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7. Rates of Returns to Education Based on the NBER-TH Data

In previous chapters we estimated the effect of education on earnings at several points in time. The extra income resulting from education is not constant from year to year. There are several possible explanations for this variation. For example, while education may better equip a person to handle very difficult jobs, he may only be responsible for these jobs after gradual promotions. Hence, more highly educated people will gradually display the extra marginal product gained from education, and earnings differences will grow over time.[1] Alternatively, skill levels may change over time because of maturation or, later in life, because of mental and physical deterioration. These changes need not be constant for people with different education levels. Finally, educational earnings differences may vary by age because people "invest" in on-the-job training as defined by Mincer (1970).

Thus, to determine if the extra earnings from education are enough to justify the investment in schooling, it is customary to compute the internal rate of return or the present discounted value of the incremental income stream arising from education.[2] With I_t representing the costs of an incremental investment in education, *PDV* the present discounted value of the additional net income stream obtained from the investment, r the internal rate of return on the education increment under discussion, i the interest rate, and X_t the extra income earned in year t at-

[1] Earnings and promotions can also reflect the benefits from on-the-job training.

[2] If Mincer (1970) is correct, this is the combined rate of return to education and general on-the-job training.

tributable to education, the two concepts can be expressed as

$$0 = \sum_{t=1}^{n} \frac{X_t - I_t}{(1+r)^t} \tag{7-1}$$

$$PDV = \sum_{t=0}^{n} \frac{X_t - I_t}{(1+i)^t} \tag{7-2}$$

While a substantial body of literature exists on the relationship between the two formulas, for our purposes the rate of return as defined in Eq. (7-1) is sufficient.[3] This rate of return clearly depends upon the cost of investment I_t and the profile of the extra income due to education X_t.

COST OF THE INVESTMENT

The relevant costs of an investment in education are not the same for an individual as for society. For an individual, the costs consist of earnings forgone while attending school, tuition, fees, and other school-related expenses.[4] Since the latter expenses are quite small and since data on tuition and fees are readily available, the only difficulty in estimating costs is in measuring forgone earnings. We estimate forgone earnings at each ability level from the data on earnings on initial job by education level but reduce it by an estimate of student's summer and part-time earnings.

From society's viewpoint, direct costs are all the resources used in educating individuals. In general, it is not appropriate to use the average expenditure per pupil at higher education institutions as the resource cost if average and marginal costs are not the same. Because of lack of information, however, we will follow other investigators and will use the average rather than the marginal cost. In addition, we do not distinguish between graduate and undergraduate costs, although we do follow Becker and others in attributing a fraction of total educational costs to research.[5]

[3] For a discussion of the relationship between the concepts, see the articles in Soloman (1959).

[4] The arguments summarized in Bowman (1966) that alternative costs are irrelevant when there are compulsory-school-attendance laws are not appropriate at this level of education.

[5] A discussion of cost calculations appears in Appendix K.

EX ANTE AND EX POST RETURNS

It is necessary at this point to distinguish between an ex post and an ex ante rate of return to education. We define an ex post return as the rate that an individual actually receives from his investment in education; that is, we use the *actual* differences in income that occur in each year during the working lifetime of two individuals alike in all respects but education. We define the ex ante return as the rate that an individual expects to make at the time he undertakes the investment;[6] that is, we use earnings that the individual anticipates will occur in future years of his working life.

Ex post returns should be calculated by using earnings of a group of individuals throughout their working lifetimes. Although no such (longitudinal) study has ever been completed, the NBER-TH sample, which spans at least 25 years of working lifetime, can be used to approximate a life-span.[7] If the economy is on a balanced growth path, this ex post rate of return will also be received by individuals in other cohorts. Of course, the economy may not be on a balanced growth path. Given the rapid increase in educational attainment after World War II, we would not be surprised if the rate of return realized by individuals educated in the late 1940s were greater than the return that will be realized by individuals currently going to college.

