Volume Title: Higher Education and Earnings: College as an Investment
and Screening Device

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Volume Publisher: NBER

Volume ISBN: 0-07-010121-3

Volume URL: http://www.nber.org/books/taub74-1

Publication Date: 1974

Chapter Title: Appendix J: Interpolation Methods

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Chapter URL: http://www.nber.org/chapters/c3665

Chapter pages in book: (p. 245 - 252)

Appendix J: Interpolation Methods

In Table 6-1 (p. 115) we presented estimates of the mean income earned by education level in the years 1955, 1968, and 1969.[1] In addition, in Table 5-10 (pp. 108–109) we presented estimates of starting salary by year and education level. For such purposes as computing rates of return, we need a complete profile through age 65 for a person 24 years old in 1946 who had no higher education before the war.[2] The purpose of this section is to describe the various interpolation procedures used. To make maximum use of the data available, we used different interpolation devices for the periods 1946–1950, 1950–1955, 1955–1969, and after 1969.

Consider first the period 1946–1950. We have estimates on starting salary by education level during this interval. Some of the sample sizes are too small to be reliable, but the estimates for those with an undergraduate degree are large for 1947 to 1950 and reasonable in 1946. For those with some college we have large samples from 1946 through 1949, for high school graduates only the 1946 sample has more than 100 people, and for those with graduate training we have large samples from 1948 through 1951.

For the large samples, we use average initial salary as a starting point. The numbers after 1946 must be adjusted because those who began work in 1946 received lower salaries than those beginning work later. In our analysis of 1955 data, we estimated the effect of both age and postwar time-on-the-job vari-

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[1] We presented estimates based both on the average ability and background characteristics of each education level and on the average high school graduate.

[2] We shall indicate below how to convert the profile to apply to an individual who was 18 years old in 1946.

ables. The latter seemed more appropriate for adjusting initial salaries. After correcting the coefficient estimated in 1955 for inflation, we determined that each year on the job after 1946 added about $112 to income.[3]

Since we are interested in the profile of a person deciding on higher education in 1946, we do not need college-graduate incomes until 1950.[4] However, we interpolate the income of high school graduates using incomes of college graduates. In Table J-1, we give the adjusted incomes of the college graduates. (The unadjusted estimates are in parentheses.) Next, we compute G for 1946 and 1955 from $Y_{HS} = Y_{BA}/(1 + G)$, where Y_{HS} and Y_{BA} are the incomes of high school graduates and college graduates. From 1946 to 1955, G rose from 1.5 to 12 percent. We judge this change to be a valid representation of the real world for two reasons. First, the low value in 1946 is confirmed by the ratios that can be calculated from the much smaller samples of 1945, 1947, and 1948. Second, most theoretical and empirical work would suggest that the age-income profiles of the more educated are steeper. We then interpolated G linearly and estimated high school incomes by applying the above formula to the adjusted Y_{BA} in the years 1947 to 1950.

For the period 1951–1954, there are no directly relevant data. Rather than interpolate college-graduate income linearly, however, we based our estimates on the percentage change in the median income of white males in each year relative to the total percentage change in this median income from 1950 to 1955. Then we applied $Y_{BA}/(1 + G)$ to these estimates.

Our income figures are, of course, only estimates, but we would expect these to be accurate enough for our purposes. The B.A. income figures from 1947 to 1950 are in each year based on more than 100 observations, while the time-on-the-job effect is close to that estimated from Miller (1960). Our estimates of G between 1946 and 1955 are interpolations, but the errors introduced here should not be great. For example, if in 1953 G were 5 percent rather than 10 percent, our estimate of the high

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[3]The data presented in Miller (1960) yield estimates of the same magnitude for 1946.

[4]Following Becker (1964), we set their part-time earnings to one-quarter of the average high school graduate's earnings.

[5]Constant-dollar figures are given in U.S. Bureau of the Census (1966). To the percentage change implied by these figures we added the percentage change in the Consumer Price Index.

Year	Earnings of those with undergraduate degrees— adjusted for time on the job		G	Earnings of high school graduates
1946	$3,433		1.5%	$3,342
1947	3,576		2.7	3,480
1948	3,970		3.9	3,820
1949	3,850		5.1	3,660
1950	4,250	(3,800)	6.3	4,000
1951	5,471	(5,271)	7.5	5,089
1952	5,935	(5,835)	8.7	5,460
1953	6,277	(6,233)	9.9	5,711
1954	6,228	(6,188)	11.1	5,605
1955	6,720	(6,720)	12.0	6,000

NOTE: Unadjusted estimates are in parentheses.

school graduate's income would be 5 percent higher. Random errors of this magnitude have little effect on our computations discussed on pages 123 to 131. The interpolations for the average college graduate's income between 1951 and 1954 are crude, but since we primarily use differences in income, much of the error in the levels is not crucial.

