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CHAPTER VIII

Age, Earnings, Wealth, and Human Capital

Virtually all the implications of the theory of investment in human capital developed in Part One depend directly or indirectly on the effect of human capital on the earnings and productivity of persons and firms. Consequently most of my empirical work has been concentrated on measuring and assessing these effects. Chapters IV through VI contain the results for various demographic groups and time periods in the United States.

Several investigators have examined a variety of other implications, and the additional empirical support given to the theory has been quite gratifying.[1] Thus Oi independently developed an analysis of the effect of investment in human capital on unemployment and turnover that is quite similar to ours, and tested it empirically in a number of ways.[2] Smith applied the analysis to the turnover of skilled personnel

[1] One criticism was made of this theory largely on the grounds of lack of realism and relevance (see R. S. Eckaus, "Investment in Human Capital: A Comment," *Journal of Political Economy*, October 1963). Instead of quarreling with details of his comment—and there are several that seem wrong or misleading—I would like to urge that the evidence provided by this chapter and the previous ones, by the studies mentioned here, and by many other studies indicates that the theory is quite useful in interpreting the real world.

[2] See Walter Y. Oi, "Labor as a Quasi-fixed Factor of Production," unpublished Ph.D. dissertation, University of Chicago, 1961, and "Labor as a Quasi-fixed Factor," *Journal of Political Economy*, December 1962.

in the military, and developed rules for increasing the efficiency of their expenditures on personnel.[3] Mincer applied the analysis in estimating the amounts spent on on-the-job training, and then used his estimates to understand the income and employment behavior of different groups.[4] In an earlier and pioneering article, Mincer had already developed and tested a theory that related the distribution of earnings to the distribution of investments in human capital.[5] Or to take a final and very different example, Clara Friedman has neatly used the human capital approach to show that virtually nobody enters the New York City public school teaching system with more than the minimum required schooling because the value of the additional pay given for additional schooling is less than the cost of postponed earnings.[6]

This chapter covers still another aspect: the effect of human capital on earnings and wealth at different ages. The first part deals with the steepness and shape of the well-known age-earnings profiles. Since these are relevant in studying the declining incomes of older persons or the low incomes of younger persons, the effect of learning on productivity, and many other life-cycle changes, a demonstration that their shape is determined by investment in human capital should be of considerable interest.

In recent years there has been a noticeable shift of emphasis in economic theorizing and data collection from income and flows to capital and stocks. This surely is the thrust of the permanent income and related hypotheses in consumption studies,[7] of the emphasis on the allocation of assets in monetary theory,[8] and of the attention paid to the capital aspects of expenditures on durable goods.[9] In line with

[3] See G. Smith, "Differential Pay for Military Technicians," unpublished Ph.D. dissertation, Columbia University, 1964.

[4] See J. Mincer, "On-the-Job Training: Costs, Returns, and Some Implications," *Investment in Human Beings*, NBER Special Conference 15, supplement to *Journal of Political Economy*, October 1962, pp. 50–59.

[5] See his "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy*, August 1958.

[6] See her "Differential Pay of New York City School Teachers," unpublished Ph.D. dissertation, Columbia University, 1962.

[7] See M. Friedman, *A Theory of the Consumption Function*, Princeton for NBER, 1957; and F. Modigliani and R. Brumberg, "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data," in *Post-Keynesian Economics*, K. K. Kurihara, ed., New Brunswick, 1954.

[8] See J. Tobin, "Money, Capital and Other Stores of Value," *American Economic Review*, May 1961; or M. Friedman, "The Quantity Theory of Money—A Restatement," in *Studies in the Quantity Theory of Money*, M. Friedman, ed., Chicago, 1956.

[9] See R. W. Goldsmith, *A Study of Saving in the United States*, Princeton, 1955–1956.

this shift, life-cycle economic changes should be related not only or even primarily to changes in earnings and other income, but also to changes in human and other wealth. Accordingly, the second part of this chapter develops the concept of age-wealth profiles—the relation between age and the discounted value of subsequent earnings—and shows that their shape, like that of the underlying age-earnings profile, is determined by investment in human capital. A few applications illustrating the usefulness of age-wealth profiles and thus indirectly the importance of human capital conclude the discussion.

