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Chapter Author: Paul Wachtel

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6. The Returns to Investment in Higher Education: Another View

by Paul Wachtel

INTRODUCTION

Estimates of the rate of return to investments in education frequently omit any reference to differences in costs among schools, largely because the requisite data are not available.[1] For this chapter a sample of individuals and the college each attended was available, and therefore it was possible to calculate the specific costs of each individual's college education. The assumption was that if cost differences among schools are associated with earnings differences among graduates, these differences should be considered in estimating the rate of return. If cost and earnings differentials are perfectly correlated, rates of return will be unaffected; if they are not, rates of return will vary inversely with costs.

Besides providing estimates of the returns to higher education on the basis of both years of schooling and costs per year, the study represents a very preliminary investigation of the importance of school quality: if colleges operate as efficient firms (at the limits of their production-possibilities frontier), then cost differences will reflect quality differences. However, it is not at all clear that colleges have either the necessary incentives or the knowledge to make efficient use of the resources used in the production of education. Thus there may be many other determinants of college quality besides costs. However, if cost differences alone, which are only a partial determinant of quality, prove to play an important

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[1] Early studies of returns (e.g., Becker, 1964), use aggregate average estimates of costs and returns. More recently, estimates of returns from a human capital earnings function (Chiswick & Mincer, 1972) use the number of years of schooling as an index of investment costs because of the paucity of data on other differences in investment costs.

role in the determination of earnings, that would demonstrate the importance of college quality in general as a determinant of earnings.[2]

The data examined are from the NBER-TH sample, which is described at length elsewhere in this volume (Chapters 4 and 5). The respondents are in many ways atypical: They fall in the upper half of the population ability distribution; most obtained their college education after completing their military service and were therefore somewhat older than the average college student; and they had had access to large educational subsidies as a consequence of the GI Bill.

The results show that the variation in investment costs among colleges is an important determinant of earnings. In addition, the estimated rates of return to schooling are lower when all costs are considered than when years of schooling are used as a proxy for all direct and indirect investment costs. This finding supports the hypothesis that students with higher earning potential invest more per year of schooling. Finally, rates of returns on the direct (tuition, etc.) and indirect (forgone earnings) components of investment were estimated, and large differences were observed between the rates.

THE MODEL AND THE DATA

The basic framework for the analysis is the human capital earnings function developed by Becker and Mincer. The model states that the earnings of the ith person at time t can be written as the sum of an initial earnings endowment[3] E_{i0} and the sum of returns to all previous human capital investments $r_{ij}C_{ij}$:

$$E_{it} = E_{i0} + \sum_{j=0}^{t-1} r_{ij}C_{ij}, \; t \geq 1 \tag{6-1}$$

where r_{ij} is the rate of return and C_{ij} is the cost of investments by the ith person in the jth period. The cost of investments can be expressed as a fraction k_{ij} of potential earnings: $C_{ij} = k_{ij}E_{ij}$. Substituting into Eq. (6-1) and expanding yields Eq. (6-2).

$$E_{it} = E_{i0} + r_{i1}k_{i1}E_{i1} + r_{i2}k_{i2}E_{i2} + \ldots + r_{it-1}k_{it-1}E_{it-1} \tag{6-2}$$

[2] The issue of school quality is not further taken up in this chapter. However, the importance of quality-related differences among schools is discussed in Solmon and Wachtel (1973). Solmon is now undertaking an extensive examination of various measures of college quality and their effect on earnings.

[3] The initial time period is assumed to be the age of high school graduation since this study is devoted to the returns to college education; therefore, $C_{i0} = 0$.

The final form of the earnings function is obtained by substituting recursively into Eq. (6-2) as shown in Eq. (6-3):

$$\begin{aligned} E_{it} &= E_{i0} + r_{i1}k_{i1}E_{i0} + r_{i2}k_{i2}(E_{i0} + r_{i1}k_{i1}E_{i0}) + \ldots \\ &= E_{i0} \prod_{j=1}^{t-1} (1 + r_{ij}k_{ij}) \end{aligned} \tag{6-3}$$

For estimation purposes, Eq. (6-4) is obtained by taking the natural logs of Eq. (6-3) and using the approximation that $ln\ (1 + x) = x$ when x is small:

$$ln\ E_{it} = ln\ E_{i0} + \sum_{j=1}^{t-1} r_{ij}k_{ij} \tag{6-4}$$

Mincer has pointed out that k is not zero in the postschool years because of investments in on-the-job training. Following Mincer, it is assumed that investments in the form of on-the-job training follow a linearly declining pattern over the life cycle. In addition, the log of weeks worked W is included as a correction for less than full-year employment. The assumption that the returns to college investments are constant for all investments and all individuals yields the estimating equation:

$$\begin{aligned} ln\ E_{it} &= b_0 + b_1 g_{it} + b_2 g_{it}^2 + b_3 ln\ W_{it} \\ &\quad + r \sum_{j=1}^{s} k_{ij} + u_{it} \end{aligned} \tag{6-5}$$

where u_{it} is a residual, labor force experience g is measured from the year of first full-time job after high school, and s is the number of years of college education.[4] The least squares coefficient on the investment variable Σk_{ij} is the average rate of return on college investments. It should be noted that in this interpretation, all the returns from education are assumed to be in the form of earnings; other possible benefits, such as the consumption value of attending college and the psychic benefits of being educated, are ignored.

