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WAGE DIFFERENTIALS ARE LARGER THAN YOU THINK

Edward Lazear*

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Wage differentials have been a topic of interest to economists for many years. Analyses have been conducted with respect to skill and industry differentials,[1] union differentials,[2] and more recently black-white differentials.[3] Virtually all of these studies are cross-sectional in nature and, as such, examine wage differences as viewed at a point in time. More recent labor economics literature has focused on the importance of wealth rather than income, and more specifically on the conscious decisions that individuals make which alter the nature of their earnings stream.[4] Thus, we do not view two individuals with the same current measured incomes as having the same real incomes if one is on a job track that will yield him $50,000 per year at age 30 and the other is on a profile that yields him $10,000 per year at that same age. Individuals are clearly not indifferent between varying rates of wage growth. In fact, one may calculate the value of differential wage growth by determining the amount by which wealth is altered as the result of the differential. If jobs offer differing wage growth opportunities, the compensation for those jobs should be measured in a way that includes this unobserved (at a point in time) compensation.

This distinction is especially important with respect to black-white wage differentials since whites enjoy more rapid wage growth than do blacks. In particular, Welch (1973) has argued that black schooling quality has gone up over the 1960's and that this has resulted in an increase in the black/white earnings ratio. Freeman (1975) suggests that the narrowing was the result of the increased role of blacks in the political process which resulted in institutional changes causing blacks' wages to rise. The studies use wage rates or annual earnings of the individuals to examine differentials. But particularly for young workers, ignoring the human capital or wage growth component of earnings may seriously disguise wage differentials and trends in them. For example, suppose that governmental legislation made it increasingly difficult to discriminate in the form of differential pecuniary wages. Employers would raise the observed wage for blacks while at the same time decreasing the unobserved (or more difficult to observe) human capital component and thereby keep the true differential constant. Since most government programs concentrate on entry level job discrimination, and since differential on-the-job training does not show up until later, examining the pecuniary wage rate for young workers may greatly distort the true wealth differential. Indeed, almost any conceivable model of optimal law evasion would suggest that employers would respond to legislation requiring equal pecuniary wage rates across non-whites and whites at least in part by altering non-pecuniary aspects of the wage. On-the-job training is, at least for young workers, a large part of the non-pecuniary component. Both Welch and Freeman would miss this by their techniques. Indeed, this may help explain why Freeman finds a narrowing of the differential for young workers that is absent among older cohorts. Since older workers have flatter profiles, there is less room to take back in wage growth what has been given in pecuniary wage levels. Employer resistance to elimination of pecuniary differentials is likely to be greater with respect to older workers.

This paper will employ a method (devised in Lazear (1976)) to estimate the unobserved component of wages. The size of this component will be calculated for non-whites and whites separately and then compared. Since, as it turns out, the component is larger for whites than non-whites, observed wage differentials understate true differentials. Furthermore, comparison of the period between 1966-1969 with the 1972-1974 period reveals that this unobserved differential increased substantially over time. The results of this study suggest that although the pecuniary non-white - white differential has narrowed substantially between 1966 and 1974 for young men, the on-the-job training differential has increased by almost the exact same amount. This implies that in real wealth terms there has not been any narrowing of the differential at all. This will become more apparent in later years as those non-whites who were hired into skilled jobs today fail to be promoted or obtain higher paying jobs elsewhere at the same rate as their white counterparts.

I. A Model

Consider an individual who has an observed earnings stream, $f(t)$. His true earnings stream may be written as $F(t)$ where $F(t)$ includes the value of human capital paid to him. The value of the unobserved human capital payment is then defined as $H(t) \equiv F(t) - f(t)$. When one invests in on-the-job training, the potential earnings of that individual will grow over time. $F(t)$ does not measure the potential earnings, but will necessarily be at least as large as potential earnings. The reason is as follows: Let potential earnings, i.e., the amount that the individual would receive in the absence of investment in on-the-job training be written as $\phi(t)$. If an individual undertakes investment in on-the-job in period t, the cost of that investment is $C(t) \equiv \phi(t) - f(t)$. The value of that investment, $H(t)$ is equal to the present value of the amount by which potential earnings are increased over the lifetime, or

$$(1) \quad H(t) \equiv \phi'(t) \int_0^{T-t} e^{-r\tau} d\tau$$

where T is the age of retirement. But $H(t)$ is the return to the total investment in period t and total return necessarily is greater than or equal to total cost.[5] That is, investment in human capital can yield infra-marginal profits. The individual pushes the rate of investment in any period to the point where the cost of increasing that rate exactly equals the returns.

On the last increment of rate increase no profits are earned, but they are earned on all inframarginal increases. Thus, lifetime wealth is increased by

$\int_0^T [H(t) - C(t)]e^{-rt}dt$ as the result of investment in on-the-job training.

It is $f(t) + H(t)$ that is received by the individual, however, and this is the amount that constitutes real earnings. If one could observe $\phi(t)$, eq. (1) would allow $H(t)$ and therefore $f(t) + H(t)$ to be determined. But only $f(t)$ can be observed. However, although $\phi(t) \geq f(t)$, under certain circumstances $\phi'(t) \approx f'(t)$.. Since $f'(t)$ can be observed, true earnings could be ascertained under these conditions.