1. Age-Earnings Profiles

Table 19 shows the mean net after-tax incomes in 1939 and 1949 of males classified by age and years of schooling; the word "net" indi-

TABLE 19

Net After-Tax Incomes of White Males in 1939 and 1949, by Age and Years of Education (dollars)

Age	*16+* (*1*)	*12* (*2*)	*7 and 8*[a] (*3*)
	1939		
14–21	29	360	457
22–24	1185	1136	925
25–29	1930	1494	1182
30–34	2839	1929	1453
35–44	3878	2488	1768
45–54	4361	2744	1935
55–64	3856	2527	1773
	1949		
14–21	42	705	795
22–24	1794	2151	1769
25–29	2929	2763	2185
30–34	4380	3218	2498
35–44	6295	3623	2778
45–54	7883	4215	2959
55–64	7329	4165	2711

Source: See Tables 2 and 3 and Appendix A, section 1.
[a] For 1939, 7 and 8 years of schooling; for 1949, 8 years.

cates that direct outlays on schooling have been subtracted from reported incomes. Although the analysis in this chapter does not at all depend on the use of such an income concept, I have done so because foregone income—an important part of the total cost of education—is implicitly subtracted from reported incomes. Economic analysis as well as consistent accounting would be made easier either if direct outlays were also subtracted or if foregone income was added back. Since the discussion in Chapter II indicates that *all* the costs of general on-the-job training and of certain other investments are implicitly subtracted from reported incomes, comparability among different kinds of human capital is most easily achieved by explicitly subtracting direct school outlays, which brings us to the net income concept used in Table 19.

The table clearly shows that average incomes at each age class are strongly related to education, a relation explored in the previous chapters. The table also shows that incomes tend to be relatively low at the beginning of labor force participation, rise throughout later ages until a common peak is reached in the 45 to 54 age class, and decline in the last age class. Although the peaks are reached in the same *class*, they are not necessarily reached at the same *age*. For example, if incomes continually increased to the peak age and continually declined thereafter, actual peak ages could be anywhere from 35 to 64, a spread of thirty years, and yet all the observed peaks might occur in the 45 to 54 age class.

Therefore, these data do not necessarily contradict the common notion that unskilled persons reach their peak earnings before skilled persons. This notion has been based, however, on misleading statistics. Since occupation changes with age, the more able tending to rise and the less able to fall in the occupational hierarchy, earnings in different occupations at a given moment in time might show an earlier peak in unskilled occupations merely because older unskilled workers are less able than younger ones. Education statistics are less affected because education is usually completed at an early age.

Table 19 gives the incomes of different cohorts at a moment in time, not those of a given cohort aging over time. Age-income profiles based on longitudinal or time series data can differ from those based on cross-sectional data because of business cycles, secular trends toward higher education, and occupation or life-cycle employment changes (see the discussion in the beginning of Chapter IV). Probably the most important, pervasive, and calculable difference results, however, from the secular growth in incomes, which implies, for example, that the cohort of college graduates aged 25 in 1939 received a higher real income at age 35 than did the cohort aged 35 in 1939. Since secular growth in the United States has been large, averaging almost 2 per cent per person per annum, the difference would be considerable.

