NBER WORKING PAPER SERIES

AGE, EXPERIENCE, AND WAGE GROWTH

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Working Paper No. 51

CENTER FOR ECONOMIC ANALYSIS OF HUMAN BEHAVIOR AND SOCIAL INSTITUTIONS
National Bureau of Economic Research, Inc.
204 Junipero Serra Blvd., Stanford, CA 94305

August 1974

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This research was partially supported by a grant from the Rockefeller Foundation to the NBER in support of its program in education and information and the distribution of income.

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by Edward Lazear*

During the past decade, much has been said about the role that on-the-job training plays in augmenting one's stock of human capital.[1] Up to this point, little has been done to distinguish the effect of on-the-job training from that of aging on the increase in human wealth. The reason rests primarily on the fact that it is difficult to observe or even define in some appropriate way the amount of on-the-job training that an individual possesses. In this paper, a method is developed by which one may compare the effects of work experience to those of aging per se. The difference is then attributed to on-the-job training.

The analysis deals with the relationship between an individual's wage growth pattern and his employment history. If, as the human capital framework suggests, individuals increase their wealth by investing in themselves in the form of on-the-job training, one might expect that workers who spend less time on the job during a given period of time would acquire less human capital. If so, individuals who work a smaller proportion of time during say, a three year period, will experience less rapid wage growth than individuals who work continuously throughout this time. Thus, it is expected that the growth rate of wages will be related not simply to an individual's chronological age, but also to the amount of time spent on the job during the period under consideration. If this is in fact the case, then part of the cost of being unemployed takes the form of human capital foregone during the period. The total cost of unemployment is then the sum of foregone earnings plus the value of foregone human capital. The majority of this paper will be devoted to estimating the size of this effect.

Suppose that wage growth over time takes the form of

$$(1) \qquad W_{69_i} = (A)W_{66_i}e^{(\gamma_i)t + u_i}$$

where W_{69_i} is the hourly wage rate in 1969 in cents for individual i,

W_{66_i} is the hourly wage rate in 1966 in cents for individual i,

γ_i is the average annual growth rate of wages which varies across individuals,

A is a wage shift parameter unique to this three year period, but invariant across individuals,

u_i is the random error term where $u \sim N(0, \sigma^2 I)$.

The growth rate, γ_i, depends on a number of other parameters, the most fundamental of which relate to aging and the acquisition of human capital. Let us then start with

$$(2) \qquad \gamma_i = \alpha_0 + \alpha_1(S_{69_i} - S_{66_i}) + \alpha_2(OJT_{69_i} - OJT_{66_i})$$

where S_{69_i} is the highest grade of schooling completed in 1969 by individual i,

S_{66_i} is the highest grade of schooling completed in 1966 by individual i,

OJT_{69_i} is the individual's stock of on-the-job training in 1969,

OJT_{66_i} is the individual's stock of on-the-job training in 1966

with α_0, α_1, and α_2 all positive.

α_0 reflects the effect of aging per se on wage growth while α_1 is the result of on-the-job training which would not be acquired were the individual not at work.

Although the data to be used in this analysis are quite explicit with respect to job experience, it still remains impossible to directly measure with any confidence the amount of on-the-job training acquired over this three year period. It is possible, however, to approximate the change in the stock of on-the-job training if it is assumed that

$$(3) \qquad OJT_{69_i} - OJT_{66_i} = \delta_1(E_{69_i} - E_{66_i}) + \delta_2 E_{66_i} + \delta_3 S_{66_i} + \delta_4 Age_i$$

where E_{69_i} is the amount of job experience in 1969 for individual i,

E_{66_i} is the initial amount of job experience in years held by individual i,

Age_i is the individual's age in years in 1966.

δ_1 and δ_3 are positive while δ_2 and δ_4 are negative.

