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ABSTRACT

Characteristics and determinants of earnings distributions for black and white males are revealed in samples from the 1960 and 1970 censuses. Using this data, this paper describes and contrasts the properties of black and white male earnings distributions. It also uses earnings functions estimated from the census to identify and rank variables in terms of their contribution in explaining relative earnings dispersion. Extensive statistical analysis is used to make predictions about black and white earnings. A short bibliography is included. (Author/PB)

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INEQUALITY: RACE DIFFERENCES IN THE DISTRIBUTION OF EARNINGS***

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Inequality: Race Differences in the Distribution of Earnings

James P. Smith and Finis Welch[1]

Too often income inequality in the United States is characterized by stressing differences in average earnings between various demographic groups. In fact, repeated emphasis on race and sex differentials might lead one to suspect that mean wage differentials represent a large part of total inequality. Yet, according to the most recent Census, the story of income inequality in America can be told with little mention of black-white differences in mean earnings: for males, the black-white wage differential accounts for less than three percent of total (log) earnings variances.[2] Moreover, within race, blacks' earnings are often less equally distributed than earnings of whites. The economic pie may be smaller for blacks, but it is also sliced less evenly.

In this paper, we examine characteristics and determinants of earnings distributions for black and white males as they are revealed in

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[2]If blacks were to represent half of the population and if both average differences and variances within race were preserved, the mean difference would still represent only six percent of total variance.

the 1/100 Public Use Samples of the 1960 and 1970 Censuses.[3] This paper is divided into two sections. The first describes and contrasts the salient properties of black and white male earnings distributions. Section II relies on earnings functions estimated from the Census to identify and rank variables in terms of their contribution in explaining relative earnings dispersion. These earnings equations are used to predict the full distributions of earnings for blacks and whites separately so that predicted and observed distributions can be compared throughout the complete range of the distributions. We think that the predictions capture many important features of the observed distributions. In particular, predicted earnings variances in 1960 and 1970 are higher for blacks than whites and, in 1970, this difference is also reflected in our predictions. A concluding part of this section, briefly, presents results for a more generalized random-coefficients model that aims at identifying sources of residual variation.

I. An Overview

Because comparisons of full distributions may reveal differences not conveyed by summary measures, we begin with a convenient method of contrasting distributions illustrated in Figure 1. In the curves labelled

[3] The sample is restricted to non-self-employed males with positive earnings. Including the self-employed would increase inequality and impart a more positive skew to the distribution. Ignoring non-earnings income probably leads to an underestimation of total income at both the lower and upper tails of the income distribution - the lower tail because of government transfers, the upper because of non-human wealth income.