Previous estimates of the returns to schooling have been restricted by the availability of data for direct schooling costs that could be matched with individual earnings. The assumption in

[4] Data on time spent in the military are not available. It is therefore assumed that no human capital investments took place during military service unless the initial job experience preceded the war, and then military experience is considered part of labor force experience. About 20 percent of the respondents reported an initial job prior to 1945.

most studies is that the only costs of schooling are forgone earnings; that is, k is equal to one for each year in school. This amounts to assuming that direct private costs are equal to the part-time earnings of students and that the earnings are in turn perfectly correlated with interschool variation in costs. This last assumption is not plausible. The effect of interschool cost differences on the return to education has never been examined, nor has the validity of forgone earnings as a proxy for total costs been tested.

In this study direct cost data for each college or university attended by sample respondents are used to make an explicit calculation of k, the ratio of costs to potential earnings. The total costs of schooling are the indirect costs (forgone earnings) and the direct ones. Alternative measures of direct costs are available; here, tuition charges are used to measure direct private costs, and total school expenditures per full-time equivalent student are used to measure direct social costs.[5] Using expenditures per student as a measure of direct social cost implies that colleges produce a single, homogeneous product—student years. Different product mixes of research work, graduate and undergraduate training, sports, and intellectual endeavors are therefore ignored.

To estimate ex post returns to schooling, each k should be a measure of costs as a fraction of potential earnings at the time the educational investments took place. However, the available cost data postdate most of the investments. If costs (tuition or expenditures) have become relatively greater over time, calculated values of k will need to be adjusted accordingly. On the average, expenditures per college student have in fact increased more quickly than earnings in the postwar period. The increase may reflect improvements in the output of colleges, as well as an increase in the relative cost of education. Average tuition charges in private institutions have increased almost as much as expenditures and more than earnings, but tuition charges in public institutions have increased less than earnings.

[5] The expenditure data were obtained from unpublished U.S. Office of Education sources and refer to the 1963–64 school year. The data are for gross current expenditures; no allowance is made for the capital account of colleges. The tuition data are taken from *Higher Education: Basic Student Charges, 1962–63*, U.S. Office of Education Circular 711. Most of the respondents, however, attended college in the immediate postwar years. It is therefore necessary to assume that cost differences among colleges remained unchanged. There is some limited evidence in Solmon (1973) that college cost and quality rankings are fairly constant over time.

Opportunity costs for each individual were calculated from the 1960 census.[6] For the undergraduate years, opportunity costs are represented by the median income of white high school graduates in the state where the respondent attended college, adjusted for age of the respondent. For the graduate school years, the data used were average earnings of white college graduates in the state where the respondent attended graduate school, adjusted for age. The census data do not provide the necessary race-age-education earnings breakdown by state, and so the figures were calculated by interpolation from national and regional averages.[7]

The adjustment for age represents an upper limit for opportunity costs. Human capital theory suggests that earnings increase with age because of increased labor force experience. The use of opportunity costs based on average earnings of persons of the age at which the respondents attended college implies that the military experience of the respondents was of the same value as an equivalent amount of time spent in the civilian labor force. If this is not the case, the age adjustment will lead to an overstatement of opportunity costs. The adjustment is significant, as the average age of the respondents at college graduation was 26, and age-earnings profiles are very steep at that age.

It might be argued that respondents have higher opportunity costs than the population average for their age-education group, since they are all drawn from the upper half of the ability distribution. However, in Chapter 4 Taubman and Wales report that the starting salaries of the NBER-TH respondents are not related to ability and amount of education. Their predicted initial salary in 1947 dollars is $4,089 for those with some college, $3,464 for those with an undergraduate degree, and $3,460 for those with

[6] The 1960 census is used because the data provided are more detailed than in previous censuses and are almost coincident with the cost data. The tuition and expenditure cost data are adjusted to the census income year (1959) by the consumption expenditures deflator.

[7] Earnings of adult white male high school and college graduates in each state and region were derived from the nonwhite and total data. Regional data for white male earnings, classified by age and education, were used to approximate state medians for 22- to 24-year-old high school graduates and 25- to 29-year-old college graduates. The ratio of all adult white male earnings in each state to the appropriate regional age group for each education class was used to make the adjustment. Finally, national differences in income by age for each education class were used to adjust the estimated state median earnings for 22- to 24-year-old high school graduates and 25- to 29-year-old college graduates to the age of the respondent at the time of his schooling.

graduate education. The average opportunity cost based on 1960 census data is $4,744, or $3,648 in 1947 dollars.