δ_1 is expected to be positive since individuals who spend more time working are more likely to acquire on-the-job training (this essentially is the requirement that the cost of learning be a convex function of the learning rate).[2] δ_2 should be negative since it pays an individual who plans to invest in one-the-job training to do so during his first years on the job. This means that as previous experience increases, incremental investment in on-the-job training should fall.[3] The sign of δ_3 depends upon the marginal complementarity or substitutability of formal schooling and on-the-job training. If, as seems most likely, formal schooling and on-the-job training are complements, δ_3 will be positive. Finally, δ_4 is negative since older individuals are less likely to invest in human capital.[4]

$(E_{69_i} - E_{66_i})$ may be rewritten as $(156 - TN_i)/52$ where TN_i is the total number of weeks during the three year period in which the individual did not engage in work. On substituting, we obtain

$$(4) \qquad OJT_{69} - OJT_{66} = 3\delta_1(156) - \frac{\delta_1 \, TN_i}{52} + \delta_2 \, E_{66_i} + \delta_3 \, S_{66_i} + \delta_4 \, Age_i$$

so that

$$(5) \qquad \gamma_i = \alpha_0 + \alpha_1(S_{69_i} - S_{66_i}) + \alpha_2[\delta_1(3) - \frac{\delta_1 TN_i}{52} + \delta_2 E_{66_i} + \delta_3 S_{66_i} + \delta_4 Age_i]$$

or

$$(6) \qquad \gamma_i = \theta_0 + \theta_1 S_{66_i} + \theta_2 E_{66_i} + \theta_3(S_{69_i} - S_{66_i}) + \theta_4 TN_i + \theta_5 Age_i$$

where
$$\theta_0 = \alpha_0 + \alpha_2\delta_1(3) > 0,$$
$$\theta_1 = \alpha_2\delta_3 > 0,$$
$$\theta_2 = \alpha_2\delta_2 < 0,$$
$$\theta_3 = \alpha_1 > 0,$$
$$\theta_4 = \frac{\alpha_2(-\delta_1)}{52} < 0,$$
$$\theta_5 = \alpha_2\delta_4 < 0.$$

Substituting (6) into (1) and taking the log of both sides yields

$$(7)\quad \ln W_{69_i} = \ln A + \ln W_{66_i} + 3[\theta_0 + \theta_1 S_{66_i} + \theta_2 E_{66_i} + \theta_3(S_{69_i} - S_{66_i}) + \theta_4 TN_i + \theta_5 Age_i] + u_i$$

or

$$(8)\quad \ln W_{69_i} - \ln W_{66_i} = \eta_0 + \eta_1 S_{66_i} + \eta_2 E_{66_i} + \eta_3(S_{69_i} - S_{66_i}) + \eta_4 TN_i + \eta_5 Age_i + u_i$$

where $\eta_0 = \ln A + 3\alpha_0 + 9\alpha_2\delta_1 > 0,$

$\eta_1 = 3\alpha_2\delta_3 > 0,$

$\eta_2 = 3\alpha_2\delta_2 < 0,$

$\eta_3 = 3\alpha_1 > 0,$

$\eta_4 = \dfrac{3\alpha_2(-\delta_1)}{52} < 0,$

$\eta_5 = 3\alpha_2\delta_4 < 0.$

This implies that

$$(9)\quad \eta_0 = \ln A + 3\alpha_0 - 156(\eta_4)$$

so that

$$(10)\quad \alpha_0 = [\eta_0 - \ln A + 156(\eta_4)]/3.$$

Equation (10) is not identified since we are unable to estimate ln A. However, since it is reasonable that $A \geq 1$, it must be the case that

(11) $\alpha_0 < [\eta_0 + 156(\eta_4)]/3$

so that we can obtain an upper bound to the effect of aging on wage growth.