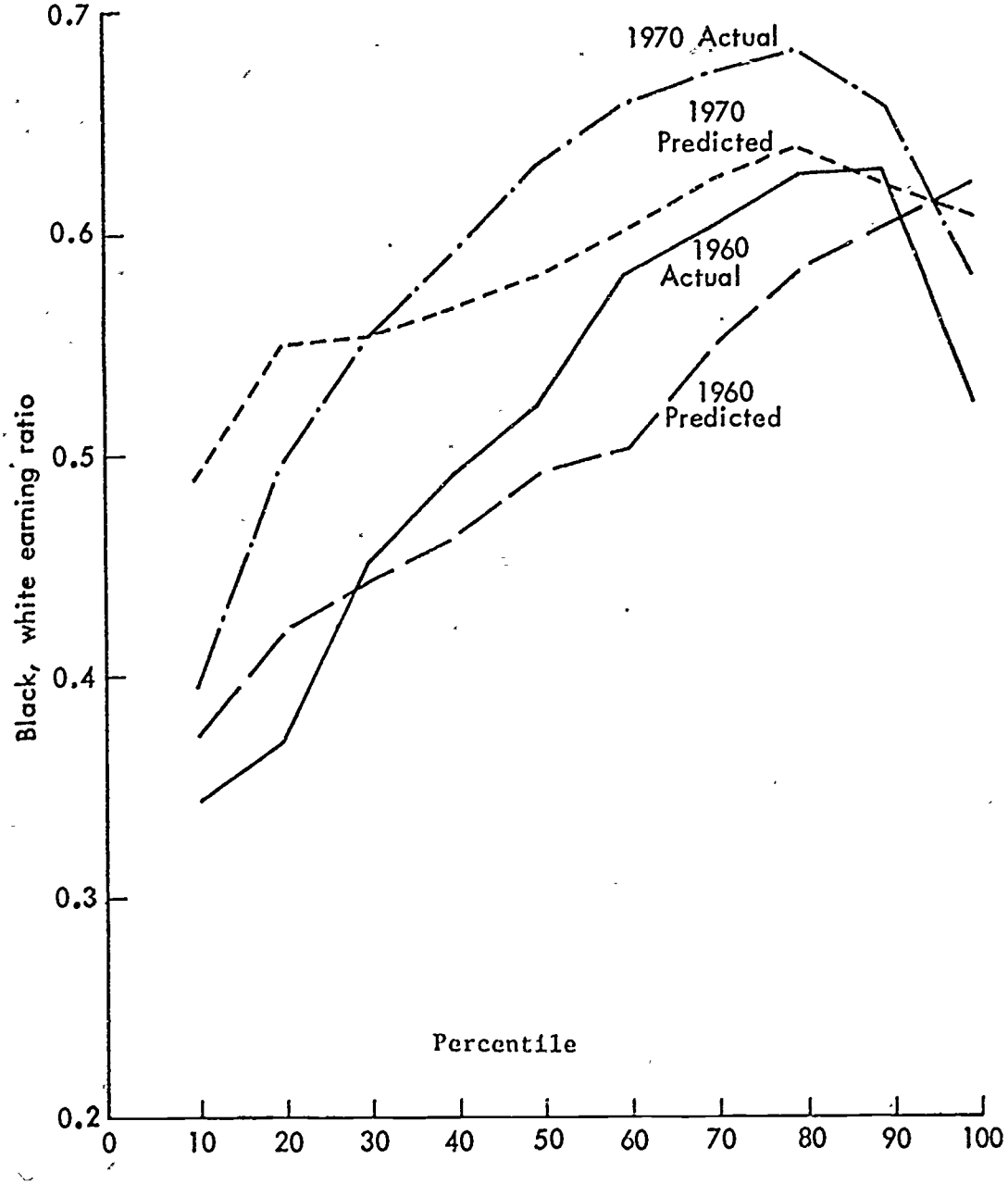

Fig. 1 – Male Earnings Ratios

"actual", earnings of black males at selected percentiles of black earnings distributions are presented relative to the earnings of white males at the same percentiles of white distributions. (The curves labelled "predicted" are discussed below.) Since the curve is positively sloped, there exists more relative dispersion for blacks up to the 70 to 80 percentile. In the top tail of the distribution, the relative dispersion of white earnings is greater, indicating greater positive skewness in the white distribution. The reversal at the 80th percentile shows that a unique ranking of inequality by race is not possible. Those summary measures which weight the bottom tail of the distribution more heavily (e.g., log variances) will tend to rank blacks over whites in inequality. Other measures (e.g., coefficients of variation) could produce the opposite result. Although we will initially rely on only one measure of inequality, logarithmic variance, we will also deal with some distinctions between this summary measure and the full distribution.

Variances of log male earnings and weekly wages are listed in Table 1 separately by year (1960 and 1970), and race (blacks and whites). These variances exhibit their familiar U-shaped age profile. For both races, total variance is dominated by the within-age cell variances with over 70 percent of the aggregate variance consisting of within-cell variance.[4]

[4] Between age cell variance is lower for blacks both absolutely and as a proportion of total variance reflecting a less steeply-graduated age earnings profile for blacks.