Conventional wisdom has it that many other factors determine earnings in addition to specified human capital investments. Social background, luck, and ability can affect the dispersion in observed rates of return among individuals. However, estimates of the basic earnings function discussed in the following section provide estimates of the expected value of the distribution of rates of return. The effect of ability and social class on the dispersion of rates of return is also examined below.

ESTIMATION OF RATES OF RETURN

Estimates of various specifications of the basic earnings function for 1969 earnings are shown in Table 6-1. In the first set of equations it is assumed that forgone earnings are the only cost of schooling. In the second set, expenditures per full-time equivalent student are used to represent the cost of direct social investment. Finally, in the last pair of equations tuition payments are taken as a measure of direct private investments.[8] The sample sizes for the expenditures and tuition equations differ because direct cost data were not available for all the colleges attended by the respondent.[9]

Each equation allows for different rates of return to the direct and indirect components of investment r_D and r_I. The investment variables can be written as

$$r_I s_i + r_D \sum_{j=1}^{s_i} \frac{D_{ij}}{E_{ij}}$$

This follows from the definition of costs $C_{ij} = D_{ij} + E_{ij}$, where D_{ij} is the direct investment cost—either tuition or expenditures. In addition, in the even-numbered equations of each set, direct and indirect investment variables for graduate and undergraduate training are included separately.

The formulation of the indirect investment component implies

[8] For schools with different tuition charges for residents and nonresidents, the resident tuition is used for undergraduates only if a respondent's undergraduate college was located in the same state as his high school; it is used for graduates if a respondent's undergraduate and graduate school were in the same state.

[9] Of the 5,086 respondents, 1,246 never attended college and were excluded from the regressions. Also excluded were respondents with zero earnings in 1969 and all medical doctors and airplane pilots. The name of the college attended or the tuition and cost data were not available for about 600 respondents, leaving about 3,000 observations for the regressions.

TABLE 6-1 ***Earnings functions for investments in higher education* (figures in parentheses are standard errors of the regression coefficients)***

	No direct investment†		*Expenditures as direct investment†*		*Tuition as direct investment‡*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Constant	.2931	.3018	.4064	.4907	.5796	.6043
g	.0225(.0089)	.0195(.0090)	.0227(.0087)	.0198(.0088)	.0278(.0088)	.0224(.0089)
g^2	−.0004(.0002)	−.0003(.0002)	−.0005(.0002)	−.0004(.0002)	−.0006(.0002)	−.0004(.0002)
$\ln W$	.4761(.0874)	.4700(.0874)	.4405(.0858)	.4121(.0857)	.3907(.0842)	.3790(.0842)
s_U		.0644(.0089)		.0326(.0095)		.0410(.0092)
s_G		.0394(.0076)		−.0273(.0136)		−.0155(.0125)
s	.0504(.0049)		.0124(.0059)		.0164(.0058)	
D_U				.1353(.0150)		.2064(.0246)
D_G				.1745(.0318)		.2973(.0589)
D			.1423(.0129)		.2164(.0205)	
R^2	.0463	.0475	.0834	.0897	.0788	.0825
S.E.	.4867	.4865	.4773	.4758	.4773	.4765

* Dependent variable is natural log of 1969 earnings.

† Sample size is 3,045.

‡ Sample size is 3,004.

NOTE: g = labor force experience; W = weeks worked; s = years of college education; D = direct investment costs; U = undergraduate; G = graduate. See text for further details of definition and description of data used and for form of estimating equations.

that students forgo a full year's income. An alternative assumption —that earnings from part-time and summer work during schooling are on the average one-fourth of full-time earnings—is used to adjust the estimated rates of return upward.[10] Most of the respondents obtained part or all of their education after World War II, when they had access to the GI Bill, which paid monthly stipends to full-time students and covered tuition payments up to $500.[11] These stipends are not deducted from the calculated investment variables; therefore, the coefficients are lower than the rates of return earned by the respondents. Clearly, private rates of return increase when the GI Bill stipends are deducted from costs.

When direct investment costs are ignored, the estimated rate of return to investments in college is 5.04 percent. In Table 6-1 eq. (2) indicates that the rate of return to undergraduates schooling (6.44 percent) exceeds the return to graduate schooling (3.94 percent). The coefficients differ significantly when tested at the 10 percent level.[12] Clearly, the number of years of graduate and undergraduate schooling are correlated, as all those with graduate schooling completed four years of undergraduate schooling.[13]

The rate-of-return coefficients are somewhat lower than those generally found in studies of returns to college investment. If part-time work is set at three months per year, the rate of return is increased by one-third and would be 6.72 percent. If, in addition, an average stipend of $1,000 per year is deducted from direct costs, the true value of k is not one but .48, and the private rate of return would be 10.6 percent.[14] The adjusted rates of return from eq. (2)

[10] The fraction one-fourth is suggested by Becker.

