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INEQUALITY: EARNINGS VS. HUMAN WEALTH

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INEQUALITY: EARNINGS VS. HUMAN WEALTH

by

Lee A. Lillard*

Inequality in economic well-being is an important contemporary issue. Historically most studies have dealt with inequality in annual earnings or wages[1] based on cross section data or on changes in these cross sections over time and space. See, for example, the works of Mincer (1974) and Chiswick (1974).

Recent developments in human capital theory stress the need to consider a broader definition of economic well being encompassing life cycle behavior. Major contributions by Becker (1964), Ben-Porath (1967), and Mincer (1974) emphasize individual decisions which affect lifetime earning patterns such as years and quality of schooling and the level and pattern of on-the-job post-schooling investment as in Mincer and Polachek (1974).

The basic model presented in Ben-Porath (1967) has become a popular vehicle for detailed refinement of models of optimal life cycle investment in human capital. The basic model, considered by Haley (1973), Johnson (1970), Lillard (1973), Rosen (1973), and Wallace and Ihnen (1974), assumes individual

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[1] Some studies have dealt with non-human earnings and wealth but these will not be elaborated here. For an example see some of the papers in James D. Smith (1975).

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maximization of discounted earnings net of investments. Individuals choose "optimal" schooling periods and lifetime patterns of investment levels depending on their own endowments, constraints, and abilities. These endogenous decisions then determine a lifetime pattern of earnings[1] which has greatest present value.

This maximum present value is termed human wealth. The individual then maximizes his intertemporal utility subject to this wealth constraint.

This formulation begs several questions but so far provides the broadest range of clear predictions. Some of the more important omissions include the choice between labor, investment, and leisure over the lifetime, patterns of consumption, non-market returns to schooling, and risk and uncertainty as well as obvious extensions to entire families. These and other aspects have been studied by Heckman (1975), Smith (1974), Stafford and Stephan (1973), Michael (1972), Levhari and Weiss (1972), Razin (1973), Blinder and Weiss (1975) and Ghez and Becker (1974).

All of the foregoing studies unquestionably point to the use of longitudinal data which observes the same individuals over long periods of time, preferably an entire lifetime.

The objective of this paper is to draw some inferences concerning the relative magnitudes of inequality in annual earnings, the traditional measure, and in human wealth, the measure suggested by recent literature[2]. A second

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[1]Details of individual solutions and further constraints are available in the reference cited and will not be elaborated here.

[2]A similar approach is taken in Lillard (1975) where the emphasis was demonstrating the usefulness of empirical earnings functions for generating earnings and human wealth distributions and a more detailed account of when human wealth may be considered an index of lifetime economic well-being.

objective is to assess the relative importance of schooling, measured ability and to a limited extent family background in earnings and human wealth inequality as well as the overall contribution of these variables combined. A unique feature of this study is the estimation of earnings and human wealth and their distribution for a group of men for which several age-earnings data points are available over almost an entire lifetime (ages eighteen to fifty-four).

This study concludes first that human wealth is substantially more equally distributed than is earnings, either over all or by age group, for this NBER-TH population as measured by the coefficient of variation. These inequalities are remarkably insensitive to either discounting or length of working life. A second conclusion is that the contribution of schooling, measured cognitive ability, and a limited set of background variables to variation in human wealth is roughly the same as its contribution to variation in earnings within age groups. Both are roughly ten to twelve percent. Thirdly, while schooling has a much larger effect on annual earnings than ability, at any age, it is much more sensitive to discounting in human wealth calculations due to the period of foregone earnings. As noted by Griliches and Mason (1972) and several studies cited in Jencks (1972), cognitive ability has a negligible effect on the earnings of young men. However, in the NBER-TH population the effect becomes more substantial and positive as the men become older. The result is a substantial effect of cognitive ability on human wealth which persists even at high discount rates where the return to schooling has turned negative.

In the following sections we will present the model, the data, predicted earnings and human wealth, earnings distributions, human wealth distributions and more detailed results.

ANALYTICAL FRAMEWORK

For our present purposes we will simply assert that human wealth may index lifetime economic well-being or at least that it is a less myopic indicator than annual earnings. We will assume that the individuals in the population behave in such a way as to maximize the present value of net earnings and that the resulting optimal age-earnings patterns can be approximated by a polynomial earnings function.[1]

The earnings function to be estimated is of the form

$$\text{(1)} \qquad \hat{Y}\,(\text{Age},\text{Sch},\text{Abil},\text{Soc}) = \left(\sum_{i=0}^{a} \alpha_i \text{Age}^i\right)\left(\sum_{j=0}^{b} \beta_j \text{Sch}^j\right)\left(\sum_{k=0}^{g} \gamma_k \text{Abil}^k\right) + \sum_{\ell=1}^{7} \Gamma_\ell \text{Soc}_\ell$$

where

Age is chronological age in years

Sch is years of schooling

Abil is an index of cognitive ability

and Soc is a vector of family background variables including parent's education, number of siblings, religion and number of pre-high school moves.

