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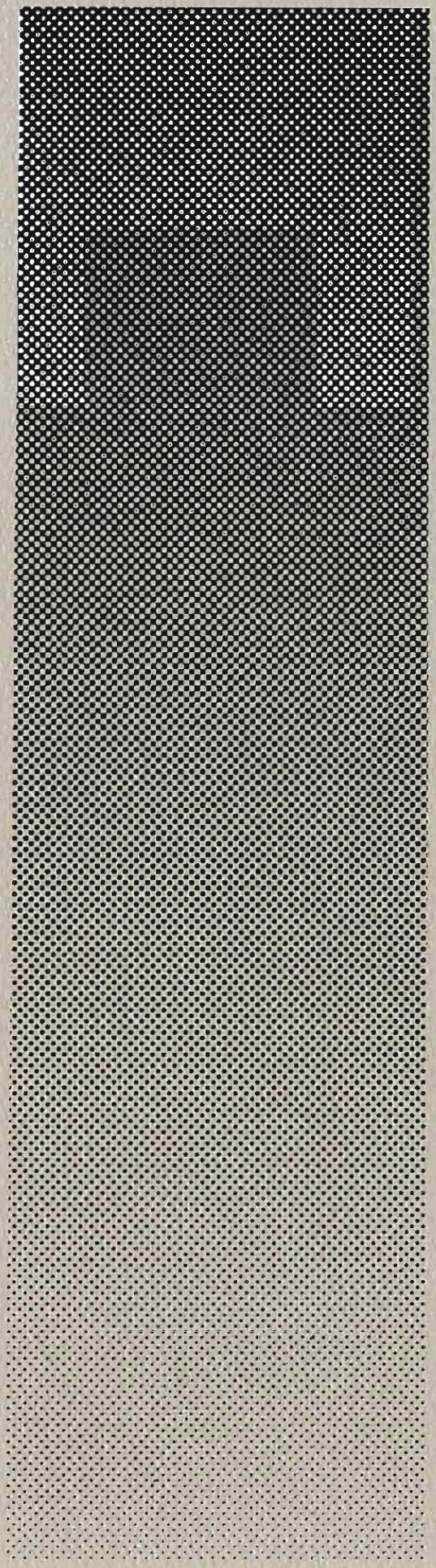

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A Comparison of Human Capital and Structural Models of the Distribution of Earnings: Evidence From Connecticut

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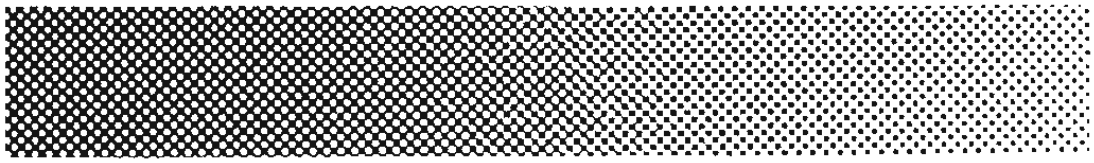


1. INTRODUCTION

Census Bureau statistics reveal that the (post-transfer) poverty rate dropped sharply in the late '60s and early '70s, declining from 19.0 percent in 1964 to a record low of 11.1 percent in 1973. Subsequently, poverty rose slightly to 12.3 percent in 1975 and then to 13.0 percent in 1980, but by 1983 it had climbed to 15.2 percent, the highest rate since 1965 (U.S. Dept. of Commerce, 1969 and 1983a).

Various income transfer programs have been instituted in recent decades in an attempt to ameliorate the plight of the poor. While these programs temporarily diminish the hardships of the poor, they do not lead to the enhancement of earning capacities which could result in a permanent solution to the poverty problem. According to Plotnick and Skidmore (1975), despite a substantial drop in the poverty rate between 1965 and 1975, when transfer payments for this period were subtracted from earnings, the pre-transfer poverty rate remained consistently within a few percentage points of 25 percent. The resiliency of poverty in the face of government programs has brought about renewed interest in determining the forces that affect the distribution of earnings in this country.

Currently, the two best known bodies of thought attempting to explain the distribution of earnings are marginal productivity theory and a collection of works loosely categorized as structuralist theory (Osberg, 1984). According to marginal productivity theory each factor of production is paid an amount equal to the value of its marginal product. In the case of labor, payments are in the form of earnings. Higher earnings are obtained through investment in productive capabilities which most often occur through schooling, job training, and job experience. The marginal productivity model of the distribution of earnings assumes that individuals attempt to maximize earnings through investments in productive abilities based on their perceived returns on these investments. Within marginal productivity theory the specific body of literature relevant to this study is the human capital model of the distribution of earnings. The development of this model is attributed primarily to Becker and Chiswick (1966), Mincer (1970 and 1974), and Chiswick (1972, 1973 and 1974).

Structuralist theory maintains that while earnings are partially a function of the marginal productivity factors discussed above, structural variables, such as gender, race and family background, also play an important role in the determination of earnings. The latter variables are considered important in the determination of earnings because non-market forces, such as discrimination and job segmentation, are believed to be prevalent in the labor market (Thurow 1969). These non-market forces lead structuralists to conclude that the distribution of earnings does not occur in a perfectly competitive market and that investment decisions take place within the constraints imposed by market imperfections.

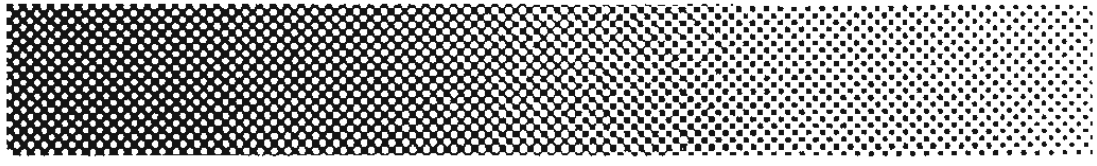
The interpretation of structural theory adopted in this study corresponds to what can be called the "segmentation approach," which views the labor market as stratified into numerous segments (Thurow 1975). Earnings arise not only from productive abilities, but according to the segment of society to which an individual is relegated by personal characteristics and abilities. A structural theorist might see schooling not as an investment, but rather as a major factor that sorts individuals into various segments of the labor market. Another sorting mechanism is work

experience, which is hypothesized to be positively correlated with earnings, because once an individual has been sorted into a segment of the labor force, his/her earnings increase due to seniority, ability, and any investments in skill the individual might make.