[11] The stipend varied with the number of dependents and with several changes in the law during the postwar period. Solmon estimates the average stipend during the late 1940s at $100 per month.

[12] The test value for the null hypothesis that the coefficients on s_U and s_G are equal is $F(1, 3{,}039) = 3.83$.

[13] The simple correlation of s_U and s_G is .33. The mean number of years of schooling is 15.96, with a standard deviation of 2.0. Twenty-nine percent of the respondents had some graduate training; 37 percent had an undergraduate degree; and the rest had between 13 and 15 years of schooling.

[14] The calculation is

$$k = \frac{C}{E} = \frac{3/4\,(3747) - 1{,}000}{3747} = .48$$

The average opportunity cost for the respondents was $4,744, as calculated from the 1960 census, or $3,747 in 1948 dollars. The median year of college attendance is 1948. The corresponding adjustment for undergraduate returns is $k = .46$; for graduate returns, $k = .55$, as opportunity costs increase with are 14.0 percent for undergraduate and 7.1 percent for graduate training. Without the GI Bill, rates of return on private investments in schooling would have been much lower and would probably have discouraged many of the respondents from further educational investments.

The direct investment variable for social investment (expenditures) is added in Table 6-1 eq. (3) and for private investment (tuition) in eq. (5). The proportion of variance explained rises dramatically from less than 5 percent in equations (1) and (2) to about 8 percent in the other two pairs. The coefficient of years of schooling (the indirect investment variable assuring that full annual earnings are forgone) declines to just over .01 from .05; in the expenditure equation it is barely twice its standard error.[15] The coefficients on the direct investment variables are significantly larger than the coefficients on indirect investment in both eqs. (3) and (5). Direct investments are much more important in explaining variation in earnings. For tuition, the beta coefficient on direct investment is 5.6 times that for indirect investment, while for expenditures the ratio is 3.5.

In order to interpret the coefficients as rates of return, the investment variables need to be adjusted for part-time work by students and differential growth trends in investment costs and earnings.[16] At this point, no adjustment is made for stipends received

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education. The value of k for graduate students may be biased upward because of their increased opportunities for scholarships and part-time work, which reduce costs.

[15] The indirect investment variable (the number of years of college) and the direct investment variable (the ratio of direct costs to forgone earnings summed over the years of college) are clearly correlated. If the ratio of costs to forgone earnings were constant, the correlation would be 1.0. However, forgone earnings increase with education and costs and may be different in graduate and undergraduate school. The correlation of direct and indirect variables is .65 for expenditures (eq. 3) and .55 for tuition (eq. 5).

[16] The direct investment variables $\sum_j D_{ij}/E_{ij}$ utilize wage and cost data that postdate the respondents' schooling. The true value of the variable is $\sum_j \bar{D}_{ij}/\bar{E}_{ij}$, where the bar indicates 1947–48 values. For expenditures, $D = 2.27\ \bar{D}$, and for earnings $E = 1.89\ \bar{E}$. The growth rates are based on national average college expenditures and the average weekly wage in manufacturing. Substituting gives the proportional correction factor for the direct social investment variable. The regression coefficients on the measured variable should then be adjusted by the inverse of the ratio of growth in direct costs to the growth in earnings. The average tuition charge increased by the same percentage as earnings between 1947–48 and 1962–63. The average tuition charge for 1962–63 is based on the 1947–48 distribution of students between private and public institutions, applied to the national average tuition in each type of school.

under the GI Bill. Thus, these are the rates of return that would have been earned by the respondents if they had not received any educational subsidies. The adjusted rates of return from eqs. (3) and (5) of Table 6-1 are shown in Table 6-2. The difference between the rate of return on direct and indirect investments is still large. The return to indirect investments, time spent out of the labor force, is very small. If the return to forgone earnings is as low as indicated here, full-time college attendance must have a large consumption component because the economic incentives for part-time attendance are large.[17]

Unfortunately, the sample does not provide any direct information on full- versus part-time college attendance by the respondents. However, the typical respondent had completed four years of college at a school with an annual tuition charge (in 1959 dollars) of $685 and annual expenditures per student of $1,490.

The results in Table 6-1 imply that if the typical respondent attended college without leaving the labor force, his earnings would be unchanged if he attended a college which spent 26 percent more per student and charged 48 percent more in tuition. That is, part-time attendance can be compensated for by an increase in direct investments of less than two standard deviations. These results are only suggestive of the available trade-offs between direct and indirect investment expenditures due to differences in the rates of return.

The total private and social rates of return to education investments can be calculated by taking weighted averages of the returns

[17] Weiss concludes that there is little economic incentive for full-time as opposed to part-time study. The difference in our findings may be due to the larger role of part-time earnings of graduate students in his study. His study includes estimates of the part-time earnings of graduate students (assistantships, fellowships, etc.), while I assume that the only earnings are the GI Bill stipends. As the earnings of full-time graduate students increase, the incentives for part-time study disappear.