The expected, or ex ante, rates of return can be estimated in as many ways as expectations can be formed. The method that has been most often used in economics and that we will follow involves converting cross-section earnings data of cohorts to an expected time profile. The conversion process assumes, among other things, that the economy is on a balanced growth path. Because this method has often been used in the literature, we shall not discuss it here in detail (see Miller, 1960; Becker, 1964; and Hanoch, 1967). Basically, the method assumes that one can estimate what an average person with a given amount of education and other measured characteristics will be earning n years later on the basis of the average income currently being earned

[6] For simplicity, we shall assume that an individual decides at the end of high school the number of additional years of schooling he will obtain. This assumption allows us to avoid the "option" benefit of education discussed in Weisbrod (1964).

[7] Rogers (1967) has used sample data to approximate an ex post return. In addition, Project Talent (1964) plans to follow a group of students from elementary and high school through their lifetimes, but the study began only in 1960.

by people with the same characteristics, but in a cohort n years older. When this assumption is applied to all other cohorts, it is possible to estimate age-income profiles at any education level. These age-income profiles must then be adjusted for mortality rates and technological-change rates.[8]

THE EX POST RATE OF RETURN IN THE NBER-TH SAMPLE

In Appendix J, we present our estimates of the age-earnings profiles by education level for people with a given set of personal characteristics. We use these profiles, together with the cost estimates presented in Appendix K, to estimate the rate of return to various levels of education.

We calculate these returns for individuals in our sample under the following assumptions. First, to obtain rate-of-return estimates applicable to the population as a whole, we do not include GI education benefits as offsets to forgone earnings. Second, we assume that, as in our sample, the average age of people about to undertake higher education in 1946 was 24. We also calculated a rate of return for people identical to those in the sample, but who were 18 in 1946. Since these rates of return

[8] As shown in Becker (1964), the mortality adjustment does not have a large impact on rates of return, and it will be omitted here.

TABLE 7-1
***Ex post* rates of return to higher education**

	Private			
	Not deflated		*Deflated*	
Educational categories	*After tax*	*Before tax*	*After tax*	*Before tax*
High school to:				
Some college	15.0	14.8	11.7	11.5
B.A. (not teacher)	9.7	10.7	7.3	8.2
Some graduate (not teacher)	7.0	8.0	4.7	5.6
M.A. (not teacher)	7.7	8.5	5.4	6.2
Ph.D	3.6	4.4	1.4	2.2
LL.B.	11.3	11.8	9.0	9.4
Some college to B.A.		7.4		5.2
B.A. to LL.B.		13.1		11.0

NOTE: In these calculations we have assumed that the differences in income (in current prices) for the various education categories will remain at 1969 levels for the next 18 years.

are very similar, we restrict discussion to rates of return to 24-year-olds.

In Table 7-1, we present four types of rates of return: deflated, not deflated, private, and what we and others call social.[9] The social return, however, does not include the value of any externalities. The costs used in calculating the social rates of return are forgone earnings set at three-quarters of the earnings of high school graduates (until a B.A. is obtained) plus the resource cost per student in higher education. The private costs are forgone earnings plus expenses for tuition and college-related items. In neither case do we allocate any of the costs for current consumption or future nonmonetary benefits from education. While some of the future benefits may be negative—for example, alienation—the sum of these benefits is probably positive. Thus, we probably underestimate the total return to education. The undeflated returns indicate what individuals actually received, while the deflated returns eliminate the effects of inflation on the level of earnings differentials and yield a real rate of return.

[9] In extrapolating to age 65 we have assumed that current-dollar income differences between education groups remain at the 1969 level. This assumption is supported by evidence in Miller (1960) and Becker (1964). However, we do test the sensitivity of our results to this assumption.

	Social			
	Not deflated		*Deflated*	
Biased	*Whole sample*	*High ability*	*Whole sample*	*High ability*
15.9	13.7		10.5	
12.2	10.0		7.6	
9.4	7.4	8.4	5.1	6.1
9.9	8.0	8.9	5.7	6.6
7.3	3.8	4.9	1.7	2.7
12.5	11.1	11.7	8.7	9.4
	7.0		4.9	
	12.3		10.1	