In the present study, human capital and structuralist models are tested using data for Connecticut household heads for 1969 and 1979. The poverty issue is of particular interest in Connecticut which, despite being one of the richest states in the U.S., exhibits notorious pockets of poverty. Therefore, the general purpose of this study is to better understand the factors that explain the variation in earnings among Connecticut household heads. The specific objective is to develop and test marginal productivity and structural models of the distribution of earnings. It is hoped that a better understanding of the factors that explain the variability of earnings can be helpful in designing programs targeted to increase the earnings capacity of the poor.

Human capital models are estimated separately for whites, blacks, and in 1979 for individuals of Spanish origin as well. The human capital models are then expanded to include three structural variables — race, sex and ethnic origin. Our study varies from previous works in two ways. First, the data used include all economically active household heads, not just the economically active white male population. Second, earnings are defined differently than in previous studies. Instead of viewing only wage income as earnings, we include wages plus non-farm and farm self-employment income as a measure of earnings since productive abilities affect all of these forms of earnings.

It should be noted that the U.S. economy has experienced major structural changes in the last few decades, such as the persistent growth of the service economy relative to the manufacturing sector. Although these changes have had an important impact on earnings, particularly in Connecticut where many skilled manufacturing jobs have been lost, discussion of these factors is beyond the scope of our study.



2. DATA AND METHODOLOGY

Ordinary least squares regression techniques are used to estimate several distribution of earnings equations separately for 1969 and 1979. The data employed are from the Public Use Sample of Connecticut household heads between 18 and 65 years of age with positive earnings during the previous calendar year. The 1969 data is a one in 15 random sampling of the long form questionnaire given to 15 percent of all households or a one percent sample. The 1979 data is a one in four random sampling of the long form questionnaire given to 20 percent of all households or a five percent sample.[1]

The dependent variable in all models is earned income, obtained by summing wages and salaries plus non-farm and farm self-employment income. Earned income is the major, if not the only, source of non-transfer income to the poor and thus the relevant variable in an analysis of economic inequality focusing on this group. The independent variables used in vary-

[1] *The Census long forms are detailed questionnaires on all individuals in a household and provide information on housing, social, geographic and economic characteristics.*

ing combinations in the different models are schooling, experience, log of weeks worked, race, sex, and Spanish origin. Schooling is measured by last grade of school attended. Experience is assumed equal to age minus years of school attended minus the three year period before the individual attends nursery school. This definition is a crude measure of the actual experience gained in the post school years because it assumes that all individuals were equally employed during the post-school period and received equal experience from their employment. Weeks worked measures the number of weeks a household head reported to have worked in the previous year. Finally, dummy variables are used to test the effect of the racial groups, white, black, and other races on earnings. A dummy variable on whether the individual was of Spanish origin is also included in the 1979 models. It should be noted that the latter variable is an ethnic designation separate from race because individuals of Spanish origin are also classified on the racial dimension as white, black or other.

Human Capital Models of the Distribution of Earnings

The human capital models presented in this section provide estimates of the rates of return on investments in schooling and in post-school abilities, as well as the initial amount invested in post-school productive abilities. The exposition of the human capital model closely follows Mincer's and Chiswick's formulations.

First consider that the general expressions for earnings in time periods t and $t\text{-}1$ may be expressed as

$$(1) \quad E_t = E_{t-1} + rC_{t-1} \qquad \text{and} \quad E_{t-1} = E_{t-2} + rC_{t-2}$$

where:

E_t = total earnings in time period t;[2]

r = rate of return on investments in productive abilities; and

C_t = amount invested in productive abilities in time period t.

If the amount invested is assumed to be a constant proportion of earnings, i.e.,

$$(2) \quad C_t = KE_t$$

where:

K = ratio of the amount of time invested in productive abilities to total potential earnings time;

then earnings in time periods t and $t\text{-}1$ may be written as

$$(3) \quad E_t = E_{t-1}(1 + rK) \qquad \text{and} \quad E_{t-1} = E_{t-2}(1 + rk).$$

Allowing the rates of return on investment in productive abilities and time invested in productive abilities as a portion of potential earnings to vary for each time period, the equations in (3) become

$$(4) \quad E_t = E_{t-1}(1 + r_{t-1}K_{t-1}) \quad \text{and} \quad E_{t-1} = E_{t-2}(1 + r_{t-2}K_{t-2}).$$

Through recursion, earnings in time period t may be expressed as a function of initial earnings and of returns from investments in previous time periods, thus

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[2] *Abbreviated variables are defined once, when first introduced. In addition, all abbreviated variables are defined in Appendix A.*

$$(5)\quad E_t = E_o \prod_{j=1}^{t-1} (1 + r\,K)$$

where:

E_o = initial earnings before investment in productive abilities.

Assuming that K is less than or equal to one and that r is relatively small, and using the relation $ln(1+a) = a$ when a is small,[3] an approximation of the logarithmic form of the model may be written as

$$(6)\quad lnE_t = lnE_o + \sum_{j=o}^{t-1} r_j K_j.$$

If all investments are made in the form of schooling and post-school productive abilities, and if different rates of return on schooling and post-school investments are included, then the earnings function may now be expressed as

$$(7)\quad lnE_t = lnE_o + \sum_{i=o}^{s} r_{si}K_{si} + \sum_{j=s}^{t-1} r_{pj}K_{pj}$$

where:

r_{si} = rate of return on investment in schooling in time period i;

r_{pj} = rate of return on post-school investment in time period j;

K_{si} = ratio of the amount of time invested in schooling to total potential earnings time in time period i; and

K_{pj} = ratio of the amount of time invested in post-school investment to total potential earnings time in time period j.

Equation (7) corresponds to the standard human capital model.

Assuming further that individuals in school spend all their potential earning time in school, then K is equal to one during the schooling years. If it is also assumed that the rate of return on investment in schooling is the same for all schooling periods, and that the rate of return on post-school investments is the same for all post-school periods, then the model can be expressed as

$$(8)\quad lnE_t = lnE_o + r_s S + r_p \sum_{j=s}^{t-1} k_{pj}$$

where:

S = number of years of school attended.