TABLE 6-2 ***Rates of return on direct and indirect investment, adjusted for part-time work and secular changes in costs (in percentages)***

	Social investment (expenditures)	*Private investment (tuition)*
Return on indirect investment	1.65	2.19
Return on direct investment	16.92	21.64
TOTAL RETURN	5.78	5.57

to direct investments (r_D) and indirect investment (r_I). The weights are the average levels of the investment variables adjusted for part-time work and the secular change in costs. In both cases earnings of the respondent are the only returns considered. The social rate of return is based on the cost of schooling investments to society (forgone earnings plus expenditures by the college), whereas the private rate of return is based on investment costs borne by the individual (forgone earnings plus tuition). The total rate of return to private investment is 5.57 percent,[18] and that to social investment is 5.78 percent.[19] Although direct and indirect returns are about one-fourth larger for private investments than social investments, the total returns are almost identical. The reason is that indirect costs are a larger fraction of private than of social investment costs; therefore, the smaller return is weighted more heavily in calculating the total private return. For the same reason, the total returns are not very sensitive to changes in the adjustment of direct investment for secular changes in costs.

Forgone earnings are a large fraction of total investment costs: 72.5 percent of total social investment and 82.6 percent of total private investment. However, the variance in forgone earnings is a smaller proportion of the varianace in total costs; 50.5 percent for total social investment and 75.4 percent for total private investment. Thus years of schooling is hardly an adequate proxy for total schooling investment. When differences in direct costs are taken into account, the total rates of return to both private and social investment are smaller than the comparable rate of return from eq. (1) Table 6-1. When forgone earnings are used as a proxy for all investments, the return is 6.72 percent (i.e., the coefficient on s, adjusted for part-time work by students).

Alternatively, the total rates of return can be obtained by aggregating the adjusted direct and indirect investment variables into a single total investment variable whose coefficient in the earnings model would be the total rate of return. This approach avoids the multicollinearity between the direct and indirect investment vari-

[18] This is not the private return actually earned by the respondents since stipends under the GI Bill were not subtracted from costs.

[19] The standard errors of the total rates could not be calculated because the program used does not provide a covariance matrix of regression coefficients. However, an estimate of the covariance of r_D and r_I from some preliminary experiments in which constant opportunity costs were assumed for all individuals indicates that the standard error of the total rate is about 0.9 percent.

ables that might make the estimates of the individual rates of return unreliable. However, the Table 6-1 regressions with the disaggregated investment variables explain a significantly larger proportion of the variation in earnings than corresponding regressions with a single total investment variable. This would not be the case if the returns on direct and indirect investments did not differ significantly. The total returns estimated by a regression using the aggregate adjusted investment variables are 6.04 percent for social investments and 6.54 percent for private investments.[20] Thus the private returns are just 0.5 percent higher than the social returns.

For the most part, the respondents attended college after spending several years in the Armed Forces and were therefore about four years older than the average college student. This four-year age difference almost doubles the estimate of their potential earnings as students. Thus the total returns that would have been earned by equivalent but younger students with opportunity costs reduced to one-half of the estimated amounts are 8.0 percent for total private investments and 8.1 percent for total social investments.

As previously noted, many of the respondents benefited from the GI Bill, which had the effect of reducing private costs substantially. Adjusting for part-time work and a $1,000 annual stipend increases the return on indirect private investments from 1.64 to 3.42 percent.[21] Assuming that each respondent also received a tuition stipend (up to a $500 maximum) reduces the average level of direct private investments by 80 percent and increases the estimated return on the average direct, private investment from 21.6 to 121.3 percent. However, in this case, direct investments are only a small fraction of schooling investments; the total private return on investments actually made by the respondents would be 9.91 percent.

In eqs. (4) and (6) of Table 6-1, both the indirect and direct investment variables are disaggregated into undergraduate and graduate school components. The disaggregation adds less than 1 percent to explained variance, but the increase is significant at the 1 percent level.[22] The results indicate that there are large and

[20] These are alternative estimates of the total returns shown in the bottom row of Table 6-2. The variables were adjusted for part-time work and secular changes in costs; the standard error of both estimates is 0.5 percent.

[21] Based on eq. (5), Table 6-1. See footnote 14 for the correction factor.

[22] The test value for the expenditure equations is $F(2, 3038) = 10.5$, and for the tuition equations it is $F(2, 2997) = 6.04$.

significant differences in the rates of return earned at the graduate and undergraduate levels. The estimated return on indirect investments is negative for graduate studies. Interestingly enough, the returns to direct social and private investments are larger for graduate than for undergraduate studies.