The polynomial order is determined by the data by selecting a, b, and g such that higher orders will not significantly reduce variance. The assumed error

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[1]The optimization assumption is meant to impute theoretical content to the calculated values but is in no way necessary for their estimation. The present value of lifetime earnings may be interesting for other reasons.

structure plays a crucial role in estimating human wealth and its distribution. Earnings are composed of a component systematically related to observed variables, $\hat{Y}$, a component due to unobserved but individual specific variables δ, and a purely random or transitory component, i.e. for individual n.

$$(2) \qquad Y_n(\text{Age}) = \hat{Y}(\text{Age}, \text{Sch}_n, \text{Abil}_n, \text{Soc}_n) + \delta_n + \eta_{n\text{Age}} .$$

The error components δ and η are assumed independent of each other and over individuals, are uncorrelated with Age, Sch, Abil, and Soc and η is homoschedastic with respect to individuals and Age; therefore, $\delta \sim (0, \sigma_\delta^2)$ and $\eta_{nA} \sim (0, \sigma^2)$. For empirical purposes we will later define δ such that the present value of deviations from it, η_A, is zero for any one individual.

Human wealth is defined as the present value of post schooling earnings net of investments in training. We correspondingly caluculate estimated human wealth as the present value of observed earnings discounted to age sixteen[1] for common reference, i.e.

$$(3) \qquad HW_n = \hat{HW}(\text{Sch}_n, \text{Abil}_n, \text{Soc}_n) + \sum_{t=\text{Sch}_n+1-10}^{N-16} \hat{\delta}_n (1+R)^{-t}$$

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[1]Age sixteen was chosen arbitrarily because it is roughly the age at which an individual is no longer legally constrained to school attendance and may begin to make his own investment decisions.

where

$$(4) \qquad \hat{HW}(Sch_n, Abil_n, Soc_n) = \sum_{t=Sch_n+1-10}^{N-16} \hat{Y}(t, Sch_n, Abil_n, Soc_n)(1+R)^{-t}$$

$$(5) \qquad \hat{\delta}_n = \sum_{i=1}^{T_n} (\delta_n + \eta_{ni})(1+R)^{-t_i} \Big/ \sum_{i=1}^{T_n} (1+R)^{-t_i}$$

T_n = number of age-earnings points observed for individual n

R = rate of discount common to all individuals and time periods

and N = sixty-six, the age of total retirement common to individuals.
Again, $\hat{\delta}_n$ is calculated such that the present value of the remaining

η_A, $\sum_{i=1}^{T_n} \eta_{it} (1+R)^{-t_i}$, is zero.[1]

Using this formulation we obtain for an individual

$$(6) \qquad E(HW_n) = \hat{HW}(Sch_n, Abil_n, Soc_n) + \sum_{t=Sch_n+1-10}^{N-16} \hat{\delta}(1+R)^{-t}$$

but over individuals with the same observable characteristics

[1] This format is not necessary but simplifies calculations. It has no effect of the results for human wealth distributions.

(7) $E(HW) = \hat{HW}\,(Sch,\ Abil, Soc)$.

Consider the variance in human wealth over individuals within a specified schooling level. First for a specified ability level and background

(8) $$Var(HW) = \sigma_\delta^2 \left[\sum_{t=Sch+1-10}^{N-16} (1+R)^{-t} \right]^2$$ 1/

then over all ability and background combinations

(9) $$Var(HW) = Var_{Abil,Soc|_{Sch}} [\hat{HW}(Sch, Abil, Soc)] + \sigma_\delta^2 \left[\sum_{t=Sch+1-10}^{N-16} (1+R)^{-t} \right]^2$$

However, when schooling varies as well, as in the overall distribution

(10) $$Var(HW) = Var_{Abil,Soc,Sch} [\hat{HW}\,(Sch,\ Abil, Soc)] + \sigma_\delta^2\, E_{Sch} \left[\sum_{t=Sch+1-10}^{N-16} (1+R)^{-t} \right]^2 .$$

The σ_δ^2 will be estimated from the data as $\sigma_{\hat{\delta}}^2$.

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[1]When these formulas are applied to $\sigma_{\hat{\delta}}^2$ they obviously assume the present value of all the unobserved η for each individual has present value zero. This assumption has been relaxed with negligible empirical effect.

THE POPULATION

The population under study is the NBER-TH survey group. Inferences are made only for this population since it may not be representative of any broader group. The NBER-TH sample is based on a group of males volunteering for Air Force pilot, navigator, and bombardier programs in the last half of 1943. These volunteers were given initial screening tests and a set of twenty tests to measure various cognitive abilities. Thorndike and Hagen (1959) sent a questionnaire to a sample of 17,000 of these men in 1955 which included a question on 1955 earnings. The NBER sent to a subset of these a subsequent questionnaire in 1969 which included additional questions on earnings in later years and questions on schooling and initial job earnings.