In the human capital models, investment in productive abilities is measured as net investment, which is equal to gross investment minus depreciation. As individuals' post-school experience levels increase, their net investment as a portion of total earnings decreases due to two factors. First, as individuals age, the period in which returns on investment in post-school productive abilities could be enjoyed decreases making such investments less desirable and thereby causing gross investments in post-school productive abilities as a portion of earnings to decrease. Second, the amount of depreciation on past investments in productive abilities increases as the stock of productive abilities increases. Assuming a linear decrease in lifetime investment as a portion of earnings,[4] the equation for K may be written as

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[3] *See Chiswick (1974) pp 36-37.*

[4] *An exponentially declining Gompertz curve for investment in productive abilities was tested but the models failed to yield significant estimates. Hence, a linear relationship is assumed.*

(9) $K_t = K_O-(K_O/T)EX$

where:

T = period of positive net investment, or the number of years before depreciation in productive abilities becomes greater than additional productive abilities gained during the year; and

EX = years of post-school experience in time period t.

If years of experience are considered to be in continuous time, then the log of earnings is a function of a parabolic experience term equal to

$$(10) \quad \int_{o}^{EX} r_p K_t \, EX = (r_p K_O)EX - (r_p k_O/2T)EX.$$

By substituting (10) for the experience term in equation (8), the human capital model becomes

$$(11) \quad lnE_t = lnE_O + r_S S + (r_p K_O)EX - (r_p K_O/2T)EX.$$

So far, the measure of earnings in a given time period has included the amount of earnings foregone in favor of investments in productive abilities for that period. However, earnings are always measured as the actual dollar amount gained in a certain time period excluding the opportunity cost of investments in productive abilities. Therefore the model must be expressed in terms of net earnings which is equal to

$$(12) \quad Y_t = E_t(1-K_t) \text{ or } lnY_t = lnE_t + ln(1-K_t)$$

where:

Y_t = net earnings in time period t.

The expression $ln(1-K_t)$ may be evaluated as a function of experience around point T using a Taylor expansion. If the expansion is carried to the third term the expression becomes

$$(13) \quad ln(1-K_t) = -K_O(1+(K_O/2)) + (K_O/T)(1+K_O)EX + (-(K_O)^2/2(T)^2)EX^2.$$

Substituting equation (11) and (13) into equation (12), the model can be written as

$$(14) \quad lnY_t = (lnE_O - K_O(1+(K_O/2)) + r_S S + (r_p K_O + (K_O/T)(1+K_O))EX - (r_p K_O T + K_O^2)/(2(T)^2)EX^2.$$

The human capital model shown in equation (14) can be empirically estimated as

$$(15) \quad lnY = A + A1*S + A2*EX + A3*EX^2$$

where:

A = $lnE_O - K_O(1+(K_O/2))$;

$A1$ = estimated rate of return on schooling;

$A2$ = $r_p K_O + (K_O/T)(1 + K_O)$; and

$A3$ = $-((r_p K_O/2T) + K_O^2/2(T)^2)$.

An alternative version of equation (15) includes a term $A4*lnWW$ which accounts for variations in weeks worked (WW).

The following signs are hypothesized for the parameters of equation (15):

(A) The schooling parameter has a significantly positive value ($A1 > O$);

(B) The return on post-school investments in productive abilities is positive ($r_p > O$) and the time equivalent of the investment in post-school productive abilities is initially positive and decreases as experience increases ($K_O > O$); and

(C) The elasticity of earnings with respect to weeks worked does not vary greatly from unity ($A4 = 1$).

Structural Models of the Distribution of Earnings

In this study the structural model of the distribution of earnings is presented as an extension of the human capital model. The variables incorporated into the human capital model are viewed as relevant in explaining the distribution of earnings, but other variables, representing characteristics believed to affect earnings, are also included. The structural model, in general form, can be expressed as

ln(Earnings) = f(human capital factors, sex, race, and ethnic origin).

To empirically estimate the model, the equation may be written as

$$\begin{aligned} lnY = {} & lnE_O + B1*S + B2*S^2 + B3*S*EX + B4*EX - B5*EX^2 \\ & + B6*lnWW + B7*SEX + B8*RACE1 + B9*RACE2 \\ & + B10*ETHNI \end{aligned}$$

where:

WW = weeks worked in the previous calendar year;

SEX = dummy variable equal to one for females and zero for males;

$RACE1$ = dummy variable equal to one for people of the racial category "other" and zero otherwise;

$RACE2$ = dummy variable equal to one for people of the racial category "black" and zero otherwise;

$ETHNI$ = dummy variable equal to one for people of Spanish origin and zero otherwise;

$B1, B2$ = parameters for returns to a year of schooling;

$B4, B5$ = parameters for returns to a year of experience;

$B3$ = interaction parameter between schooling and experience;

$B6$ = estimated parameter of log of weeks worked;

$B7$ = estimated parameter for dummy variable SEX;

$B8$ = estimated parameter for dummy variable $RACE1$;

$B9$ = estimated parameter for dummy variable $RACE2$; and

$B10$ = estimated parameter for dummy variable $ETHNI$.

The following signs of the parameters of the structural model are hypothesized:

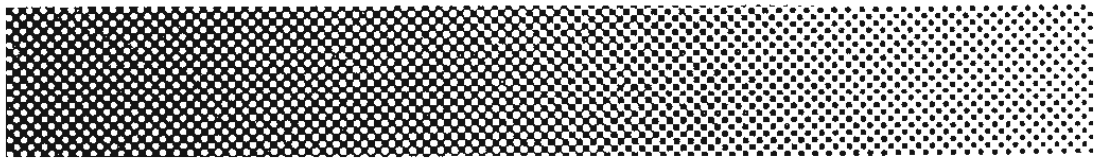
(A) The marginal rate of return on schooling and experience is positive;

(B) The elasticity of earnings with respect to weeks worked is above unity ($B6 > 1$);

(C) The sign of the parameter of the sex variable is negative ($B7 > O$);

(D) The sign of the race parameters *B8* and *B9* and of the ethnic parameter *B10* is negative; and

(E) The average rates of return for schooling and post-school investment varies according to the personal characteristics of the groups to which the human capital model is applied.



