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DIFFERENCES IN EXPECTED POST-SCHOOL INVESTMENT AS A DETERMINANT OF MARKET WAGE DIFFERENTIALS*

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MUCH OF THE RECENT LITERATURE on the distribution of income has centered not only on the distribution of earnings between the basic factors of production capital and labor, but also on the more narrow problem of the distribution of earnings within the labor sector. In this regard, labor is viewed as a heterogeneous group whose members have accumulated differing amounts of human capital. The problem of actually measuring human capital has proven to be a difficult task if only because some forms of human capital are not directly observable.

Early studies [**2, 17, 8**] have concentrated on measuring the effects of one form of human capital—namely that of education on earnings. However, even this concentration on schooling poses theoretical and empirical problems. First, as some [**12, 28, 30**] have argued, examining only levels of schooling accounts sufficiently neither for quality differences between schools nor for the interactive effects between schooling and individual ability. Second, since schooling does not represent the only form of investment, then neglecting other investments may bias measurements of the effects of education on earnings. A positive correlation between schooling level and other investments implies that the impact of schooling would be overestimated, while conversely a negative correlation implies an underestimate. Because of the importance of preventing such biases, a large portion of the research in human capital has been devoted to understanding nonschool investment. Although in part these investments consist of intergenerational transfers [**27, 15**] in the form of pre-school investment, the bulk of the research has centered on post-school investment (*PSI*) sometimes referred to as on-the-job training (*OJT*) [**18, 4, 25, 13, 29, 11**].

Post-school investment has not been directly observable. However, under two main assumptions, namely (1) that the marginal cost of human capital produced in a given period is upward sloping and (2) that an individual's labor force participation over his life cycle is non-increasing, *PSI* can be shown to decline monotonically with age. It is for this reason that *PSI* has been specified as some

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function of age yielding a characteristically concave age-earnings profile. To date no one has questioned the validity of declining *PSI* with age. Instead, by analyzing the effects of ability and initial human capital endowment on the marginal cost of human capital investment, research has concentrated only on ascertaining the rate of decline of *PSI* over the life cycle [**19**, **4**, **13**, **29**, **11**]. This paper questions these results by illustrating that when the above second assumption (only implicit in past research) is violated, investment need not decline monotonically with age. Such non-monotonicity of invesment becomes important in explaining the earnings behavior of secondary workers who tend to have more intermittent life cycle labor force participation (*LFP*) patterns than white married males to which most empirical studies apply.

Section 1 outlines the theory of life cycle human capital accumulation when expected labor force participation is intermittent; Section 2 applies this theory by developing a new technique for measuring expected human capital investment. These measurments are then used in Section 3 to explain male-female and married-single earnings differentials.

1. THE THEORY OF LIFE CYCLE ACCUMULATION OF HUMAN CAPITAL AND ITS APPLICABILITY TO THOSE WITH INTERMITTENT LABOR FORCE PARTICIPATION

For the most part, models in economics deal with the problem of allocation. The human capital model is no exception; it deals with the allocation of goods and time resources in the production of human capital. For the individual, the motivation behind such a choice is obvious. Higher stocks of human capital increase individual wages; yet the allocation of time and goods for such investment is costly. The individual must weigh the present value of these costs and benefits over the life cycle to determine an optimal path of human capital accumulation.

To analyze this problem we assume that an individual's objective is to maximize the present value of his earnings stream over a finite lifetime assumed to end with certainty at year T.[2] Such an objective function can be represented by maximizing a functional representing discounted lifetime earnings, and can be written as

$$\text{(1-a)} \qquad \text{Max } J = \int_0^T [N_t - s_t] w(K_t) K_t e^{-rt} dt$$

subject to the following constraint on the rate of change of capital stock

$$\text{(1-b)} \qquad \begin{aligned} \dot{K} &= Q_t - \delta(t, K)K_t \\ &= f[s_t, K_t, X_t] - \delta(t, K_t)K_t \end{aligned}$$

[2] Such an objective function is not the most general. However, as was pointed out by a reviewer of this paper, if the individual's utility function in each period is a monotonic transformation of earnings, and the market and subjective discount rates are equal, then both the more general model of utility maximization and the simplified model of maximization of discounted lifetime earnings yield the same results.

$$= b_0 s_t^{b_1} K_t^{b_2} X_t^{b_3} - \delta K_t$$

where,

$K_t \equiv$ stock of human capital at time t,
$w(K_t) \equiv$ rental value (wage rate) per unit of human capital,
$s_t \equiv$ percent of total time available spent investing in period t,
$N_t \equiv$ percent of total time available spent in labor force participation (including the time devoted to investment),
$r \equiv r' + \delta$ the sum of the rate of discount and rate of depreciation of human capital stock,
$X_t \equiv$ goods used in the production of human capital, and
$\delta(t, K_t) \equiv$ the annunal rate of depreciation of capital stock of age t.

The parameters b_0, b_1, b_2, and b_3 are parameters of the production function of human capital.