TABLE 1

MEASURES OF DISPERSION

VARIANCE IN LOG MALE EARNINGS

Ages	1970 Whites	1960 Whites	1970 Blacks	1960 Blacks
21-25	0.8242	0.7128	1.0584	0.9367
26-30	0.4108	0.4404	0.6436	0.7310
31-35	0.3988	0.4003	0.5834	0.6814
36-40	0.3845	0.4592	0.6020	0.6710
41-50	0.4712	0.4992	0.6763	0.7356
51-60	0.5271	0.6087	0.7732	0.8966
21-60	0.5858	0.5593	0.7595	0.7991
18-65	0.8190	0.7222	0.9495	0.9412

VARIANCE IN LOG MALE WEEKLY WAGE

21-25	0.4638	0.3809	0.6557	0.5293
26-30	0.2813	0.2491	0.4164	0.4223
31-35	0.2759	0.2606	0.3922	0.4307
36-40	0.2881	0.2951	0.4082	0.4282
41-50	0.3359	0.3341	0.4707	0.4917
51-60	0.3786	0.3873	0.4901	0.5565
21-60	0.3794	0.3433	0.4892	0.4930
18-65	0.5006	0.4302	0.6322	0.5992

TOTAL EARNINGS INEQUALITY USING VARIANCE IN LOG EARNINGS

	Within Race	Between Race	Total
Actual Racial Proportions			
1960	.7409	.0336	.7744
1970	.8310	.0203	.8511
Equal Weighting*			
1960	.8317	.1077	.9394
1970	.8842	.0591	.9433

*Assumes equal number of the blacks and whites in population.

Using log variance as the criterion, we find in the Census data that earnings of blacks are less evenly-distributed than those of whites. For those aged 18-65, variances in log weekly or yearly earnings rose for white males but remained relatively constant for black men between 1960 and 1970. The lower between-race variance in 1970 was not sufficient to prevent aggregate inequality from rising.[5]

2. Sources of Difference in Earnings Dispersion

2.1 Regression Accounting

Earnings distributions are determined by the functional relationship between earnings and personal characteristics and the underlying joint distribution of these characteristics in a population. The regression technique has become the standard format for accounting for group differences in mean earnings but is less often used for examination of full distributions. Yet, the interest of policymakers often resides in the tails of distributions rather than in comparisons of representative or "average" persons belonging to the respective population under study. Because the number of explanatory variables is large, the distributions of these variables will be initially characterized simply by their variances and covariances. The regressions are based on the 1/100 Public Use Samples of the 1960 and 1970 Censuses. Individuals are

[5] This results from aggregate variance being heavily weighted by the white sample.

partitioned according to estimated years of work experience[6] and within each experience class (1-5, 6-10, 11-15, 16-20, 21-30, and 31-40), the regression estimated is of the form:

$$(1) \qquad y = x'(b_o + d_1\delta_1 + d_2\delta_2 + d_1d_2\delta_{12}) + u$$

where y = ln (earnings last year/weeks worked last year),[7] x' is a vector of characteristics of the individual and

$$d_1 = \begin{cases} 1 \text{ if black} \\ 0 \text{ otherwise} \end{cases} \qquad d_2 = \begin{cases} 1 \text{ if 1960} \\ 0 \text{ otherwise} \end{cases}$$

In accounting for explained variance, let b_i represent the estimated parameter vector for the i-th group. Explained variance is:

$$(2) \qquad \sigma_y^2 = b_i' V_i(x) b_i$$

where $V_i(x)$ is the observed variance-covariance matrix of characteristics for the i-th group. Characteristics are partitioned according to:

$$x' = (\underline{x}'_1, \underline{x}'_2, \underline{x}'_3, \underline{x}'_4, \underline{x}'_5)$$

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[6] Estimates by Hanoch by ages of beginning work level by schooling:

Schooling:	0-7	8	9-11	12	13-15	16	17+
Age at beginning work:	14	16	18	20	23	25	28

[7] This is equivalent to an earnings equation with log annual earnings as the dependent variable and weeks worked included as an independent variable with unit coefficient.

with

$\underline{x}_1'$ = (years of grade school, years of college) = schooling;

$\underline{x}'_2$ = (North Central, South, West, Metropolitan, Central City years in current residence) = location;

$\underline{x}_3'$ = (federal employee, employee of regulated industry, federal share of industry, state and local governments' share of industry) = government employment;

$\underline{x}_4'$ = (years of experience, years of experience squared) = experience;

$\underline{x}_5'$ = (log of weeks worked) = weeks worked.