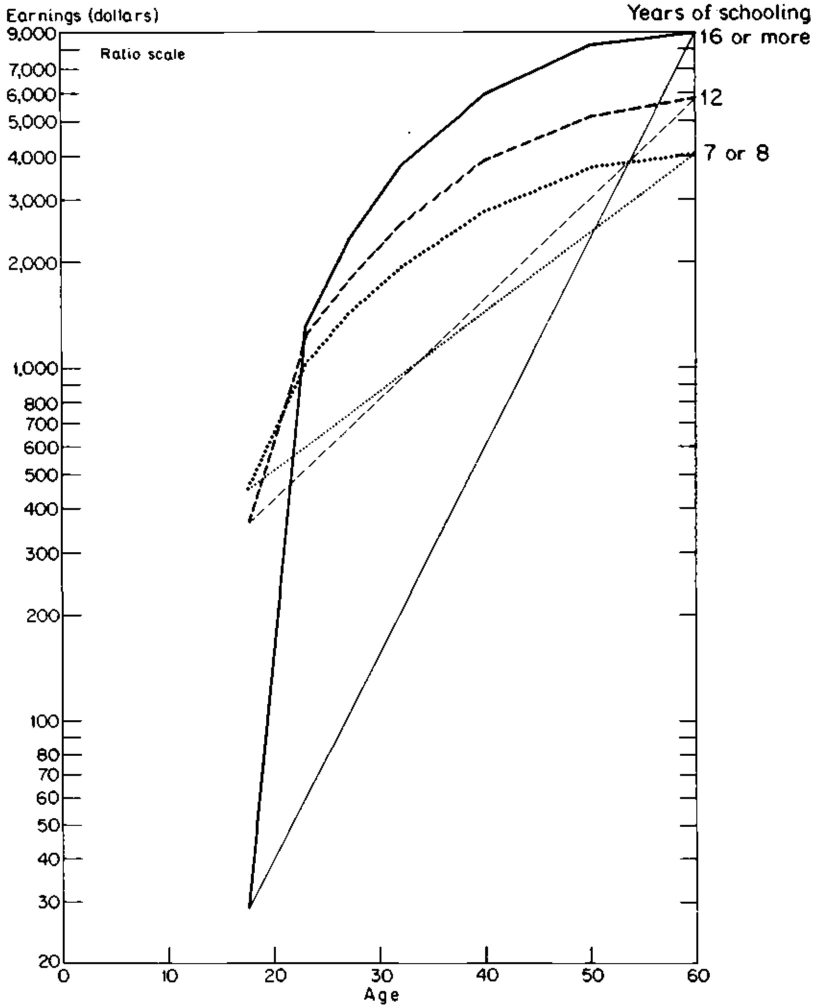
The cross-sectional education profiles have been converted into time series profiles only by adjusting very simply for the secular growth in incomes. The income t years later of a cohort finishing its schooling in a base year was estimated by multiplying the base year income of the cohort with the same schooling and t years older by $(1.02)^t$, where 2 per cent is the assumed average annual growth in incomes. For example, the cohort of college graduates aged 35 to 44 in 1939 had an income of $3400, and the estimated income at age 35 of a cohort graduating from college in 1939 at age 22 would be $3400 multiplied by $(1.02)^{13}$. Chart 10 plots such time series profiles for college, high-school, and elementary-school graduates of 1939.

This adjustment for secular growth is inaccurate on several counts. Although 2 per cent is a good estimate of the average growth in real per capita income since the 1880s, the growth during the last twenty-five years, especially in after-tax incomes, has been less. Moreover, Chapter VI suggests that incomes of less-educated persons grew more rapidly before 1940 and possibly less rapidly after 1940 than those of more educated persons. Consequently, a more accurate adjustment of recent data would have a lower average rate of growth and different rates at different educational levels. Since, however, none of the conclusions reached in this chapter would be greatly affected, I have retained a simple 2 per cent adjustment. The rate of return estimates in Chapters IV through VI are more sensitive, and different adjustments were tried there.

The profiles in Chart 10 do not decline at older ages, but continue to rise through age 65, the last age covered by the data. This perhaps surprising conclusion can be checked with data from surveys taken at different times, which provide an independent measure of the change over time in a cohort's income. For example, college graduates aged 45 to 54 in 1939 would be 55 to 64 years old in 1949, and the real incomes of 45- to 54-year-old college graduates in the 1940 Census could be compared with those of 55- to 64-year-old college graduates in the 1950 Census. Such evidence is not altogether reliable since the income concept is not the same in different surveys, sampling and response errors abound, and so on; nevertheless, it can serve as a check. Table 20, which brings together data from the 1940 and 1950 Census, and from a Census survey in 1958, indicates that a cohort's income increases more with age than is shown by cross-section data. In particu-

CHART 10

"Time Series" Age-Earnings Profiles for Several 1939 Education Cohorts



lar, there is no systematic tendency for time series profiles to decline in the last age class even though cross-section ones do.[10] The decline in the latter has been responsible for an erroneous inference about the

[10] The result may be due to selective retirement before the age of 65, since persons whose earnings would decline most might elect to retire early. I owe this point to J. Mincer.

TABLE 20

Estimated Incomes over Time of Cohorts at Different Educational Levels (dollars)

Age of Cohort in 1939	Income of Cohort in 1939	1949	1958
	COLLEGE GRADUATES		
25–34	5155	8960	12,269
35–44	8386	11,543	10,966
45–54	9430	10,732	—
55–64	8338	—	—
	HIGH SCHOOL GRADUATES		
25–34	3699	4812	6295
35–44	5380	5770	6510
45–54	5933	5798	—
55–64	5464	—	—
	ELEMENTARY SCHOOL GRADUATES		
25–34	2848	3610	4337
35–44	3823	3896	3960
45–54	4182	3586	—
55–64	3833	—	—

Source: Tables 2 and 3 and Appendix A, section 1.

shape of the former[11] which has made for misunderstanding of the economic position of older workers. For example, their retirement at 65 has been misinterpreted because their earnings have been assumed to be way below their peak earnings rather than possibly higher than ever.

