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Chapter Title: Earnings : Higher Education, Mental Ability, and Screening

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1. Earnings: Higher Education, Mental Ability, and Screening

A cursory examination of census data and studies based thereon reveals that earnings increase with education and that the rate of return to education is at least equal to the return available to society on other investments (Becker, 1964; and Miller, 1960). The proposition that education can be treated as an investment in human capital has proved to be powerful and illuminating in its own right and a major ingredient in studies of the sources of economic growth and the distribution of income (see Becker, 1964; Denison, 1964; Miller, 1960; and Schultz, 1963). Central to these studies are two concepts. First, the (observed or adjusted) differences in earnings by education level represent the net effect of education, rather than some other personal characteristics that have not been held constant. Second, these observed differences in earnings represent increases in productivity produced by education.

The fact that differences in earnings may not be due solely to differences in educational attainment has long been recognized (Becker, 1964; and Wolfle & Smith, 1956). Also, as is well known, omission of a variable that is positively correlated with education and that has a separate influence on earnings biases the education coefficient upward. Many people have hypothesized that the omission of mental ability and family background, in particular, will result in such a bias. Although in a number of studies attempts have been made to standardize for family background and other relevant determinants of earnings, there are no studies of higher education based on large samples that contain the relevant earnings, ability, and education information.[1] One of our goals is to obtain good estimates of the rate of return to higher education at various ability and education levels.

Most studies of the rate of return to education are based on the premise that differences in earnings at different education levels arise because of the various cognitive and affective skills produced by education. The existence of income differences need not imply that education has produced such skills, however; instead, differentials might arise because lack of education is a barrier to entry into high-paying occupations. As shown more rigorously below, if people are denied entry into an occupation because they lack education *credentials*, the private rate of return to education differs from, and may be higher than, the social rate.

Although many people have suggested that a primary role of education is to serve as a screening, certification, or licensing device, we are aware of no research in which an attempt has been made to separate differences in earnings due to productivity gains from those due to screening. Thus, our second goal is to examine the hypothesis that education adds to income by screening people with low education out of high-paying occupations.

We make use of a new and extremely rich data source to obtain substantially improved estimates of the private and social returns to higher educational attainment and crude estimates of the effect of screening on earnings differentials. Our findings, all of which are subject to qualifications as given in the text, can be briefly summarized as follows. First, the realized (real) rate of return—ignoring consumption and nonmonetary benefits—to the college dropout or college graduate is $7\frac{1}{2}$ to 9 per-

[1]Studies for the United States include Ashenfelter and Mooney (1968); Becker (1964); Bridgman (1930); Cutright (1969); Duncan, Featherman, and Duncan (1968); Griliches and Mason (1972); Hansen, Weisbrod, and Scanlon (1970); Hause (1972); Hunt (1963); Morgan and David (1963); Rogers (1967); Weisbrod and Karpoff (1968); and Wolfle and Smith (1956). Except for one segment of Hause (1972), each of these studies suffers from one or more of these serious problems: poor measures of education and ability; small and inadequate sample size; improper statistical technique; or too specialized a sample from which to form generalizations. In addition, only the Rogers study contains enough data to permit estimation of a rate of return as opposed to simply studying income differentials at a given age. The portion of the Hause study that is based on our sample is discussed below.

cent and does not vary with the level of mental ability. Ignoring the screening argument, the private and social rates of return are approximately the same. Second, certain types of mental ability and various personal characteristics are as important as education in determining earnings, and omission of these variables biases education coefficients by up to 35 percent. Finally, and more tentatively, there is evidence consistent with the hypothesis that education is used as a screening device and that up to one-half of (net) earnings differentials are due to such screening.

An important caveat is in order. This study is based primarily on a population that is much brighter and better educated than the United States population as a whole and is probably less averse to risk. Our results need not be capable of generalization to the population at large.

THE NBER-TH SAMPLE

In this study we analyze hitherto unpublished details of the Wolfle-Smith sample and a new body of data that goes under the unpronounceable acronym of NBER-TH (National Bureau of Economic Research–Thorndike-Hagen). Most of our detailed conclusions are based on the NBER-TH sample, although comparisons are made between this sample and Wolfle-Smith. Since this study represents the first use of what we consider to be a major body of data, and because of the special characteristics of the population from which it is drawn, we will discuss the NBER-TH sample at this point, although more details are given in Chapter 4. During World War II, the Army Air Corps accepted volunteers for the pilot, navigator, and bombardier training programs. The volunteers, of whom there were some 500,000, had to pass the Aviation Cadet Qualifying Test with a score equivalent to that of the median of high school graduates.[2] These people were then given a battery of 17 tests that measured such abilities as mathematical and reasoning skills, physical coordination, reaction to stress, and spatial perception. While the tests were changed during the war, a given set of tests was used for 75,000 men in the period July to December 1943. In 1955, Robert L. Thorndike and Elizabeth Hagen undertook a study to determine how well these tests predicted the sub-

[2] This was about equivalent to the person's being able to complete two years of college. See Thorndike and Hagen (1959, p. 52).

sequent vocational success of a random sample of 17,000 of these 75,000 individuals. A large fraction of the 17,000 people responded to the questionnaire.[3]

Thorndike and Hagen have shown that there was no significant difference between the test scores of the civilian respondents in 1955 and those of the 75,000 tested on the same battery. But compared to the United States male population aged 18 through 26 in 1943, the air cadet group was more highly educated and brighter; all had at least a high school diploma, and a score equivalent to the average for college sophomores was used as a preliminary screening level.[4] Also, the tested group consisted of people willing to volunteer for the various programs. While the differences between the sample and the United States population complicate the extrapolation of our results, a substantial benefit in having a sample more homogeneous than that in a census is that many earnings determinants are held constant by sample design.