Up to this point, only human capital variables of the most traditional types have been included in the wage growth equation. However, there are reasons to expect that wage growth will depend on other factors as well. In light of the work by Lindsay (1971), Mincer and Polachek (1974), and Parsons (1974), it is reasonable to suppose that wage growth will be a function of the change in the number of hours worked between 1966 and 1969. In addition, to the extent that military experience offers an alternative method of acquiring human capital, the change in the amount of military experience should be included. Finally, since there are many reasons why blacks may have different incentives to invest in on-the-job training than whites, race may be a factor in determining wage growth. These variables are added to (8) so that it becomes

(12) $$\ln W_{69_i} - \ln W_{66_i} = \eta_0 + \eta_1 S_{66_i} + \eta_2 E_{66_i} + \eta_3 (S_{69_i} - S_{66_i}) + \eta_4 TN_i + \eta_5 Age_i + \eta_6 CH_i + \eta_7 D + \eta_8 CM_i + u_i$$

where D is a dummy variable set equal to 1 for white individuals, CH is the "usual" number of hours worked in 1969 minus the "usual" number of hours worked in 1966,

CM is the number of years of military experience in 1969 minus the number of years of military experience in 1966.

This equation can be easily estimated with longitudinal data obtainable from the National Longitudinal Survey. The data selected for this study was that pertaining to young men, 14 to 24 years old. The reason is straightforward. Since we are trying to estimate the effect of experience on wage growth, postulating that missed work time represents missed on-the-job training, we would like to examine a group of individuals who undertake substantial investment in human capital. Since the young tend to invest most and since men invest in on-the-job training more than do women, the desired effects are most likely to be observed when looking at young men. The results should therefore be interpreted in this light: The estimated effects will tend to be stronger for the group in question than for the working population as a whole.

The original sample has records on 5,225 individuals. This had to be reduced to 1,996 observations to meet the following criteria: First, it was necessary for the purposes that individuals in the sample have wage rates reported in both 1966 and 1969. Although this tended to systematically throw out observations on younger individuals in the sample, the mean age of those remaining was still 19.334 years. Second, individuals who reported that their wage rate was either less than fifty cents per hour or greater than ten dollars were dropped on the grounds that reported wages in those cases were unlikely to be correct. Finally, observations were dropped for which there was incomplete information on variables used in this analysis.

Equation (12) was estimated by OLS.[5] The results were:

$$(13)\quad \ln W_{69} - \ln W_{66} = \underset{(.1000)}{1.0456} + \underset{(.00625)}{.007537}\, S_{66} - \underset{(.00649)}{.02204}\, E_{66}$$

$$+ \underset{(.0121)}{.04106}(S_{69} - S_{66}) - \underset{(.000277)}{.0008853}\, TN$$

$$- \underset{(.00644)}{.03125}\, Age + \underset{(.000686)}{.002772}\, CH$$

$$- \underset{(.02404)}{.05941}\, D + \underset{(.11329)}{.05195}\, CM$$

$R^2 = .129$

$SEE = .4434$

$F(8,\ 1987) = 36.8.$

(The figures enclosed in parentheses are standard errors.)

The equation yields a number of interesting results. First, the coefficient on TN is negative and significant. This is consistent with the theory. Individuals who spend less time in the work force acquire less human capital in the form of on-the-job training. Since this equation holds formal schooling constant, this coefficient is not biased by the substitution of formal schooling for on-the-job training during the non-worked period. The term reflects the net foregone investment in human capital associated with dropping out of the work force.[6]

The coefficients are more easily interpreted when converted by the following computation: Taking the anti-log of (12), we may write

$$(14)\quad W_{69} = W_{66}\, e^{(\eta_0 + \eta_1 S_{66} + \eta_2 E_{66} + \dots + \eta_8 CM)}.$$

Differentiating (14) with respect to TN gives

$$(15) \qquad \frac{\partial W_{69}}{\partial TN} = W_{66}\, e^{(\eta_0 + \eta_1 S_{66} + \ldots + \eta_8 CM)} (\eta_4)$$

so that

$$(16) \qquad \frac{\partial W_{69}}{\partial TN} = 201.05(e^{.434507})(-.0008853)$$

$$= -.2749$$

for a white worker who was not in the military between 1966 and 1969. (All other variables assume their mean values.)