The data include five separate approximately equally spaced points on the age-income profile as well as the year of initial job, year of last full-time schooling, years of schooling, and the twenty separate measures of ability. The age-income points are approximately initial job, 1955, 1960, 1964, and 1968. The observed age range is nineteen to fifty-seven years but with less than 1 percent outside the range nineteen to fifty-five.

Specifically, Table I presents the distribution of age-earnings data points by year interval and by number of points for all 5089 individuals in the sample.

Year:	1945-52	1953-57	1958-62	1963-66	1967-70	TOTAL
Number of observations	3824	1864	3768	1288	4834	15578

No. of points per person	None	1	2	3	4	5	TOTAL
No. of persons	72	179	939	1987	1317	456	5089

Table 1. Distribution of age-earnings points

The results reported in this paper are based on the 4699 individuals for which two to five age-earnings points (a total of 15387) are observed.

The individuals in the sample differ from the U.S. male population as a whole in several ways. First the sample includes a high ability group. All of the men completed high school or high school equivalency examinations, and passed the initial screening for the Air Force flight program. Their general health was better than the general population in 1969. They were more homogenous in height and weight due to military qualifications. They seem to have a high degree of self confidence and self reliance. Some of these factors may however be related to the high ability. In addition, all of the men had the G.I. Bill available to help finance their schooling.

The ability index used here is one aggregated by the first principal component of a larger set of ability test scores corresponding approximately to IQ like attributes including mathematics, reading comprehension, and mechanical principles. These test scores were measured approximately just post high school upon entrance into the military and application for pilot and navigator school. These individuals clearly had an incentive to perform well on tests, which overcomes some of the problems suggested by Jencks (1972).

EARNINGS AND HUMAN WEALTH

Earnings and human wealth are estimated in stages. First the basic earnings function $\hat{Y}$(Age, Sch, Abil, Soc) is estimated as that polynomial surface which "best" fits the data in the sense of minimum error variance without excessive order. That is, additional order polynomials are introduced until they fail to significantly[1] reduce error variance. The best equation is found to be cubic in age, quadratic in years of schooling, and quadratic in cognitive ability with full (fifth order) interaction. The social variables

[1]Significance at the five percent level.

contribute additively shifting the surface up or down. While this earnings function is more complex than the usual additive linear versions it fully reveals the interactive nature of the relationships. The R^2 for this regression is .301[2].

Representative age-earnings profiles based on this earnings function are presented in Figure 1 for a Protestant with average levels of all other social variables. Mean values of background variables and their contribution to annual earnings are presented in Table 2.

The life cycle earnings patterns and differences in those patterns due to schooling and ability levels are clearly represented. Earnings rise over the lifetime and rise more rapidly for the more educated and the more able. For example, between the ages forty and forty-five earnings rise at a rate of 556 dollars per year for the college graduate of mean ability while at a rate of 366 dollars for a high school graduate and 880 dollars for a professional or Ph.D. of mean ability. For a college graduate, earnings rise at a rate of 494 dollars per year for an individual one standard deviation below mean ability and 627 dollars for an individual one standard deviation above mean ability. It is clear that within this population a standard deviation change

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[2] The exact earnings are given by:

Y = 4157. + 84. FATHED + 101. MOTHED + 28. NO. MOVES - 110 NO. SIBS.
- 295. (PROT DUMMY) + 50. (CATH DUMMY) + 3852 (JEW DUMMY)
+ 1935.5 (Sch) - 296.1 (Sch Sq) - 785.9 (Age) + 59.4 (Age Sq)
- 1.085 (Age Cu) - 162.6 (Age) (Sch) + 14.3 (Age Sq) (Sch)
- .23 (Age Cu) (Sch) + 38.0 (Age) (Sch Sq) - 2.9 (Age Sq)(Sch Sq)
+ .05 (Age Cu)(Sch Sq) + 2979.1 (Abil)(Age) - 213.9 (Abil) (Age Sq)
+ 3.9 (Abil) (Age Cu) - 296.2 (Abil)(Age)(Sch) + 21.9 (Abil) (Age Sq) (Sch)
- .47 (Abil) (Age Cu) (Sch) - 33.3 (Abil) (Age)(Sch Sq) + 2.4 (Abil)(Age Sq)(Sch Sq)
- .032 (Abil)(Age Cu)(Sch Sq) - 2774.5 (Abil)(Sch) + 459.7 (Abil)(Sch Sq)
- 2106.1(Abil Sq)(Age) + 149.6 (Abil Sq)(Age Sq) - 2.7 (Abil Sq)(Age Cu)
+ 364.9 (Abil Sq) (Age)(Sch) - 25.4 (Abil Sq)(Age Sq) (Sch)
+ .48 (Abil Sq) (Age Cu) (Sch) - 2.9 (Abil Sq) (Age) (Sch Sq)
+ .17 (Abil Sq) (Age Sq) (Sch Sq) - .008 (Abil Sq) (Age Cu) (Sch Sq)
+ 463.8 (Abil Sq) (Sch) - 139.8 (Abil Sq) (Sch Sq) - 3393.1 (Abil)
+ 3533.0 (Abil Sq)

Sch = years schooling beyond 10, Age = age beyond 16.

