Education, on-the-job training, and the black-white earnings gap

Black men's earnings lag those of white men,
but their monetary returns for each year
of education are as high as those for white men;
on-the-job training does not pay off as well for blacks

DANIEL E. TAYLOR

More than a decade after the passage of the Economic Opportunity Act and the establishment of the Equal Employment Opportunity Commission, black men continued to earn much less than white men. Those who worked full time in 1977 earned a median of $8,714 in wage and salary income, compared with $12,603 earned by white men. Median weekly earnings for black men were $189, or $72 less than those of white men.[1]

During most of the postwar era, the earnings of black men increased faster than those of white men. Richard Freeman, in a comprehensive study of the economic status of blacks in the 1950's and 1960's, demonstrated that during that period, the median wage and salary annual income of black men increased at a rate of 3.2 percent per year, compared with a 2.6-percent rate for white men.[2] According to Janice Hedges and Earl Mellor, usual weekly earnings of black men who worked full time increased relative to those of white men from 1967 until the recession of 1974–75, but made little gain subsequently. Black men's usual weekly earnings rose from 69 percent of white men's earnings in 1967 to 77 percent in 1973 and to 78 percent by 1978.[3]

The interplay of social and economic factors complicates the analysis of the black-white earnings gap. For example, discrimination historically has played an important role in keeping black workers out of occupations which provide higher levels of earnings, skills training, and job stability. Racial disparities in educa-

tion and other spheres that influence the worker's productivity also affect earnings.[4] Both the quantity and quality of education differ for whites and blacks. While the quantity usually is measured by years of school completed, the quality—which is affected by housing patterns, geographic location, and community and family investments in education—is more difficult to measure.

The human capital approach

The notion that workers embody wealth similar to that of capital is not new. Although the concept of human capital has been discussed since the 18th century, it received more attention in the 1960's, spurred by the National Defense Education Act of 1958 and the manpower development acts of the early 1960's. Gary Becker presented a general statement of human capital theory in 1964.[5] A decade later, Jacob Mincer set down perhaps the most fully developed discussion of the human capital theory to date.[6] This article uses Mincer's approach to report earnings differences of black and white men in 1977, by years of educational attainment and work experience.

Basically, human capital theory states that job skills obtained by workers through formal schooling and on-the-job training increase productivity. Because workers put aside time for training in which earnings otherwise could be made, they expect a return on this investment analogous to that on invested funds. This return is in the form of increased earnings for higher productivity. Under the human capital approach, education and work

Daniel E. Taylor is an economist in the Office of Current Employment Anaylsis, Bureau of Labor Statistics.

experience along with other variables are used to explain differences in earnings among workers.[7]

Because dollar amounts of investment are difficult to obtain, education is most often measured by years completed. Educational achievement affects both weekly earnings (earnings are increased because of the effect of education on productivity) and weeks worked per year (workers with more education tend to work more weeks, recapturing investments in education). Furthermore, education affects earnings and worktime indirectly through workers' occupations. Actual work experience also is difficult to measure and often is approximated by the number of years since leaving school.

Black-white earnings ratios

In 1977, both median annual and median weekly earnings ratios (black to white) of men with 1 or more years of college exceeded those with 1 to 4 years of high school. (See table 1.) Two exceptions were the groups who had been out of school 11 to 15 years and those out more than 30 years. For them, the weekly earnings ratios were about the same at both educational levels. The earnings differential by race was smallest for college-educated men who had been out of school fewer than 6 years and largest for men with some high school education and fewer than 6 years of work experience.[8]

The black-white weekly earnings ratio exceeded the annual earnings ratio in all groups, except for college

men with more than 30 years of work experience. This reflects the fact that black men generally work fewer weeks in a year. The difference between the weekly and annual earnings ratios is greatest for men with some high school education and fewer than 6 years of work experience. This large difference is attributed to the high rate of unemployment among black men in this group: in 1977, 18- and 19-year-old black men had an unemployment rate of 38 percent, nearly 3 times that of their white counterparts.