3. RESULTS

This section presents and examines the results obtained from the distribution of earnings models developed in Section 2. As indicated earlier, the independent variables used to explain the variation in the log of earnings are schooling, experience, log of weeks worked, sex, race, and Spanish origin. All models are estimated using the 1969 and 1979 Public Use Sample data.

Human Capital Models

This subsection discusses the results of human capital models of the distribution of earnings. The first model tested is the simple linear schooling equation:

$$(1) \quad lnY = AO + A1*S + e$$

where:

Y = earnings in 1969 or 1979;
AO = intercept term;
$A1$ = average rate of return on schooling;
S = years of school attended; and
e = normally distributed error term.

The estimates of the linear schooling model for 1969 and 1979 are given in panel A of Table 1. In the above model the antilog of the intercept (AO) is interpreted as the initial earnings level without investment, and the parameter of the schooling variable ($A1$) is interpreted as the average rate of return on schooling for the population. The results indicate that the initial earnings levels for 1969 and 1979, in nominal terms, were $3,533 and $4,964, respectively. The rates of return on schooling increased from 6.0 percent in 1969 to 6.9 percent in 1979. All estimates in this and the following models are statistically significant at the five percent level or above unless otherwise noted.

The results for the simple linear schooling equation for both time periods support the marginal productivity hypothesis that the schooling parameter is positive. However, the model shows an extremely low explanatory power for both years suggesting that schooling plays only a small part in the determination of earnings.

The second model tested includes, in addition to schooling, a linear and a quadratic term for experience. The specific model estimated, which corresponds to equation (15) in Section 2, is

$$(2) \quad lnY = AO + A1*S + A2*EX + A3*EX^2 + e$$

where:

(2a) $AO = lnE_O - K_O(1+(K_O/2))$;

(2b) $A2 = r_pK_O + (K_O/T)(1 + K_O)$;

(2c) $A3 = -((r_pK_O/2T) + (K_O)^2/2(T)^2)$;

EX = years of experience; and

e = normally distributed error term.

It should be noted that the intercept in equation (2) is no longer interpreted as the initial earnings level and has no special meaning. The inter-

TABLE 1. Estimates of Human Capital Models of the Distribution of Earnings for Connecticut Household Heads for 1969 and 1979.[1]

A. Linear Schooling Model

1969 $(N = 7133)$

$$lnY = 8.170 + .060S \quad (24.4)$$

$R^2 = .08$

1979 $(N = 39659)$

$$lnY = 8.510 + .069S \quad (53.2)$$

$R^2 = .07$

B. Quadratic Model with Experience

1969 $(N = 7133)$

$$lnY = 7.419 + .066S + .592EX - .0010EX^2 \quad (24.4) \quad (24.6) \quad (-22.5)$$

$R^2 = .15$

1979 $(N = 39659)$

$$lnY = 7.530 + .082S + .068EX - .0011EX^2 \quad (60.0) \quad (55.3) \quad (-46.9)$$

$R^2 = .15$

C. Quadratic Model with Weeks Worked

1969 $(N = 7133)$

$$lnY = 5.801 + .064S + .038EX - .0006EX^2 + 1.114lnWW \quad (27.6) \quad (17.9) \quad (-16.1) \quad (48.9)$$

$R^2 = .36$

1979 $(N = 39659)$

$$lnY = 3.289 + .075S + .050EX - .0008EX^2 + 1.183lnWW \quad (65.3) \quad (48.3) \quad (-39.3) \quad (129.6)$$

$R^2 = .40$

[1] Based on Public Use Sample data from the U.S. Census Bureau.

Y = earnings, S = years of school attended, EX = years of post-school experience, WW = weeks worked.

The figures in parentheses are t statistics.

pretation of the schooling parameter *(A1)* is the same as for the model in equation (1). The experience parameters (*A2* and *A3*) are used to calculate the rate of return on post-school investment in productive abilities (r_p) and the ratio of the initial amount of time invested in post-school productive abilities to total potential earnings time (K_0) by simultaneously solving equations (2b) and (2c). K_0 is henceforth referred to as the initial investment in post-school abilities.

Before rates of return on investments in post-school productive abilities can be generated, a value for the variable T (period of positive net investment in post-school productive abilities) has to be estimated. By plotting years of experience against average earnings and visually inspecting the resulting plot, it appears that after 20 years average earnings do not increase with years of experience. If it is assumed that this tapering off in earnings is due to the fact that depreciation in skills exceeds gross investments in post-school productive abilities, then T can be set at 20 years.[5]

The empirical results for equation (2), referred to as the "quadratic model with experience," are given in panel B of Table 1 and the corresponding rates of return are reported in panel B of Table 2. The inclusion of the experience variable improves the explanatory power of the model for both years. The rates of return on school and post-school investment are positive in 1969 and 1979 as are the initial rates of investment in post-school productive abilities. The results indicate that the rate of return on schooling and the initial investment in post-school productive abilities were higher, while the rate of return in post-school productive abilities was lower in 1979 than in 1969.

The results of the quadratic model with experience for 1969 and 1979 support the hypothesis that the rate of return on post-school experience is positive, and that the initial investment in post-school productive abilities is

TABLE 2. Returns Based on Human Capital Models of the Distribution of Earnings for Connecticut Household Heads for 1969 and 1979.

	Rate of Return on Schooling	Rate of Return on Post-School Abilities (r_p)	Initial Invest. in Post-School Abilities (K)	Elasticity of Weeks Worked
	%	%	%	
A. Linear Schooling Model				
1969	6.00			
1979	6.90			
B. Quadratic Model with Experience				
1969	6.60	8.88	37.54	
1979	8.20	7.46	45.92	
C. Quadratic Model with Weeks Worked				
1969	6.45	8.85	25.30	1.11
1979	7.50	7.08	36.04	1.18

[5]*For details see equation (9) in Section 2.*

positive but decreases in accordance with the model of lifetime investment specified in equation (9) of Section 2.

In panel C of Table 1 the varible log of weeks worked is added to equation (2) which allows the model to be interpreted as a weekly earnings model. The form of the equation estimated, which is called "quadratic model with weeks worked," is

$$(3) \quad lnY = AO + A1*S + A2*EX + A3*EX^2 + A4*lnWW + e$$

where:

$A4$ = parameter of the log of weeks worked;

WW = weeks worked; and

e = normally distributed error term.