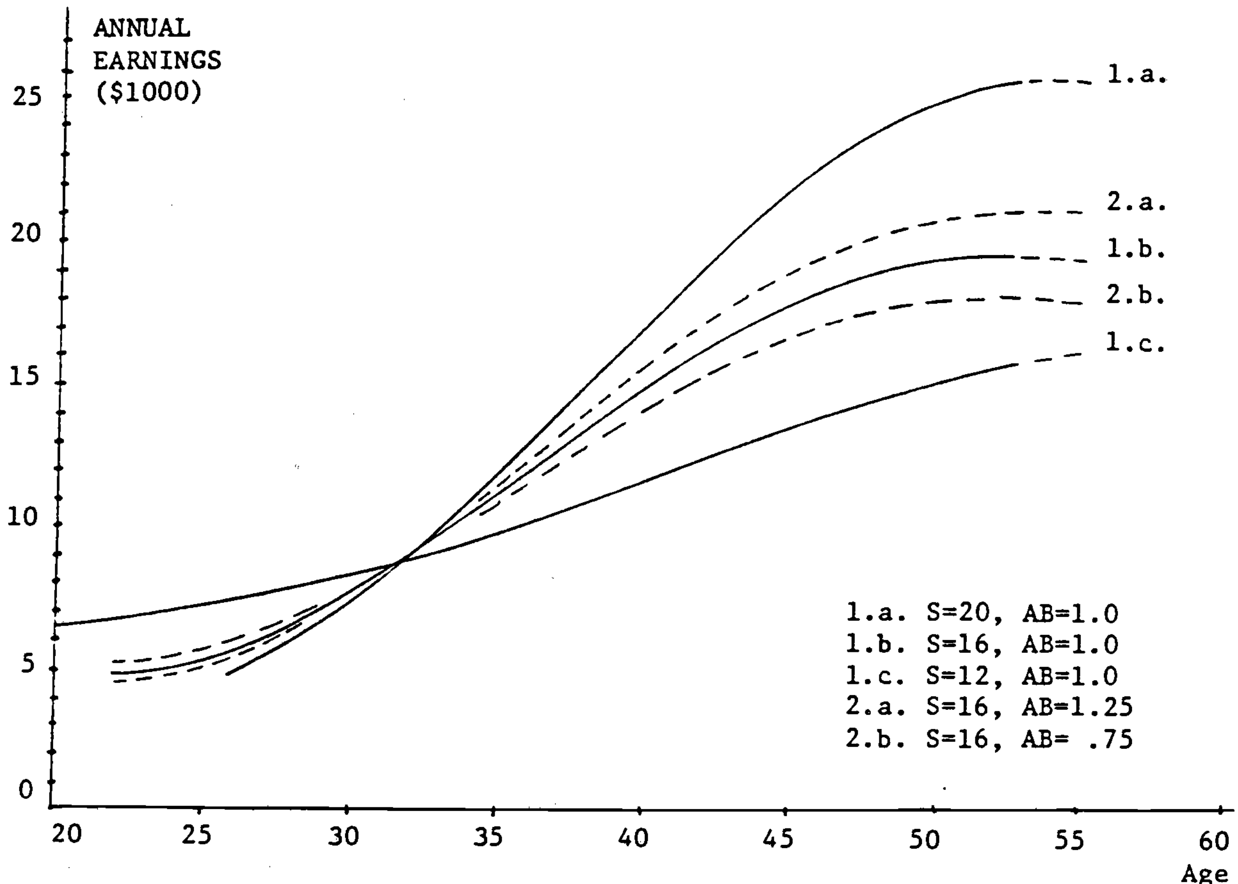

Figure 1. Age-Earnings Profiles for NBER-TH Population by Schooling and Ability at Average Level of Other Variables and Protestant Religion in 1970 dollars.

Note: The ability index is distributed with mean 1 and standard deviation .25.

Table 2. Contribution of Variables to Earnings and Human Wealth

Source	Mean or Percent	Contribution in 1970 Dollars: Annual Earnings	Human Wealth Discounted at 0%	3%	5%	7%
College vs. High School						
Ability						
High (1.25)			71689	9181	-6170	-13132
Average (1.00)			58757	3932	-9587	-15603
Low (.75)			58963	2652	-10917	-16810
Ph.D./Professional vs. College						
High (1.25)			142787	42531	17440	5452
Average (1.00)			131285	35612	12560	1991
Low (.75)			58462	4281	-6423	-10027
Average to High Ability						
High School			30606	10285	4816	2060
College			43538	15534	8233	4531
Ph.D./Prof.			55040	22453	13113	7992
Low to Average Ability						
High School			28524	7702	2839	648
College			28318	8982	4169	1855
Ph.D./Prof.			101141	40313	23152	13873
Background*						
Father's Educ (one year)	9.90	84	3696	1714	1107	753
Mother's Educ (one year)	10.02	101	4444	2061	1331	905
Number Siblings (one more)	1.81	-110	-4840	-2245	-1449	-986
No.Pre-HS Moves (one more)	2.01	28	1232	571	369	251
Religion (Prot)	.64					
Jewish-Prot	.05	4147	182468	84620	54637	37157
Cath-Prot	.23	345	15180	7040	4545	3091

*Note: Contributions to human wealth of background variables are for college graduates assuming retirement at age sixty-six.

from mean schooling has a greater impact at every postschooling age than the same change from mean ability.