Above, $C(t)$ was defined to be $\phi(t) - f(t)$. Thus

$$(2) \quad C'(t) = \phi'(t) - f'(t)$$

or

$$(3) \quad f'(t) = \phi'(t) - C'(t)$$

so that if $C'(t)$ equals zero, $f'(t) = \phi'(t)$. If investment in on-the-job training is approximately constant over time, then $f'(t)$ will approximate $\phi'(t)$. Thus, using $f'(t)$ for $\phi'(t)$[6],

$$(4) \quad F(t) \equiv f(t) + H(t) = f(t) + f'(t) \int_0^{T-t} e^{-r\tau}d\tau .$$

Now the point addressed in the introduction can be discussed more rigorously. Cross-sectional analyses of wage differentials only consider differences in the observed values of $f(t)$ at some point in time. Yet eq. (4) reveals that this only tells part of the story. A true measure of the wage differential is $F_W(t) - F_{NW}(t)$ where NW and W refer to nonwhites and whites, respectively. Since it is likely[7] that $H_W(t) > H_{NW}(t)$, the wage differential will be understated by $f_W(t) - f_{NW}(t)$. In addition, it may well be that trends in true differentials are dominated by changes in

$H_W(t) - H_{NW}(t)$ over time so that examination of observed wages obscures the true picture.

Empirical verification of the propositions outlined above may be obtained. Following the method described in Lazear (1976), a wage growth equation can be estimated so that one can ascertain $f(t)$ and $f'(t)$. Once that is done it is a simple matter to estimate "true" wages by the approximation of $F(t)$ given in eq. (4).

II. Estimation.

Theory[8] and empirical evidence tell us that investment in human capital, in the form of formal schooling and on-the-job training, is larger for younger individuals than it is for older ones. Age-earnings profiles are generally observed to be steeper in the early part of life so that $f'(t)$ is a decreasing function of (t). Therefore differences between measured wages and "true" wages are likely to be greatest during the first years of work experience. For this reason, the two data sets to be used provide information exclusively on young individuals. The 1966-1969 period is analyzed with the use of the National Longitudinal Survey on Young Men, 14-24 years of age in 1966. The 1972-1974 period makes use of the National Longitudinal Study of the High School Class of 1972. The first part of this section will be devoted to examination of the 1966-1969 NLS. In the second part we will compare results from this earlier period to those obtained for the later 1972-1974 period.

A. The National Longitudinal Survey, 1966-1969.

1. The basic equation.

This data set provides detailed information on schooling and work experience. The fact that it is longitudinal allows one to determine more precisely the nature and extent of work experience during the particular period. The estimating equation used throughout this part of the analysis is:

$$(5)\quad \ln W_{69} - \ln W_{66} = \beta_0 + \beta_1 E_{66} + \beta_2 A_{66} + \beta_3(\Delta H) + \beta_4(\Delta S) + \beta_5(\Delta ST) + \beta_6(\Delta E) + \beta_7 U_{69} + \beta_8(U_{69})(\Delta E) + \beta_9 M_{66} + \beta_{10} D + \beta_{11} S_{66} + \beta_{12} S_{66}(\Delta E) + \beta_{13} D(\Delta E)$$

where

E_{66} is years of work experience by 1966,

W_{69} is the hourly wage rate in cents in 1969,

W_{66} is the hourly wage rate in cents in 1966,

A_{66} is the individual's age in 1966,

ΔH is the change in "usual" hours worked between 1966 and 1969,

ΔS is the change in the highest grade of formal schooling completed between 1966 and 1969,

ΔST is the difference between a dummy set equal to 1 if the individual was attending school in 1969 and a dummy similarly defined for 1966,[9]

ΔE is the number of weeks worked between 1966 and 1969 divided by 52 (i.e., it is the proportion of years worked),

U_{69} is a dummy set equal to one if the individual was in a union in 1969,

M_{66} is a dummy set equal to one if the individual was married in 1966,

D is a dummy set equal to one if the individual is white,

and

S_{66} is the highest grade of schooling completed in 1966.

Observations were dropped for which no wage rate in either 1966 or 1969 was reported or for which information was incomplete. The motivation behind this particular form is discussed in depth in Lazear (1976) and Lazear (1976a) and will not be examined here. Suffice it to say that the included variables are those suggested by human capital theory which entered significantly into the regression. Equation (5) may be rewritten as

$$(6) \quad W_{69} = W_{66} \exp(\beta_0 + \ldots\ldots + \beta_{12}S_{66}(\Delta E))$$

and as such is a general form for a growth equation. Further, the specification in (5) has the advantage that it differences out unobserved ability components which affect wages in both years. That is, it is equivalent to allowing each individual to have his own constant term in a wage levels equation. This implies that the estimates obtained from (5) are not as likely to be biased by omitted ability variables.