The parameter for the log of weeks worked ($A4$) can be interpreted directly as the elasticity of earnings with respect to weeks worked since it is the partial derivative of lnY with respect to $lnWW$.

As would be expected, the inclusion of log of weeks worked greatly improves the explanatory power of the human capital model in both years. Panel C of Table 2 shows that the elasticity of earnings with respect to weeks worked is greater than one in both 1969 and 1979, implying that average weekly earnings increase with the number of weeks worked during the year. Comparing the results between 1969 and 1979, the model shows a higher rate of return on schooling, a larger initial investment in post-school productive abilities, and a lower rate of return on investments in post-school abilities in 1979. With the inclusion of weeks worked the initial rates of investment in post-school productive abilities were less in both years than for the model in equation (2) suggesting that the exclusion of the log of weeks worked variable creates an upward bias in the estimates of the initial rate of investment in post-school productive abilities.

Quadratic (Human Capital) Model with Weeks Worked by Sex

Up to this point, the three models tested have used a random sample of all Connecticut household heads. Now, the model in equation (3) is applied separately for male and female household heads in order to determine the effect of sex, a structural variable, on the distribution of earnings. The resulting estimates are given in Table 3, and comparisons between sexes for both 1969 and 1979 are shown in Table 4.

In 1969 the experience parameters for the female model do not differ significantly from zero suggesting that experience plays a small role in the explanation of the log of earnings for females. Despite the lack of statistical significance, rates of return on post-school experience and initial rates of investment in post-school productive abilities are estimated. In 1969, females show a slightly higher rate of return on schooling and a lower rate of return on experience than do males. Females also show a low rate of initial investment in post-school productive abilities suggesting that females are not making post-school investments or receiving returns on those investments at the same rate as males. For both sexes, the elasticity of earnings with respect to weeks worked is close to unity.

In 1979 females have a slightly lower rate of return on schooling than males and a higher rate of return on post-school investments. However, females, as was the case in 1969, make smaller initial investments in post-school productive abilities. According to marginal productivity theory the results of the model for 1979 suggest that if females invested in post-school abilities at the same rate as males, then they could expect to receive comparable rates of return on such investments. The elasticity of earnings with respect to weeks worked for both males and females is above unity, which

suggests that for additional weeks worked during the year male and female average weekly earnings increase.

As Table 4 indicates, between 1969 and 1979 males showed an increase in their rate of return on schooling and their initial investment in post-school productive abilities, and a decrease in their rate of return on post-school investments. Females showed a lower rate of return on schooling, and higher rates of return on post-school investment and initial investment in post-school productive abilities. Nevertheless, the initial investment in post-school productive abilities still remained much lower for females than males.

To the marginal productivity theorist, the results of the quadratic weeks worked models by sex would imply that females received lower earnings primarily because they invest less time in post-school abilities. In 1969 the low rate of return on post-school investments may have acted as a deterrent for post-school investment. However, in 1979 the rate of return on post-school productive abilities was higher for females than for males, yet females still showed lower initial investments. Two possible explanations may be put forth for the latter results. First, investments may be lower for females because initial investment decisions were made by women when the rate of return on investment in productive abilities was low. Second, the role of the career female is gaining increasing acceptance in our society, but

TABLE 3. Estimates of Human Capital Models of the Distribution of Earnings for Female and Male Connecticut Household Heads for 1969 and 1979.[1]

A. 1969

MALES $(N = 6338)$

$$\ln Y = 6.049 + \underset{(28.7)}{.065S} + \underset{(19.4)}{.041EX} - \underset{(-16.6)}{.0007EX^2} + \underset{(38.0)}{.9691nWW}$$

$R^2 = .33$

FEMALES $(N = 913)$

$$\ln Y = 5.484 + \underset{(9.6)}{.077S} + \underset{(1.4)}{.009EX} - \underset{(-0.9)}{.0001EX^2} + \underset{(22.3)}{1.0831nWW}$$

$R^2 = .40$

B. 1979

MALES $(N = 31402)$

$$\ln Y = 3.796 + \underset{(65.3)}{074S} + \underset{(48.7)}{.053EX} - \underset{(-39.4)}{.0008EX^2} + \underset{(96.0)}{1.0761nWW}$$

$R^2 = .37$

FEMALES $(N = 8250)$

$$\ln Y = 3.490 + \underset{(22.5)}{.067S} + \underset{(8.6)}{.018EX} - \underset{(-6.7)}{.0003EX^2} + \underset{(79.0)}{1.1331nWW}$$

$R^2 = .47$

[1] Based on Public Use Sample data from the U.S. Census Bureau.

Y = earnings, S = years of school attended, EX = years of post-school experience, WW = weeks worked.

The figures in parentheses are t statistics.

TABLE 4. Returns Based on Human Capital Models of the Distribution of Earnings for Male and Female Connecticut Household Heads for 1969 and 1979.

	Rate of Return on Schooling	Rate of Return of Post-School Abilities (r_p)	Initial Invest. in Post-School Abilities (K)	Elasticity of Weeks Worked
	%	%	%	
1969				
Males	6.52	7.47	29.52	.97
Females	7.65	3.55	9.90	1.08
1979				
Male	7.38	6.53	39.34	1.08
Females	6.72	8.05	14.04	1.13

it is still not the norm. Hence, on the average, females may be spending less time in the labor market than males, which is reflected in lower initial rates of investment in productive abilities.

Quadratic (Human Capital) Models with Weeks Worked for White, Black, and Spanish Origin Populations

In order to determine the effect of race and ethnic origin (two structural variables) on earnings, the model in equation (3) is applied separately to white and black household heads in 1969 and 1979, and also to household heads of Spanish origin in 1979. The results of the models are given in Table 5 and the rates of return are reported in Table 6.