The time series and cross-section profiles would be identical in a

[11] Whether Marshall's statement that occupation profiles eventually turn down held for time series profiles in nineteenth-century England is not clear. Many related statements for the United States, however, make no allowance for growth and thus incorrectly jump from cross-section data to a longitudinal inference. To take one of many possible examples, H. Miller said, "When he [the average male worker] is in his forties or early fifties he has usually attained the peak of his earning power, and from that time until he is ready to retire from the labor market his annual earnings shrink until they are not any higher than those he received as a young man" (*Income of the American People,* New York, 1955, p. 64). He then refers to cross-section data that would not decline (at least up to the age of 65) if adjusted for the annual growth in earnings.

stationary economy since they differ only because of the growth in per capita earnings. If growth were due to the operation of forces, like neutral technological changes, that uniformly raised earnings at all ages, cross-sectional profiles would be unaffected, while time series profiles would decline to the former if growth ceased. If, on the other hand, growth were due to the embodiment of new technology in younger (that is, "newer") workers, or to other improvements in the economic effects of the human capital invested in successive cohorts with the same number of school years, cross-sectional profiles would be affected by growth and would approach the shape of the time series profiles if growth ceased. For example, if new technology were embodied in younger workers, they would have greater technological knowledge than older workers, so cross-sectional profiles would understate, while time series profiles would accurately measure, the effect of age on the earnings of workers with the same technological knowledge. So even though the time series profiles were derived from cross-sectional ones by adjusting for growth, they may more accurately describe the relation between age and earnings in a stationary economy. In particular, earnings may not decline before age 65 even in such an economy.

Although all the profiles in Chart 10 rise continuously, they do so at very different rates, the average rate of increase being positively related to education. This is apparent from the lines connecting incomes at ages 14 to 21 with those at 55 to 64, for they have slopes of 15, 7, and 5.5 per cent, respectively, for college, high-school, and elementary-school graduates. The analysis in Part One indicated that investment in human capital steepens age-earnings profiles because earnings are net of investment costs at younger ages and gross of returns at older ages. Indeed, the proposition could be turned around and if two profiles differed in steepness, the steeper could be said to indicate the presence of greater human capital. Consequently, the positive relation between steepness and education in Chart 10 seems to support this approach.

It does, but note that the data plotted there include the effects of all investments in human capital, including vocational and on-the-job training, health, knowledge of economic opportunities, and so forth, as well as education. College graduates could have more education than high-school graduates and less total capital because, for example, the latter had more on-the-job and vocational training. If so, high-school graduates would have lower net earnings at younger ages, higher earnings later on, and a steeper profile than college graduates. Since the contrary is indicated, the main inference must be that there is a positive correlation between education and total capital.[12] This inference is quite sensible because education is presumably an important part of the total, and other kinds of investment in human capital, such as health, migration, adult education, and on-the-job training, appear to be positively related to education (see Chapter IV, section 2).

TABLE 21

Annual Rates of Income Change between Successive Age Classes for 1939 Cohorts at Different Educational Levels

Education (*years*)	$t = 23$ $t' = 18$ (*1*)	$t = 27$ $t' = 23$ (*2*)	$t = 32$ $t' = 27$ (*3*)	$t = 40$ $t' = 32$ (*4*)	$t = 50$ $t' = 40$ (*5*)	$t = 60$ $t' = 50$ (*6*)	$t = 60$ $t' = 18$ (*7*)
16+	.43	.19	.10	.06	.03	.01	.05
12	.17	.09	.07	.05	.03	.01	.04
8	.14	.08	.06	.04	.03	.01	.04
Simple average	.25	.12	.08	.05	.03	.01	.04

Source: The data plotted in Chart 10. The entries are computed from the formula $\frac{Y_t - Y_{t'}}{Y_t + Y_{t'}} \times \frac{2}{t - t'}$, where Y_t is income at age t, and $Y_{t'}$ is income at age t'.

The entries in Table 21 bring out precisely what should be apparent from even a cursory glance at Chart 10; namely, the profiles are quite concave to the age axis, especially at younger ages and higher educational levels. The concavity is shown by the continual decline in annual rates of increase between successive age classes, the declines being strongest at younger ages and higher educational levels. In addition, rates of increase of earnings with age differ appreciably only at younger ages; for example, the rate of increase is 30 percentage points higher for college than for elementary-school graduates between ages 18 and 23, while they increase at about the same rate between 40 and 60.