One point should be made. The t in equations (1) through (4) refers to experience time rather than chronological time. That is the $f'(t)$ that is relevant is that wage growth which occurs as the result of job experience per se. It is only this component of growth that can be counted as part of the wage rate. Residual wage growth that occurs as one "ages" even in the absence of job experience is not part of compensation received while on the job and should not be counted in the total return. Thus, r(t) should be rewritten as

(7) $W_t = f(E_{66}, A_{66}, \Delta H, \Delta E, \Delta S, \Delta ST, U_{69}, M_{66}, D, S_{66})$

and $f'(t)$ becomes $\frac{\partial f}{\partial(\Delta E)}$ since ΔE equals E_{69} when E_{66} is defined to be period zero. If wage growth takes the form expressed in eq. (6), then

(8) $$f' = W_{66}\exp(\beta_0 + \dots + \beta_{13}D(\Delta E))(\beta_6 + \beta_8 U_{69} + \beta_{12}S_{66} + \beta_{13}D)$$

Equation (5) was estimated by OLS and the results are contained below:

(9) $$\ln W_{69} - \ln W_{66} = \underset{(.185)}{1.040} - \underset{(.00626)}{.01208}E_{66} - \underset{(.00632)}{.02016}A_{66} + \underset{(.00067)}{.00165}\Delta H$$

$$+ \underset{(.01141)}{.04869}\Delta S - \underset{(.02129)}{.15237}\Delta ST - \underset{(.07173)}{.10354}\Delta E$$

$$+ \underset{(.00661)}{.01878}S_{66}(\Delta E) - \underset{(.03139)}{.01199}D(\Delta E) + \underset{(.1006)}{.50927}U_{69}$$

$$- \underset{(.03505)}{.13433}U_{69}(\Delta E) - \underset{(.02650)}{.09737}M_{66} - \underset{(.07768)}{.02151}D$$

$$- \underset{(.01779)}{.04477}S_{66}$$

$R^2 = .185$

SEE = .4324

N = 2115

(standard errors are enclosed in parentheses.)

The interpretation of these coefficients is provided elsewhere [see Lazear (1976)]. Basically, they suggest that positive changes in the stock of human capital positively affect wage growth. Thus, the coefficient on ΔS (changes in the stock of schooling) is positive and substantial. For the mean individual,

$$(10)\qquad \frac{\partial W_{69}}{\partial \Delta S} = W_{66}\exp(\beta_0 + \ldots + \beta_{13}D(\Delta E))\beta_4$$

$$= 14.4¢$$

so that a one year increase in schooling between 1966 and 1969 is associated with a 14 cent increase in wages in 1969. Similarly, for the mean individual

$$(11)\qquad \frac{\partial W_{69}}{\partial \Delta E} = f' = W_{66}[\exp(\beta_0 + \ldots + \beta_{13}D(\Delta E))](\beta_6 + \beta_8 U_{69} + \beta_{12}S_{66} + \beta_{13}D)$$

$$= 18.81$$

From (4), mean "actual" wages in 1966 can be estimated:

$$(12)\qquad \bar{F}(1966) = \bar{f}(1966) + 18.81 \int_0^{T-t} e^{-r\tau}d\tau$$

$$= 196.6 + \int_0^{45} (18.81)e^{-r\tau}d\tau$$

$$= 196.6 + \frac{1}{.1}(1-e^{-4.5})(18.81)$$

$$= 196.6 + 186.0$$

$$= 382.6¢ \text{ per hour}$$

if $r = .1$ and retirement occurs in the year 2011. (The hours-worked-per-year term enters both sides of the equation and therefore cancels.) Thus, observed wages are only about 51 percent of actual wages where the latter include the value of wage growth that results from job experience. The sheer magnitude of the wage growth value for young men suggests that examination of differences in this number across individuals may be important. Therefore, the expression is evaluated for whites and non-whites separately, taking the conditional mean values of the variables and substituting them into (11) .

For whites,

$$(13) \quad \frac{\partial W_{69}}{\partial \Delta E}\Big|_{D=1} \equiv f'\Big|_{D=1} = 21.13$$

so that

$$(14) \quad \overline{F}(1966)\Big|_{D=1} = \overline{f}(1966)\Big|_{D=1} + \int_0^{T-t} (21.13)e^{-r\tau}d\tau$$

$$= 214.1 + 209.0$$

$$= 423.1¢$$

For non-whites,

$$(15) \quad \frac{\partial W_{69}}{\partial \Delta E}\Big|_{D=0} \equiv f'\Big|_{D=0} = 12.80$$

so that

$$(16) \quad \overline{F}(t)\Big|_{D=0} = \overline{f}(t)\Big|_{D=0} + \int_0^{T-t} (12.80)e^{-r\tau}d\tau$$

$$= 156.7 + 126.9$$

$$= 284.6$$

The measured wage differential between white and non-white young men in 1966 was \$2.14 - \$1.56 = \$.58 . The estimate of the true wage differential, on the other hand, is a much larger \$4.23 - \$2.84 = \$1.39. Even in relative terms, the ratio of white to non-white observed wages is 1.37. The ratio of white to non-white true wages is 1.48. Thus, neglecting the value of different experience-earnings profiles between whites and non-whites leads to serious understatement of true wage differentials.