Both the annual and weekly earnings ratios have improved since 1969. Following are annual and weekly earnings ratios by work experience cohorts in 1977 from this study, which uses the Current Population Survey, and from a study based on a similar universe from the 1970 Census:[9]

	1970 Census (mean)	1977 Current Population Survey	
Work experience		(mean)	(median)
Fewer than 6 years:			
Annual	.65	.81	.74
Weekly	.70	.82	.76
6–10 years:			
Annual	.65	.75	.72
Weekly	.68	.78	.75
11–15 years:			
Annual	.62	.71	.68
Weekly	.64	.76	.71
16–20 years:			
Annual	.60	.75	.72
Weekly	.62	.80	.73
21–30 years:			
Annual	.59	.67	.66
Weekly	.62	.68	.68
31 years or more:			
Annual	.60	.65	.63
Weekly	.62	.67	.64

Black men made earnings gains relative to white men in each work experience category, with particularly large gains for black men recently out of school. However, the large difference between the median and mean earnings for those with fewer than 6 years of work experience suggests that only a portion of young black men benefits from high-paying, stable jobs.

By education. Over the last two decades, black and other men have made considerable gains in education.[10] In 1959, for example, only 21 percent of black and other men 18 years and over and in the labor force had completed at least 4 years of high school, compared with 58 percent in 1977. During the same period, the proportion of white men completing 4 years of high school rose from 49 percent to 75 percent. Thus, the educational attainment of black men continues to lag behind that of white men. Chart 1 contrasts the educational attainment of white and black men who were full-time wage

Table 1. Median annual and weekly earnings and earnings ratios of male full-time wage and salary workers, by race, educational attainment, and work experience, 1977

Education and work experience	Annual earnings			Weekly earnings[1]		
	White	Black	Ratio[2]	White	Black	Ratio[2]
All educational levels[3]	$12,603	$8,714	69	$261	$189	72
Fewer than 6 years experience	5,489	4,084	74	152	115	76
6 to 10	11,243	8,071	72	233	174	75
11 to 15	14,308	9,703	68	292	206	71
16 to 20	15,513	11,225	72	313	227	73
21 to 30	16,037	10,519	66	321	218	68
31 or more	14,078	8,836	63	292	186	64
High school — 1 to 4 years	11,737	8,268	70	245	181	74
Fewer than 6 years experience	4,702	2,893	62	130	102	78
6 to 10	9,402	7,191	76	202	155	77
11 to 15	12,424	8,729	70	254	196	77
16 to 20	14,452	10,125	70	294	210	71
21 to 30	15,030	10,255	68	304	214	70
31 or more	14,386	10,509	73	296	219	74
College — 1 year or more	15,126	11,867	78	306	246	80
Fewer than 6 years experience	7,065	6,861	97	186	186	100
6 to 10	13,517	10,976	81	272	233	86
11 to 15	16,778	12,382	74	331	251	76
16 to 20	19,101	14,742	77	377	305	81
21 to 30	20,306	15,170	75	403	307	76
31 or more	18,575	14,547	78	382	281	74

[1] Weekly earnings are calculated by dividing annual earnings by weeks worked.
[2] Ratios are calculated by dividing the earnings of black men in a particular cohort by those of white men in that cohort.
[3] Includes elementary school.

and salary earners in 1977. Although slightly more than one-third of both white and black men had completed 4 years of high school, the relative proportions are quite different at other levels of schooling. Whereas, 41 percent of black men had fewer than 4 years of high school, this was true for only 23 percent of the white men; and, while 25 percent of the black men attended college, 38 percent of the white men did so.