Equation (16) implies that being out of the work force for a period of one additional year between 1966 and 1969 will cost the individual 14.3¢ per hour in lower wages in 1969. The following calculation reveals this to be a substantial loss.

Suppose the individual in question missed work during 1968-69. Let us make the optimistic assumption that he catches up with his otherwise expected wage rate after five years, i.e., four years after re-entering the work force. During those four years, he loses 14.3¢ per hour for each hour worked. The present value of the human capital loss to an individual who works full time is then

$$(17) \qquad P.V. = (2000)(14.3) \sum_{i=1}^{5} \frac{1}{(1+r)^i} .$$

If r = 10%, expression (17) is equal to $1,084.17.[7]

When computing the cost of a given amount of unemployment, one should add to foregone earnings the value of the foregone human capital. The foregone earnings associated with being unemployed during 1968-69 can be estimated for this individual. If

$$(18) \qquad W_{69} = W_{66}\, e^{.434507} = W_{66}\, e^{3\gamma}$$

then

$$(19) \qquad \gamma = .144836$$

so that

$$(20) \qquad W_{68} = W_{66}\, e^{2(.144836)}$$

$$= 201.05(1.3360) = \$2.686 \text{ per hour.}$$

Foregone earnings associated with missing 1968-69 then amount to 2000($2.686) or $5,372.

Given the assumptions, the cost of foregone human capital amounts to about one-fifth the cost of foregone earnings associated with being out of work. This amount is not insignificant, especially when it is remembered that a relatively short catch-up period was assumed and that the costs of catching up were assumed to be zero. If, at the other extreme, one were to assume that the individual never catches up, the present value of the human capital loss would be $2,860, or over one-half the amount of foregone earnings.[8]

These results are important in that they reveal the existence of an experience effect. Work experience (or its complement) is related to wage growth independent of aging. Individuals who spend more time at work over the three year period seem to experience more rapid wage growth which, it may be inferred, reflects on-the-job training. (This, of course, holds other types of human capital acquisition such as formal schooling constant.)

It must be pointed out, however, that the effect of experience on wage growth is much smaller than the upper bound of the aging effect. From (11) and (13), $\alpha_0 < .3025$. The total effect of aging on wages is

$$(21) \quad \frac{\partial W_{69}}{\partial(\text{Aging})} = \left.\frac{\partial W_{69}}{\partial(\text{Aging})}\right|_{\text{Age}} + \frac{\partial W_{69}}{\partial \text{Age}}$$

or

$$(22) \quad \frac{\partial W_{69}}{\partial(\text{Aging})} = [W_{66}\, e^{(\eta_0 + \ldots + \eta_8 CM)}](\alpha_0 + \eta_5)$$

where the second term on the right hand side of (21) is the effect of reduced on-the-job training investment as the result of being older. Thus

$$(23) \quad \frac{\partial W_{69}}{\partial(\text{Aging})} = 84.2.$$

Since $\frac{\partial W_{69}}{\partial(\text{Working})} = \frac{-\partial W_{69}}{\partial \text{TN}} = .2749$, one year of experience implies a 14.3¢ increase in wages. The upper bound of the effect of aging is therefore about six times as large as that of work experience per se.

Part of this difference may be attributed to a measurement bias. Since older individuals are less likely to invest in on-the-job training than are their younger counterparts, the observed wage understates the true wage (which includes compensation in the form of human capital) by a greater amount for younger individuals than it does for older ones. If so, a portion of the observed returns to aging would be illusory, resulting from this systematic bias in observed wages.

The last few paragraphs should not be taken to imply that experience is unimportant. It is clear that aging is important and understandably so for individuals in the 14 to 24 year old age group. However, aging is parametric whereas experience is not. Experience has been shown to be important both in an absolute sense and relative to current wages. The fact that the effect of aging is so pronounced for the group in question is an interesting and useful result; it does not, however, negate the importance of the experience effect.