Since the latest studies discuss the effect of variation in the production function parameters b_1, b_2, and b_3 on the control variable s_t, we shall not deal with this problem. Instead we assume neutrality in the production function of human capital (i.e., $b_1 = b_2$) thereby guaranteeing that the marginal cost of investment does not shift as K_t changes over time.[3] Further, let us assume that the amount of investment in each period is invariant with the rental value of a unit of human capital ($b_3 = 0$), that the rate of depreciation is zero at all ages and levels of human capital stock ($\delta(t, K) = \delta = 0$), and finally that the wage rate per unit of human capital is constant and independent of total capital stock [$w(K_t) = w_0$].[4]

The main point of departure of this model from its predecessors is that this model does not assume N_t to be a constant equal to one. Although such a hypothesis may be plausible for white married males who have a high and relatively constant commitment to the labor force over the life cycle, such an assumption is clearly not true for other groups such as single white males, blacks, or females all of whom have a lesser lifetime labor force commitment [7, 6].[5]

To solve the more traditional maximization for which it is assumed no corner solutions are binding and that N_t is constant over time but not equal to unity, the Hamiltonian[6]

$$H = w_0(N_t - s_t)e^{-rt}K_t + \lambda b_0 s_t^{b_1} K_t^{b_1}$$

is maximized with respect to the control variable s_t to obtain the following necessary conditions:

[3] For discussion of the cases for which $b_1 \neq b_2$ see Becker [3], Ben-Porath [4, 5] and Ghez [10].

[4] The assumption that $\delta = 0$ is relaxed in the empirical implementation of the model. It is used here to simplify the notation.

[5] It is beyond the scope of this paper to postulate reasons for life cycle differences in labor force participation across groups. Rather, our point of view is to ascertain what if any effect such differences in labor force participation have on one's human capital investment stream.

[6] The Hamiltonian is defined on the basis of assuming that no corner solutions are binding. An interior solution is guaranteed because H is concave in N_t and s_t for a given K and t. See [1, Proposition 5, lecture 1)].

$$\frac{\partial H}{\partial s_t} = -w_0 K_t e^{-rt} + \lambda b_0 b_1 s_t^{b_1-1} K_t^{b_1} = 0\,, \tag{1}$$

$$\dot{\lambda} = -w_0(N_t - s_t)e^{-rt} - \lambda b_0 b_1 s_t^{b_1} K_t^{b_1-1}\,, \tag{2}$$

$$\dot{K} = Q_t = b_0 s_t^{b_1} K_t^{b_1}\,. \tag{3}$$

Equation (1), which implies that the quantity of invesment in each period is obtained by equating its marginal costs and benefits may be solved for the costate variable, λ, representing marginal returns on human capital investment in terms of the production function parameters

$$\lambda = \left[\frac{w_0}{b_0 b_1}\right] K_t^{1-b_1} s_t^{1-b_1} e^{-rt}\,. \tag{1'}$$

By substituting (1′) into (2), $\dot{\lambda}$ can be expressed as:

$$\dot{\lambda} = -w_0 N_t e^{-rt} \le 0 \tag{2'}$$

thereby illustrating that the marginal revenue of an incremental unit of human capital investment diminishes over the life cycle. Solving this differential equation for λ given the initial condition that

$$\lambda(t_0) = \int_0^T w_0 N_\tau e^{-r\tau} d\tau$$

yields the formula of marginal revenue per unit of investment

$$\lambda(t) = \int_t^T w_0 N_\tau e^{-r\tau} d\tau\,. \tag{1''}$$

Further, (1) can be solved for $(s_t K_t)$—the amount of capital reinvested during each period:

$$s_t K_t = \left[\left(\frac{b_0 b_1}{w_0}\right)\Psi\right]^{1/(1-b_1)} \tag{4}$$

where Ψ equals λe^{rt} or the current dollar equivalent of marginal revenue. Taking the partial derivative of $s_t K_t$ with respect to time yields the yearly change in investment

$$\frac{\partial s_t K_t}{\partial t} = \left[\frac{1}{1-b_1}\right]\left[\frac{b_0 b_1}{w_0}\right]^{1/(1-b_1)} \dot{\Psi}^{b_1/(1-b_1)} \le 0 \tag{5}$$

which, by being negative, illustrates that dollar investment declines with age.[7]

[7] This result holds because:

$$\begin{aligned} \dot{\Psi} &= \lambda r e^{rt} + \dot{\lambda} e^{rt} \\ &= N_t e^{rt}\left[r\int_t^T w_0 e^{-r\tau} d\tau - w_0 e^{-rt}\right] \\ &= N_t e^{rt}[-w_0 e^{rT} + w_0 e^{-rt} - w_0 e^{-rt}] \\ &= -w_0 N_t e^{r(t-T)} \le 0\,. \end{aligned} \tag{6}$$

Similarly, the percentage of one's available time devoted to investment $[\partial s_t/\partial t]$ is also declining.[8] To illustrate the effect on investment of an exogenous decrease in labor force participation (N_t), investment is differentiated with respect to N_t yielding

$$-\frac{\partial}{\partial N_t}[s_t K_t] = \frac{-1}{1-b_1}(s_t K_t)^{b_1/(1-b_1)}\frac{\partial \dot{\Psi}}{\partial N_t} \leq 0$$

because $\partial\dot{\Psi}/\partial N_t \geq 0$. Thus an exogenous decrease of per period labor force participation decreases the amount of current investment in human capital, as well as decelerates the investment process. If this smaller labor force participation is sufficient to cause a decline in current marginal revenue of investment, by one percent, investment expenditures decrease by $(1 \div [1 - b_1])\%$, and the rate of decline of investment expenditure decreases by $(b_1 \div [1 - b_1])\%$.