Black men not only completed fewer grades, they also scored lower on standardized scholastic aptitude tests. Mean scores of high school seniors were significantly lower for blacks. The racial difference between scores remained about the same over the school years reported (1972–73 through 1976–77).[11] According to a test administrator:

> . . . a typical result is to find that only 10 to 20 percent of disadvantaged minority groups score above a point that is . . . exceeded by 50 percent of whites . . . . Such differences should come as no surprise to anyone familiar with histori-

cally unequal education available to blacks as compared with whites, or with corresponding differences in social, economic, and occupational spheres of American life.[12]

By occupation. In 1977, nearly twice as many black men as white men were employed in low-paying occupations, for example, as service workers or laborers, while smaller proportions were in professional, managerial, and craft occupations. It is estimated that one-fourth of the pay differential[13] would be eliminated if black men were represented in major occupational groups in the same proportions as white men.

The overall black-white wage gap is also affected by pay differences within major occupational groups. (See table 2.) This is because earnings differ among individuals within the same occupational group. For example, the professional and technical group includes both physicians and health technicians, workers with vastly different earnings.

Chart 1. Educational attainment of male full-time wage and salary workers, by race, 1977
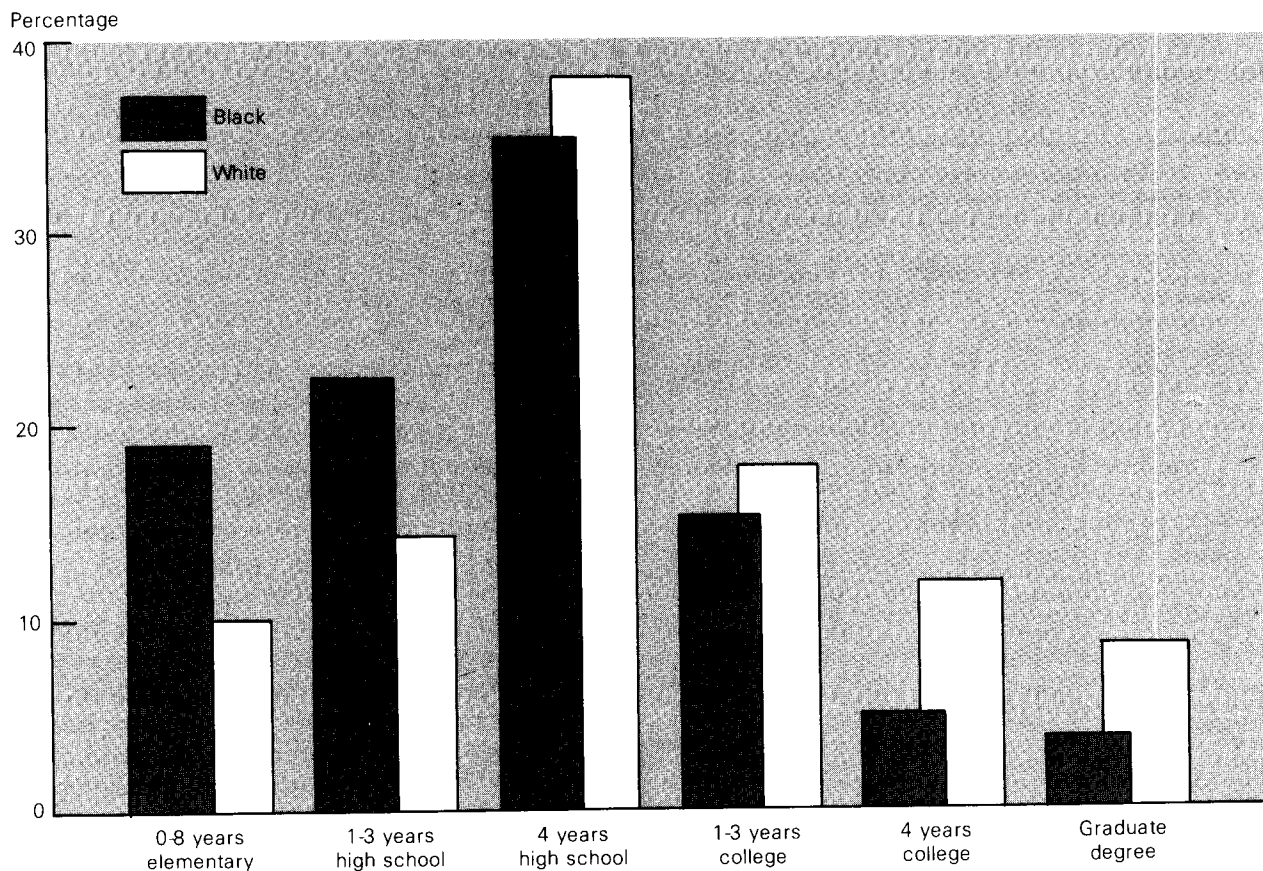
Payoffs for investment in education