The theory developed in Part One also explains these results remarkably well. Earnings are depressed "artificially" during the in-

[12] The net earnings of young persons in Chart 10 are overestimated because the direct costs of certain investments (such as migration and health) do not tend to be subtracted from earnings. The overestimate is probably not too large, however, because many direct costs (such as on-the-job training and education) are subtracted, and indirect costs are usually more important than direct costs. Moreover, earnings at older ages would include the return on all investments, and they are clearly directly related to education.

vestment period because costs are written off then, and rise unusually rapidly afterward because the depressant is released. A concave age-earnings profile results, especially near the investment period which is concentrated at younger ages. Since the total amount invested is positively correlated with education, more-educated cohorts would have more concave profiles, again especially at younger ages. So a simple theory of investment in human capital can explain the differences in concavity as well as in steepness.

2. Age-Wealth Profiles

As pointed out in the introduction, in recent years there has been a shift in both theoretical and empirical work from flows to stocks, which suggests that, in studying life-cycle behavior, attention should be paid to age-wealth profiles as well as to the more familiar age-earnings profiles. This section discusses the influence of investment in human capital on the shape of age and human-wealth profiles (little direct attention is paid to nonhuman wealth).

Although the market value of human wealth cannot be determined directly because, happily, there no longer is a market in human beings, an indirect estimate can be based on the rule that the value of an asset equals the discounted sum of the income stream yielded. In others words, the value of the human wealth "owned" at a particular age would equal the discounted sum of subsequent earnings. So the shape of the relation between age and the discounted sum of subsequent earnings, which is called an age-wealth profile, would be completely determined by interest rates and the shape of age-earnings profiles.

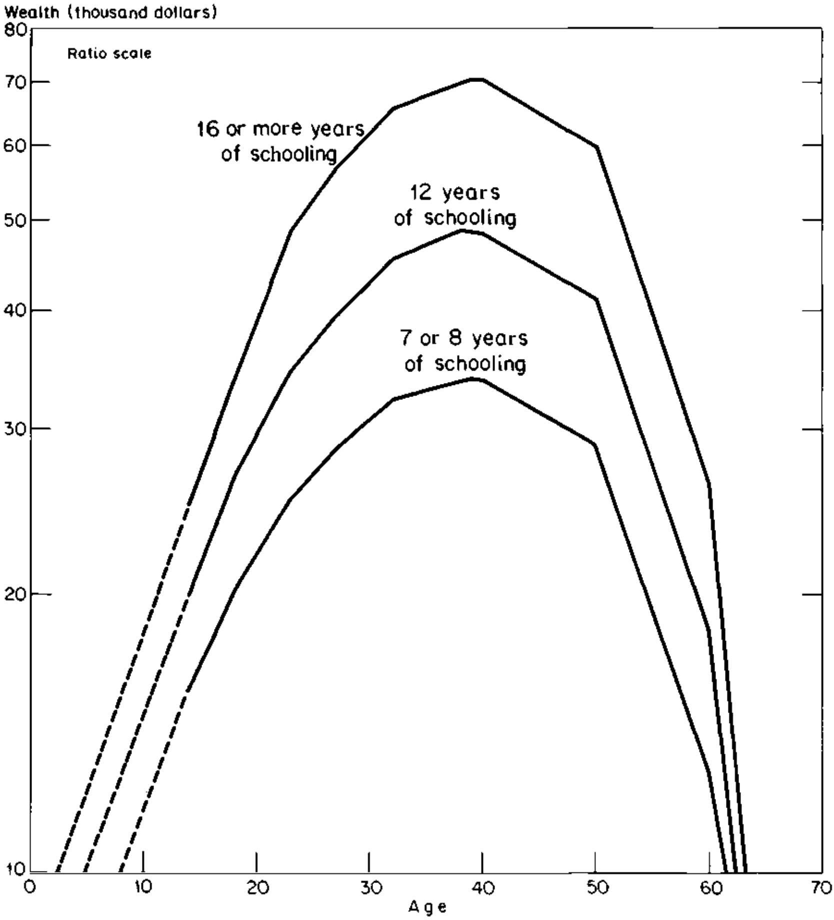
If interest rates were zero, age-wealth profiles would decline continuously because wealth would simply be the sum of subsequent earnings and, consequently, would have to decline with age regardless of the shape of age-earnings profiles.[13] If interest rates were infinitely large, wealth and earnings profiles would be identical; in particular, the former would rise as long as the latter did. With interest rates between these extremes, wealth profiles would peak somewhere between the initial and the peak earnings age, closer to the latter the higher the rates.[14]

[13] More precisely, they would rise only during periods of negative earnings. Since net earnings could be negative only during the investment period, even these rises would be at younger ages.