RATE OF RETURN TO A BACHELOR'S DEGREE

The undeflated social rate of return from completion of high school to a bachelor's degree is 10 percent. (There is no difference between a B.S. and a B.A.) This estimate is admittedly based on a number of assumptions that may be inappropriate. Perhaps the assumption based on the least amount of information is that current-dollar differences in income will remain at their 1969 level for 18 more years. However, even if we let this difference grow at the rate of 3 percent a year, so that the difference is 70 percent larger by the end of 18 years, our estimate of the rate of return rises only from 10 to 10.4 percent. If this difference declines at the rate of 3 percent a year, the rate of return falls from 10 to 9.4 percent. Another possible source of error is that our estimates of the average resource cost of educating a student may not be accurate. If we decrease these costs by 10 percent, the rate of return increases trivially from 10 to 10.1 percent. A halving of these costs raises the rate of return to 10.7 percent. Another possible source of error is in our estimates of forgone earnings, which happen to be equal to about four times the resource costs. Since forgone earnings enter the rate-of-return calculation in the same way as resource costs, changes in the rate of return of the same magnitude as given above (0.1 and 0.7 percentage points) would require errors of only 2.5 and 12 percent in the forgone-earnings estimates. While a 2.5 percent error in our initial-earning series is quite possible, a 12 percent error is not as likely, and even this error would not greatly affect our calculations. Thus, we conclude that the rate-of-return estimates are not sensitive to these assumptions or estimates.

If we deflate all incomes by the Consumer Price Index (CPI), which we assume increases beyond 1969 at the rate of 2 percent per year, the social rate of return falls sharply from 10 to 7.6 percent. It is often thought that the CPI is biased upward because of its inadequate treatment of quality changes. If we were to allow for a bias of 1 percent per year in the CPI, the deflated social rate of return would be about 8.7 percent. In either case, the inflation since 1946 has had a fairly large effect on the rate of return.

The calculations given in Table 7-1 are for a person with the ability and background characteristics of the average high school graduate in our sample. Except for graduate education, these estimates also apply at other levels of ability because (1)

forgone earnings are the same at all ability levels, (2) for subsequent earnings the effect of ability is the same at all education levels, and (3) we assume that tuition payments do not vary with ability. This does not mean that standardization for ability and background is unimportant. In the *Biased* column of Table 7-1 we present social undeflated rates of return when ability, background, and biography are not held constant. In this instance, the social rate of return is about 12.2 percent rather than 10 percent.

Finally, we consider the private rate of return to a B.A. degree. On a before-tax basis, the estimate is 10.7 percent (and 8.2 percent when deflated). Private returns, however, should be calculated on an after-tax basis. Although we have not had the time and resources to adjust our profiles using progressive tax rates, we have made the following rough adjustment. We use an average tax rate of 12.5 percent for those with at least a B.A. and 10 percent for everyone else, and we assume that part-time earnings of students are not taxed. Considering that no one in our sample earned much more than $100,000 in 1969, these assumptions probably overstate the average tax burden. Using these tax rates, the private rate of return declines from 10.7 to 9.7 percent.

RATE OF RETURN TO COLLEGE DROPOUTS

Next we consider the rate of return for those who attended but did not graduate from college. As shown in Table 7-1, the social rate of return is 13.7 percent (16 percent with no ability and background standardization) but falls to 10.5 percent when the effects of inflation are eliminated. That the rate of return to some college is substantially more than for college graduation (13.7 versus 10 percent) is surprising in that previous studies have generally concluded the opposite (see Becker, 1964; and Morgan & David, 1963). Part of the explanation may be the greater concentration of business owners in our sample in the some-college group. (In 1969 about 30 percent of the some-college group were business owners.) The "earnings" figures reported by the self-employed may include a return to financial investment in their businesses. A rough adjustment for such returns can be made by holding constant self-employment via a dummy variable. The results of such equations for 1969 were reported in Chapter 5. But even if the same 25 percent adjust-

ment found for business owners in 1969 is made for each year, the rate of return to some college is unchanged, and is still slightly greater than the rate for an undergraduate degree.

Our primary explanation for this better performance of the people with some college is the following. By the end of World War II, the men in our sample ranged in age from 22 to 30, with an average age of 24. Many of these men were married and had children before, during, or right after the war. Despite the availability of the GI Bill, many married men probably could not afford to wait to start providing for their families. Thus, in an equation explaining years of schooling, those married before 1949 obtained about two-thirds of a year less schooling after controlling for ability, family background, and age. It seems likely that those who dropped out for family reasons are much more like the college graduate with respect to personality, other unmeasured aspects of ability, and so on. Thus, our estimates may be better than those obtained from census data. Incidentally, a similar conclusion also applies to the high school–bachelor's degree rate-of-return estimate.