Earlier studies. Using the human capital approach, Finis Welch calculated rates of monetary return to schooling for white and for black and other men in various job experience groups, using data from the 1960 Census (reporting 1959 earnings data) and the 1967 Survey of Economic Opportunity (reporting 1966 earnings data).[14] His results for 1959 showed a higher rate of return for white men than for black men in each experience group. However, over the period, younger black men gained relative to white men with the same years of work experience, both in rates of return for schooling and in relative earnings. The Vietnam War and a strong economic upswing at the time of the second survey may have influenced these results because employment and earnings of black workers rise faster than those of white workers during rapid economic expansions.

Leonard Weiss and Jeffrey Williamson used the same Survey of Economic Opportunity data to estimate income elasticities of education (percentage change in income resulting from a one percentage point change in education) by race.[15] They too noted the importance of full employment conditions as a source of improvement in black-white earnings differentials, but they also noted the possibility of a decline in discrimination as a probable cause.[16]

. . . there may have been an independent shift in the incidence of discrimination at all education levels as well. The strong effect of secondary and even primary education on black male incomes in 1967 suggests that the improved opportunities in 1967 extended considerably beyond the token employment of a few black executives . . .

Other research also demonstrates that blacks made some gains during the 1960's although results are mixed. For example, Charles Link published income elasticities of education for 1960 and 1970 which showed that black men with 9 to 12 years of education made earnings gains, but his results differed from those

of Weiss and Williamson, which showed a large increase at all educational levels. Weiss and Williamson (in an update of their earlier study) concluded that in 1970, "the effect of education on earnings is roughly as strong for blacks as for whites."[17]

James Smith and Finis Welch (using 1960 and 1970 Census data) found that returns for education in 1969 were less for black men who had not attended college than for their white counterparts.[18] However, among the college trained with 1 to 5 years of work experience, black men received more handsome returns than white men.

More recent research by Smith and Welch used Current Population Survey data for 1968–75 to estimate schooling coefficients, along with other measures of economic equality, for both white and black men.[19] They found that the declining proportion of blacks residing in the South (as well as movements within the South) has been an important factor in the decrease in the racial wage differential, but that education also played an important role in the movement towards wage parity in the late 1960's and early 1970's.[20]

Results of current study. In 1977, the rate of monetary return for education, measured in terms of weekly wages, was as high for black men as that for white men (8.1 percent versus 7.3 percent per year of school). These results appear to be in line with the trends noted earlier. The average rates in 1977 are shown in table 3.[21] Rates of return are highest for men most recently out of school and rates generally decline with additional years of work experience. The decline is less among those with some college education.

Two effects govern the decline in the rates of return for those with more years of work experience. The "vintage" effect suggests that workers who have been out of school longer receive lower returns than more recent graduates because of the increasing quality of schooling and the obsolesence of knowledge. The "life cycle"

Table 2. Median annual and weekly earnings and earnings ratios of male full-time wage and salary workers, by race and occupation, 1977