The earnings variation attributed to the j-th set of explanatory variables is:

$$\sigma_y^2 V(x_j) = b_j' V(x_j) b_j \tag{3}$$

where $V(x_j)$ is the diagonal block in $V(x)$ describing the variance of x_j. Similarly, that part of the explained variance attributable to covariance between x_j and x_k is:

$$\sigma_y^2 C(x_j, x_k) = 2b_j' C(x_j, x_k) b_k \tag{4}$$

Where b_j and b_k refer to x_j and x_k, and $C(x_j, x_k)$ is the covariance of x_j, x_k. A summary of the more important accounting effects is contained in Table 2.

With respect to black-white inequality, the partial effect of weeks worked accounts for roughly half of explained variance. Depending upon one's view of underlying causes of hours variation, it may be preferable

Table 2

CONTRIBUTION OF SELECTED FACTORS TO VARIANCES PREDICTED FROM ESTIMATED EARNINGS EQUATION

	Experience Class					
	1-5	6-10	11-15	16-20	21-30	31-40
1970 WHITES						
Total Variance in Annual Earnings	.773	.481	.370	.419	.413	.422
Explained Variance	.273	.129	.070	.077	.083	.110
Contributions of						
A. Log Weeks Worked	.138	.058	.034	.039	.043	.064
B. Years of Schooling	.040	.030	.016	.016	.017	.016
C. Regional Variables	.008	.007	.007	.007	.010	.012
D. Government Variables	.006	.004	.004	.003	.003	.010
E. Schooling-Weeks Worked Interaction	.035	.018	.005	.007	.006	.005
F. Location-Schooling Interaction	.004	.003	.002	.003	.003	.004
1970 BLACKS						
Total Variance in Annual Earnings	1.130	.730	.551	.536	.555	.632
Explained Variance	.430	.256	.148	.149	.163	.192
Contributions of						
A. Log Weeks Worked	.187	.093	.067	.066	.085	.105
B. Years of Schooling	.054	.036	.022	.021	.020	.016
C. Regional Variables	.016	.012	.012	.013	.016	.024
D. Government Variables	.008	.004	.004	.006	.006	.010
E. Schooling-Weeks Worked Interaction	.064	.029	.013	.011	.013	.012
F. Location-Schooling Interaction	.010	.006	.005	.006	.007	.007
1960 WHITES						
Total Variance in Annual Earnings	.856	.533	.397	.389	.463	.535
Explained Variance	.393	.193	.126	.125	.149	.177
Contributions of						
A. Log Weeks Worked	.268	.135	.077	.074	.083	.093
B. Years of Schooling	.030	.036	.018	.013	.009	.007
C. Regional Variables	.020	.034	.028	.036	.043	.053
D. Government Variables	.006	.004	.004	.003	.003	.018
E. Schooling-Weeks Worked Interaction	.041	.021	.006	.004	.003	.004
F. Location-Schooling Interaction	.008	.014	.010	.011	.012	.012
1960 BLACKS						
Total Variance in Annual Earnings	1.187	.819	.695	.608	.648	.734
Explained Variance	.591	.398	.314	.273	.286	.322
Contributions of						
A. Log Weeks Worked	.327	.207	.181	.140	.168	.173
B. Years of Schooling	.056	.051	.025	.019	.011	.007
C. Regional Variables	.060	.043	.048	.051	.057	.077
D. Government Variables	.015	.008	.001	.013	.014	.018
E. Schooling-Weeks Worked Interaction	.037	.023	.011	.010	.008	.006
F. Location-Schooling Interaction	.041	.036	.023	.022	.017	.016

especially for welfare statements, to partition out that part of total earnings dispersion due to hours worked. Clearly, if leisure time has value and if the hours decision is voluntary, earnings fluctuations resulting from fluctuations in time worked should not be viewed as equivalent to variance associated with wage differentials. Even though employment instability is an obvious cause of inequality, it is important to note that the interracial differences are not solely due to employment factors. Using variance in log weekly wage to measure inequality, the dispersion among blacks still exceeds that among whites.