The increase in returns to direct graduate school investments compared with the increase to undergraduate investments seems to contradict the usual finding that the rate of return declines with the amount of investment in schooling. However, the total rate of return to graduate education is less than the total rate of return to undergraduate education for both the social and private investment equations. Table 6-3 shows the total returns adjusted for part-time work and the secular change in costs, as discussed previously. The private returns are not adjusted for stipends under the GI Bill, and the total returns to undergraduate investments are more than twice the returns to graduate training. This difference is much larger than the difference suggested by the forgone earnings coefficients in eq. (2), Table 6-1. The results confirm the idea that there has tended to be overinvestment in graduate training.[23]

The other coefficients of the model all have the expected signs. The two experience variables do not provide estimates of either the rate of return to postschool investments or the value of k in the first job; the coefficient on experience is the product of the rate of return and k. A coefficient of .02 suggests, therefore, that a return of 10 percent is consistent with an initial k of .2. The span of the postschooling investment period can be derived from the two regression coefficients. The coefficients indicate that the postschool investment period is about 25 years, ending at an average age of 52 for this sample.[24]

Finally, the reader will note the relatively low values for all the coefficients of determination (only between 5 and 10 percent of

[23] This conclusion is also reached by Taubman and Wales (see Chap. 4 of this volume).

[24] These conclusions are based on Mincer's explicit formulation of a linearly declining net investment profile. See Mincer (1970, p. 17).

TABLE 6-3 ***Total rates of return on investment in graduate and undergraduate training adjusted for part-time work and secular changes in costs***

	Social investment (expenditures), percent	*Private investment (tuition), percent*
Undergraduate	7.67	8.11
Graduate	3.01	3.39

the variance in earnings is explained). This is due to the relatively homogeneous nature of the sample, which has little variance in age, experience, hours and weeks worked, and ability when compared with the population as a whole. All the regression coefficients themselves are highly significant.

The proportion of earnings variance explained can be raised by somewhat less than 2 percent by adding a measure of ability.[25] As would be expected, the addition of an ability measure reduces the rate-of-return estimates. For example, when years of schooling is the only investment variable, its coefficient is reduced from 5 to 4.4 percent with ability included, a reduction of almost 15 percent.[26] The reduction in the direct social investment (expenditure) coefficient is somewhat smaller, about 13 percent. The coefficients on the direct private investment (tuition) variables are reduced by about 10 percent when ability is included in the equation.

THE EFFECT OF ABILITY AND SOCIO-ECONOMIC STATUS ON RETURNS

The estimated rate-of-return coefficients are the mean values of the distribution of average rates of returns received by individuals in the sample. Human capital theory suggests that the amount of, and returns to, educational investments for a particular individual depend on both his supply and demand curves for investments. Becker suggests that supply curves will depend on opportunity factors, and demand curves on ability.

The NBER-TH respondents all had access to GI Bill subsidies, which equalized educational opportunities. For this reason a single supply curve for all respondents, as shown in Figure 6-1, is a plausible hypothesis. The supply curve is upward-sloping because opportunity costs increase with age and with the amount of previous schooling. Demand curves for high-ability (D_H) and low-ability (D_L) respondents are shown; the curves shift to the right with ability since schooling is more valuable for more able students. Under these assumptions, high-ability respondents will invest more and earn a higher marginal rate of return at every level of investment and therefore have a higher observed average rate of return.

If the assumption of common supply curves is relaxed, as in

[25] These results are not shown.

[26] This estimate of the bias from omitting ability is within the range of the Taubman and Wales estimates. Although they use the same sample, their specification differs. In their chapter both ability and schooling are measured categorically (by classes) rather than continuously, as here.

FIGURE 6-1 ***Effect of ability differences on the demand for schooling***

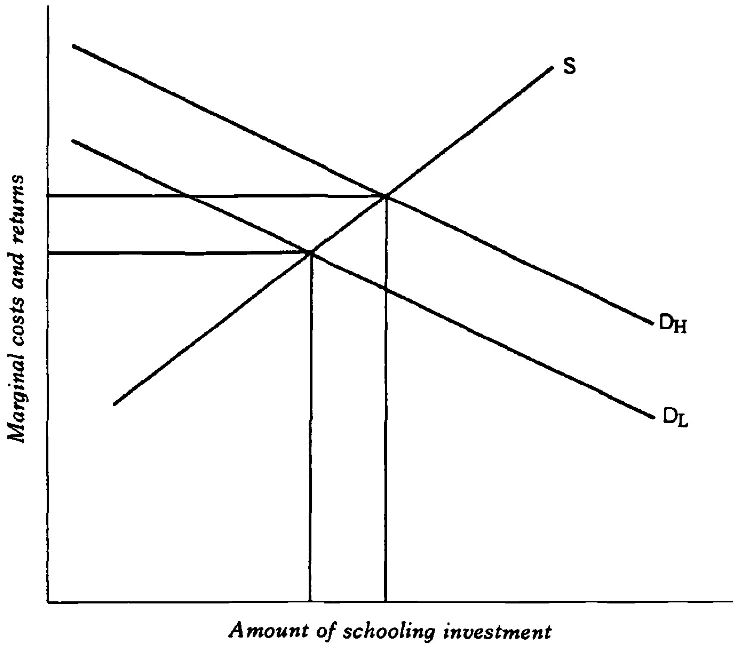

FIGURE 6-2 ***Effect of ability and SES differences on the supply and demand for schooling***