Both the more educated and the more able initially, prior to age thirty,[1] have lower earnings due to higher levels of job training investment which in turn causes future earnings to rise more rapidly. This empirical relationship illustrates the finding in previous studies, e.g., Griliches and Mason and many works cited in Jencks, that measured cognitive ability has little effect on earnings "at early ages." It is important to note that almost all studies of the effect of ability on earnings have been based on young, under thirty-five years, men. Since ability has its greatest effect late in the life cycle, either using young samples or ignoring interaction with age substantially understates the effect of ability.

Another important finding not illustrated in Figure 1 is the strong positive interaction between ability and schooling operating primarily through the age earnings relationship, i.e., when a lifetime is considered. That is, schooling has a greater impact on the age-earnings relationship for more able persons and vice versa. These same positive interactions are also quite evident in their effect on human wealth.

Estimates of mean human wealth are calculated by summing discounted earnings predicted by the earnings function,[2] i.e.

$$\hat{HW}\text{ (Sch, Abil, Soc)} = \sum_{t=Sch+1-10}^{N-16} \hat{Y}(t,Sch, Abil,Soc)/(1+r)^{t}$$

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[1]Age thirty is also approximately the age at which the individual begins to surpass his own mean lifetime earnings.

[2]Estimates of human wealth exclude consideration of earnings while in school, for which no data are available, and lower earnings incurred while in military service. Age-earnings profiles are assumed to be flat beyond the upper end of the sample age range, about age fifty-two, since the profiles in Figure 1 appear to peak there.

Table 3. Predicted Human Wealth by Ability, Schooling Level, and Discount Rate Assuming Retirement at Age Sixty-Six for the NBER-TH Population in 1970 Dollars. Values are for a Protestant at Average Levels of Other Background Variables.

Discount Rate	Ability	Years of Schooling 12	13	14	15	16	17	18	19	20
	Low (.75)	561734	570387	587666	604956	620697	634832	648042	661958	679159
.00	Average (1.00)	590258	590257	604210	624534	649015	677003	708208	742350	780300
	High (1.25)	620864	629259	645082	666390	692553	722883	756962	794537	835340
	Low (.75)	252447	251049	252256	253773	255099	256116	256899	257786	259380
.03	Average (1.00)	260149	255425	255719	258868	264081	270992	279337	288874	299693
	High (1.25)	270434	267564	268909	273106	279615	288035	298072	309510	322146
	Low (.75)	163305	159107	156424	154280	152388	150610	148886	147276	145965
.05	Average (1.00)	166144	160014	156981	155992	156557	158374	161195	164796	169117
	High (1.25)	170960	165399	163198	163166	164790	167737	171754	176643	182230
	Low (.75)	113200	107650	103253	99566	96390	93570	90985	88578	86363
.07	Average (1.00)	113848	107091	102601	99773	98245	97741	98027	98897	100236
	High (1.25)	115908	109217	105424	103441	102776	103129	104270	106020	108228

NOTE: Human wealth is defined as the present value of lifetime earnings at age sixteen and is calculated from predicted annual earnings. The Ability index is distributed with mean one and standard deviation .25.

The contribution of the variables in this relationship to mean human wealth are summarized briefly in Table 2. Predicted values of human wealth for several combinations of schooling and ability for a Protestant with mean values for other background variables are presented in Table 3. Predicted values of human wealth may be obtained for other background combinations by using Tables 2 and 3 together.[1]

Perhaps the most striking result is that while schooling has a larger effect on annual earnings than ability, at any age, it is much more sensitive to discounting due to the period of foregone earnings. When undiscounted, schooling clearly has the dominant effect on lifetime earnings. However, cognitive ability continues to have a positive effect on human wealth at discount rates beyond seven percent while the effect of schooling turns negative at approximately five percent depending upon the individual's ability. This clearly illustrates the strong positive interaction between ability and schooling in their effect on human wealth. More able persons gain more human wealth from additional schooling than do less able persons and the returns to greater ability are greatest at higher levels of schooling. A less obvious result is that for this population, contrary to other studies, the returns to schooling increase rather than decrease with more schooling. Similarly, the return to additional ability is an increasing function of ability. This result may be partially due to the population composition of only highly able and well-educated men.