The distribution of schooling is a second factor underlying black-white differences in inequality. For all but the most recent cohorts, schooling is more unequally distributed among black males. There exists a clear secular trend for both races towards less dispersion in schooling and a narrowing of the differentials in variance between races. Given similar average returns to education within experience classes, this larger variance in black schooling would imply more black earnings inequality. However, proportionate variation in human capital, as measured only by years of schooling completed, accounts for little of the difference in inequality. The variance attributed to schooling declines as work experience increases.[8] The lower schooling variances in 1970 also lead to a reduction in inequality for both races. Since both schooling and weeks worked increase annual earnings, the positive correlation between them adds to earnings dispersion. Evidently labor supply behavior builds positive correlation between wages and time worked and spreads the distribution of earnings. Because schooling coefficients

[8] This is a result of lower estimated returns to schooling in the more experienced groups.

and the covariance between education and weeks worked decline over the life cycle, this interaction has its primary influence in earlier experience intervals. Moreover, it usually has a slightly larger effect for whites than blacks and thus does not help explain race differences.

The regional distribution of blacks combined with the large variance between regions in black earnings is important in explaining higher black inequality. Among our region variables, Southern residence was the most important. Holding constant schooling, experience and weeks worked, black-white ratios of earnings range from 12 to 29 percent lower (depending on the amount of job experience) for Southern residents than they do for Northeastern residents. Regional disparities in earnings are far more important for older (more experienced) workers and are more important in 1960 than in 1970. Also, part of schooling's contribution to explained variance is captured via covariance between schooling and geographic location, reflecting the fact that average school completion levels are higher where wages are high.

We attempted to measure the direct and indirect influence of government on aggregate wage dispersion. The direct influence is captured simply with a dummy variable for employment in the government sector. Since government has the potential for influencing wages in other sectors, as well, we also included variables indicating employment in those sectors that seem most susceptible to government's power - industries regulated by the government and those that sell a significant fraction of their product to government. Compared to the other factors included in our regressions, government employment, both direct and indirect, proved to be relatively unimportant, accounting for around 10 percent of explained weekly wage variance.

2.2 Full Distributions

Although larger black relative dispersion was on average an accurate characterization, we have noted that a comparison of the top quarter of black and white earners reveals more relative dispersion in white earnings. We examine next complete distributions of earnings to see how closely our predictions compare to observations throughout the entire distribution.. Using our estimated wage equations, earnings for all males in the Census samples with one to forty years of market experience are predicted. In Figure 1, black-white earnings ratios at deciles of the predicted black and white distributions are compared to the wage ratios based on the actual black-white distributions. Because a positively sloped curve indicates larger black relative variance, the rising predicted earnings ratios until the 80 decile confirm our ability to capture some factors leading to larger black inequality. Although the decline is not as rapid as that in actual earnings, our predicted earnings ratios in 1970 decrease after the 80th decile. In 1960, our predicted distributions fail to track the decline in black-white earnings ratios in the upper deciles, but the rate of increase in the predicted ratios is clearly attenuated. The factors used earlier to explain larger black inequality apparently also cause the reversal in relative variance by race in the upper section of the earnings distribution.

We will illustrate why the reversals in relative variance occur using the marginal distributions of the two variables identified by our earnings equation as the dominant causal factors in explaining wage dispersion - education and geographical location.

In Table 3, years of schooling completed at deciles of the black and white schooling distribution for 1960 are listed.[9] The larger dispersion

[9] A similar pattern (not shown) exists in 1970.