It should be noted that the effect of experience on wage growth is not analytically the same as the effect of previous experience on wage growth. The effect of the former as reflected by the TN coefficient represents the amount by which wages increase with additional work experience in the current period. The latter relates to the rate at which individuals will acquire on-the-job training in the current period for each unit of current experience. It was anticipated that individuals with a greater amount of previous experience would invest in less on-the-job training during the current period since it (generally) pays to invest in larger amounts of training during the initial years of work. The coefficient on E_{66} bears this out.

This also sheds light on the question of neutrality. If the rental price of human capital were constant over all units of human capital once age were given,[9] and if the marginal cost of human capital were not a function of previous investment (i.e., Ben-Porath's neutrality assumption), the effect of previous experience on the (absolute) change in wages would be zero. More simply, if neither the marginal cost nor marginal return to investment in human capital varies with previous experience, there is no reason for the experienced worker to behave differently from the unexperienced one. The wage growth behavior of both individuals would be expected to be the same. The fact that experience does have a negative effect on ($\ln W_{69} - \ln W_{66}$) implies that the neutrality assumption is invalid or that retirement (or more generally, length of time in the labor force) is a function of experience. From (14), we can write

$$(24) \qquad W_{69} - W_{66} = W_{66}(e^{(\eta_0 + \ldots + \eta_8 CM)} - 1).$$

(In the context of this question, W_{66} is a parameter. We are interested in the effect of previous experience on wage growth between 1966 and 1969, given wages in 1966 rather than the total effect of previous experience on wage growth which includes the effect of E_{66} on W_{66}.) Then differentiating with respect to E_{66} yields

$$(25) \qquad \frac{\partial(W_{69} - W_{66})}{\partial E_{66}} = W_{66}[e^{(\eta_0 + \ldots + \eta_8 CM)}]\eta_2 \qquad (= \frac{\partial W_{69}}{\partial E_{66}})$$

This expression is necessarily negative since $\eta_2 < 0$.

The negative effect of previous experience on inferred investment in on-the-job training implies that one of two situations holds: On the one hand, it may be the case that the retirement age (or the amount of future time to be spent working) is a function of past experience with this age falling as previous experience increases. This reduces the returns to investment in human capital and decreases the optimal amount of on-the-job training purchased. It is unlikely, however, that this can account for much of the effect since the retirement date for these individuals is expected to occur about forty years hence.

The alternative explanation is provided by relaxing the neutrality assumption. If previous investment in on-the-job training affects the productivity of time spent working by more than it affects the productivity of time spent in the production of human capital, then the marginal cost of a unit of human capital rises as experience rises. Thus, given age, individuals with more previous experience enjoy less rapid wage growth over the period.[10]

Age enters negatively and significantly and the coefficient is of roughly the same magnitude as that on previous experience. However, since the date of retirement occurs so far in the future, it is unreasonable to infer that the age coefficient reflects the difference in marginal returns to investment in human capital across individuals. Two explanations seem more plausible. First, as pointed out above, aging is an important component in the determination of wage growth. It is reasonable to suppose that aging matters more for younger workers than for older ones since both physical and emotional maturity appear to be concave functions of time. If so, the age coefficient is essentially an interaction relationship between aging and age. Second, one may attribute the negative age effect to a quality component not held constant by the included variables. That is, a 24-year old who has the same amount of work experience as an 18-year old obviously uses his time differently. If past work history is correlated with future labor force behavior, the older individual has a lower probability of being employed throughout the full year than does the younger one. The age coefficient then not only picks up the effect of age per se, but also the desire to spend a smaller proportion of each working year at the job.