Many studies recently, Leibowitz (1974), and Stafford and Hill (1974) for example, have been concerned with parents' investments in their children. While the set of background data used here is quite limited we may get some

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[1]Estimates of the internal rate of return to consecutive years of schooling by ability level are reported in a separate paper by the author.

idea of their relative importance to earnings and human wealth. As is often found in other studies, mother's education has a slightly larger effect on son's earnings, and human wealth, than does the father's education, by roughly twenty percent. Consider, for example, that these estimates imply that the mother's attainment of a college degree versus a high school degree is associated with an increase of 17,776 dollars in undiscounted lifetime earnings, compared to 14,784 dollars for the same change in father's education. This is roughly thirty percentas large as the effect of the son's own college attainment over high school for an average ability son. The effect of parents' education is enhanced by their strong positive correlation.

The number of siblings has the expected negative effect on earnings and human wealth while the number of pre-high school family moves, geographic, has an insignificant positive effect. By far the largest background effect is due to religion, particularly if the son is Jewish[1].

The direct effect of these background variables on earnings and human wealth appear to be rather small compared to schooling and ability. These variables also indirectly affect earnings and human wealth through their effect on schooling and ability which is not accounted for here[2]. Secondly, the

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[1]Part of the effect of this variable may be due to the city size of the respondents' residence since much of the Jewish population resides in the New York metropolitan area which has substantially higher wages than most other parts of the United States.

[2]A detailed study of these indirect effects is underway by the author in the context of a full recursive system relating background, ability, achooling, and lifetime patterns of earnings and occupational choice.

Table 4. Distribution of Predicted and Actual Annual Earnings in 1970 Dollars for the NBER-TH Population.

	Sample Size	Predicted Annual Earnings				Actual Annual Earnings			
	percent	Mean	Standard Deviation	Coefficient of Variation	Skew.	Mean	Standard Deviation	Coefficient of Variation	Skew.
Overall	15387	12721	5227	.41	.48	12725	9555	.75	3.65
By Schooling									
12	.22	11179	3259	.29	.22	10831	6811	.63	3.78
13	.11	11846	3817	.32	.12	12338	9691	.79	4.45
14	.07	12330	4360	.35	.06	12840	9961	.78	4.95
15	.07	13011	4891	.38	.02	13189	10119	.77	3.63
16	.30	13039	5474	.42	.11	13419	9954	.74	3.17
17	.06	13598	6010	.44	.09	12631	9352	.74	3.74
18	.08	14059	6477	.46	.08	12405	8799	.71	3.05
19	.01	13864	6962	.50	.15	10679	6219	.58	1.35
20	.07	15130	7409	.49	.16	16510	13258	.80	2.52
By Age									
<20	.03	6571	1456	.22	1.99	6144	2947	.48	4.59
20-24	.08	8313	1732	.27	1.36	6724	3782	.56	5.01
25-29	.13	6734	1616	.24	1.28	6599	3040	.46	2.78
30-34	.16	9966	1854	.19	1.19	10284	6115	.59	6.18
35-39	.19	12662	2342	.18	.72	12429	7396	.60	4.41
40-44	.12	16009	3160	.20	.49	15110	9037	.60	3.18
45-49	.24	18261	3657	.20	.45	18795	12260	.65	3.10
>49	.04	17917	3507	.20	1.07	17418	11502	.66	3.32
By Ability									
<.75	.15	11682	3968	.34	.22	11610	8563	.74	3.99
.75-1.00	.37	12166	4688	.39	.33	12152	9075	.75	4.23
1.00-1.25	.32	13018	5484	.42	.29	13138	9912	.75	3.46
>1.25	.17	14293	6413	.45	.19	14189	10508	.74	2.84

Note: Skewness is measured by the square root of $E(X-\bar{X})^3/S^3$. Coefficient of variation is $S/\bar{X}$. The ability index is distributed with mean one and standard deviation .25.

large individual variance component, δ , may be due partly to yet unmeasured background characteristics. Parents' education is only a crude proxy for the quality of the child's home environment and resources allocated to the child's early education.

DISPERSION IN EARNINGS AND HUMAN WEALTH

Dispersion in earnings and human wealth arises from the underlying dispersion of their determining characteristics. In this section we will assess the magnitudes of dispersion or inequality, measured by the coefficient of variation, in earnings relative to human wealth. A second objective is to assess the relative importance of schooling, ability, and background as determinants of inequality in human wealth.

Table 4 presents selected statistics for the distribution of annual earnings observed in the NBER-TH population for an aggregate of all age-earnings points observed for the whole population, as well as for schooling, ability, and age sub-groups. The same statistics are given for the distribution of annual earnings values predicted from the estimated earnings function $\hat{Y}$(Age, Sch, Abil, Soc). Roughly thirty percent of the variation in annual earnings is "explained" by schooling, ability, and background variables.

An estimate of human wealth, $\hat{HW}$, is made for each individual in the population based first on his schooling, ability, and background by summing discounted predicted earnings as in equation (4). This distribution is labeled as the distribution of human wealth "due to schooling, ability, and background" and selected statistics for it are presented in Table 5 for several rates of discount.