TABLE 3

EDUCATION DISTRIBUTIONS 1960

A. Deciles of the Schooling Distribution

	1	2	3	4	5	6	7	8	9
Black	2.3	4.1	5.6	6.8	7.6	8.7	10.0	11.2	11.8
White	6.2	7.4	8.1	9.5	10.9	11.3	11.7	12.4	15.1

B. Marginal Returns to Schooling

	Years of Schooling		
	0-8	9-12	13+
Black	.0490	.1118	.1135
White	.0601	.0972	.1048

C. Residential Distribution by Deciles of Predicted Earnings*

1970 Whites

Region	10	30	50	70	90	100
North Central	.213	.240	.304	.327	.330	.310
South	.402	.453	.238	.189	.174	.165
West	.183	.153	.165	.195	.222	.209

1970 Blacks

Region						
North Central	.125	.059	.090	.300	.486	.429
South	.688	.834	.726	.204	.072	.121
West	.055	.028	.048	.115	.117	.157

in black schooling is not present throughout the education range. Between the 10 and 70 percentile, black schooling increased by 5.9 years while white schooling increases by 4.3 years. Given similar returns to schooling by race, this is consistent with the rising income by decile curve observed in Figure 1. But after the 70 percentile, we increment black schooling by only 1.8 years and white schooling by 3.4 years. Therefore, in the top three deciles, the schooling distributions predict more relative earnings dispersion among whites. This pattern of differential variances in schooling is reinforced by rising income returns with schooling level. Although schooling coefficients are similar within schooling class by race, whites achieve higher schooling categories at earlier percentiles. Comparing individuals in the top third of the earnings distribution, an additional year of schooling adds more to white earnings, spreading out the distribution of white earnings compared to that among blacks.

The geographical distribution of blacks and whites is also listed in Table 3 at selected percentiles of the 1970 predicted earnings distribution. White males are fairly uniformly distributed over their deciles. For blacks, however, the disparities between the deciles are large. For example, over 70 percent of blacks with less than the median black income live in the South, but less than 20 percent of the blacks in the top three deciles are Southerners. Moving across the lower 75 percent of the earnings distributions, the region variables contribute to a rising black-white earnings ratio. This is due to the larger black wage differentials between regions and the extensive outmigration of blacks from the South over this range of the distribution. With substantial black North-South wage differentials, black earnings will rise relative to whites as black representation in the South is decreased. Within region dispersion is also significantly larger in the South so that those sections of the distribution more heavily weighted by

Southerners will exhibit more dispersion. Among high earners, the movement across regions is considerably smaller so that the power of region variables in affecting these earnings ratios is largely eliminated.

2.3 Residual Variation

After adjusting for personal attributes, the residual variances obtained from our regressions were substantial and were also larger among blacks. Although these residuals are "unexplained" by our regressions, they contain useful information about the process determining individual earnings. In this section, we employ a random coefficients framework to determine whether the residual variation about our estimated earnings equations is systematically related to individual differences in the returns to certain characteristics.

As an approximation,[10] the expected value of an individual's squared residual can be written as

$$E(\varepsilon_\ell^2) = \sigma_u^2 + \sum_i^k 2\sigma_{uBi}x_i + \sum_{ij}^{kk} (\sigma_{BiBj}) x_i'x_j \qquad (5)$$

The diagonal terms in the double summation are the variance in the coefficient among individuals; the off diagonal terms represent the covariances in these coefficients. For example, if the earnings equation included only schooling and a constant term, we would write

$$E(\varepsilon_i^2) = \sigma_u^2 + 2\sigma_{uBi}S_1 + \sigma_{Bi}^2 S_i^2$$

The coefficient of schooling squared measures the variance in the return to schooling among individuals; the schooling coefficient measures the covariance between the individual intercept and the return to schooling.

[10] Instead of the standard linear model with randomness only in the intercept, assume that individuals differ in all parameters.

$$V(\hat{\beta}) = (X'X)^{-1} (\Sigma_j x_j x_j' V x_j x_j') (X'X)^{-1}$$

The intercept measure the underlying residual variation unrelated to characteristics. We estimated equation (5) for blacks and whites in six experience groups in 1970. An individual's residual was computed by subtracting from his actual earnings his earnings predicted by our OLS earnings equation.[11] After squaring these residuals, we estimated equation (5).