[14] See section 2 of Appendix B.

CHART 11

Age-Wealth Profiles of 1939 Graduates



Note: Earnings discounted at an 8 per cent rate.

Although time series profiles are clearly more relevant in calculating cohort wealth profiles than cross-sectional ones are, even the former have to be modified because they consider only the earnings of cohort members alive and participating in the labor force. They could be converted into the relevant cohort profiles with an adjustment for the fraction not participating at different ages. Since participation declines with age, the differences between time series and cohort profiles would be greater at older ages, especially at lower educational levels; in particular, the latter profiles would tend to turn down before age 65 even though the former did not. The peak in cohort earnings would be later, however, than that in cross-sectional earnings.

If a cohort earnings profile did not rise much, the wealth profile would necessarily decline continuously, at least if interest rates did not decline much with age. If earnings rose sufficiently, wealth would also rise, and the rate of increase in wealth would be positively related to, yet less than, that in earnings. Although wealth necessarily peaks before earnings, the peak wealth age would be later, the greater the increase and the later the peak in earnings.[15] Since the increase in earnings is related to investment in human capital, the increase in wealth and its peak age would also be related to this investment.

Chart 11 illustrates these effects by graphing the wealth profiles of the 1939 cohorts of college, high-school, and elementary-school male graduates.[16] All earnings have been discounted at an 8 per cent interest rate, about the average rate of return on business capital (see section 1 of Chapter V). Time series earnings were only adjusted for mortality, still by far the major cause of nonparticipation before age 65.

All the wealth profiles rise for about the first twenty years of labor force participation and then decline. The rates of increase are positively related to education, although the differences here are smaller than those in earnings. Wealth peaks at about age 39, some fifteen years before cohort earnings do. The peaks in wealth are not much affected by education because neither the peaks in earnings nor their rates of increase after the early thirties are much affected by education (see Table 21).

Investment in human capital explains not only these differences in wealth profiles, but also changes over time. For example, in the early nineteenth century wealth profiles usually peaked quite early, say at age 20 or so,[17] because mortality was high and workers were usually relatively unskilled. Unskilled workers with high mortality rates

15 For proofs of these assertions, see sections 2 through 4 of Appendix B.

16 Chart 11 was computed from earnings figures that are slightly different from and presumably less accurate than those used in section 1. Since the more correct figures would yield very similar wealth profiles, I have not bothered to make any corrections.

17 The value of a typical male Negro slave rose until he was in his early twenties, reached a peak there, and then declined for the rest of his life. (See R. Evans, Jr., "The Economics of American Negro Slavery, 1830–1860," *Aspects of Labor Economics*, Special Conference 14, Princeton for NBER. 1962. Table 12.) Since the value of slaves was determined by maintenance costs as well as productivity, the peak in the present value of subsequent productivity would have come still earlier, unless, as is unlikely, maintenance costs rose significantly during the late teens and early twenties. The present value of the earnings of unskilled free persons probably peaked at a similar age.

would have a flat or even declining (cohort) earnings profile,[18] and thus a continually declining wealth profile. The heavy investment in education, training, and health during the past hundred years has steepened the typical earnings profile and, consequently, shifted the typical peak wealth age to about 40.[19]

Before concluding, it might be wise to consider explicitly some applications of wealth profiles since they are less well known than earnings profiles and their importance may not be obvious to many readers. Two applications were chosen for their interest and timeliness. The first deals with the need to provide depreciation on human as well as physical capital and the second with life-cycle variations in savings.[20]

Many persons have suggested that a term accounting for the depreciation of human beings be subtracted from reported earnings. Irving Fisher, in his brilliant presentation of the conceptual foundations of the income and wealth concepts, said: "If it were true that income could never trench on capital, we could not reckon a laboring man's wages as income without first deducting a premium or sinking fund sufficient to provide for the continuance of this income after the destruction by death of the laborer." [21] If by "laboring man" is meant relatively unskilled, as seems reasonable, then Fisher's conclusion is supported by my analysis of age-wealth profiles. Since their earnings profile would not rise much with age, their wealth profile would tend to decline continuously. Wealth could be maintained constant, therefore, only if the rate of decline in wealth was subtracted from earnings at the same age and added to a depreciation or sinking fund.