The private before-tax and after-tax rates of return are both about 15 percent.[10] This rate of return indicates that many more high school graduates could have profited from attending college for some time. In the above calculations we assumed that the average stay in college was two years. In analyzing the 1969 earnings data, however, we found that all the increase in income from some college occurred in the first year. If this finding is extrapolated to all points on the age-income profile, the rate of return to the first year of college is above 20 percent. On the other hand, as shown in Table 7-1, completing the last two years of college yields rates of return about one-half as large as those for the first two years.

RATE OF RETURN TO GRADUATE EDUCATION

The social and private rates of return from high school to some graduate work and an M.A. are about 7 to 8 percent, while the return to a Ph.D. is about 4 percent.[11] In these calculations, we have eliminated the nonpecuniary return to elementary and

[10] It is possible for the after-tax rate to exceed the before-tax rate. Although taxes reduce the return to education, they also reduce the opportunity cost more than proportionately, since we assume summer earnings of students to be tax-free.

[11] There are only about 50 Ph.D.'s in our sample.

high school teachers but not to college teachers.[12] Therefore, these low rates are indicative of diminishing returns to education. Indeed, the return from B.A. to Ph.D. is negative, although this presumably reflects some nonpecuniary factors.[13] Some types of graduate training, on the other hand, yield larger returns. Thus, the social rate of return from high school to an LL.B. is 11.1 percent, and that from a B.A. to an LL.B. is 12.3 percent. Although we have not calculated the return to M.D.'s because there are so few in the sample, it is clear from the discussion of their age-income profiles that their rate of return is higher than that of LL.B.'s.

In 1969, the effect of graduate education in the top two mathematical-ability fifths was about 10 percent greater than the effect in the bottom three fifths. We have estimated the rates of return in the graduate categories for those in the top two ability fifths.[14] These estimates, which are presented for the social rate in Table 7-1, are generally about one percentage point above the average rates. In the bottom fifths, the corresponding rates are about one percentage point below the average. Even for people with the highest ability, returns to a general graduate education appear low.

EX ANTE RETURNS TO EDUCATION

The ex post rates of return indicate what was earned, on the average, by those in our sample who invested in higher education in 1946. An estimate of the rate of return that could have been expected in 1946 can also be calculated.

It is useful to determine if ex ante returns calculated with various assumptions are good approximations to ex post rates —then we would have more faith in ex ante estimates of the rate of return from the 1968 *Current Population Reports* or the 1970

[12] In Chapter 8 we find that in the managerial and owner categories those with a B.A. and M.A. have about the same income. There should be no differences within these occupations in nonpecuniary returns at the B.A. and M.A. levels. This suggests that our rates of return to an M.A. are not being affected by other nonpecuniary factors. However, Ph.D.'s within these occupations earn about 20 percent more than B.A.'s. If this is indicative of the extra monetary and nonmonetary income attributable to a Ph.D., the rate of return from a B.A. to a Ph.D. would still be less than the rate of return from high school to B.A.

[13] These results are similar to Hunt's ex ante rates (1963).

[14] This was accomplished by increasing the existing graduate profiles by 5 percent in 1969 and by interpolating the difference between zero and 5 percent from 1955 to 1969.

census. Second, the bias in our sample from omitting ability and sociodemographic information is larger than that generally allowed for in other studies, so that it is difficult to compare our ex post returns to ex ante estimates of others.

Expectations can be formed in many ways. For simplicity we make the types of assumptions that other economists have made and ignore the shifts in wages implied by known changes in education levels between cohorts. Using data in Miller (1960) and the correction procedures given in Appendix J, it is possible to estimate ex ante returns in 1946 and in 1949 for 24-year-old high school graduates contemplating one to three years or four or more years of college.[15] In Table 7-2 we present estimates of the various ex ante rates of return from high school to some college, and from high school to four or more years of college.