Even the above calculation is likely to understate the true differential for two reasons, both of which have to do with differences in labor force behavior between whites and non-whites. First, since whites are less likely to suffer unemployment than are non-whites and since they typically retire at a later date,[10] the time period over which (12), (14), and (16) are integrated should be longer for whites. Thus, the assumption that $T - t = 45$ for all individuals is likely to cause the estimate of the value of wage growth for whites relative to non-whites to be understated.

Second, since in any given year a white worker is more likely to be employed than a non-white worker (once he begins full-time participation in the labor force) $\overline{F}(t)|_{D=1}$ and $\overline{F}(t)|_{D=0}$ might reasonably be weighted by the probability of obtaining that wage. This, however, to be conceptually correct, requires a great deal of information on the value of leisure. If the world were in equilibrium, the marginal value of a minute spent in leisure must equal the marginal value of a minute of employment; i.e., on the margin the value of leisure equals the wage rate. However, as changes in time worked come in discrete blocks, the value of leisure of that discrete block of time must necessarily be smaller than earnings. (This is simply the result of the diminishing marginal rate of substitution between leisure and goods as leisure increases). The amount by which it is smaller depends upon the utility function itself. Without information on the parameters of that function it is impossible to choose correct weights for white vs. non-white wages. This notwithstanding, the estimates of wage differentials obtained above are lower bounds to the true differentials since both of those labor force participation effects work in the direction of increasing the true differential.

2. Decomposition of wage growth

It is useful to consider the individual components of the unobserved wage differential. From (11), it is clear that differences in $\frac{\partial W_{69}}{\partial \Delta E}$ between whites and non-whites result either from differences in the average wage levels across groups (i.e., $W_{66}[\exp(\beta_0 + \ldots + \beta_{13}D(\Delta E))] \equiv W_{69}$) or from differences in the effect of experience itself on growth rates (i.e., $\beta_6 + \beta_8 U_{69} + \beta_{12} S_{66} + \beta_{13} D$) it turns out, the most important determinant of differences in wage growth is the grade of schooling completed, S_{66} . This variable operates in three ways. First, it causes there to be differences in the initial wage level, W_{66}, since W_{66} is itself dependent upon schooling level. Second, changes in S_{66} affect the difference between W_{66} and W_{69} since $W_{69} = W_{66} \exp(\beta_0 + \ldots + \beta_{11} S_{66} + \beta_{12} S_{66} \Delta E + \beta_{13} D(\Delta E))$. Third, differences in S_{66} affect the degree to which job experience affects wage growth since S_{66} interacts with ΔE in the wage growth equation. Let us consider each in turn.

One cannot infer directly the effect of schooling on the wage level in 1966 from eq. (9). However, elsewhere (Lazear [1976]) an analogous wage level equation was estimated for the NLS young men. There, it was found that

$$\frac{\partial \ln W_{66}}{\partial S_{66}} = .0606 \ .$$

Thus, $$\frac{\partial W_{66}}{\partial S_{66}} = .0606(\overline{W_{66}}) \ .$$

This amounts to

$$\frac{\partial W_{66}}{\partial S_{66}} = 9.45 \ .$$

If non-whites, whose mean level of S_{66} is 10.988 years had the whites' average schooling of 11.464 years, their mean wages in 1966 would have been

$$(17) \qquad \hat{W}_{69}\Big|_{D=0} = \overline{W}_{69}\Big|_{D=0} + 9.45(11.464 - 10.088)$$

$$= 169¢ \text{ per hour rather than } 156¢ \text{ per hour.}$$

Second, by substituting 11.464 as opposed to 10.088 in

$$\exp(\beta_0 + \ldots + \beta_{13}D(\Delta E)),$$

one obtains that $\exp(\beta_0 + \ldots + \beta_{13}D(\Delta E)) = 1.547$ rather than 1.551. (The negative effect of increased schooling through β_{11} exceeds the positive effect of $\beta_{12}\Delta E$.)

Third, and most important, is that the effect of job experience itself depends upon schooling level. Adjusting this for the higher level of schooling yields $(\beta_6 + \beta_8 U_{69} + \beta_{12} S_{66}) = .0795$ as opposed to .0537 with $S_{66} = 10.088$. Thus, if non-whites had the same level of schooling as whites,

$$(18) \qquad \frac{\partial W_{69}}{\partial \Delta E}\Bigg|_{D=0, S_{66}=11.464} = (\hat{W}_{66}\Big|_{D=0})\left[\exp(\beta_0 + \ldots\ldots\ldots + \beta_{13}D(\Delta E)\Big|_{S_{66}=11.464}\right]$$

$$\cdot \left[(\beta_4 + \beta_6 U_{69} + \beta_{12} S_{66})\Big|_{S_{66}=11.464}\right]$$

$$= (169)(1.547)(.0795)$$

$$= 20.78$$

Since $\left.\frac{\partial W_{69}}{\partial \Delta E}\right|_{D=0} = 12.80$ and $\left.\frac{\partial W_{69}}{\partial \Delta E}\right|_{D=1} = 21.13$,

correcting for differencies in the initial level of schooling removes about 96% of the differential experience effect. In terms of true wage rates, it implies that non-white wages would be

$$(19) \qquad \left.\bar{F}(t)\right|_{D=0,S=11.464} = \left.\bar{f}(t)\right|_{D=0,S=11.464} + \int_0^{T-t} (20.78)e^{-r\tau}d\tau$$

$$= 169 + 205$$

$$= \$3.74 \text{ per hour.}$$

Since the average white's true wages were estimated to be \$4.23 , this cuts the true wage differential from the estimated 139¢ to 49¢ per hour.