Table 5. Estimated Distribution of Human Wealth in 1970 Dollars for the NBER-TH Population Assuming Full Retirement at Age Sixty-six.

Sub Group	Due to Observed Variables, $\hat{HW}$ (Schooling, Ability, Background)				Total, HW_n		
	Mean	Standard Deviation	Coeff. of Variation	Skew.	Standard Deviation	Coeff. of Variation	Skew.
				UNDISCOUNTED			
Overall	674146	104479	.15	.84	289380	.43	2.69
By Years of Schooling							
12	590801	70471	.12	1.90	229598	.40	2.83
13	614474	76832	.13	2.05	338072	.53	3.27
14	638119	75982	.12	1.73	316687	.48	3.61
15	667024	74664	.11	1.80	333981	.49	3.31
16	699917	80657	.12	1.43	275940	.39	2.60
17	724362	82598	.11	1.25	248088	.36	2.65
18	749605	93410	.12	1.00	235536	.35	2.34
19	761192	92288	.12	.96	122487	.19	.90
20	814340	89213	.11	.03	321582	.37	1.36
By Ability Level							
<.75	601350	73647	.12	1.25	284104	.48	3.25
.75-1.00	641869	84279	.13	1.21	271566	.42	3.18
1.00-1.25	693146	92230	.13	.91	291196	.42	2.64
>1.25	774392	97833	.13	.81	295946	.38	2.18
				DISCOUNTED AT 3 PERCENT			
Overall	277533	37886	.14	1.60	115878	.42	2.94
By Years of Schooling							
12	259009	33425	.13	2.05	100039	.40	2.82
13	264372	35253	.13	2.13	144525	.53	3.19
14	268401	34408	.13	1.95	130023	.47	3.45
15	275261	32896	.12	2.02	143310	.51	3.66
16	282933	34620	.12	1.66	109068	.38	2.83
17	288722	35013	.12	1.49	92336	.34	2.08
18	294200	39410	.13	1.14	89128	.33	1.97
19	294438	38529	.13	1.07	48046	.20	.73
20	311446	37245	.12	.07	123796	.37	1.34
By Ability Level							
<.75	255457	30767	.12	2.04	120460	.48	3.61
.75-1.00	266629	32472	.12	1.98	110363	.42	3.37
1.00-1.25	282561	33960	.12	1.50	115818	.41	2.82
>1.25	311182	38192	.12	1.23	116103	.38	2.20
				DISCOUNTED AT 5 PERCENT			
Overall	166895	22324	.13	2.09	69632	.42	3.18
By Years of Schooling							
12	164721	22566	.14	2.28	64330	.41	2.98
13	164981	23198	.14	2.33	89964	.53	3.12
14	164151	22408	.14	2.13	78738	.47	3.29
15	165520	20971	.13	2.18	89252	.53	3.91
16	167147	21636	.13	1.62	64201	.38	3.10
17	168455	21560	.13	1.62	51789	.33	1.73
18	169394	23927	.14	1.34	50582	.33	1.81
19	167472	23158	.14	1.16	27920	.20	.60
20	175459	22167	.13	.24	71267	.38	1.42
By Ability Level							
<.75	157652	21015	.13	2.25	75790	.49	3.96
.75-1.00	161686	20718	.13	2.00	67149	.42	3.47
1.00-1.25	168583	20246	.12	1.81	69207	.41	3.02
>1.25	183213	22669	.12	1.74	67769	.38	2.23
				DISCOUNTED AT 7 PERCENT			
Overall	106775	15699	.15	1.71	45483	.43	3.38
By Years of Schooling							
12	112299	16319	.15	2.42	44858	.42	3.24
13	109931	16434	.15	2.35	59893	.53	3.04
14	106867	15650	.15	2.17	51009	.46	3.08
15	105659	14301	.14	2.23	59245	.55	4.12
16	104555	14335	.14	1.83	40382	.38	3.47
17	103839	14116	.14	1.72	31028	.32	1.43
18	102826	15407	.15	1.41	30620	.33	1.72
19	100251	14663	.15	1.24	17241	.20	.46
20	103872	13878	.13	.28	43681	.39	1.56
By Ability Level							
<.75	103747	16499	.16	1.82	51726	.51	4.33
.75-1.00	104444	15509	.15	2.01	44314	.43	3.49
1.00-1.25	106908	14201	.13	2.29	44800	.42	3.24
>1.25	114350	15000	.13	2.13	42365	.38	2.27

Note: Skewness is measured by the square root of $E(X-\bar{X})^3/S^3$. Coefficient of variation is $S/\bar{X}$. The ability index is distributed with mean one and standard deviation .25. Individual observations are weighted by the number of observed age-earnings points.