Occupation	Number (in thousands)		Annual earnings			Average weekly earnings [1]		
	White	Black	White	Black	Ratio [2]	White	Black	Ratio [2]
All workers [3]	41,677	4,180	$12,603	$8,714	69	$261	$189	72
Professional, technical and kindred workers	6,527	290	16,322	13,247	81	325	271	83
Managers and administrators	5,302	196	17,774	14,587	82	348	283	81
Sales workers	2,264	([4])	13,970	([4])		285	([4])	
Clerical workers	2,666	303	12,615	9,363	74	255	199	78
Craft and kindred workers	9,775	651	13,093	10,072	77	275	214	78
Operatives, except transport	5,565	779	10,332	9,428	91	221	201	91
Transport equipment operatives	2,628	389	11,418	8,721	76	245	194	79
Nonfarm laborers	3,065	729	7,081	5,935	84	178	138	78
Service workers [5]	3,131	671	8,358	6,764	81	181	144	80
Farm laborers	724	104	4,098	3,875	95	121	91	75

[1] Weekly earnings are calculated by dividing annual earnings by weeks worked.
[2] Ratios are calculated by dividing the earnings of black men in a particular cohort by those of white men in that cohort.
[3] Includes farm managers and private household workers who are not listed separately.

because of their small sample size.
[4] Base is less than 75,000.
[5] Excludes private household workers.

Table 3. Rates of return on educational attainment for male full-time wage and salary workers, by race, educational attainment, and work experience, 1977

Education and work experience	White	Black	Difference
High school — 1 to 4 years:			
Fewer than 6 years experience	[1] .193	[1] .207	.014
6 to 10	[1] .124	[1] .111	– .013
11 to 15	[1] .126	[1] .084	–.042
16 to 20	[1] .112	[1] .133	.021
21 to 30	[1] .073	[1] .062	– .011
31 or more	[1] .041	[1] .090	.049
College — 1 year or more:			
Fewer than 6 years experience	[1] .098	[1] .116	.018
6 to 10	[1] .074	[1] .097	.023
11 to 15	[1] .068	[1] .144	[1] .076
16 to 20	[1] .078	.081	.003
21 to 30	[1] .072	[1] .074	.002
31 years or more	[1] .060	[1] .089	.028

[1] Statistically different from zero at the 95 percent confidence level.
NOTE: See appendix for the methodology used in deriving rates of return.

effect results from the compounding effect of training received at school and that received at work over one's lifetime. For example, a high school dropout would be less likely to be in a job which provides opportunity for advancement. Smith and Welch suggested that the life cycle effect may be of more importance to those who attend college, and this may explain why the rates of return decline much faster with additional years of work experience for those with only a high school education than for those who have also attended college.[22]

Within each schooling-experience group, the rates of return for white men and black men are not statistically different, except for college-educated men with 11 to 15 years of work experience. In this category, black men posted a rate of return 8 percentage points higher than that of white men. Three possible explanations for their exceptional performance are that (1) they entered the labor market during a period of a sharp economic up swing (1962–66), (2) they entered the labor market with at least some college training at a time when employers were eagerly looking for minorities to meet Fed-

eral affirmative action guidelines, and (3) they were the last cohort to enter the labor market before the entrance of the baby-boom cohorts, whose large number has lowered the relative wages of more recent workers.[23]

Rates of return based on a year of college is less than that for a year of high school. However, these estimates are the average rates; marginal rates imply that for black men with 12 years of schooling and 13 years of work experience, an additional year of education would bring with it an 11-percent rate of return. (See appendix.) For white men at a comparable level of education and experience, an additional year of school would result in about a 9-percent marginal rate of return.[24] These rates suggest that for white men, the marginal benefit of each additional year of school is less than that for blacks.

A rough estimate of the rates of return for on-the-job training suggests that black men do not fare as well as white men. The returns for on-the-job training (measured by time since leaving school) are estimated at about 13 percent for white men, and 8 percent for black men.[25] However, these estimates should be interpreted with caution. First, on-the-job training is measured by years of work experience; therefore, the training component is overestimated for black men because their jobs usually require less training.[26] Second, because black men have higher levels of unemployment than white men, their work experience is also overestimated.