In 1969 the model fits the distribution of earnings for whites better than for blacks. In the model for blacks the experience parameters are not highly significant, which suggests that experience was not an important variable in the determination of this group's earnings in that year. Despite the lack of statistical significance, the rate of return on post-school productive abilities and the initial post-school investment in abilities are calculated using the experience parameters. Comparison of the 1969 results reveals that whites enjoyed a higher rate of return on schooling, higher rates of return on post-school investments, and initially invested more of their potential earnings time in post-school productive abilities than blacks. The elasticity of earnings with respect to weeks worked is above unity for whites and well below unity for blacks, which suggests that the average weekly earnings of whites increased with additional weeks worked and the average weekly earnings of blacks decreased with additional weeks worked.

In 1979 the model shows the greatest explanatory power for persons of Spanish origin and the lowest explanatory power for blacks. Blacks and persons of Spanish origin had lower rates of return on schooling than whites, which might reflect attendance at lower quality schools or discrimination based on race or ethnic origin. In 1979 blacks showed a higher rate of return on post-school investments than whites, but continued to show a lower initial investment in post-school productive abilities.

TABLE 5. Estimates of Human Capital Models of the Distribution of Earnings for White, Black, and Spanish Origin Connecticut Household Heads for 1969 and 1979.[1]

A. 1969

WHITE $(N = 6340)$

$$\ln Y = 5.830 + .062S + .039EX - .007EX^2 + 1.132 \ln WW$$
$$(26.1) \quad (18.0) \quad (-16.4) \quad (48.4)$$

$R^2 = .37$

BLACK $(N = 387)$

$$\ln Y = 6.324 + .057S + .021EX - .0003EX^2 + .782 \ln WW$$
$$(3.8) \quad (2.0) \quad (-1.6) \quad (8.2)$$

$R^2 = .19$

B. 1979

WHITE $(N = 36783)$

$$\ln Y = 3.295 + .073S + .052EX - .0008EX^2 + 1.192 \ln WW$$
$$(61.6) \quad (48.6) \quad (-40.0) \quad (123.4)$$

$R^2 = .40$

BLACK $(N = 2502)$

$$\ln Y = 3.955 + .063S + .033EX - .0005EX^2 + 1.042 \ln WW$$
$$(10.9) \quad (7.4) \quad (-6.0) \quad (34.8)$$

$R^2 = .38$

SPANISH ORIGIN $(N = 1119)$

$$\ln Y = 3.809 + .068S + .036EX - .0004EX^2 + 1.060 \ln WW$$
$$(12.1) \quad (6.2) \quad (-3.7) \quad (23.1)$$

$R^2 = .47$

[1] Based on Public Use Sample data from the U.S. Census Bureau.

Y = earnings, S = years of school attended, EX = years of post-school experience, WW = weeks worked.

The figures in parentheses are t statistics.

Household heads of Spanish origin showed a very low rate of return, but initially made the largest investment in post-school productive abilities.

The results indicate that individuals of Spanish origin initially make large investments in post-school productive abilities but receive minimal returns on these investments. A possible explanation for these irregular results is that, due to immigration into Connecticut of many individuals of Spanish origin, schooling and experience may improperly measure productive abilities relevant to the Connecticut labor market. For example, an individual's verbal and literacy skills in Spanish and his/her job experience are of little use in the Connecticut labor market if the same individual knows little or no English.

In 1979 the elasticity of earnings with respect to weeks worked is larger for whites than for blacks and persons of Spanish origin. This finding sug-

TABLE 6. Returns Based on Human Capital Models of the Distribution of Earnings for White, Black and Spanish Origin Connecticut Household Heads in 1969 and 1979.

	Rate of Return on Schooling	Rate of Return on Post-School Abilities (r_p)	Initial Invest. in Post-School Abilities (K)	Elasticity of Weeks Worked
	%	%	%	
1969				
Whites	6.16	9.39	24.84	1.13
Blacks	5.69	6.25	17.66	.78
1979				
Whites	7.27	7.24	36.74	1.19
Blacks	6.30	7.32	24.28	1.04
Spanish	6.77	2.22	39.16	1.06

gests that average weekly earnings increased for whites as additional weeks are worked, while average weekly earnings for blacks and persons of Spanish origin remained virtually constant with additional weeks worked.

From 1969 to 1979 whites experienced a drop in the rate of return on post-school investments and an increase in the initial investment in post-school abilities. In the same period blacks showed higher rates of return on post-school investment and on initial investment in post-school productive abilities.

Structural Models

The results reported thus far have been based on equations derived from the human capital model. In this section the structural model discussed earlier is tested using a random sample of all Connecticut household heads. Although the structural and human capital models are quite similar, there is a major difference in the interpretation of the parameters. In the human capital model, rates of return were to productive abilities gained from investing in schooling (r_s) and in post-school experience (r_p). In the structural models returns are to years of schooling and experience. Since school and experience serve as sorting mechanisms in the determination of earnings, it is the number of years of schooling and experience that affect earnings and not the productive abilities gained during those years. Other sorting mechanisms included in the structural model are sex and race. The model also allows the rate of return on schooling and experience to vary with the years of schooling and experience, and includes an interaction term between schooling and experience. The form of the equation estimated is

$$(4)\quad InY = BO + B1*S + B2*S^2 + B3*S*EX + B4*EX + B5*EX^2 + B6*InWW + B7*SEX + B8*RACE1 + B9*RACE2 + B10*ETHNI + e$$

where:

SEX = dummy variable equal to one for females and zero for males;

RACE1 = dummy variable equal to one for people of the racial category "other" and zero otherwise;

RACE2 = dummy variable equal to one for people of the racial category "black" and zero otherwise;

ETHNI = dummy variable equal to one for people of Spanish origin and zero otherwise;

B0 = intercept term interpreted as the log of initial earnings;

B1,B2 = parameters for returns to an additional year of schooling;

B4,B5 = parameters for returns to an additional year of experience;

B3 = interaction parameter between schooling and experience;

B7 = estimated parameter for dummy variable *SEX*;

B8 = estimated parameter for dummy variable *RACE1*;

B9 = estimated parameter for dummy variable *RACE2*;

B10 = estimated parameter for dummy variable *ETHNI*; and

e = normally distributed error term.