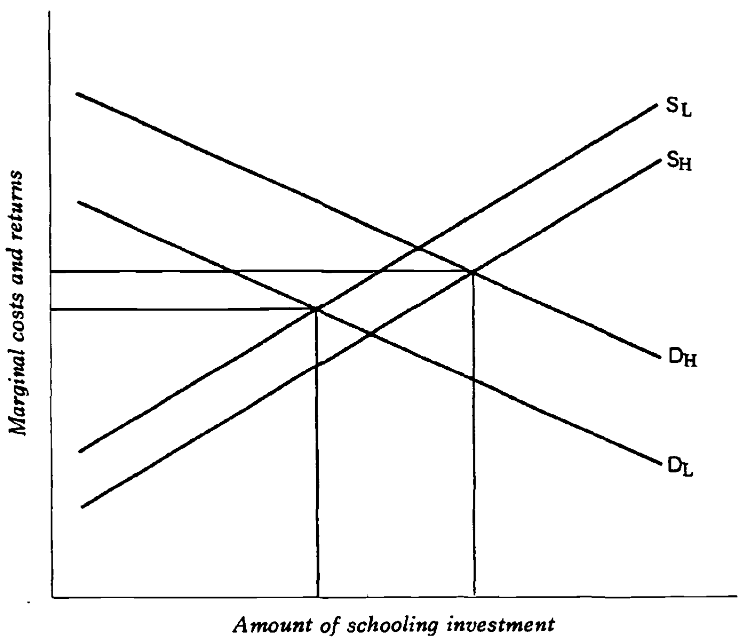

Figure 6-2, the implications of the model are less conclusive. It could be argued that the supply curve shifts with the socioeconomic status (SES) of the respondent: a higher SES increases educational opportunities and pushes the supply curve to the right. If SES and ability are correlated, high SES respondents may or may not have higher marginal returns, although they will invest more.[27] It is likely that average returns will increase with SES as shown in Figure 6-2, but this result depends on the relative positions of the supply and demand curves.

The effect of ability and opportunity factors on the dispersion of estimated rates of return can be examined by segmenting the sample into ability and SES groups. Ability quartiles were calculated from a constructed IQ measure.[28] An SES variable based on father's

[27] The correlation between SES and ability is very small. The IQ variable is scaled to a mean of 100 and a standard deviation of 10 for the entire NBER-TH sample. The mean IQ of college-attending respondents in the highest SES group is 101.7, and in the lowest it is 100.6.

[28] The IQ variable was constructed from a factor analysis of the Air Force tests taken by the respondents in 1943. The quartiles are based on the test scores of all respondents, including those who did not attend college.

TABLE 6-4
Effect of ability on rates of return*

	Direct investment variable		
	None	*Expenditure*	*Tuition*
Constant	.4410	.5514	.6651
g	.0204(.0088)	.0236(.0087)	.0259(.0088)
g^2	−.0004(.0002)	−.0005(.0002)	−.0005(.0002)
$\ln W$	.4481(.0870)	.4110(.0858)	.3769(.0842)
s_1	.0293(.0066)	−.0011(.0118)	.0115(.0097)
s_2	.0371(.0062)	−.0033(.0109)	.0032(.0092)
s_3	.0535(.0059)	.0103(.0104)	.0128(.0086)
s_4	.0620(.0055)	.0167(.0086)	.0278(.0077)
D_1		.1086(.0339)	.1385(.0506)
D_2		.1392(.0301)	.2226(.0450)
D_3		.1380(.0266)	.2558(.0424)
D_4		.1260(.0175)	.2016(.0315)
R^2	.0593	.0921	.0881
S.E.	.4836	.4754	.4753
N	3045	3045	3004

* Dependent variable is natural log of 1969 earnings. Standard errors of the regression coefficients are in parentheses.

NOTE: Symbols are defined in Table 6-1. Subscripts denote ability quartiles; for explanation, see footnote 28.

TABLE 6-5
Effect of socioeconomic status on rates of return*

	Direct investment variable		
	None	*Expenditure*	*Tuition*
Constant	.3454	.4850	.6232
g	.0222(.0089)	.0251(.0087)	.0273(.0002)
g^2	−.0004(.0002)	−.0005(.0002)	−.0006(.0002)
$\ln W$	.4637(.0874)	.4211(.0856)	.3803(.0843)
s_L	.0386(.0070)	−.0018(.0131)	.0116(.0113)
s_M	.0486(.0055)	.0104(.0088)	.0171(.0079)
s_H	.0548(.0053)	.0062(.0075)	.0188(.0066)
D_L		.1329(.0347)	.1687(.0607)
D_M		.1245(.0218)	.1977(.0355)
D_H		.1439(.0160)	.2344(.0267)
R^2	.0487	.0869	.0819
S.E.	.4863	.4767	.4768
N	3045	3045	3004

* Dependent variable is natural log of 1969 earnings. Standard errors of the regression coefficients are in parentheses.