In recent years emphasis has shifted from the laboring man to the educated man and from conceptual issues to more practical ones. Tax laws are said to discriminate against education and other kinds

[18] There is some evidence that the productivity of male Negro slaves did not change much between their twenties and fifties (see J. R. Meyer and A. H. Conrad, "The Economics of Slavery in the Ante Bellum South," *Journal of Political Economy*, April 1958, p. 106).

[19] For example, the profiles plotted in Chart 9 would have peaked several years earlier if mortality rates of the middle-nineteenth century had been used.

[20] I omit possibly the most well-known application, namely, to the relation between age and life insurance. This stimulated the pioneering book by L. Dublin and A. Lotka, *The Money Value of a Man*, New York, 1930, revised in 1940. Also see B. Weisbrod, "The Valuation of Human Capital," *Journal of Political Economy*, October 1961, pp. 425–436. A related application is to damage suits resulting from disability or death. An absorbing example is given in the best seller by L. Nizer, *My Life in Court*, New York, 1961, Chapter 5, section II, entitled "The Worth of a Man."

[21] *Nature of Capital and Income*, New York, 1930, p. 111. Fisher, however, argued against the use of this "ideal" definition of income.

of human capital because depreciation can be deducted only from the taxable income of physical capital.[22] Unquestionably, a more symmetrical tax treatment of these two classes of capital would be desirable. However, one should be aware that a good deal of depreciation on human capital occurs unknowingly. Thus, as pointed out elsewhere, part of the costs of human capital are "written off" immediately because foregone earnings are, in effect, deducted from accrued taxable income.[23] Since these indirect costs are about 75 per cent of the private costs of college education in the United States,[24] and an even higher percentage of general on-the-job training costs, the depreciation unknowingly permitted is considerable. Indeed, the present value of the amount so permitted would often be greater than that explicitly allowed on physical assets depreciated over a five- or ten-year or even longer period!

Some important relations between depreciation and human capital can be obtained using age-wealth profiles if true income were simply defined as the amount necessary to keep wealth intact.[25] Then the depreciation or "appreciation" necessary to convert reported into true earnings would simply equal the rate of change in wealth. Consequently, the depreciation could be said to be insufficient whenever wealth declined and excessive whenever it increased.

Since the wealth profile of unskilled workers would decline continuously, an explicit depreciation deduction is needed at each working age. The profiles of skilled workers, on the other hand, rise for a spell and the rises are larger and steeper, the greater the investment in human capital. Consequently, since their true earnings would actually be greater than reported earnings at younger ages and less only after the peak wealth age, an appreciation term would be required at all ages before the peak in wealth. So while tax laws can be said to discriminate against all unskilled and older skilled workers, they discriminate in *favor* of younger skilled workers. Of course, during the whole period of labor force participation there would be a net decline even in the wealth of skilled workers. But it would be relatively small: for example, using an 8 per cent interest rate, the average annual depreciation in the wealth of workers with a flat earnings profile (during an assumed forty-two-year earning period)

[22] See T. W. Schultz, "Investment in Human Capital," *American Economic Review*, March 1961, p. 13, and R. Goode, "Educational Expenditures and the Income Tax," in *Economics of Higher Education*, S. J. Mushkin, ed., Washington, 1962.

[23] See Chapter II, section 1, and Chapter V, section 1.

[24] See Chapter IV, section 1.

[25] Such an ideal definition is not necessary for our purposes, but it does simplify the discussion.

would equal 30 per cent of average earnings while that of the 1939 cohort of college graduates would equal only 18 per cent of their earnings.[26]

So death rather than investment in human capital appears to be the main reason why reported earnings, on the whole, overestimate true earnings. When the former is the principal determinant of wealth changes, as with unskilled workers, depreciation bulks large relative to earnings, but when the latter is more important, as with skilled workers, depreciation becomes less important. Probably the major explanation of this paradoxical conclusion is that much depreciation is unknowingly permitted on human capital.

In recent years studies of household behavior have been greatly influenced by the argument that current expenditures depend not only on current income but also on expected future income.[27] In particular, total consumption at any age would be affected by expectations about incomes at later ages. So life-cycle variations in consumption would not match those in earnings because the latter would be at least partly anticipated and then offset by appropriate savings and dissavings.[28] It shall be demonstrated that this new approach makes life-cycle changes in savings a function of age-wealth profiles and thus indirectly of the amount invested in human capital.