TABLE 7. Estimates of Structural Models of the Distribution of Earnings for Connecticut Household Heads for 1969 and 1979.[1]

A. 1969 *(N = 7133)*

$$\begin{aligned} lnY = 6.465 &- \underset{(-1.6)}{.025S} + \underset{(9.0)}{.004S^2} - \underset{(-2.7)}{.001S*EX} + \underset{(10.7)}{.052EX} - \underset{(-15.4)}{.001EX^2} \\ &- \underset{(-27.3)}{.554SEX} - \underset{(-0.1)}{.014RACE1} - \underset{(-6.8)}{.202RACE2} + \underset{(45.4)}{.9931nWW} \end{aligned}$$

$R^2 = .44$

B. 1979 *(N = 39659)*

$$\begin{aligned} lnY = 3.988 &+ \underset{(1.4)}{.012S} + \underset{(10.9)}{.002S^2} - \underset{(-6.8)}{.001S*EX} + \underset{(25.9)}{.061EX} - \underset{(36.8)}{.001EX^2} \\ &- \underset{(-71.7)}{0.566SEX} + \underset{(4.2)}{.155RACE1} - \underset{(-11.7)}{.152RACE2} - \underset{(-4.3)}{.010ETHNI} + \\ &\underset{(126.7)}{1.0891nWW} \end{aligned}$$

$R^2 = .48$

[1] Based on Public Use Sample data from the U.S. Census Bureau.

Y = earnings, S = years of school attended, EX = years of experience, SEX = dummy variable for sex, $RACE1$ = dummy for other race, $RACE2$ = dummy for black, WW = weeks worked, $ETHNI$ = dummy for people of Spanish origin.

The figures in parentheses are t statistics.

The structural models show the greatest ability to explain the distribution of the log of earnings of all the models tested for both the 1969 and 1979 data. The dummy variables for race, ethnic origin and sex are in log linear form; hence, the antilog of the parameters of these variables reflect percent deviations in the earnings of females, blacks, and other races, or those of Spanish origin relative to the earnings of white males. As Table 7 shows, in 1969 the parameter of the dummy variable for other races is insignificant, while the same parameter is positive and significant in 1979. The parameters for the dummy variables for blacks and sex are negative and significant in both time periods. Finally, the parameter for persons of Spanish origin, estimated only for the 1979 model, is also significant and negative. In sum, except for other races, the results support the hypothesis that racial and sexual characteristics affect individual earnings.

Examining trends in the distribution of earnings by race and sex between 1969 and 1979, as shown in Table 8, reveals that females have not im-

TABLE 8. Elasticity of Weeks Worked, and the Effect of Race, Sex, and Ethnic Origin on Earnings Relative to the Earnings of White Males for Connecticut Household Heads for 1969 and 1979.

	Elasticity of Weeks Worked	Earnings of 'Other' Race as a % of White Males	Earnings of 'Blacks' as a % of White Males	Earnings of 'Spanish Origin' as a % of White Males
1969	.993	98.57	81.74	N.A.[a]
1979	1.089	116.81	85.86	90.57

	Earnings of Females as a % of White Males
1969	57.47
1979	56.81

[a] N.A. = Not Available.

proved their level of earnings relative to males with the same schooling and experience levels. However, blacks and especially other races have improved their level of earnings relative to whites with the same schooling and experience levels.

As shown by Mincer, the partial derivative of lnY with respect to S yields an equation for the marginal rates of return on schooling, and the partial derivative of lnY with respect to EX yields an equation for the marginal rates of return on experience. Table 9 gives the rates of return on schooling and experience calculated at the arithmetic mean for each population (see Appendix B). The results indicate that from 1969 to 1979 the average rates of return on schooling decreased for both sexes, and for whites, blacks and other races. Because the rate of return on schooling was positively related to years of schooling, those groups with lower education levels (females, blacks, persons of Spanish origin) showed lower average

rates of return on schooling. The average rates of return on experience increased for all groups between 1969 and 1979, and those groups with higher experience levels showed lower rates of return on experience.

TABLE 9. Rates of Return (R of R) Based on Structural Models of the Distribution of Earnings for Connecticut Household Heads for 1969 and 1979.

	R of R Schooling %	R of R Experience %
A. Entire Population		
1969	6.61	0.44
1979	4.59	3.20
B. By Sex		
1969		
Males	6.65	0.49
Females	6.03	0.04
1979		
Males	4.59	1.03
Females	4.55	1.21
C. By Race and Ethnic Origin		
1969		
White	6.68	0.42
Black	5.42	0.83
Other	7.93	1.58
1979		
White	4.61	1.04
Black	4.07	1.38
Other	5.89	1.89
Spanish Origin	3.43	2.36

4. CONCLUDING REMARKS

The objective of this study was to develop and test human capital and structural models of the distribution of earnings for Connecticut. The models were estimated using Public Use Sample Data for 1969 and 1979 for Connecticut household heads between 18 and 65 years of age with positive earnings during the previous calendar year. Regression techniques were used to analyze the relationship between the earnings of household heads and schooling, experience, weeks worked, sex, race and Spanish origin.

The study found that for the human capital models the rates of return on schooling and on experience were positive for all populations. However,

the rates of return as well as the elasticity of earnings with respect to weeks worked varied across populations. The results for the structural models tested suggest that returns to years of schooling are positive and increasing with additional years of schooling, while the returns to years of experience are positive but decreasing with additional years of experience. The results of the structural model also indicate that the earnings of females are less than those of males, and that the earnings of blacks and of individuals of Spanish origin are lower than those of whites, holding education, experience and weeks worked constant.

The results mentioned above suggest policies that could be undertaken in order to decrease inequality. Since the distribution of earnings models show that inequality is partially explained by schooling and work experience, it appears that individuals could increase their share of the distribution of earnings by raising their education level or through investments in post-school productive abilities.

The study found that groups with higher poverty rates (e.g., blacks and females) tended to invest less in post-school productive abilities. Therefore, programs designed to place the poor in jobs which would enhance their productive abilities would undoubtedly lessen the ranks of poverty. Such programs may be expensive but, compared to many years of welfare and the social costs associated with poverty, they may be an efficient alternative.

It is clear from the results reported in this study that sex and race have a significant impact on earnings, a conclusion which lends support to structuralist theory. There are two possible explanations for the difference in earnings by sex and racial characteristics. First, the differing social contexts and social roles in which some groups are raised might affect their abilities. Second, discrimination may be present in the labor market. If the differing social context in which groups are raised affects earnings, then inequality could be reduced by implementing programs that would enhance the productive abilities and stimulate post-school investment of low earning groups. If, on the other hand, sexual and/or racial discrimination is present in the labor market then increasing the skill levels of victims of discrimination would not be an effective means of combating inequality. Instead, the aggressive enforcement of existing laws or the adoption of new laws designed to combat discrimination would appear necessary.