DIFFERENCES IN EDUCATIONAL attainment and work experience are major forces determining earnings. Black men appear to be gaining as much or more from their fewer years of school relative to white men, but on-the-job training may not pay off as well for blacks. Compared with white men, the rates of monetary return for education are estimated to be slightly higher for black men but on-the-job training may be considerably less. However, limitations in measuring work experience suggest caution in drawing any policy interpretations. □

——— FOOTNOTES ———

[1] Information on annual earnings and educational attainment in 1977 was gathered from questions in the March 1978 supplement to the Current Population Survey (CPS). Weekly earnings data were derived by dividing the annual wage and salary earnings reported for an individual worker by the number of weeks that individual worked during the year. The CPS is conducted each month by the Bureau of the Census for the Bureau of Labor Statistics. A detailed description of the survey appears in Concepts and Methods Used in Labor Force Statistics Derived From the Current Population Survey, Report 463 (Bureau of Labor Statistics, 1976). The universe for this study included full-time (but not necessarily year round) wage and salary workers, age 16 to 65.

[2] Richard B. Freeman, "Changes in the Labor Market for Black Americans, 1948–72," Brookings Papers on Economic Activity, No. 1, 1973, p. 73.

[3] Janice N. Hedges and Earl F. Mellor, "Weekly and hourly earn-

ings of U.S. workers, 1967–78," Monthly Labor Review, August 1979, pp. 31–41.

[4] See, for example, James Gwartney, "Discrimination and Income Differentials," American Economic Review, June 1970, pp. 396–408.

[5] Gary Becker, Human Capital (New York, Columbia University Press, 1964).

[6] Jacob Mincer, Schooling, Experience, and Earnings (New York, Columbia University Press, 1974).

[7] Additional variables relating to workers' social, economic, and demographic status have been used in various specifications of the human capital model. These variables include marital status, region, family background, city, size of residence, and veterans status. (See, for example, Randall D. Weiss, "The Effect of Education on the Earnings of Blacks and Whites," Review of Economics and Statistics, February 1970, pp. 150–59 or Leonard Weiss and Jeffrey G. Williamson, "Black Education, Earnings, and Inter-regional Migra-

tion: Some New Evidence," *American Economic Review,* June 1972, pp. 372–83.) Occupation, a variable which has an important indirect effect upon the distribution of earnings, is often discussed. Another important variable in the model, individual ability, is often excluded from consideration because it is difficult to measure.

[*] Work experience is estimated in the following manner: the years of schooling plus 5 years representing the preschool years are subtracted from the worker's age. Although this estimation of work experience is often used in human capital studies, it has serious limitations. Among these are that it assumes men finish school, go immediately to work, and work continuously until retirement. Also, it implicitly assumes that the amount of on-the-job training embodied in a given amount of work experience is the same for all men and that on-the-job training decreases over the life cycle in the same manner for all men.

[*] James P. Smith and Finis Welch, "Black-White Male Wage Ratios, 1960–70," *American Economic Review,* June 1977, p. 324. Smith and Welch groups with the shortest and longest work experience exclude workers with less than 1 year of experience and those with more than 40 years. (The Current Population Survey data include all full-time wage and salary workers between age 16 and 65 in 1977, irrespective of length of work experience.) Smith and Welch describe their ratios in the following manner: "Numbers reported are ratios of averages, i.e., they are average black earnings or weekly wages relative to appropriate averages for whites. Weekly wages are earnings last year divided by weeks worked last year. The average weekly wage used here is total earnings of all persons divided by total weeks worked, i.e., individual earnings per week are weighted by weeks worked." Although their data include workers with less than full-time schedules, this has little effect on the earnings ratios because the black-white ratio of median usual weekly earnings of part-time workers was .98 in May 1977.

[10] The term "black and other" is used for historical data which are not available for blacks only. In the 1970 Census of Population, 89 percent of the black and other group were black; the remainder included American Indian, Alaskan Natives, Asian and Pacific Islanders. The regression model, however, was designed to measure the earnings differential between blacks and other races. Whites comprised the overwhelming majority of the nonblack group—about 98 percent in 1970.