The only variables that proved significant were schooling and

(footnote 10 continued)

For the ℓ-th individual, we have the prediction,

$$Y = x_\ell'\beta \quad \text{with the observation } Y_\ell = X_\ell\bar{\beta} + \eta_\ell$$

The expectation of the squared calculated residual ($\varepsilon_\ell = \hat{Y}_\ell - Y_\ell$) is

$$E(\varepsilon_\ell^2) = x_\ell'V(\hat{\beta})x_\ell - 2x_\ell'E(\hat{\beta}-\bar{\beta})\eta_\ell + E(\eta_\ell^2)$$

since $E(\hat{\beta}-\bar{\beta})\eta_\ell = (X'X)^{-1}x_\ell x_\ell' V x_\ell$ and

$E(\eta_\ell^2) = x_\ell' V x_\ell = \sigma^2_{\eta\ell}$, we have

$$E(\varepsilon_\ell^2) = x_\ell'V(\beta)x_\ell + (1-2x_\ell'(X'X)^{-1}x_\ell')\,\sigma^2_{\eta\ell}.$$

In general, estimation of V, the individual covariance structure of parameter differences from the population mean presents a formidable problem. But, in this case, since the number of observations ranges between 4,000 and 7,000, we can appeal to large numbers. Notice, in particular, that both $x_\ell'V(\beta)x_\ell$ and $x_\ell'(X'X)^{-1}x_\ell$ are of order, T^{-1}, where T refers to the number of observations. It follows that $\operatorname{plim}_{T\to\infty} \varepsilon_\ell^2 = x_\ell' V x_\ell = \sigma^2_{\eta\ell}$ and as an approximation $\varepsilon_\ell^2 = x_\ell' V x_\ell + W_\ell$ is used along with the assumption that W has zero expectation and is independent of X.

[11] The random coefficient model suggests that a GLS approach may have been more appropriate. The absence of any meaningful heteroscedascity (noted below) indicates that this would not alter our results.

schooling squared. The coefficients of these two variables along with the mean squared residual for each experience group is reported in Table 4.

Table 4

A. Coefficients from Regressions on Squared Residuals

	Experience Group					
1970 Whites	1-5	6-10	11-15	16-20	21-30	31-40
Schooling Squared	.0069	.0062	.0050	.0030	.0047	.0027
Schooling	-.2073	-.1861	-.1355	-.0964	-.0807	-.0572
Mean White Squared Residual	.453	.284	.245	.283	.298	.294
1970 Blacks						
Schooling Squared	.0066	.0045	.0025	.0080	.0001	.0063
Schooling	-.3176	-.1913	-.0461	-.0107	-.0186	-.0717
Mean Black Squared Residual	.772	.457	.388	.374	.402	.453

In all twelve regressions, the schooling squared variable had the required positive coefficient. The negative coefficient on schooling may indicate that earnings from other pursuits and schooling are substitutes. Individuals who are able to obtain high earnings in endeavors unrelated to schooling may well behave so that they achieve low ex post returns to schooling. Based on these regressions, variation in rates of return to schooling are large and are an important source of the residual variances. For racial comparisons, variation in schooling returns may be slightly larger for whites so that they explain little of the black-white difference.

Our results suggest that at least additional research on this topic using (more) appropriate panel data may be fruitful.

3. Conclusion

We have examined the potential for using earnings equations estimated from two large cross-sectional data bases in explaining the complete distributions of black and white male earnings. Although we have achieved some success in documenting the contribution of several variables, there are numerous factors omitted in our study. Perhaps the most serious omission involves the role of differences in the underlying distribution of ability within population. Assortative mating patterns alone could produce differential distributions of ability. The more positive the degree of assortative mating, the larger the dispersion in genetic traits in succeeding generations. Discrimination against blacks may also operate in a manner that increases dispersion in black incomes. If discrimination takes the form of quotas or non-price rationing, it is the least able and qualified blacks who will bear the major burden. Unionism and minimum wage laws will tend to produce similar results as the least skilled blacks are crowded into the unprotected sectors. Although the evidence we have suggests that on net government is relatively unimportant and that its contribution probably receives too much emphasis, the influence of a broad package of governmental welfare legislation should surely be investigated.

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