Relaxing the assumption of constant per period *LFP* implies.[9]

$$(7) \qquad \dot{\Psi} = -w_0 N(t)e^{r(t-T)} + w_0 r e^{rt}\int_t^T [N(\tau) - N(t)]e^{-r\tau}d\tau\,.$$

The first term represents the change in marginal revenue if labor force participation were constant. It is negative and identical to (6). The second represents the incremental change to marginal revenue when labor force participation is not constant over the life cycle. If labor force participation is rising then this second term is positive, and if sufficiently large in magnitude would cause the marginal revenue of investment to rise (i.e., $\dot{\Psi} > 0$), and hence investment $s_t K_t$

8 Because $(b_1 - 1) \leq 0$ and $\dot{\Psi} \leq 0$

$$\frac{\partial s_t}{\partial t} = \frac{\partial}{\partial t}\left[\left(\frac{b_0 b_1}{w_0}\right)\Psi K^{b_1 - 1}\right]^{1-(1-b_1)}$$
$$= \left[\frac{b_1}{(1-b_1)}\right]\left[\frac{b_0 b_1}{w_0}\right]^{1-(1-b_1)}[\Psi K_t^{b_1-1}]^{b_1-(1-b_1)}$$
$$= [(b_1 - 1)\Psi\dot{K} + K_t^{b_1-1}\dot{\Psi}] \leq 0\,.$$

9 This result can be derived from Equation (6):

$$\dot{\Psi} = \lambda r e^{rt} + \dot{\lambda} e^{rt}$$
$$= re^{rt}\int_0^T w_0 N(\tau)e^{-r\tau}d\tau - w_0 N(t)e^{-rt}e^{rt}\,.$$

Adding and subtracting

$$w_0 e^{rt}\int_t^T N(\tau)e^{-r\tau}d\tau\,,$$

we obtain

$$\dot{\Psi} = w_0 e^{rt}\int_t^T N(\tau)e^{-r\tau}d\tau - w_0 N(t)e^{-rt}e^{rt}$$
$$+ re^{rt}\int_t^T w_0 N(\tau)e^{-r\tau}d\tau - w_0 e^{rt}\int_t^T N(\tau)e^{-r\tau}d\tau\,,$$

which upon simplification yields Equation (7).

to rise too.[10] These results therefore illustrate that if one plans not to be in the labor force because of a greater degree of home specialization or unemployment, then marginal revenue of investment would be lower than it would otherwise be. Further, if the marginal cost function is unaffected by such an absence from the labor force, then human capital investment also would be lower thereby implying lower and flatter age-earnings profiles.

Whereas previous models deal only with differences in the rate of decline of $s_t K_t$ with respect to changes in the parameters of the human capital production function, this analysis shows that *PSI* crucially depends on expected life cycle *LFP*, and in fact need not decline monotonically with age. Similarly the level of *PSI* need not differ among individuals because of differences of initial human capital endowments or abilities, but instead may differ because of expectations of future labor force participation. For example, if females expect family, social, and maternal pressures to mold their work decisions during say only the child rearing period, then their investment patterns would be affected over their entire life history. If blacks are last hired and first fired, then expectations of greater unemployment also would affect their investment decisions. As a corollary, one may add that given the assumption of risk aversion, uncertainty with respect to one's expectations of future labor force participation would also result in less human capital investment.[11] It is for this reason, namely the failure to account for differing expectations and hence differing amounts of investment even while at work, that current studies of male-female wage differentials fail to explain more than fifty percent of the wage gap. In the remainder of this paper the theory developed in this section is applied to estimate the importance of differing life cycle labor force expectations on human capital investment and hence on the existing male-female and married-single wage gap.[12]

2. THE COMPUTATION OF EXPECTED POST-SCHOOL INVESTMENT

Assume that the human capital production function defined in Equation (1-b) varies across schooling groups. It then follows that marginal cost of investment across individuals of the same level of education is identical, and that individual post-school investment in each time period is determined by the differing indi-

[10] For the special case when *LFP* is constant

$$N(\tau) = N(t) \qquad \text{for all} \quad t \leq \tau \leq T$$

then the second term becomes zero and (7) reduces to (6).

[11] Such a conclusion can be derived by attaching probabilities on the degree of per period labor force participation [$N(t)$].

[12] The exact groups on which we concentrate are: (1) married-once-spouse present males compared to married-once-spouse-present females (2) single-never-been married males compared to single-never-been married females, (3) married-once-spouse-present males compared to married-once-spouse-present females, and (4) single-never-been-married males compared to single-never-been married females.