[11] Statement of Winton H. Manning, senior vice president for Research and Development, Educational Testing Service, before the Subcommittee on the Civil Service. (See *Professional and Administrative Career Examination,* U.S. House of Representatives, Subcommittee on the Civil Service of the Committee on Post Office and Civil Service, 96th Cong. 1st sess., May 15, 1979.)

[12] Statement of Winton H. Manning, *Professional and Administrative . . . ,* p. 62.

[13] This figure was calculated by distributing black men across occupations in the same proportions as white men, then redistributing these groups across their earnings distribution in the same proportions. This new income distribution was then used to calculate a revised median in which 24 percent of the black-white difference was explained.

[14] Finis Welch, "Black-White Differences in Returns to Schooling," *American Economic Review,* December 1973, pp. 893–907.

[15] Weiss and Williamson, "Black Education, Earnings . . ."

[16] Weiss and Williamson, "Black Education, Earnings . . ."

[17] Charles R. Link, "Black Education, Earnings, and Interregional

Migration: Comment and Some New Evidence," and Leonard Weiss and Jeffrey G. Williamson, "Black Education, Earnings and Interregional Migration: Even Newer Evidence," *American Economic Review,* March 1975, pp. 236–44. Link's estimates were based on grouped data from the 1970 Census, while Weiss and Williamson's estimates were based on individual data from the 1970 census.

[18] Smith and Welch, "Black-White . . . ," pp. 323–38. In their analysis of earnings ratios, they found that the earnings differential diminished somewhat over the decade yet remained large in 1970; that blacks entering the labor market in the 1960's, especially in the late 1960's fared best; and that college educated black men made the greatest improvements.

In their regression model, Smith and Welch include government employment and geographic location as explanatory variables as well as school completion and years of work experience which means that their results are not directly comparable with those reported in this article. However, it is useful to note that they found that little change had taken place between 1960 and 1970 in the rates of return for schooling of either black or white men in the elementary and secondary category and that data for both years showed the rate of return for black men to be lower than that for white men in each experience category. For example, white men in the 1 to 5 years of experience category accrued a return of .143, compared with a rate of .097 for black men of this category; in the 31 to 40 years of experience group, the rates of return were .050 and .026. Among those who attended college, the rate grew in the 1960's, while there was little difference between the races. In 1970, black men in the 1 to 5 years experience category had a rate of return for schooling of .158, compared with a rate of return of .124 for white men of this group.

[19] James P. Smith and Finis Welch, "Race Differences in Earnings: A Survey and New Evidence," in Peter Mieszkowski and Mahlon Straszheim, eds., *Current Issues in Urban Economics* (Baltimore, The Johns Hopkins University Press, 1979), pp. 40–73.

[20] Smith and Welch, "Race Differences . . . ,"

[21] Differences were tested for statistical significance using results from the dummy variable analysis. (See appendix.)

[22] Smith and Welch, "Black-White Male . . . ," p. 330.

[23] For a discussion of the "baby-boom" effect on wages see Richard B. Freeman, "The Effect of Demographic Factors on Age-Earnings Profiles," *The Journal of Human Resources,* Summer, 1979, pp. 289–318.

[24] These calculations were derived in the following manner for whites:

$$\frac{\text{Change in logarithm of weekly earnings}}{\text{Change in education}} =$$

$$.1414 - .0022 \times (12) - .0018 \times (13)$$

[25] Coefficients of experience and experience squared were used to derive these estimates. Mincer, *Schooling . . . ,* p. 91, provides formulas used in the derivation of these estimates. For estimates of the effect experiences on earnings using a more direct measure of on-the-job training, see Greg J. Duncan and Saul Hoffman, "On-the-Job Training and Earnings Differences by Race and Sex," *Review of Economics and Statistics,* November 1979, pp. 594–603.