NOTE: Symbols are defined in Table 6-1. Subscripts *L, M,* and *H* denote low, medium, and high socioeconomic status as defined in footnote 29.

occupation was used as a rough measure of opportunity.[29] The earnings functions were reestimated with college investment variables classified by ability or SES. That is, if X_n is a dummy variable with a value of 1 if the respondent is in the *n*th group, then the coefficient on $X_n s$ is the indirect rate of return for individuals in the *n*th group. Only the schooling investment variables are categorized by the ability or status groups. The other variables in the equation have the same coefficient for the whole sample.

In Table 6-4 the investment variables are categorized by ability quartiles, with 1 being the lowest and 4 the highest. In Table 6-5 the investment variables are categorized by the SES groups defined in footnote 29. The categorization by ability or SES adds significantly to the proportion of variance explained.[30]

[29] Three groups were constructed as follows: high—managerial, proprietor, professional, and technical; medium—office worker, salesman, foreman, skilled worker, and others; low—service worker and semiskilled, unskilled, and other blue-collar workers.

The high SES group includes 49.7 percent of the respondents; 13.8 percent are in the low group.

[30] The equations in Tables 6-4 and 6-5 are compared with the corresponding equations in Table 6-1. The increase in R^2 is significant at the 1 percent level for all equations except those which do not include direct investments and those with SES expenditure classification; these are significant at the 5 percent level.

The schooling coefficients indicate that returns tend to increase with both ability and SES. The strongest trends are in the equations without a direct investment variable. These equations suggest that persons in the highest ability quartile earn more than twice the return of those in the lowest quartile and that persons from the high SES groups have a return which is over 40 percent higher than the return to those in the low group.

Total private and social rates of return by ability and status groups are shown in Table 6-6. The regression coefficients are adjusted for part-time work and secular cost changes, as before.[31] Returns increase consistently with both status and ability. The increase in returns with ability is not as large as the increase shown in the equation without a direct investment variable. The return for the high-status group is consistently about 40 percent larger than the return for the low-status group.

If all individuals in the sample have the same opportunities (common supply curve), then persons with higher ability not only should earn a higher return but also will have higher levels of investment. The average number of years of college in the highest ability quartile is 4.4, about 24 percent more than in the lowest ability quartile. However, more able students also make more expensive college investments. Their direct costs (private and social) are about 40 percent greater than the average for the lowest ability quartile.

Differences in the returns to education by ability level in the

[31] Private rates of return understate the returns actually earned by the respondents because stipends under the GI Bill were not subtracted from private costs.

TABLE 6-6
Adjusted total rates of return for ability and status groups

	Social investment, percent	*Private investment, percent*
Ability group		
1 (lowest)	3.3	3.6
2	4.0	4.2
3	5.5	5.8
4 (highest)	6.0	6.7
Socioeconomic status		
Low	4.0	4.1
Medium	5.0	5.4
High	5.5	6.2

NBER-TH sample have been investigated by Taubman and Wales and by Hause. The results in this section suggest that Hause's evidence of a strong interaction between schooling and ability will be mitigated somewhat when costs are fully specified to include cost differences among schools. However, the results do suggest that a strong relationship exists between ability and both the amount of schooling investments and the rate of return.

It is worth noting that the specification of the model in Table 6-4 does not allow for any direct influence of ability on earnings. Ability affects earnings only insofar as it makes schooling more valuable or productive. The results are not a conclusive demonstration of the interaction between schooling and ability because the categorization of the rate-of-return coefficients by ability classes does not add to the explanatory power of the model when IQ is already included as a variable.

The private and social returns to college do increase somewhat with socioeconomic status. However, there is no discernible difference in the average number of years attended. The direct social investment costs are about 14 percent higher for persons from the high socioeconomic group than for persons from the low group.

CONCLUSION

The major conclusion to be drawn from this study is that estimates of the rate of return from college that ignore institutional differences in expenditures and tuition are biased upward. This situation results from the tendency of students with higher earnings potential to make more expensive investments. The second conclusion to emerge from this study is that the returns to the direct and indirect components of investments are strikingly different. More research on this issue is clearly needed before we can judge whether part-time college attendance should be encouraged.

The difficulties in arriving at a unique measure of the returns to college that can be applied to future investments are highlighted by these results. Alternative adjustments and assumptions can alter the estimated return. The sample respondents have earned a private return on their schooling investments of almost 10 percent. The social return is about 6 percent, the difference being due to GI Bill subsidies. The adjusted private return is comparable to most estimates, whereas the social return is fairly small. Care should be taken in applying ex post returns from this sample to future investments because the respondents were in many respects atypical and the relative costs of schooling investments have changed. However, the finding of systematic differences in the returns to graduate and undergraduate training, to direct and indirect investment, and to ability and socioeconomic class suggests that these differences are important. They have been previously overlooked mainly because investigation has focused on the size of the rate of return.

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