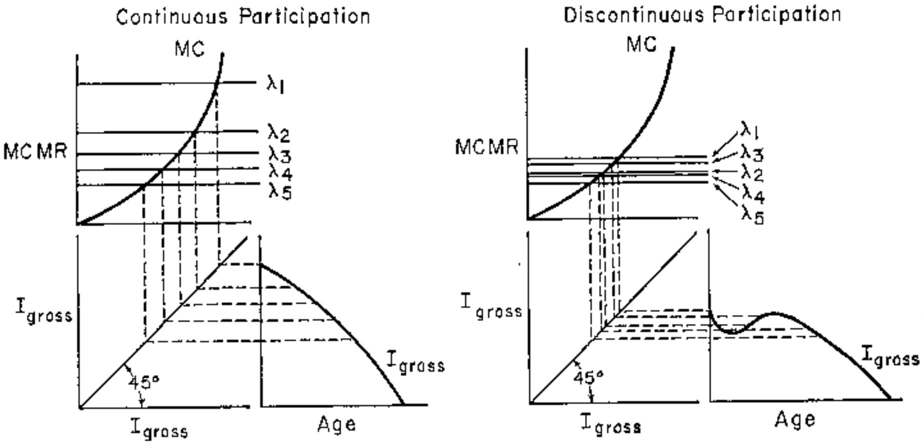

FIGURE 1

A GRAPHICAL DETERMINATION OF POST-SCHOOL INVESTMENT

vidual sets of marginal revenue (λ).[13] For such a determination of *PSI* (illustrated graphically in Figure 1), the marginal cost of investment (*MC*) is invariant over the life cycle, and *PSI* in each period t ($I_t = s_t K_t$) is determined by the intersection of *MC* and λ_t.[14] If labor force participation is continuous and constant over the life cycle, λ_t gradually shifts down and traces out an optimal path of diminishing gross investment:[15]

$$\underline{I} = (I_1, I_2, \ldots, I_T) \quad \text{such that} \quad I_1 > I_2 > \cdots > I_T .$$

On the other hand, if *LFP* is intermittent λ_t need not shift downward monotonically, and hence would generally result in a smaller lifetime investment (Figure 1). Based on these equilibrium conditions, this section is devoted to empirically measuring investment differences caused by differing *LFP* patterns.

To briefly outline the computational procedure,[16] note that if both the *MC* and $\underline{\lambda} = (\lambda_1, \lambda_2, \ldots, \lambda_T)$ functions are known, then $\underline{I}$ can be estimated as the solution of the equation relating to *MC* to $\underline{\lambda}$. Conversely, if given $\underline{I}$ and $\underline{\lambda}$, *MC*

[13] According to the model presented, differences in the wage rate (w_0) per unit of embodied human capital would not affect the amount or rate of *PSI* because b_3 of Equation (1-b) is assumed equal to zero. Such an assumption is made so as to isolate the implicit discrimination effect of differing wages for the same stock of human capital.

[14] *MC* is invariant over the life cycle because the specification of the production of human capital assumes $b_1 = b_2$ in Equation (1-b).

[15] We specify "gross" investment because in the process of simplifying the notation of the theoretical model, the assumption $\delta = 0$, (Equation 1-b) was made. If, as is more realistic, $\delta \neq 0$, depreciation must be subtracted out to obtain "net" or "observed" investment. In the empirical computation of investment depreciation of existing capital stock was computed, and subtracted from gross investment.

[16] A more detailed explanation of the estimation method as well as sets of tables containing the precise data are available upon request to the interested reader.

can be uniquely determined.[17] Since methods are available for determing the married male investment[18] [I (t; Male, Married, E) where $E = 1, \ldots, 5$ representing five levels of education] and the marginal revenue vectors λ [t; Male, Married, E][19], a unique MC can be determined for each level of education. When these marginal cost curves [$MC(E)$] are equated with single male as well as single and married female marginal revenue functions of comparable levels of education [$\lambda(S, N, E)$], estimates of each of these group's investment relative to that of married males are obtained (Appendix Table).

As the theory developed in Section 1 predicts, both the quantity of investment as well as its rate of accumulation differs with the degree of labor force intermittency. For those groups with the least labor force commitment, investment

[17] If MC is identical across individuals of given levels of education regardless of sex and marital status, then the solution of

$$\lambda(t; 1, 1, E) = I(t; 1, 1, E)$$

for $E = 1, 2, \ldots, 5$ representing 8, 12, 14, 16 and 18 years of schooling

yields MC, such that

$$MC(S, M, E) = MC(E)$$

for S = male (1), female (2)
M = Married (1), single (2)
$E = 1, \ldots, 5$.

[18] Married male investment for each level of education can be computed from age-earnings profiles fit according to the following specification:

$$LnY_t = LnE_0 + r\int_0^t S(\tau)d\tau + \varepsilon$$

where

$Y_t \equiv$ earnings at period t
$E_0 \equiv$ initial earnings capacity
$r \equiv$ rate of return to PSI
$s(t) \equiv$ net time equivalent PSI in year t specified as a linear function of experience in the labor force (t).

Thus net PSI in time equivalent terms (S_t) can be computed as

$$S_t = \frac{1}{r}\frac{\partial LnY_t}{\partial_t} = \frac{1}{r}(\alpha_0 - \beta t).$$

Net PSI in dollar terms would be:

$$I_N = \frac{1}{r}\frac{\partial y_t}{\partial t} = S_t Y_t = (\alpha_0 - \beta t)Y_t$$

$$= (\alpha_0 - \beta t)\exp\left[LnE_0 + \alpha_0 t - \frac{1}{2}\beta t^2\right].$$

In principle net investment of the other groups can also be determined by such methods. However, since only cross sectional data is available, biases of measurement exist because of these groups' labor force intermittency. Further, we wish to obtain independent measures of the PSI of these groups so as to enable their use in Section 3 as a determinant of own wage rate.

[19] Marginal revenue $\lambda(S, M, E)$ is computed for all groups using a discrete form of (1″). Cross Sectional Data on labor force participation by age and education were computed from the *1960 U.S. Census of Population and Housing*, (1/1000) sample. The LFP rates of single females used in Table 3 were adjusted by the probability of becoming married. Rates of discount were assumed equal to the rate of return from education for each sex—marital status category.

is least monotonic and smallest in magnitude. Consequently, expected investment of married males exceeds that of single males, and expected investment of single females is greater than that of married females. Similarly, because of the greater labor force commitment of the more educated, expected gross investment rises consistently with education. However, because of the greater depreciation associated with higher levels of education, these patterns of rising investment need not hold for net investment. In fact, net *PSI* does not increase as continually by level of education as does gross *PSI*.