Another term that interacts with ΔE is a dummy for union membership. Although the effect of this variable is sizeable, the probability of being in a union did not differ between the whites and non-whites in this sample. Of non-whites, .246 had $U_{69} = 1$. For whites, the proportion was .243.

It should be noted that the coefficient on $D(\Delta E)$ for this early period is close to zero. The differential experience-induced wage growth between whites and non-whites during this early period is the result of differences in initial conditions. This is not the case in the later period analyzed below. There, the coefficient on $D(\Delta E)$ is large and positive. Other things constant, whites enjoy larger experience-induced wage growth than do non-whites in 1972-1974 although this is not true during the early period.

A final point on white-non-white differences in wage growth are in order. Despite all that has been said above, it is not the case that during 1966-1969 white young men's wages grew at a more rapid rate than that for non-white young men. On the contrary,

$$\left.\frac{W_{69}-W_{66}}{W_{66}}\right|_{D=0} = .55$$

whereas

$$\left.\frac{W_{69}-W_{66}}{W_{66}}\right|_{D=1} = .47$$

This difference is reflected in the coefficient on D which is negative, although insignificant.[11] This is quite consistent with the scenario outlined above. If firms have responded to government pressure to reduce white - non-white wage differentials by reducing the wage growth component for non-whites relative to whites, initial observed wages will rise relatively for non-whites. That is, since the group in question consists of young men who are predominantly at entry level jobs, pecuniary wages of non-whites will rise on these jobs at a more rapid rate for non-whites than whites. This is reflected in the negative coefficient on D. Yet once those initial jobs are obtained, non-whites' experience will have a differential effect on wage growth than whites' experience. In this early period, the differential effect appears to be the result of differences in initial conditions. In the later period to be analyzed below, the differential experience induced wage growth occurs even in the absence of differing initial conditions.

3. Some details

In this section, the validity of assumptions made initially are tested empirically. Eq. (3) states that if $C'(t) = 0$, $\phi'(t) = f'(t)$. The question then becomes how small must ε be in order for $c(t + \varepsilon) - c(t)$ to be approximately zero. In this study, a three year time span was chosen in order to obtain sufficient variation in right-hand variables. The minimum time span for which data are present is $\varepsilon = 1$ year. If $c(t + \varepsilon) < c(t)$, this implies that $f''(t) < 0$. Thus, an estimate of $f'(t)$ based on $[f(t + 3\varepsilon) - f(t)]/3$ will be smaller than $f(t + \varepsilon) - f(t)$. In order to see that estimates of $\theta'(t)$ are insensitive to the choice of ε , two regressions were run identical to eq. (9) except that all variables with 1969 subscripts were replaced first with their 1968 values and then with their 1967 values.

The question then is, do the coefficients of primary interest with respect to f', namely β_6, β_8, β_{12}, and β_{13}, differ significantly across years. To test this, the estimates of these coefficients obtained from eq. (9) were inserted into the 1966-68 and 1966-67 equations. Then after constraining the coefficients to take on these values, the regressions were rerun and the sum of squared residuals were compared to those obtained in the unconstrained versions. For 1966-68, it was found that $F(4,904) = 1.030$. For 1966-67, the corresponding value was $F(4,693) = .410$. In neither case do β_6, β_8, β_{12}, and β_{13} taken jointly differ significantly from those obtained from the 1966-69 regression. The conclusion is that the choice of $\varepsilon = 3$ years yields a value of f' which is a good approximation for ϕ'.

A second way to define ε is in terms of life-cycle rather than chronological time. In order to test the sensitivity of f' to differences in life-cycle time, an (Age)(ΔE) interaction term was added to Eq. (9). The coefficient on this variable was insignificant so the assumption that, for these ages, f' is invariant with respect to age, is borne out.[12]

Given that some of these individuals are currently enrolled in school, it is interesting to perform the analysis on non-students. Eq. (5) was therefore rerun, deleting the ΔS and ΔST terms on the non-student subsample. This reduced the number of observations to 1021 and standard errors increased as expected. However, the primary findings remained the same: $\bar{F}(1966)|_{D=1}$ = \$4.46 while $\bar{F}(1966)|_{D=0}$ = \$1.94, yielding a true differential of \$2.52. The observed wage rates were $\bar{f}(1966)|_{D=1}$ = \$2.65 and $\bar{f}(1966)|_{D=0}$ = \$1.74 so that the observed differential was 91¢ per hour.