The coefficient on incremental schooling is positive and significant. As I have argued elsewhere,[11] this should not be interpreted as a rate of return to education, but simply as the average effect of schooling on wage growth over this three year period. It is, however, interesting to ask what the net effect is of dropping out of the labor force to attend school. The results in (13) permit this calculation. Since

$$(26) \qquad TN = (S_{69} - S_{66})36 + TO$$

where TO is non-school time not worked and the school year is assumed to be thirty-six weeks long, we may substitute so that

$$(27) \qquad \left[\frac{\partial(\ln W_{69} - \ln W_{66})}{\partial(S_{69} - S_{66})}\right]^* = \frac{\partial(\ln W_{69} - \ln W_{66})}{\partial(S_{69} - S_{66})} + \frac{\partial(\ln W_{69} - \ln W_{66})}{\partial TN} \cdot \frac{\partial TN}{\partial(S_{69} - S_{66})}$$

where the expression on the left hand side is the gross-partial associated with an increase in schooling that occurs by dropping out of the labor force. Then

$$(28) \qquad \left[\frac{\partial(\ln W_{69} - \ln W_{66})}{\partial(S_{69} - S_{66})}\right]^* = .04106 - (.0008853)(36)$$

$$= \underset{(.0158)}{.009189}$$

where (.0158) is the standard error computed from the variance-covariance matrix.

Attending school is then slightly more productive in terms of wage growth than is on-the-job training. This is as it should be since the costs associated with the former are larger than those associated with the latter. In fact, the difference between the two may appear to be too small. This can be explained by the fact that the estimates relate to the average rather than marginal effects over the three year period. If the ratio of average to marginal effects of schooling are less than the ratio of average to marginal effects of on-the-job training, then the estimate of the schooling effect overstates the marginal schooling effect by less than the estimate of the on-the-job training effect overstates the marginal on-the-job training effect. Under circumstances where the effect of schooling (on-the-job training) on the difference in the log of wages was a negative, convex function of previous schooling (on-the-job training), this would be the expected result since individuals in this group are at relatively high levels of formal schooling, but at low levels of on-the-job training.

As anticipated, an increase in the number of hours per week worked has a positive effect on wage growth. The partial effect is

$$(29) \qquad \frac{\partial W_{69}}{\partial CH} = W_{66}[e^{(\eta_0 + \ldots + \eta_8 CM)}]\eta_6 = .8606$$

so that increasing average weekly hours by 20 (i.e., moving from the typical part-time to the typical full-time job) increases wages in 1969 by about 17¢ per hour.

One rather interesting result is that, ceteris paribus, white workers experienced less rapid wage growth over this period than did black workers. This probably reflects the fact that 1966-69 witnessed rather significant change in the institutional structure, one of the results of which was a narrowing of the black-white differential.[12] The signalling hypothesis provides another explanation.[13] It may be the case that blacks with equal schooling and job experience as whites may be self-selectingly higher quality workers than are the corresponding whites. Employers who fail to discriminate in their reading of signals at the time of hiring will tend to pay the higher quality non-whites the same wage as the lower quality white workers. Over time, however, employers learn about the non-white's relative advantages and the non-white worker's wages increase accordingly. (This would not be expected to persist over time, though, since employers who discriminated in favor of non-whites with equal schooling and experience at the time of hiring would drive their less efficient competitors out of business.)

Finally, the coefficient on incremental military experience is positive and of roughly the same magnitude as incremental schooling. The standard error here is large, probably because only 52 out of 1,996 individuals had a non-zero value for this variable. To the extent that the estimate is taken to be close to the true value, it appears as though one year in the military contributes as much to the stock of human capital as one year of formal schooling.

Summary and Conclusions

This paper has been an attempt to distinguish between the effects of experience and age in the formation of human capital. By asking "What is the cost in foregone human capital associated with not working?" we have obtained estimates of the age-experience differential. The major findings were:

1. The effect of current work experience on wage growth is substantial. Under reasonable assumptions, anywhere from one-sixth to one-third of the total cost of unemployment consists of the value of foregone human capital.

2. For individuals in the 14-24 year-old age group, aging is the most important factor in the determination of wage growth. It should be remembered, however, that aging is not an economic variable which is subject to choice.

3. The finding that wage growth is inversely related to previous work experiences casts serious doubt on the validity of the neutrality assumption. Since this assumption is almost universal throughout the age-earnings literature, this result should cause some concern.