A lifetime consumption pattern is assumed to depend upon utility functions, expectations about earnings and other income, market interest rates, and planned bequests. Since savings are residually defined as the difference between income and consumption, savings are adjusted over a lifetime so as to make the consumption plan feasible. In particular, since earnings are high during the middle ages and low during the younger ages and retirement, the rate of savings would also be high during the middle ages and low or even negative during other periods. Broadly speaking, this pattern is usually found in empirical studies.[29]

More precise implications can be obtained by specifying the model more fully. In order to bring out clearly and simply the effects of

26 See section 5 of Appendix B for a more general result.

27 See especially Friedman, *Consumption Function*.

28 This approach to life-cycle consumption patterns has been stressed by F. Modigliani and his associates. See Modigliani and Brumberg, in *Post-Keynesian Economics*, or F. Modigliani and A. Ando, "The Life Cycle Hypothesis of Savings," *American Economic Review*, March 1963.

29 See Friedman, *Consumption Function*, Tables 8 and 9, and F. Modigliani and A. Ando, "The 'Permanent Income' and the 'Life Cycle' Hypothesis of Saving Behavior: Comparison and Tests," in *Consumption and Saving*, I. Friend and R. Jones, eds., Vol. II, Philadelphia, 1960, Table III-4.

human capital, several assumptions will be added that certainly have to be modified in a more complete analysis. Thus, let it be assumed that each cohort knows its earnings profile, that a single market interest rate applies to all transactions, that consumption is the same at all ages, and that after entry into the labor force the nonhuman wealth of a cohort can be changed only by its own savings and dissavings.[30] Each cohort starts out with wealth, partly in earning power and partly in property, and at "its" death leaves behind wealth, partly in the earning power of descendants and other subsequent cohorts and partly in property.

If its bequest, or terminal wealth, equaled the amount it was bequested, or initial wealth—that is, if there were zero generational or "social" savings—the rate of savings[31] at any age would exactly equal the rate of change of human wealth.[32] So savings would be negative from the initial to the peak human-wealth age, zero then,[33] positive at subsequent ages until retirement, and zero during retirement. A more reasonable assumption for the United States and other developed economies would be that social savings were positive, or that terminal wealth exceeded initial wealth. Then the initial dissavings would be smaller and of shorter duration, the zero savings rate would be reached before the peak wealth age, and a positive savings rate would continue into the retirement period.

Since the wealth profile of unskilled workers would decline continuously, they would have positive savings throughout their labor force period. Profiles of workers with investment in human capital, on the other hand, rise initially more sharply and longer, the greater the investment. So the magnitude and extent of the initial dissavings would be greater for cohorts with more human capital.

Since an initial period of dissavings would result in an initial decline in nonhuman capital, an increase in indebtedness, or some of both,[34] the large secular increase in human capital should have caused a secular increase in household indebtedness. Therefore, the

30 These assumptions, as well as several others, are also made by Modigliani *et al.* in their quantitative work.

31 Note that our concept of savings, unlike the usual ones, includes investment in the human capital of subsequent generations as well as accumulation of assets.

32 In terms of the language just used, savings would equal the rate of depreciation or appreciation on wealth.

33 Before retirement, only at the peak wealth age would permanent income, defined as the income accruing on wealth, equal actual income. So depreciation and thus savings equal zero when actual and permanent incomes are equal.

34 Consequently, one can say that investment in human capital is substituted for investment in other capital.

observed increase in consumer credit and other debt may not have resulted simply from an increased demand for durables or from improvements in the market for credit, but probably also was a disguised effect of the secular increase in education and other human capital.

A change in the rate of population growth would probably change aggregate, although not necessarily social, savings because the relative number of persons at different ages would be affected. If savings rates were always greater at younger than at older ages, an increase in population growth would increase the aggregate savings rate. Such would tend to be the result in a world of unskilled workers because they would save more throughout the labor force period than during retirement.[35] Skilled workers, on the other hand, would have low and even negative savings rates at the youngest ages, and a larger population growth rate might actually reduce their aggregate savings rate. Therefore, the secular increase in human capital should have reduced the positive effect of a higher population growth rate on aggregate savings, and might even have led to a negative effect.

[35] This essentially is the model assumed by Kuznets in his discussion of the effect of population growth on aggregate savings. See his *Capital in the American Economy: Its Formation and Financing*, Princeton for NBER, 1961, Chapter III. Also see Modigliani and Ando in *American Economic Review*, March 1963, pp. 59–60.