B. The NLS High School Class of 1972:

1. Estimation

In this section, longitudinal data from the National Longitudinal Study of the High School Class of 1972 (NLSHS) will be used to estimate the unobserved on-the-job training component of earnings during this later period. This sample, although similar to the NLS for 1966-1969, has some important differences. The major difference is that all individuals in this sample were enrolled in twelfth grade in 1972 so no early high school drop-outs are contained. This also implies that the age distribution of respondents is much more tightly centered around the mean age in 1972 than was the 1966-1969 sample (although the difference in mean ages is not that substantial). Furthermore, there is virtually no variation in initial schooling levels during October, 1972, the date of the initial wage rate. These differences imply slight differences in the forms of the wage growth equation (obvious ones are deletion of initial schooling and age variables), but the basic form is the same.

The NLSHS is a national probability sample of about 22,000 high school seniors. A survey was taken during the Spring of 1972 and two follow-ups were conducted in October of 1973 and 1974. For the purposes of this analysis, a sub-sample of males who had wage rates reported and who supplied complete information on the other relevant variables was selected. (2393 individuals fit this category.) The basic estimating equation for this period was:

$$\begin{aligned}(20) \qquad \ln W_{74} - \ln W_{72} = {} & \gamma_0 + \gamma_1 (E_{72}) + \gamma_2 (\Delta H) \\ & + \gamma_3 \Delta S + \gamma_4 (\Delta ST) + \gamma_5 (\Delta E) \\ & + \gamma_6 (\Delta S)(\Delta E) + \gamma_7 (M_{74}) + \gamma_8 D \\ & + \gamma_9 (D)(\Delta E)\end{aligned}$$

where:

W_{74} is the hourly wage rate in October 1974 in dollars,

W_{72} is the hourly wage rate in October 1972 in dollars,

E_{72} is the amountof previous work experience in October, 1972,

ΔH is hours per week on the October 1974 job minus hours per week on the October 1972 job,

ΔS is the grade level completed in 1974 minus twelve,

ΔST is a dummy equal to one if the individual attended school in 1974 minus a similar dummy for 1972,

ΔE is the number of weeks worked between October 1972 and October 1974 divided by 52,

M_{74} is a dummy equal to one if the individual is married in 1974 and

D is a dummy equal to one for whites.

Given this specification, one can derive the relevant f'(t). For white workers,

$$(21) \qquad f'(t)\Big|_{D=1} \equiv \frac{\partial W_{74}}{\partial \Delta E}\Big|_{D=1} = W_{72} \exp(\gamma_0 + \ldots \gamma_9 D (\Delta E)) \cdot (\gamma_5 + \gamma_6 \Delta S + \gamma_9)$$

and for non-whites,

$$(22) \qquad f'(t)\Big|_{D=0} \equiv \frac{\partial W_{74}}{\partial \Delta E}\Big|_{D=0} = W_{72} \exp(\gamma_0 + \ldots + \gamma_7 M_{74}) \cdot (\gamma_5 + \gamma_6 \Delta S).$$

Equation (20) was estimated by OLS and the results were:

$$\text{(23)}\quad \ln W_{74} - \ln W_{72} = \underset{(.0948)}{.1169} + \underset{(.01146)}{.04172}\, E_{72} - \underset{(.00071)}{.00424}\, \Delta H$$

$$+ \underset{(.08603)}{.23748}\, \Delta S - \underset{(.02346)}{.07803}\, (\Delta ST)$$

$$+ \underset{(.05349)}{.13119}\, \Delta E - \underset{(.04766)}{.16170}\, (\Delta S)\,(\Delta E)$$

$$+ \underset{(.02042)}{.0412}\, M_{74} - \underset{(.11090)}{.14659}\, D$$

$$+ \underset{(.06193)}{.08299}\, (D)\,(\Delta E)$$

SEE = .4451
R^2 = .039
N = 2393

Making the same assumptions as were made in eq. (12), we can estimate the true total compensation for whites and non-whites, respectively. For whites in 1972,

$$\text{(24)}\quad \overline{F(1972)}\big|_{D=1} = \overline{f(1972)}\big|_{D=1} + 60.3 \int_0^{45} e^{-r\tau}\, d\tau$$

$$= 257 + 597$$

$$= 854¢/\text{hour} .$$

For non-whites in 1972,

$$\text{(25)}\quad \overline{F(1972)}\big|_{D=0} = \overline{f(1972)}\big|_{D=0} + 34.1 \int_0^{45} e^{-r\tau}\, d\tau$$

$$= 255 + 337$$

$$= 592¢/\text{hour} .$$

What is important to note is that although there was virtually no wage differential observed (whites earned on average \$2.57/hour while non-whites earned \$2.55 in 1972), the on-the-job training differential was substantial: It equalled \$5.97 - \$3.37 or \$2.60 per hour. In real terms, the true differential in 1966 (\$1.39 per hour) inflated for six years at a rate of 6% is equal to \$1.99 per hour. Thus, there is, if anything, an increase in the true differential for 1972. The major distinction is that the pecuniary differential narrowed substantially while the unobserved on-the-job training differential expended by a greater amount. This may be a response to government pressure to reduce pecuniary wage differentials.