Consider first the returns to attending college for two years. In 1946, the social rates of return are about 11 and 12 percent, with technical-change rates of 1 and 2 percent, respectively.[16] One assumption that is crucial for this analysis concerns the bias correction for ability and other omitted variables. The rates of return just noted are based on the assumption that the bias correction derived from our sample is applicable to each cohort in the census. This assumption could be wrong either because the bias shifts from one cohort to another or because the sample bias results are not applicable even to the corresponding cohort in the census. Using the method described in Appendix J, we can allow the bias to shift by cohort. Such shifts, which raise the income differences in the oldest cohorts of 1946 and 1949, increase the rate of return by about one-half a percentage point.

Next, suppose the bias in the NBER-TH sample is not the same as the (unknown) bias in the census. We can still estimate the rate of return for the people in our sample by developing estimates of the age-income profiles to apply to the income of our sample cohort in 1946. We assume the census bias to be the same in each cohort. Therefore, the census age-income growth

[15] In making these calculations, we adjust the data for technical change but not for mortality. As demonstrated in Becker (1964, p. 131), the effects of mortality on rates of return are less than one-half of one percentage point; hence, we ignore the adjustment in all our calculations. We allow for technical change by assuming both 1 and 2 percent per year growth rates.

[16] These estimates are about as sensitive as the ex post returns to the various assumptions made on costs.

TABLE 7-2
***Ex ante* rates of return to higher education, 1946 and 1949**

Type of return	1946 *from high school to:*		1949 *from high school to:*	
	Some college	*At least a B.A.*	*Some college*	*At least a B.A.*
Social rates of return				
1 percent technical change	11.1	8.3	6.7	9.1
2 percent technical change	12.2	9.4	7.8	10.2
Allowing δ to change and 1 percent technical change	11.6	8.7	7.3	9.7
No bias correction (1 percent technical change)	15.2	11.4	8.9	12.1
All incomes adjusted to NBER-TH sample level and 1 percent technical change	12.8	9.3	7.1	9.5
Private rates of return, before tax				
1 percent technical change	13.3	9.6	7.5	10.1
2 percent technical change	14.4	10.7	8.6	11.2
Allowing δ to change and 1 percent technical change	13.5	9.9	8.0	10.7
No bias correction (1 percent technical change)	17.8	12.9	9.8	13.4
All incomes adjusted to NBER-TH sample level and 1 percent technical change	14.2	10.1	7.7	10.3

NOTE: Shifts in δ are explained in Appendix J.

rates can be used to generate income profiles at each education level in our sample. In 1946, this procedure requires us to double all the income levels presented in Miller (1960). With the resource costs unchanged, this adjustment increases the social rate of return by nearly two percentage points, for example, from 11 to 12.8 percent. It is interesting to observe that if we had not made a correction for bias, the rate of return (with 1 percent technical change) would have been 15 percent rather than 11 percent.

Table 7-2 also contains estimates of private before-tax rates of return. These estimates are about two percentage points higher than the social rates, while the after-tax private rates, although not presented, are about one percentage point higher than the social rates.

Consider next the 1949 ex ante rates. The 1949 sample differs from the 1946 sample in several ways. The 1949 figures are based on a larger sample, represent the entire rather than just the nonfarm population, measure income rather than earnings, and are from a period in which reconversion from wartime was mostly finished. Finally, the period from 1946 to 1949 witnessed a substantial inflation.

The rates of return for some college in 1949 are about four percentage points lower than in 1946, but as discussed below, the returns to at least a B.A. are about the same in the two years. Although the differences between the 1946 and 1949 samples cited above may explain the difference in the return to some college, it is not clear which of these is operative or which of the two years is the more appropriate for comparison with our ex post rates.

We turn now to consider ex ante rates of return to those who graduate from college. For these individuals, the average length of college schooling is about five years (Becker, 1964).[17] As shown in Table 7-2, the expected social rate of return in 1946 for college graduates over high school was about 9 percent. These estimates are raised by one percentage point when calculated from our sample by using the census profiles (fifth row). Also, when we allow the bias correction to change with cohorts, the rate is raised one-half a percentage point. The private rates of return are about one percentage point higher than the social rates.

These rates of return are three to five percentage points below the rate for college dropouts. Of course, those with more than four years of college include many receiving nonmonetary returns. But, while all the master's degree and Ph.D. holders who taught undoubtedly received low monetary incomes in 1946, a large proportion of those with graduate training were lawyers and medical doctors who received (although not necessarily reported) large incomes.