For those with some college, we used the sample information from 1946 to 1949 and then interpolated through 1955 on the basis of median wage incomes. The results are given in Table J-4, in which the whole profile is presented. The estimate for those with graduate training is taken from the sample information in 1952, and in other years the estimates are set at the 1950 estimate of 94 percent of earnings of those with college degrees.

Beginning in 1956, we have more information that we use in a different interpolation scheme. The U.S. Bureau of the Census has published periodically since 1955 mean incomes of males in various age and education groups.[6] Using the mean age in our

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[6] The estimates are in *Current Population Reports* (U.S. Bureau of the Census, 1968). The data are available for 1956, 1958, 1961, 1963, 1964, 1966, and 1968. In all these years, it is possible to obtain data on high school graduates, those with one through three years of college, and those with four years of college. After 1956, separate estimates are available for those with four years of college and those with four or more years. We assume that from 1956 to 1958 both these categories grew at the same rate as the group with four or more years of college.

TABLE J-2 *Mean income and earnings for 33- and 48-year-olds in 1955 and 1968: Current Population Reports (income) and NBER-TH (earnings) (in dollars)*

	High school	Some college	College degree	Some graduate work	Master's	Ph.D.	LL.B.
Current Population Reports							
(1) 1955	4,680	5,400	5,985		7,200		
(2) 1968	9,106	11,072	14,281		17,223		
NBER-TH*							
(3) 1955	6,000	6,600	6,720	6,900	6,612	6,140	7,150
(4) 1968	13,968	15,852	17,232	16,908	17,906	16,715	24,189
1955 ratio (3)/(1)†	1.28	1.23	1.12	.96	.92	.85	.99
1968 ratio (4)/(2)†	1.53	1.43	1.21	.98	1.04	.97	1.40

*Calculated at the characteristics of the average high school graduate.

†For the graduate levels, each item in (3) and (4) is divided by the income figures for all graduates given in (1) and (2).

sample, we estimate mean income for the years available from the corresponding age group in the census or, where necessary, from the average of two age groups. In order to compare our sample with the census, we need data from both for the same year. This information is available in 1968 and can be estimated for 1955 by adjusting the 1956 census estimate to match the change from 1955 to 1956 in median money wages of white males. These estimates and their ratios are given in Table J-2.

In each instance, our series grew faster than the census series. Since our sample consisted of high-ability people and since we have already shown that the income of the more able grew faster than that of the less able, this increase in the ratio seems reasonable (though, of course, the 1955 estimate is not as good as that for 1968, since no appropriate *Current Population Reports* were available for 1955).[7] Therefore, we spread the difference in the ratios evenly from 1955 to 1968. Note that since the difference in the ratio for 1955 and 1968 is not large in any education category, the differences in income across education

[7]Given the high average ability in our sample, our high school graduates should be relatively more able—compared to the population—than the more educated in the sample; thus, it is encouraging to find the ratio decreasing as educational attainment increases.

groups are approximately the same as if the 1968 ratios had been used.

Finally, we filled in the missing years from the *Current Population Reports* on the basis of movements in median income of white males. The data from the *Current Population Reports* and our estimate for all years are given in Table J-3. In Table J-4, we present the entire ex post age-income profiles (through 1969) for the different education categories.

The above profiles were derived for people who were 24 in 1946. While this is the average age in our sample, most rates of return are calculated for 18-year-old high school graduates. It is necessary, therefore, to convert the profile for a 24-year-old to one for an 18-year-old. The basic hypothesis is that employers will pay nothing for skills learned during World War II. With this assumption, the initial salary of an 18-year-old high school graduate would be the same as that of the 24-year-old in our sample, while in 1950 the starting salaries of undergraduate-degree holders would be the same for 28-year-old veterans and for 22-year-old nonveterans. Assuming, then, that the effects of

TABLE J-3
Nationwide mean earnings of age groups over time, by education level (in dollars)

Age in our sample	Year	High school	Some college	Under- graduate degree	Graduate degree (s)
33	1955	$4,680	$ 5,400	$ 5,985	$ 7,200
34	1956	5,200	6,000	6,650	8,000
35	1957	5,250	6,150	6,900	8,300
36	1958	5,300	6,300	7,150	8,650
37	1959	6,000	7,500	9,000	10,200
38	1960	6,200	7,800	9,500	10,600
39	1961	6,411	8,100	10,000	11,000
40	1962	6,900	8,200	10,350	11,200
41	1963	7,200	8,300	10,700	11,300
42	1964	7,300	8,600	10,900	12,400
43	1965	7,800	9,400	12,000	13,700
44	1966	8,250	10,200	13,000	15,000
45	1967	8,700	10,600	13,500	16,000
46	1968	9,106	11,072	14,200	17,200

SOURCE: U.S. Bureau of the Census (1968, 1969) and interpolations described in Chapter 6.