It should be noted that in this equation the coefficient on D(ΔE) is positive and relatively large (although its standard error is also quite large). This was not the case during the first period analyzed. There it appeared that, initial conditions the same, experience-induced wage growth was not larger for whites than for non-whites. The difference there arose from differences in mean initial conditions. Here, even holding all else constant (including initial wage), the experience induced wage growth is larger for whites than for non-whites. The difference of the coefficients on D(ΔE) between 1966 and 1972 is equal to .0950 with a standard error of .0694. Thus, although there is a somewhat large standard error, there appears to be some evidence for a change in the coefficient on D(ΔE) over time, as well as evidence for changes in the difference $\left.\frac{\partial W}{\partial \Delta E}\right|_{D=1} - \left.\frac{\partial W}{\partial \Delta E}\right|_{D=0}$.

2. Some useful comparisons

Before reaching the firm conclusion that whatever narrowing of the pecuniary differential has occurred has been offset by increases in the OJT differential, some points should be made.

First, it is important to note that 1966-1969 was a period of rapid economic activity while 1972-1974 was a recession. (The unemployment rate for white males 16 years of age and older averaged 2.6% between 1966-1969 and 4.2% between 1972 and 1974.) This has major implications for the estimates obtained.

Note, for example, that the coefficient on initial experience (E_{66} and E_{72}) bounces from negative to positive. The negative coefficient on E_{66} is explained elsewhere (see Lazear 1976) as reflecting the fact that OJT is acquired during the first years at work. The positive coefficient on E_{72} is likely to capture the fact that given initial wage rates, more senior workers are less affected by recessions than are their more junior counterparts. If this is the explanation, the effect is sufficient to offset the tendency to invest more during early years. Similarly, DH had a positive sign in the 1966-69 regression, but a negative one later. The reversal may be due to simultaneity bias brought on by recessionary changes. If the recession lowers the wages of some workers, in the short run they may increase their hours worked. This finding has shown up in past work.[13] Thus, the negative coefficient or ΔH might reflect the fact that those individuals who experience relative declines in wages also increase their hours worked during recessions.

Another difference across periods which may result from differences in business activity relates to the levels of the on-the-job training component. The absolute magnitude of this compensation is much larger between 1972 and 1974 than it was in the earlier period. There are at least two possible explanations. First, along the lines of Butler and Heckman (1976), the differential attractiveness of welfare payments to low v. high income individuals will tend to cause only the most able workers to remain. This is especially the case during recessions (since more drop below the point at which this alternative source of income is acceptable) so that the 1972-1974 sample of individuals who are working is of higher average ability than the sample of workers during 1966-1969. (They are also more able in that they all have attended school through grade twelve.) If, as is likely to be the case, the more able invest more in on-the-job training, this would show up as a higher OJT component for the mean working individual between 1972 and 1974. Second, I have argued elsewhere, (Lazear (1974)), that it is rational to acquire OJT to a greater extent during recessions than during expansions. If so, the difference between the two periods would be a manifestation of this phenomenon.

The point raised by Butler and Heckman (1976) has other implications for this analysis. For example, it helps explain the total disappearance of a pecuniary wage differential by 1972. Since non-whites are more likely to be pulled out of the labor force by alternative welfare payments, those who remain will be of higher average quality than the working whites. This would result in a narrowing of the differential. It cannot, however, account for the finding of this paper that the non-whites' gains in pecuniary wages were offset by losses in OJT compensation. In fact, the effect works in the opposite direction. Since during recessions, non-white males exit the employment force to a larger extent than do whites, the 1972-1974 period has relatively high quality non-whites. Since they are the individuals most likely to invest in OJT, the white-non-white OJT differential would narrow between 1966 and 1972 on this score. It does not. Selectivity effects are not sufficiently large to disguise the substitution from pecuniary differentials to OJT differentials.

The fact that pecuniary wage differentials have narrowed to a greater extent for the highly educated can be explained by these findings. Since education and OJT were found to be complementary, highly educated non-whites had a larger OJT component in 1966 than did the less educated. If, say, the same proportion of OJT was reduced for all non-whites, pecuniary wages would rise by more in absolute terms for the highly educated. This would imply a greater narrowing of the differential for this group. Note that the narrowing of wage differentials to a larger extent for educated groups is inconsistent with Butler and Heckman (1976). This explanation reconciles their story with the observed result since true differentials do not seem to have narrowed at all.

A final point is that the R^2 on the 1972-1974 regression is considerably lower than the R^2 for 1966-1969. The later data set deals with a much more homogeneous group than the former. (There is no variation in initial schooling and very little in age and previous experience.) Thus, regressions on the NLSHS are asked to perform a much more difficult task than are those on the original NLS.

3. More details

In this section, some of the points considered for the 1966-1969 analysis are examined for the 1972-1974 period.

