #229). The students were asked "Which of the following best describes your grades so far in high school," and could choose from eight categories ranging from (1) Mostly A to (8) Mostly below D. These values were inversely recoded so that higher numbers reflected higher grades. The schools were also asked to provide information on each student's scholastic average. These were reported in a variety of formats depending on the grading systems used by the several schools. To provide a uniform variable for each student for whom the basic information was present, a new variable was created (Var. #632) by the Educational Testing Service. If the student's grade point average was available, then the average was coded as 1 to 14 to represent A+ through Below F. If a grade point average was not reported, then an average was estimated from the student's percentile rank and coded 15 to 28. In the present application this variable was collapsed into a single 14-point scale discarding the distinction of how the grade point average was reported or estimated. Then the scale was inversely recoded so that higher numbers on the scale indicated higher grades.

Educational Attainment. In the fourth NLS follow-up, completed in 1979 seven years after high school graduation, the respondents were asked two questions about their educational attainment as of October 1979. First, they were asked "how many years of education had you received at vocational, trade, or business schools." Then they were

asked "what was your highest level of college education." Responses to these two questions were combined to form a single educational attainment variable. Following Featherman and Carter (1976) two years of attendance in a vocational, trade or business school were coded equal to one year of attendance in an academic school. The resulting educational attainment scale ranged from 1 to 7, with the individual values representing (1) no postsecondary attendance at either vocational or academic institutions, (2) less than 2 years at a vocational school, (3) more than 2 years at a vocational school or less than 2 years at an academic college, (4) more than 2 years of college, (5) finished college, (6) received master's degree or equivalent, and (7) received Ph.D. or advanced professional degree.

In summary, the measurement model of postsecondary educational attainment included two indicators of every variable in the structural model except for educational attainment. The model specifies independence for reporting errors between indicators of the same latent variable. In the case of high-school curriculum and high-school grades this specification seems justified given that the reports were collected from separate sources. In the case of measures of social background, this specification seems to be less defensible. The model does, however, specify the empirical discovery that errors in reports of parental educational were correlated.

Table A reports the variances, covariances, and means of all indicator variables for 6,825 listwise present whites, and Table B reports similar coefficients for 433 listwise present blacks.

Insert Table A and Table B About Here

Table A. Variance-Covariance Matrix and Means for Variables in Model of Educational Attainment, White 1972 High School Graduates (N = 6,825 listwise present)

	Read	Math	SchCurr	StudCurr	GPASch	GPAStud	EdAtt	FaOcBase	FaOccl	FaEdBase	FaEdl	MaEdBase	MaEdl
Read	20.149												
Math	16.886	42.933											
SchCurr	0.925	1.735	0.248										
StudCurr	0.834	1.534	0.160	0.250									
GPASch	5.952	9.392	0.571	0.469	8.507								
GPAStud	2.648	4.216	0.254	0.224	3.089	1.920							
EdAtt	2.966	5.239	0.443	0.418	1.959	0.911	2.664						
FaOcBase	22.885	35.137	3.217	3.009	7.527	3.692	12.519	597.538					
FaOccl	19.172	31.790	2.761	2.627	6.571	3.452	11.016	416.429	531.561				
FaEdBase	1.368	2.112	0.192	0.179	0.536	0.259	0.817	18.942	17.636	1.656			
FaEdl	1.417	2.145	0.193	0.179	0.597	0.283	0.809	18.580	17.421	1.495	1.605		
MaEdBase	0.999	1.524	0.134	0.126	0.394	0.185	0.591	9.507	8.969	0.730	0.697	1.101	
MaEdl	1.035	1.586	0.133	0.127	0.448	0.205	0.598	9.303	8.760	0.690	0.703	0.914	0.981
Means	11.187	15.164	.550	.506	8.290	5.897	3.376	46.300	44.791	2.483	2.466	2.303	2.274

Table B. Variance-Covariance Matrix and Means for Variables in Model of Educational Attainment, Black 1972 High School Graduates (N = 433 listwise present)

	Read	Math	SchCurr	StudCurr	GPASch	GPAStud	EdAtt	FaOcBase	FaOccl	FaEdBase	FaEdl	MaEdBase	MaEdl
Read	20.210												
Math	15.118	39.183											
SchCurr	0.734	1.314	0.241										
StudCurr	0.634	1.257	0.129	0.243									
GPASch	4.761	8.270	0.555	0.341	9.982								
GPAStud	1.849	3.120	0.193	0.192	2.735	1.833							
EdAtt	2.481	3.772	0.308	0.308	1.288	0.517	2.317						
FaOcBase	19.143	19.594	1.481	1.818	5.272	-0.355	7.936	483.564					
FaOccl	16.433	16.358	1.344	1.843	4.608	0.950	8.905	282.481	464.480				
FaEdBase	0.927	0.771	0.088	0.092	0.129	-0.003	0.411	12.561	11.551	1.014			
FaEdl	0.905	0.862	0.072	0.091	0.073	-0.000	0.478	12.122	11.362	0.848	1.082		
MaEdBase	0.957	1.007	0.101	0.077	0.235	0.083	0.417	7.341	7.712	0.557	0.573	1.068	
MaEdl	0.899	0.993	0.072	0.091	0.143	0.064	0.462	7.729	8.191	0.559	0.657	0.914	1.168
Means	7.554	8.334	.404	.413	7.254	5.524	3.240	29.521	31.633	1.755	1.776	1.922	1.965

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