Consistent as these results are with respect to the human capital model, the assumptions explicit in the computation scheme no doubt bias these estimates of post-school investment. However, since each assumption has different and opposite effects, the net effect is impossible to determine. Assuming that each education group possesses the same production function for human capital may be unduly restrictive in the sense that differing labor market expectations may affect the quality of schooling in addition to the quantity of *PSI*. Hence if these differing labor force expectations affect the fields studied by each sex-marital status group such that investment in schooling is not Hicksian neutral with respect to home versus market production, then the assumption of invariance of marginal costs within education groups would cause an underestimate of the marginal cost function and hence *ceterus paribus*, an overestimate of expected investment. On the other hand, if the marginal cost curve of males is in reality rising over the life cycle (i.e., if $b_1 \neq b_2$ in Equation (1–6)] the outlined computation scheme would underestimate female investment.

Although these as well as certain other computational biases exist, this section has provided sufficiently robust evidence that post-school investment functions differ according to sex and marital statuss and further that behavior motivated by the maximization of discounted lifetime earnings is useful in understanding post-school investment behavior. The next section verifies the applicability of this investment process as an explanation for the intergroup wage differentials observed within the economy.

3. DIFFERENCES IN EXPECTED POST-SCHOOL INVESTMENT AS A DETERMINANT OF MARKET WAGE DIFFERENTIALS: AN APPLICATION TO MARRIED VERSUS SINGLE MALES AND FEMALES

By applying the human capital model, a link has been established between life cycle *LFP* and *PSI*. As observed, *LFP* differs across demographic groups such that, on the average, females (especially married females) tend to have a smaller life time labor force commitment than single or married males. Regardless of the reasons why these differences in life cycle *LFP* exist, the expectation of such behavioral differences bring about systematic responses in the post-school investment process. Those with smaller expectations of life cycle *LFP* have been shown to invest less even while at work, and hence to have accumulated less human capital stock.[20] It is our purpose now to measure the importance of these differences in accumulated investment as a determinant of observed market wage differentials.

To perform such a test, wage differentials between the following four basic population strata are considered: (1) married males and married females, (2) single males and single females, (3) married and single males, and (4) married and single females. Earnings within these groups are viewed as functionally related to a set of independent variables. Because of the strong correlation between human capital, and education, potential labor market experience, occupation, and industry these latter variables are most widely chosen as determinants of earnings. Thus earnings may be specified[21] as:

$$Y = g(S, E, \underline{I}, \underline{O}, \underline{V}) + \varepsilon \tag{8}$$

where

$S \equiv$ years of schooling
$E \equiv$ potential experience [age minus education minus six]
$\underline{I} \equiv$ industry (set of dummy variables)
$\underline{O} \equiv$ occupation (set of dummy variables)
$\underline{V} \equiv$ set of other standardizing variables such as region, nativity, weeks and hours worked per year).

The rate of return to schooling can be measured by $\partial LnY/\partial S$, and when E is measured as a quadratic, the linear term is generally positive and the quadratic term negative, reflecting the concavity of the earnings function.

By adding a dummy variable representing group identification [(SEX) being one for females in the male-female stratum or a (MS) being one for those married-single stratum], adjusted male-female and married-single wage diffenentials can be ascertained, so that $\partial Y/\partial SEX$ and $\partial Y/\partial MS$ in Equation (9) below

$$Y = g\left(S, E, \underline{I}, \underline{O}, \underline{V}, \left\{\frac{SEX}{MS}\right\}\right) + \varepsilon \tag{9}$$

would reflect adjusted within group differences in wages. If $S, E, \underline{I}, \underline{O}$ and $\underline{V}$ were omitted from the equation in a specification such as (10)

$$Y = \alpha_0 + \beta \left\{\frac{SEX}{MS}\right\} + \varepsilon\,, \tag{10}$$

$\partial Y/\partial SEX$ and $\partial Y/\partial MS$ would represent raw wage differentials. Such measures

[20] No doubt more explicit forms of market discrimination would probably strengthen these differences. However, in our model direct market discrimination in terms of differing wages across groups need not imply differing investment paths. Because we assumed $b_3 = 0$ in Equation (1-b), differing wages (w_0) across groups would shift MC and λ in the same proportion, causing no differences in time allocated to investment. On the other hand, if in reality $b_3 \neq 0$, differing wages w_0 would imply differing investments.

[21] The function g is usually taken as exponential. However, because the estimates of expected capital stock to be used in Equation (13) are dollar estimates and not time equivalent measures as are S and E, a linear functional form is used.