First, the 1972-1974 regression was performed for the non-student subsample. Again ΔS, ΔST, and $(\Delta S)(\Delta E)$ were deleted. Standard errors increased, but the coefficient on $D(\Delta E)$ was still positive and substantial at $\underset{(.07988)}{.09002}$. Furthermore, $\bar{F}(1972)|_{D=1}$ = \$10.06 and $\bar{F}(1972)|_{D=0}$ = \$6.46 yielding a true differential of \$3.60 per hour. The observed differential was only \$2.64 - \$2.56 or 7¢ per hour. It should also be noted that the \$2.52 differential obtained for the non-student group in 1966, when inflated at six per cent per year, becomes \$3.61 in 1972 dollars. This compares quite favorably to the estimated \$3.60 differential for 1972.

Again, the test for an $(Age)(\Delta E)$ interaction was performed. Neither age, $age(\Delta E)$, nor the two taken jointly entered significantly. Nor did stratification of the sample into two separate groups on the basis of age yield significantly different results.

Summary and Conclusion:

This paper suggests that calculations of white - non-white wage differentials which are based on observed monetary wage rates understate true differentials by a substantial amount. This is the result of differences in the steepness of the age-earnings profiles across groups, the value of which should be capitalized and added to current earnings. For young men, for whom the effect is likely to be strongest, the normally measured wage differential was found to be 58¢ per hour in 1966. The "true" differential, which includes the capitalized value of wage growth, was two and one half times as large. For 1972, the observed differential was 2¢ per hour. The true differential was $2.62 per hour. Even in terms of relative wage differentials the point remains valid. The observed relative wage rate was 1.37 in 1966 and 1.01 in 1972. The true relative wage rates were 1.48 in 1966 and 1.44 in 1972. This implies a much smaller narrowing than appears from examination of pecuniary wages.

The most important conclusion is that although white - non-white pecuniary wage differentials were eliminated between 1966 and 1972, the true differential, which includes the value of on-the-job training, remained approximately the same. This may reflect a national response on the part of employers to government pressure to narrow pecuniary wage differentials, especially for young workers.

It was found that about 95 percent of the unobserved differential in 1966 could be eliminated by bringing the average level of non-whites' schooling, currently at 10.088 years, to that for whites, at 11.464 years. This results primarily from the fact that on-the-job training seems to be complementary with level of schooling attainment so that, other things equal, highly schooled individuals have steeper age-earnings profiles.

Finally, this paper has considered only one aspect of unobserved earnings, namely payment in the form of human capital. For young men, this is substantial, amounting to as much as one-half of total earnings. Other unaccounted for remuneration may also have effects. Differences in non-pecuniary benefits, taxes, and job security, also are likely to enter. A more complete analysis would bring these differences in as well.

FOOTNOTES

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1. See Reder (1955, 1963), Rosen (1970), Keat (1960).
2. See Lewis (1963), Rosen (1969), Ashenfelter and Johnson (1972).
3. See Smith and Welch (1975), Welch (1973), Freeman (1975, 1976).
4. This is exemplified by Ben-Porath (1967), Heckman (1975), Haley (1973), and Lillard (1975).
5. See Rosen (1973) or Lazear (1975) for a complete discussion of this point. In the context of this paper, it means that

$$\phi(t) = [K_0 + \int_0^t H(\tau)\, d\tau]R$$

where K_0 is the initial stock of human capital and R is its rental rate.

So

$$C(t) = [K_0 + \int_0^t H(\tau)\, d\tau]R - f(t)$$

But

$$H(t) = \phi'(t) \int_0^{T-t} e^{-r\tau} d\tau \quad .$$

C(t) and H(t) are not the same. In fact $H(t) \geq C(t)$ or else no investment occurs. C(t) is the amount of investment. H(t) is its return. Only the marginal unit of investment equals its marginal cost. Thus, in general $F(t) > \theta(t)$.

6. The goodness of approximation can be determined empirically. More will be said on this below.
7. It is generally argued that age-earnings profiles are one steeper for whites than non-whites.

8. See Becker (1975)

9. See Lazear (1976a) for the rationale behind this variable.

10. See Bowen and Finegan (1970)

11. Regressions estimated separately for whites and non-whites did not yield significantly different sum of squared residuals from the combined regression.

12. Theory tells us that, at least over some range, $C'(t)$ must be negative. (This is because $C(T) = 0$.) That we cannot reject the hypothesis that $C'(t) = 0$ does not imply, of course, that its value is non-negative. However, $C'(1966)|_{D=1}$ is likely to be more negative than $C'(1966)|_{D=0}$ because initial levels of investment for whites are higher and both $C(T)|_{D=1}$ and $C(T)|_{D=0}$ equal zero. Thus, $C'(1966)|_{D=1} - C'(1966)|_{D=0}$ is likely to be very small indeed. Therefore, the amount by which $f'(1966)|_{D=1} - f'(1966)|_{D=0}$ overstates $\phi'(1966)|_{D=1} - \phi'(1966)|_{D=0}$ is also likely to be small. The same argument applies for 1972 as well.

13. See Mincer (1962), for example.

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