4. As expected, an increase in formal schooling is associated with more rapid wage growth. It is also found that schooling increases wage growth by slightly more than does the equivalent amount of work experience.

5. Consistent with previous work, we find that an increase in the number of hours worked implies more rapid wage growth.

6. It appears that, ceteris paribus, non-whites enjoyed more rapid wage growth over the period in question than did whites. This

may be the result of institutional changes or of unobserved quality differences at the time of hiring which work in favor of white workers.

The main conclusion of this study is that it is a serious mistake to treat "age" and "experience" as two names for the same phenomenon. Investigators are likely to be misled by a grouping which fails to distinguish between these two arguments of the human capital production function.

FOOTNOTES

* This research was supported by grants from the National Science Foundation and the Rockefeller Foundation. I wish to thank Charlie Brown, Zvi Griliches and Sherwin Rosen for comments on an earlier version of this paper.

1. See, for example, Blau and Duncan (1967), Chiswick (1974), Hause (1973), Heckman (1974), Lillard (1974), Michael and Lazear (1971), Mincer (1962, 1974), Mincer and Polachek (1974), and Rosen (1973).

2. See Lazear (1974) and Rosen (1973) for a more complete discussion of this issue.

3. This is the usual result of an optimal investment plan in a life-cycle context. Both Ben-Porath (1967) and Rosen (1972) derive this implication. Heckman (1974) and Mincer and Polachek (1974), on the other hand, show that under reasonable assumptions this result will not hold.

4. δ_4 is the effect of age on the acquisition of on-the-job training. It should not be confused with α_0 which is the effect of _aging_ on the stock of human capital and therefore on wage growth.

5. By hypothesizing that the change in hours worked enters the wage change equation we introduce simultaneity bias. The wage growth equation writes wage growth as a function of the change in hours. The supply of labor, however, would relate hours worked to wages and thus change in hours worked to the change in wages. Because of this, OLS yields biased estimates of the effects. The reader may be somewhat reassured to learn that when the CH term was deleted from the equation,

none of the remaining coefficients were significantly altered. (See the appendix for additional discussion of this issue.)

The same argument does not, however, hold for the TN coefficient. It can be argued that individuals with lower wage rates and/or higher wealth will tend to work fewer hours. This does not apply for the change in wage rates, however, since there is no reason to believe that individuals who have experienced large wage increases have either low wages or high wealth.

6. It might be argued that this coefficient is a reflection of differences in ability rather than in human capital stock levels. An attempt was made to standardize for the component of ability not held constant by inclusion of schooling, previous experience and age. The NLS has information on virtually every individual in the sample which gives their test scores on an examination which was designed to test their "knowledge of the world of work." (Similar information was not available on IQ.) If this can be considered a proxy for ability, inclusion of this variable into equation (12) should affect the TN coefficient if the ability argument were correct. Estimation of this equation yielded results which were virtually identical in all respects to equation (13). In particular, the coefficient on the ability proxy was insignificant. (See the appendix regression #2 for complete results.)

7. If foregone human capital affects non-market productivity as well as market productivity, this present value calculation will tend to understate the loss associated with unemployment. It is not likely that this understatement will be significant, however, since on-the-job training tends to be market specific in the type of human capital it provides.

8. If Ben-Porath's assumption of neutrality were correct, there would be no reason to engage in any type of catch-up behavior. The marginal cost of human capital would be independent of whether 1968-69 were worked or not. As long as the date of retirement is not significantly altered, the marginal return to a unit of human capital would be left unchanged as well so that there would be no reason to alter the optimal investment plan.

9. This amounts to assuming that retirement is a function of age alone and is independent of the amount of time spent working over the lifetime. In light of the work done by Bowen and Finegan (1969) which shows that labor force participation tends to vary positively with the level of education for older workers, it is unlikely that the assumption is a valid one.