TABLE 1

EARNINGS EQUATIONS FOR MARRIED AND UNMARRIED MALES AND FEMALES
(t-VALUES IN PARENTHESES) $N = 34,637$

	[1]		[2]		[3]		[4]		[5]	
	coef	t-value	coef	t-value	coef	t-value	coef	t-value	coef	t-value
Constant	144.70	8.34	5893.92	242.76	−3941.06	−39.98	2284.50	18.79	−1107.34	−8.59
Education					456.63	71.71				
Experience					198.15	39.37				
Experience²					−2.89	−27.80				
Hrs. worked/yr.					1.01	38.32	1.18	43.99	1.05	40.83
Region							696.52	16.93	593.52	15.14
Size							231.71	4.75	278.72	6.00
Nativity							24.02	0.32	−40.03	−0.56
Professional							1029.87	10.99	243.36	2.70
Farm							−2961.67	−11.72	−2441.36	−10.14
Managerial							1787.24	21.64	1497.34	19.00
Clerical							−918.97	−11.22	−713.26	−9.14
Craft							−976.64	−11.86	−458.60	−5.81
Operative							−1700.71	−21.63	−941.27	−12.39
Household							−1429.67	−5.84	−779.47	−3.34
Service							−1467.64	−13.90	−860.27	−8.52
Farm laborer							−2919.58	−10.33	−2126.49	−7.94
Laborer							−2121.57	−18.66	−1228.08	−11.24
Occup. N. R.							−901.40	−5.59	−510.09	−3.32
Agriculture							636.87	2.72	582.85	2.61
Mining							1750.01	10.92	1575.14	10.32
Construction							1495.07	16.75	1409.68	16.58
Manufac. durable							1650.58	25.16	1420.84	22.71
Manufac. non-durable							1572.81	23.18	1286.21	19.86
Public utility							1602.49	20.33	1381.40	18.38
Wholesale							1261.44	13.26	964.49	10.63
Finance							1715.65	19.11	1236.12	14.39
Business service							765.16	6.82	570.03	5.33
Personal service							503.99	4.19	315.17	2.75
Entertainment/recreation							737.27	3.63	716.35	3.70

TABLE 1 (Continued)

	[1]		[2]		[3]		[4]		[5]	
	coef	*t*-value	coef	*t*-value	coef	*t*-value	coef	*t*-value	coef	*t*-value
Professional services							1344.58	14.86	692.18	7.97
Industry N. R.							1461.39	8.59	1220.48	7.35
Sex			−3040.19	−65.95	−2491.31	−57.76	−2466.33	−43.88	−232.61	−3.56
Martial status							−1796.48	−30.87	−315.97	−3.21
Marital status × sex							1710.80	17.72	−971.03	−9.49
Exp. capital	0.1036	120.30							0.07	59.75
R^2	0.30		0.11		0.31		0.34		0.40	

Population: white married-once-spouse-present and single-never-been-married males and females at work and not employed by the government

Dependent variable is earnings

Source: 1960 U.S. Census of Population and Housing (1/1000 sample)

Variable Definitions

constant

educations ≡ years of schooling

experience ≡ age minus education minus six

experience^2 ≡ experience squared

hrs. worked/yr. ≡ hours worked per year measured as the product of hours worked in survey week and the number of weeks worked during the survey year (1959)

region ≡ dummy variable [1 = non-south]

size ≡ dummy variable [1 = size greater than 250,000]

nativity ≡ dummy variable [1 = native born]

sex ≡ dummy variable [1 = female]

marital status ≡ dummy variable [1 = married-once spouse present]

marital status × sex ≡ interaction of marital status and sex

exp. cap. ≡ expected capital stock accumulation as discussed in body of paper

Note that for the occupational and industrial dummy variables the missing category for occupations is sales; workers; for industry the missing category is retail sales.

of wage differentials are given for each strata. As illustrated in Table 1 for the sample of both married and never married males and females absolute male-female wage differences are \$3040.19 and decrease to \$2491.31 when adjustments are made for schooling, experience (Age minus Education minus Six), and hours worked per year. This decrease in the male-female wage differential, implies that by adjusting for human capital variables only 20% of the wage gap is explained. Similarly adjusting by occupation, industry, region, size of place and nativity yield equally poor explanatory power.

At least two reasons exist for such a poor performance of these human capital variables. First, experience measured as age minus education minus six grossly overstates female experience, and second as illustrated in Section 1 the quantity of human capital investment per working year differs by sex according to expectations of life cycle labor force commitment. For this reason, namely to over come these biases, independent measures of human capital were developed in the last section. These measures will now be employed in similar regression equations to ascertain their explanatory power in the determination of male-female wage differentials.

Since as is specified in objective Equation (1–a), earnings at any given age are related to total human capital stock, the estimates of net investment per period (including the value of education) are summed to obtain the appropriate stock variable. Thus, expected capital stock at age t can be specified as:

$$K(t; S, M, E) = \sum_{i=1}^{t} I(t; S, M, E) \tag{11}$$

(12) where

$$\begin{aligned} I(t; S, M, E) &= g[\lambda(t; S, M, E), MC] \\ &= f[N(1; S, M, E), N(2; S, M, E) \cdots N(T; S, M, E)] \\ &= f[\underline{N}(S, M, E)] \end{aligned}$$

as defined in Section 2. Earnings at each experience level are then linearly related to $K(t; S, M, E)$—the factor of proportionality being the average rate of return to human capital investment. Since expected capital stock is functionally related to the vector of group LFP rates $[\underline{N}(S, M, E)]$, expectations may differ across individuals within the same sex-age-marital status-education group. To account for these individual deviations from the norm the vector $\underline{V}$ of individual, standardization variables is added. Thus in Equation (13),

$$Y = a + bK + \underline{c}\underline{V} + d \begin{Bmatrix} SEX \\ MS \end{Bmatrix} + \varepsilon \tag{13}$$

the b coefficient can be interpreted as the rate of return of net capital, and the $\underline{c}$ coefficient as a measure of individual deviations from expectations. Again, as in Equations (9) and (10) the coefficient d would represent the male-female or married-single wage differential adjusted by K and $\underline{V}$. Note that in Equation (13) adjustments are not made for schooling and experience. These variables are not included because they already are implicitly used in the computation of K [Equations (11) and (12)].