[26] See Duncan and Hoffman, "On-the-Job Training . . . ," p. 597, for estimates of the average amount of training by occupation.

APPENDIX: Rates of return for education

The model used to estimate rates of return for education in the current study is

$\ln W = a + b_1 S + b_2 t + b_3 t^2$; where:

$\ln W$ is the natural logarithm of average weekly earnings.

S is the number of years of schooling completed.

t is the calculated number of years of work experience (Age -S -5).

Average weekly earnings (annual earnings divided by weeks worked) is used as the dependent variable of the model because earnings and work time are both dependent on schooling and experience. An advantage in us-

ing weekly earnings as the dependent variable (as opposed to annual earnings) is that the labor-leisure tradeoff is taken into account, that is, the effect of human capital on earnings is separated from its effect on work time. However, involuntary unemployment, which reduces work time beyond that which would be freely chosen, makes this variable less useful, that is, to the extent that black men are involuntarily unemployed more than white men, their rate of return to schooling is overestimated.

Because years of schooling measure the quantity of schooling but not its quality and because the black educational experience historically has been lower in quality than that of whites, the independent variable, years of schooling, overestimates blacks' educational input. Experience, defined as the time since leaving school, overestimates black men's work experience as they are more likely to have periods of unemployment than white men. Additionally, the amount of on-the-job training which is embodied within a given amount of work experience may be less for black men. The experience squared term takes into account the fact that actual on-the-job training declines as workers age, which means that additional years of work experience will have less impact on workers' earnings.

To measure the statistical significance of the difference between the effect of schooling on the earnings of white and black men (holding experience constant), the model takes the form

$$\ln W = a + a'Z + b_1 S + b_1'SZ + b_2 t + b_2'tZ + b_3 t^2 + b_3't^2 Z$$

where Z is a dummy variable designating race (Z = 1 if black, 0 if white). Using this method, it can be said that the rate of return for black men is significantly different from that for white men if the coefficient, b_1' is statistically different from zero. (These differences are reported in table 3 of the text.) For a discussion of this estimation technique, see Jan Kmenta, *Elements of Econometrics* (New York, The Macmillian Co., 1971), pp. 419–22.

The regressions were run separately by length of work experience for workers who completed 1 to 4 years of high school and for those completing at least 1 year of college (total figures include those completing only elementary school). By analyzing the data in this

manner, experience acts as an index of age (that is, successive experience groups can be considered successive age groups). In the context of the human capital model, this indexing marks the vintage of schooling. This is important because the difference in the quality of education of blacks and whites has declined over the past several decades. See John D. Owen, *School Inequality and the Welfare State* (Baltimore, the Johns Hopkins University Press, 1974), pp. 133–48. Furthermore, schooling's effect on earnings over the life cycle (successive experience groups) may differ by race.

A measure of the marginal rate of return can be estimated by altering the model to include a variable which accounts for the non-linear aspect of an additional year of education with experience. Essentially, the model is expanded to include a term for the square of education and for education by experience. The marginal change in earnings due to a change in education can then be derived by differentiating the estimated equation with respect to education. Estimates of this equation are shown in the following tabulation for the overall sample, by race (standard errors in parenthesis):

	White	*Black*
Constant	3.2	2.94
	(.05)	(.20)
Education	.1414	.1374
	(.0069)	(.0251)
Education squared	−.0011	.0001
	(.0002)	(.0009)
Education, by experience	−.0018	−.0022
	(.0001)	(.0003)
Experience	.0904	.0874
	(.0017)	(.0063)
Experience squared	−.0011	−.001
	(.00002)	(.0001)

The extra payoff from an additional year of education (at a given experience and educational level) can be estimated from the following relationships:

For whites—$\dfrac{\text{change in logarithm weekly earnings}}{\text{change in education}} =$

(.1414 − .0022 education − .0018 experience)

For blacks—$\dfrac{\text{change in logarithm weekly earnings}}{\text{change in education}} =$

(.1374 + .0002 education − .0022 experience)