TABLE J-4 *Ex post age-income profiles, 1946–1969 (in dollars)*

	High school	Some college	Under-graduate degree	Some graduate work	Master's	Ph.D and LL.B.
1946	3,392					
1947	3,480					
1948	3,820	4,377				
1949	3,660	4,240				
1950	4,000	5,207	3,800			
1951	5,089	5,798	5,271	4,223	4,223	
1952	5,460	6,104	5,835	5,213	5,103	
1953	5,711	6,317	6,233	5,909	5,722	
1954	5,605	6,293	6,188	5,829	5,650	5,814
1955	6,000	6,600	6,700	6,900	6,612	6,732
1956	6,767	7,492	7,533	7,724	7,466	7,713
1957	6,734	7,773	7,885	8,071	7,869	8,245
1958	7,102	8,058	8,243	8,473	8,331	8,845
1959	8,156	9,708	10,466	10,063	9,975	10,726
1960	8,547	10,215	11,144	10,532	10,812	11,456
1961	8,963	10,731	11,830	11,008	11,086	12,210
1962	9,780	10,989	12,348	11,287	11,454	12,758
1963	10,344	11,249	12,873	11,468	11,725	13,202
1964	10,629	11,787	13,223	12,671	13,051	14,848
1965	11,508	13,027	14,678	14,097	14,624	16,805
1966	12,332	14,292	16,031	15,541	16,235	18,836
1967	13,171	15,014	16,534	16,220	17,062	19,980
1968	13,961	15,851	17,232	16,908	17,906	21,157
1969	13,212	15,423	17,280	16,635	17,402	21,230

experience on income also do not depend on military service, we can use the same age-income profile for an 18-year-old as for our 24-year-old veteran, except that we must add six more years at the end. This hypothesis, of course, need not be correct. In particular, we would expect some vocational training in the Air Corps to be of value in civilian life. Hence, we would expect 18-year-olds to earn somewhat less than the people in our sample at all education levels, at least until the 1960s.[8] If the age-in-

[8]This would be particularly true of pilots in our sample.

come profile reflects aging as well as experience, however, we would expect the income profile of the 18-year-olds to reach a peak after the incomes of those in our sample reach a peak. We judge the net effect of these changes to have a small impact on the rate of return.

CROSS-SECTION PROFILES The basic data on income by age and education are taken from Miller (1960) for 1946 and 1949 and from the *Current Population Reports* for 1968. These data provide estimates of the income differences due to education at the average ages of 30, 40, 50, and 60. These differences are biased upward because no account has been taken of ability and background factors. We correct these estimates of income differences on the basis of the ratios of our returns to education after correcting for age, ability, biography, and background to our estimates with only age held constant. These ratios, which we calculated from our 1955 and 1969 equations, are given in Section A of Table J-5.[9] We

[9]These corrections differ from those in Chapter 5 because all background and ability variables are omitted.

TABLE J-5 *Bias corrections by age and education level, 1946, 1949, and 1968*

A. Bias from omitting ability and background as a percentage of unadjusted return to education

Age	Some college	B.A. plus Graduate	B.A.	Graduate
33	32	43	44	43
47	30	30	32	30

B. Change in bias by cohort because of shifts in δ where $A = \delta_0 + \delta ED$

Average date of high school graduation of cohort	δ
1957	.52
1947	.52
1937	1.0
1927	1.0
1917	.43
1907	.43

NOTE: *ED* is the percentage of high school graduates who enter college. *A* is the percentage rank on an IQ test.
SOURCE: Taubman and Wales (1972).

used these two bias corrections for ages 30 and 50 and obtained the biases at 40 and 60 by linear extension.

These corrections assume that the relationship between ability and education is the same in each cohort as in our sample. Even assuming that this is the case for the whole cohort aged 33 in 1955, evidence in an earlier paper of ours (Taubman & Wales, 1972) suggests that this would not be true for other cohorts. Thus we have adjusted the bias by the ratios given in Section B of Table J-5. Also, as discussed in Chapter 7, we adjusted these profiles for technical change in calculating ex ante rates of return.