TABLE 2

EARNINGS EQUATIONS FOR MARRIED MALES AND FEMALES

	[1]		[2]		[3]		[4]		[5]*		[6]*	
	coef	*t*-value	coef	*t*-value	coef	*t*-value	coef	*t*-value	coef	*t*-value	coef	*t*-value
Constant	406	8.5	662.9	9.4	−578.8	−4.5	−3620.5	−25.95	−1988.15	−12.42	1577.67	10.28
Education					65.28	7.0	476.47	60.84				
Experience					29.78	4.2	175.19	23.88				
Experience²					−.26	−1.93	2.80	−21.42				
Hrs. worked/yr.							0.89	27.66	1.027	32.57	1.15	36.64
Region									637.70	14.17	751.30	15.90
Size									214.16	3.78	173.85	2.92
Nativity									22.24	0.27	76.92	0.89
Sex			−324.7	−5.07			−3032.0	−54.87	−80.30	−1.07	−2533.35	−40.36
Yrs. married							23.57	5.76	25.73	11.90	28.89	12.71
NCH 6									87.58	3.47	−3.39	−.13
NCH < 6–11									70.34	2.89	242.50	9.56
NCH 12–17									31.59	1.14	206.49	7.15
NCH > 18									−26.47	−.42	−21.58	−.33
Exp. capital	0.106	108.5	0.102	80.7	0.1004	78.92			0.076	54.30		
R^2	0.30		0.30		0.30		0.29		0.38		0.32	

Dependent Variable: Earnings—2nd value in column is *t*-statistic. Population: white married-once-spouse-present males and females not employed by the government. No. Obs. = 28,065; See Table 1 for variables definitions.

Additional variables are as follows:

Yrs. married ≡ number of years since marriage
NCH < 6 ≡ number of children less than six years
NCH 6–11 ≡ number of children between 6 and 11 years of age
NCH 12–17 ≡ number of children between 12 and 17 years of age
NCH > 18 ≡ the existence of children over 18 in the household

* Adjustment made for occupation and industry.

TABLE 3

EARNINGS EQUATIONS FOR SINGLE MALES AND FEMALES USING MODIFIED MEASURE OF EXPECTED HUMAN CAPITAL STOCK

	[1]		[2]		[3]		[4]*		[5]*	
	coef	t-value	coef	t-value	coef	t-value	coef	t-value	coef	t-value
Constant	986.27	13.22	1127.02	14.73	−2193.9	−17.99	−919.13	−8.00	208.35	1.15
Education					253.73	25.75				
Experience					139.23	19.00				
Experience^2					−2.23	−13.28				
Hrs. worked/yr.					0.96	25.87	1.16	33.99	1.29	36.46
Region							340.99	5.12	375.85	5.48
Size							549.33	9.43	598.46	9.14
Sex			−473.80	−7.67	−671.17	−11.90	−486.41	−7.70	−507.71	−7.80
Exp. capital	0.0645	30.41	0.0659	30.77			0.0444	20.22		
R^2	0.12		0.13		0.29		0.36		0.32	

See Tables 3 and 4 for variable definitions
Population: Single (never-been married, white, nongovernmental) males and females
Dependent Variable: Earnings (wage, salary, and self-employment income)
Exp. Capital is defined to account for the probability of becoming married
Second value in each column is the t-statistic; No. observations: 6572
* Adjusted by occupation, industry, and nativity

TABLE 4

EARNINGS EQUATIONS STRATIFIED BY SEX

	Males					
Contsant	3467.39	18.56	386.55	2.09	156.47	0.77
Mar Stat	3001.82	14.71			534.65	2.64
Exp Cap			0.1102	32.51	0.1059	28.20
R^2	0.0640		0.2503		0.2520	
No. Obs.	3167		3167		3167	
	Females					
Constant	1796.61	23.38	1956.56	16.18	3142.69	50.31
Mar Stat	−624.73	−8.03			−148.26	−1.71
Exp Cap			0.0388	13.92	0.0362	11.35
R^2	0.0627		0.0762		0.0774	
No. Obs.	2350		2350		2350	

Key

Dependent Variable: Earnings (wage, salary, and self-employment income)
Mar Stat: dummy variable (1 ≡ married, 0 ≡ single)
Exp Cap ≡ expected capital stock
Second value in each column is t-statistic.

Examining Table 1 reveals that when measuring human capital as we have by accounting for expected life cycle labor force participation paths, most of the wage differential by sex and marital status is explained. The male-female earnings gap is reduced from over \$3000 to about \$230, and although the single male-female wage is increased,[22] the marital status earnings gap is reduced from \$1796 to \$315.

Taken at face value, these results have important implications with respect to the hypotheses generated in Section 1. The findings are consistent with the fact that the bulk of wage differentials can be explained by differences in human capital stock. However, to present further evidence regarding the importance of life cycle labor force participation patterns, we apply this technique to each of the four groups separately. These results, a summary of which is presented in Tables 2 to 4, again indicate that the wage gap for each group (except perhaps the wage gap between single males and single females) can be explained by expected differences in human capital accumulation. Rather than belabor the point let us just note that, in the case of married males and females, over 90% of the gap is explained. For the cases in which the data are stratified by marital status, differences in the single-married human capital investment paths explain between 75 and 83 percent of the wage gap. For single males and single females (Table 3) differences in human capital accumulation paths had little explanatory power.