A second estimate of each individual's human wealth is obtained by utilizing the individual's full observed earnings history. An estimate is made of each individual's own weighted mean deviation, δ , from the aggregate age-earnings profile based simply on schooling, ability, and background via equation (5). Since by construction the present value of observed deviations from $\hat{\delta}$ is zero, HW_n given by equation (3) estimates the individual's "total" human wealth due to all sources, observed and unobserved. Selected statistics for HW are presented in Table 5. $\hat{\delta}$ is distributed over the population with weighted standard deviation \$6054, \$5283, \$4871, and \$4555 for discount rates of zero, 3 percent, 5 percent, and 7 percent respectively. A range of two to five and a mean of 3.2 age-earnings points are observed for each individual. Each observation is weighted in proportion to the number of age-earnings points observed for that individual.

Inequality in Earnings versus Human Wealth

The primary conclusion is that human wealth is substantially more equally distributed than are annual earnings. This result holds whether considering overall earnings or earnings within narrowly defined age groups. The result holds whether comparing predictions based on schooling, ability, and background or the total and actual values. An interesting side point is that inequality measured by the coefficient of variation is scarcely affected by either the discount rate or the assumed retirement age[1]. The following will accordingly omit

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[1]Several retirement ages were considered including a retirement age differing by years of schooling estimated as the mean retirement age for that schooling group based on labor force participation rates. It made virtually no difference in the inequality conclusions reached here.

detail reference to them unless necessary. The overall[1] coefficient of variation in total human wealth is approximately 43 percent while the corresponding value for actual earnings is 75 percent. Even with the narrowly defined age groups earnings inequality is above 60 percent for mature men, over thirty. Inequality is 50 to 80 percent greater in earnings than in human wealth. It is interesting to note that the long noted skewness in earnings perseveres in the human wealth distributions and is largely due to positive skew in $\hat{\delta}$. Skewness is roughly of the same order of magnitude for both earnings and human wealth although slightly larger for earnings.

Differences in inequality persist in the distributions due only to schooling, ability, and background. The coefficient of variation is 15 percent for $\widehat{HW}$, 41 percent for $\hat{Y}$, and above 18 percent for all age groups. Since the age-earnings patterns are a primary source of differences in $\hat{Y}$, inequality is at a minimum within age groups, having only half the inequality of the overall distribution. Within age groups inequality is still 20 percent greater in earnings, $\hat{Y}$, than human wealth, $\widehat{HW}$.

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[1]Unless otherwise stated the following will be values for the overall aggregate distribution. All conclusions are valid within subgroups.

Contribution of Schooling, Ability, and Background to Inequality

A second conclusion is that the contribution[1] of schooling, measured cognitive ability, and a limited set of background variables to variation in human wealth is roughly the same as its contribution to variation in earnings within age groups. Both are roughly 10 to 12 percent. Age (or experience) is a primary determinant of earnings; it and the other variables explain just over 30 percent of overall variation in earnings[2]. Adding $\hat{\delta}$ undiscounted to the earnings function[3] boosts explanatory power to nearly 70 percent. Unobserved individual differences[4] account for a large portion of variation in both earnings and human wealth.

Summary and Conclusion

One of the primary predictions of life cycle models of human capital theory has been a life cycle pattern of investments which decline over time and which yield compensating returns later. Both tend to produce individual earnings profiles which rise more rapidly for those with larger early investments and profiles which are concave. The attributes are roughly confirmed for the NBER-TH population. Both more able and more schooled

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[1] Contribution is used loosely here as, for example, $\mathrm{Var}(\hat{HW})/\mathrm{Var}(HW_n)$ and $\mathrm{Var}(\hat{Y}|A)/\mathrm{Var}(Y|A)$.

[2] The explanatory power is much greater for the natural log of earnings, around 45 percent, but in both cases the simple correlation between predicted and observed earnings are the same to the third decimal. See Lillard (1973).

[3] A more detailed study of this breakdown is under study by the author.

[4] Many of these unobserved differences may occur during the life cycle in the form of differences in job mobility and work history as illustrated in the current work of Mincer and Bartel.

individuals who are presumably investing more are compensated by more rapidly rising earnings and higher earnings late in the life cycle.

To what extent are these differences in earnings patterns "compensated" in present value? Since each individual is assumed to maximize his lifetime position given his endowments and constraints there is no presumption that each individual's maximum should be the same, i.e., no inequality in human wealth. In this population where a lifetime of data are available we observe less inequality in human wealth than earnings, even within narrow age groups, but not a complete absence of inequality. The coefficient of variation in human wealth is approximately 43 percent compared to 75 percent in earning, and 60 percent within age groups.

A second set of issues relates to the importance of schooling and measured cognitive ability both relative to each other and relative to other effects in human wealth inequality. While both explain a substantial portion of the variation in earnings, much of the variation is in the form of life cycle pattern differences and is thus compensated. Within age groups and over a lifetime, as for human wealth, schooling, ability, and background "explain" roughly 10 to 12 percent of total variation. Whether this is large or small depends on one's point of view given that these are only a few attributes relative to the many which must influence an individual's lifetime.

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