10. See Brown (1974) for a more detailed discussion of the neutrality question.

11. See Lazear (1974).

12. See Welch (1974) for additional evidence on this point.

13. See Arrow (1972) and Spence (1972) for a more complete discussion of the signalling hypothesis.

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APPENDIX

One may formulate a simple system of simultaneous equations which treats hours worked as endogenous. Suppose

$$H_{69} = \alpha_0 + \alpha_1(\ln W_{69}) + \alpha_2(A_{69}) \quad \text{(A.1)}$$

and

$$H_{66} = \alpha_0' + \alpha_1(\ln W_{66}) + \alpha_2(A_{66}) \quad \text{(A.2)}$$

so that

$$CH = (\alpha_0 - \alpha_0') + \alpha_1(\ln W_{69} - \ln W_{66}) + \alpha_2(A_{69} - A_{66}) \quad \text{(A.3)}$$

where H_{66} is hours worked in 1966,
H_{69} is hours worked in 1969,
A_{66} is wealth in 1966, and
A_{69} is wealth in 1969.

Since wealth is a lifetime concept, if expectations about lifetime earnings between 1966 and 1969 do not change, $(A_{69} - A_{66})$ should equal zero. This term relates then to windfalls. Therefore define

$$A_{69} - A_{66} = (Y_{69} - Y_{66}) - (\bar{Y}_{69} - \bar{Y}_{66}) \quad \text{(A.4)}$$

where Y is the individual's income level and $\bar{Y}$ is the median income for individuals in his occupation. The notion is that if the individual's income increases more rapidly than does the occupation's income, he has enjoyed a windfall gain. (Since the sample consists of young workers, the average increase in individual income will exceed that of occupational income. This, however, will be netted out by the constant term.)

Appendix regression equation #4 contains the results of estimation by 2SLS. CH is taken to be endogenous and fitted values obtained from the regression on exogenous variables replace actual values.

The results of the two stage regression differ substantially from the estimates obtained by OLS. In the two stage equation, the only variable that matters is CH. None of the other coefficients differ significantly from zero. The explanation is straightforward: The variable which is excluded to identify the equation is CA. CA is a transofrmation of the change in income which for the group in question is highly correlated with the change in wages. Since the dependent variable is the change in the log of wages, it is not surprising that CH which uses CA as an instrument in its construction is highly correlated with the dependent variable. This explains the fact that its coefficient is about twenty times its size in the OLS regression and is the only significant variable in the two stage regression.

Note, however, that when the CH term is deleted in regression #3, none of the remaining coefficients differ significantly from those obtained in regression #1.

Table 1. Table of supplementary regressions.

Variable	Regression #1	Regression #2	Regression #3	Regression #4
S_{66}	.006021 (.006342)	.005258 (.007037)	.007070 (.006361)	-.008973 (.01235)
E_{66}	-.023337 (.006525)	-.023432 (.006538)	-.024276 (.006546)	-.005016 (.01279)
Age	-.030201 (.006472)	-.030374 (.006511)	-.033845 (.006432)	.02962 (.02104)
CH	.002745 (.000685)	.002747 (.000685)		.04929 (.01342)
$S_{69} - S_{66}$	.040392 (.012142)	.039998 (.012225)	.041849 (.012183)	.001604 (.002323)
CM	.051488 (.11323)	.051326 (.11326)	.070562 (.11356)	-.2713 (.2266)
TN	-.000891 (.000277)	.000893 (.000277)	.000974 (.000277)	.0005297 (.0006481)
D	-.059472 (.024075)	-.061697 (.025665)	-.059995 (.024166)	-.04833 (.04394)
Knowledge of world of work test score (=1 to 56)		.000399 (.001592)		
Constant	1.0465 (.1001)	1.0469 (.1001)	1.1157 (.0990)	-.1294 (.3828
R^2	.129	.129	.122	N/A
SEE	.4432	.4432	.4448	.8081
F	36.7	32.6	39.4	N/A
SSR	388.87	388.86	392.02	1297.5
Method of estimation	OLS	OLS	OLS	2SLS
No. of observations	1989	1989	1989	1996