[22] In the table the single male-female wage gap may be misleading because the single *LFP* rates were not adjusted by the probability of marriage. This problem is alleviated in the remainder of the tables.

Perhaps this existing $486 differential may better approximate a measure of market discrimination against women.

SUMMARY AND CONCLUSIONS

In this paper it was hypothesized that there exists a relation between one's life cycle labor force participation, post-school investment, and wage rate. This relationship derived theoretically by maximizing expected earnings over the life cycle was implemented empirically by determining the extent to which differing male-female (married-single) life cycle labor force participation explains male-female (married-single) wage differentials. Since these measures were obtained by assuming the same costs of investment for all groups, the differences in human capital investments can be attributed to differences in life cycle labor force participation. When these derived rates of investment were used in regressions on wages, much of the original intergroup wage differentials were explained. This result is consistent with the hypothesis that differences in wages can largely be attributable to differences in expected labor force participation over the entire life cycle.

In existing studies of intergroup wage differentials these differing expectations have been largely ignored. For example, to explain the male-female wage gap it is not sufficient to account only for quantity differences in labor force experience. Instead, quality defined to be the difference in the rate of *PSI* even while at work is important. Therefore empirical studies should account for the interaction of differing experience patterns and their associated rates of *PSI*. The methods devised in this paper account for such interactions.

Although the estimation procedures of capital stock are by no means beyond reproach because of the problems discussed throughout this paper, nevertheless the hypotheses generated seem to yield suggestive results such that refinements should be carried out to further substantiate the role of expected life cycle labor force participation behavior in the determination of both male-female and married-single wage differentials.

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APPENDIX

COMPUTED GROSS AND NET INVESTMENT AT FIVE YEAR INTERVALS BY EDUCATION, SEX, AND MARITAL STATUS (IN DOLLARS)

Education	Age	Expected Gross Investment				Expected Net Investment			
		MALE		FEMALE		MALE		FEMALE	
		Single	Married	Single	Married	Single	Married	Single	Married
8 or less	15	630	1533	180	243	217	1120	−232	−169
	20	1010	1691	306	306	548	1141	−85	−88
	25	824	1756	435	306	309	1073	49	−78
	30	824	1744	500	306	279	940	111	−69
	35	630	1651	435	306	69	743	35	−63
	40	630	1479	500	306	60	494	95	−55
	45	565	1239	500	243	−11	209	84	−110
	50	500	949	370	119	−74	−91	−48	−217
	55	370	630	243	58	−190	−385	−163	−252
	60	180	306	119	0	−350	−650	−260	−280
	65	0	0	0	0	−482	−868	−344	−248
9–12	20	2035	2976	966	577	948	1860	−76	−454
	25	2035	3272	1505	577	781	1813	422	−376
	30	1905	3391	2284	577	540	1609	1069	−311
	35	1505	3301	2161	704	70	1247	778	−149
	40	1369	3001	2161	704	−71	751	619	−123
	45	1234	2518	1773	577	−189	171	157	−220
	50	1099	1905	1369	454	−277	−428	−264	−296
	55	704	1234	834	218	−600	−973	−715	−460
	60	334	577	334	0	−849	−1419	−1060	−591
	65	0	0	0	0	−1010	−1711	−1188	−490
13–15	25	2654	4153	2056	679	1249	2556	809	−481
	30	2654	4528	2056	865	1031	2451	529	−210
	35	2457	4595	3706	1057	681	2077	1921	17
	40	2258	4315	2654	1057	384	1447	543	14
	45	1854	3706	3033	1057	−57	624	760	11
	50	1451	2846	2056	679	−421	−285	−231	−333
	55	1252	1854	865	499	−538	−1155	−1295	−441
	60	679	865	679	158	−988	−1867	−1260	−673
	65	0	0	0	0	−1443	−2339	−1649	−698
16	25	5190	6418	4825	1159	2646	3792	2542	−958
	30	5190	7531	5190	1159	1950	3773	2104	−706
	35	4452	8047	7045	1490	740	3223	3210	−244
	40	3311	7800	5881	1835	−553	2138	1537	144
	45	4074	5788	7276	1835	207	661	2360	106
	50	3692	5190	5881	1490	−229	−941	623	−246
	55	2192	3311	3311	843	−1460	−2365	−1817	−773
	60	843	1490	1490	262	−2305	−3355	−2992	−1100
	65	0	0	0	0	−2476	−3787	−3569	−1058
Greater than 16	25	4883	5634	5263	2478	2999	3750	3378	594
	30	5263	7111	7139	2879	2716	4241	4198	844
	35	5628	7896	6883	3284	2483	4088	3076	1025
	40	5263	7933	7896	3690	1653	3145	3313	1130
	45	4094	7139	6608	3284	208	1716	1869	512
	50	4094	5628	5263	2085	180	−43	−106	−724
	55	2085	3690	2879	970	−1740	−1796	−2198	−1558
	60	1700	1700	970	304	−1774	−3204	−3425	−1803
	65	0	0	0	0	−2904	−4034	−3578	−1656

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