Several limitations should be kept in mind when interpreting the results of this study. One such limitation is the absence of a measure of quality for the schooling and post-school experience variables. A second shortcoming is connected to the fact that all the models showed a large degree of unexplained variance possibly due to the omission of relevant variables. For the human capital models the most important variable omitted is ability, which may lead to a bias in the estimation of returns to schooling and experience. However, previous work by Griliches suggests that this bias is quite small. Important variables which are not included in the structural model tested are social status and family background. For the structural model the experience variable assumes that all time after completion of schooling is spent in the work force, which is often not the case.

Shortcomings might also stem from using experience in the human capital models as a measure of post-school productive abilities since it may not represent the true quality or quantity of productive capabilities gained after the completion of schooling. The inadequacy of experience as a measure of productive abilities may account for the low initial investment ratios found among females and blacks. These low ratios may actually indicate that females and blacks are not employed during a large proportion of their post-school period. A specific work history of each individual would be needed in order to properly estimate post-school investments in productive abilities.

Finally, a statistical problem that might affect the human capital and

structural models is heteroscedasticity, specifically that the variance of the error term increases with the log of earnings. However, residuals were plotted against the log of earnings and the results suggest that the variance was homoscedastic.

The study leaves open various areas for further research. One such area is to examine the impact that occupation has on the level of earnings according to race, sex and ethnic origin. Second, econometric models could be formulated to determine the effect that variables like age, sex, race, household type, education level, and employment status have on the chance of residing in poverty. A third area of related research is to gather more detailed data on past work experience and family background in order to more adequately measure productive abilities and explicitly account for the effect of family background on the distribution of earnings.

Appendix A

E_t = earnings in time period t;

E_O = initial earnings before investment in productive abilities;

r = rate of return on investments in productive abilities;

C_t = amount invested in productive abilities in time period t;

K_t = ratio of the time invested in productive abilities divided by total potential earnings time in period t;

r_{si} = rate of return on investment in schooling in time period i;

r_{pj} = rate of return on post-school investment in time period j;

S = years of schooling completed;

EX = years of post-school experience;

T = period of postive net investment, or, the number of years before depreciation in productive abilities becomes greater than additional productive abilities gained during the year;

Y_t = net earnings in time period t;

AO = $lnE_O - K_O(1+(K_O/2)$;

$A1$ = estimated rate of return on schooling;

$A2$ = $r_pK_O + (K_O/T)(1 + K_O)$;

$A3$ = $-((r_pK_O/2T) + K_O^2/2(T)^2)$;

$A4$ = parameter for weeks worked interpreted as the elasticity of earnings with respect to weeks worked;

WW = weeks worked in previous calendar year;

SEX = dummy variable equal to one for females and zero for males;

$RACE1$ = dummy variable equal to one for people of the racial category 'other' and zero otherwise;

$RACE2$ = dummy variable equal to one for people of the racial category 'black' and zero otherwise;

$ETHNI$ = dummy variable equal to one for people of Spanish origin and zero otherwise;

BO = intercept term interpreted as the log of initial earnings;

$B1, B2$ = parameters for returns to a year of schooling;

$B4, B5$ = parameters for returns to a year of experience;

$B3$ = interaction parameter between schooling and experience;

$B6$ = estimated parameter of log of weeks worked;

$B7$ = estimated parameter for dummy variable SEX;

$B8$ = estimated parameter for dummy variable $RACE1$;

$B9$ = estimated parameter for dummy variable $RACE2$; and

$B10$ = estimated parameter for dummy variable $ETHNI$.

APPENDIX B. Means and Standard Deviations of the Variables Used in Estimating the Distribution of Earnings Models

		1969		1979	
		Mean	Std. Dev.	Mean	Std. Dev.
A.	**Total Population**				
	Grade	13.92	3.41	15.23	3.28
	Experience	26.08	13.30	23.52	13.47
	Log of Weeks Wkd.[a]	1.67	0.31	3.83	0.37
	Log of Earnings	9.01	0.74	9.56	0.86
B.	**RACE — White**				
	Grade	14.02	3.39	15.29	3.25
	Experience	26.21	13.28	23.66	13.52
	Log of Weeks Wkd.	1.67	0.31	3.89	0.36
	Log of Earnings	9.03	0.73	9.59	0.85
C.	**RACE — Black**				
	Grade	12.22	3.10	13.98	3.03
	Experience	24.19	13.56	22.18	12.90
	Log of Weeks Wkd.	1.59	0.39	3.74	0.51
	Log of Earnings	8.54	0.81	9.12	0.95
D.	**RACE — Other**				
	Grade	15.00	4.58	17.09	4.45
	Experience	18.07	11.35	17.93	11.02
	Log of Weeks Wkd.	1.65	0.32	3.81	0.39
	Log of Earnings	9.01	0.62	9.56	0.93
E.	**SPANISH ORIGIN**				
	Grade	N.A.[b]	N.A.	12.62	4.13
	Experience	N.A.	N.A.	21.74	12.77
	Log of Weeks Wkd.	N.A.	N.A.	3.76	0.44
	Log of Earnings	N.A.	N.A.	9.18	0.88
F.	**SEX — Males**				
	Grade	13.96	3.43	15.27	3.36
	Experience	25.73	13.06	23.73	13.18
	Log of Weeks Wkd.	1.69	0.27	3.86	0.27
	Log of Earnings	9.11	0.66	9.72	0.76
G.	**SEX — Females**				
	Grade	13.72	3.21	15.04	2.90
	Experience	28.53	14.67	22.72	14.52
	Log of Weeks Wkd.	1.50	0.48	3.73	0.54
	Log of Earnings	8.31	0.87	8.93	0.95

[a] The measure of weeks worked differs between 1969 and 1979. In 1969 this measure is a grouping from one to six depending upon the number of weeks worked. In 1979 this measure represents the actual number of weeks worked as reported by the respondent.

[b] N.A. = Not available.

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