In 1949, the rates of return to at least a B.A. are only slightly

[17] We have analyzed these data assuming that for the fifth year students would earn one-fourth of the starting salary of a B.A., which is essentially that of a high school graduate with five years on the job, and that the resource and tuition costs are the same as for undergraduates. This probably understates costs and overstates rates of return, because it costs more to educate M.D.'s and Ph.D.'s and because law and medical students receive few scholarships.

higher than those in 1946. However, these now exceed the returns to some college by two or three percentage points. It might be noted that our estimates for 1949 involving no bias correction are quite close to those of Becker (1964), although there are some slight differences in treatment of the data.[18]

It is interesting to compare our ex post and ex ante estimates of the rate of return. Since the cross-section data are in constant prices, the comparison will be made using the deflated ex post returns. The 1946 ex ante and ex post returns to some college are the same, while the ex ante return to four or more years appears to be slightly above the weighted average of the corresponding ex post returns.[19] These results suggest that ex ante rates are good approximations to ex post rates.[20] There are, however, some other factors to consider. First, if the Consumer Price Index is biased upward, then we are understating the deflated ex post rates. Second, our ex post profiles are interpolated on the basis of a national series in which high school graduates suffer relatively more in recessions. Although it is proper to include the effect of fluctuations in ex post rates, we have not included them in our ex ante calculations and have therefore overstated the ex post rates relative to the ex ante rates. Third, the ex ante returns are calculated assuming that the bias corrections from our sample apply to the whole population. An adjustment for these factors probably would not alter our basic finding of approximate equality between the ex ante and ex post results.

Finally, we consider the question of whether investments in education, ignoring consumption aspects and externalities, are worthwhile. From a social point of view, this involves comparing our rates of return to education with alternative returns available to society. Assuming a fixed amount of saving and investment in society, the appropriate alternative rate is that obtainable on physical investment, which is usually thought to be

[18] For example, Becker's social rate for at least a B.A. for an 18-year-old is 12.5 percent, while ours for a 24-year-old is 12.1 percent.

[19] Although the ex ante estimates in the table are lower than those found elsewhere in the literature, our estimates are close to those of others when we do not standardize for ability and background factors.

[20] M.D.'s and teachers (not college) are included in the ex ante but not in the ex post calculations. This difference probably reduces the ex ante rate slightly.

about 12 to 15 percent in constant prices. Comparing this with our estimates of the deflated social rates, we conclude that, except perhaps for the some-college category, there is overinvestment in education from society's viewpoint.[21] This conclusion, of course, assumes that there are no consumption, nonmonetary, or external benefits from education. Moreover, the higher rate of return to some college may be due to the inclusion of returns to financial capital of business owners, who are concentrated more in the high school and some-college categories than in the college-graduate groups. We suspect that this concentration reflects the availability of capital through Veterans Administration loans and that the some-college results may not be applicable to the population as a whole. If we adjust the income differentials by including a dummy variable for business owners, the some-college rate of return is unchanged, while the return from a bachelor's degree is raised to $12^1/_2$ percent, which is competitive with the return from physical assets.

From a private viewpoint, however, the appropriate alternative return is best represented by an after-tax ex post rate of return on common stocks. A reasonable estimate of this rate is perhaps about 10 percent in nominal terms. Since the private after-tax rates differ by less than one percentage point from the before-tax rates, we conclude that, in addition to obtaining some college education, obtaining a B.A. or an LL.B. degree is a profitable investment, although it appears to be advantageous to drop out after two years of college.

There are several reasons why the private return to education is close to the rate earned on common stocks, though the social rate is less than that earned on physical capital. First, tuition does not cover the full cost of the education. Second, the rate of return on common stocks from 1929 to 1960 was probably held down by the increases in corporate tax rates. Third, the income-tax laws do not treat forgone earnings as taxable income; hence, individuals in effect are allowed to "expense" this investment cost rather than depreciate it (although, of course, this is partially offset by not allowing depreciation of tuition).

[21] However, for those with a B.A., obtaining an LL.B. may be worthwhile. These conclusions do not necessarily apply to M.D.'s, as we have not included them in our analysis.