In 1968 we contacted Professor Thorndike and learned that he had retained much of the information collected for most people in the sample. The information thus resurrected is extremely valuable, because the sample is one of the largest known (of people with at least a high school diploma) that contains detailed measures of earnings, ability, education, and family background. In 1969, the NBER decided to conduct an additional survey of the people who responded in 1955. At the time our study was undertaken, there were 4,400 respondents to the follow-up, but subsequently there have been another 600.

Since the people were surveyed in 1955 and 1969, we have "direct" reports of earnings in those years and "recalled" reports of earnings for their initial jobs and jobs at other specific points in time. We concentrate our attention on the 1955 and

[3]The high response rate occurred in part because many veterans maintained contact with the Veterans Administration through life insurance policies and disability claims. The authors were able to increase the response rate by hiring the Retail Credit Bureau to find various individuals. About 1,500 people had died since 1943.

The questionnaire is reproduced in Thorndike and Hagen (1959, p. 86). The 2,000 people who were still in the military in 1955 were eliminated from the sample.

[4]Some rough comparisons with the population as a whole can be found in Thorndike and Hagen (1959, pp. 110–111).

1969 earnings because we expect them to be more accurate. The NBER-TH average earnings are consistent with data by education and age in the 1955 and 1968 *Current Population Reports* (CPR) and, although the 1969 respondents are more heavily concentrated in the higher education and ability levels, there is no success bias in reported earnings within ability and education groups. Because the sample is drawn from a special population, a few results may not be applicable to the population as a whole.

REGRESSION ANALYSIS OF THE NBER-TH DATA

In our regressions, we relate earnings in a particular year to a large set of explanatory variables, nearly all of which are zero-one dummy variables. By breaking up the independent variables into discrete categories—for example, eight education levels—we allow for nonlinear effects, and by combining dummies we allow for interactions.[5] As noted earlier, there are scores on 17 ability tests for each person. Factor analysis conducted by A. Beaton indicates that four orthogonal factors could be extracted from these scores; two quite clearly represent spatial perception and physical coordination; the other two we treat as measuring mathematical and verbal ability.[6] A description of the tests and the factor loadings are given in Chapter 4. We divide the factors into fifths and use a separate dummy for each interval because the effect of any ability need not be linear, and because the test-score information is an ordinal rather than cardinal measure of ability. The main regression equations for both 1955 and 1969—including such measures as t statistics, $\bar{R}^2$, and standard errors—appear in Chapter 5.[7] The equations, estimated by ordinary least squares, include measures of education, mathematical ability, personal biography, health, marital status, father's education, and age—and, to account for non-

[5] Thus, our functional form incorporates the one advocated by Mincer (1970). The use of log of earnings, however, could still be justified to eliminate heteroscedasticity.

[6] As discussed in Chapter 4, Thorndike believes that our mathematical factor is close to IQ but that the verbal factor contains too heavy a mechanical component to be identified.

[7] To save space, we have not included the one containing the significant interaction between graduate education and the top two ability fifths.

pecuniary rewards, a dummy variable for precollege teachers.[8] Nearly all these variables are significant at the 5 percent level in both years studied, although a few are only significant in one of the two years.

The net earnings differentials due to education can be calculated from these equations for two points in the life cycle and appear in Table 1-1. In 1955, when the average age in the sample was 33, annual earnings of those attending college were generally 10 to 15 percent higher than they were at the high school level, although the differential was 70 percent for M.D.'s, 2 percent for Ph.D.'s, and 20 percent for LL.B.'s.[9] In 1969, those with some college received about 17 percent more income than high school graduates, while those with an undergraduate degree, some graduate work, or a master's degree received 25 to 30 percent more. Ph.D.'s, LL.B.'s, and M.D.'s received about 25, 85, and 105 percent more income, respectively, than high school graduates of the same ability level.[10] From 1955 to 1969, the differentials increased at all education levels, with the greatest percentage increase occurring for the most highly educated. As explained in more detail below, these differentials are independent of ability level except for graduate students. In some versions of the 1969 equations, we replaced the college-dropout category with the three categories of those who finished one, two, and three years of college. The coefficient for completing one year of college is essentially equal to that of the some-college variable, and the coefficients for completing the second and third years of college indicate no further increase in income.

[8]Father's education is included as a proxy for family background, but it may also incorporate other abilities that are inheritable. The personal-biography variable is a weighted average of the two indexes labeled "pilot and navigator biography" by Thorndike and Hagen. These indexes are, in turn, weighted averages of information collected in 1943 on hobbies, prior school studies, and family background. The weights used in constructing these indexes depend on how well the item predicted success in pilot school and in navigator school.

[9]Although not shown here, the returns to B.A. and B.S. holders are the same.

[10]These returns correspond to those of wage rates since average hours worked are the same at all education levels except for the combination of Ph.D., LL.B., and M.D., in which hours are 8 percent greater than that of the lowest category.

When, as in 1969, a dummy variable is included for business owners (but not self-employed professionals), the income differential for non-business owners with a bachelor's degree is raised by 25 percent, while the some-college differential is unchanged.

TABLE 1-1 **Percentages by which earnings of those with higher levels of educational attainment exceed those of the average high school graduate, 1955 and 1969**

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TABLE 1-1 Percentages by which earnings of those with higher levels of educational attainment exceed those of the average high school graduate, 1955 and 1969

Education	Percentage increases in 1955	Percentage increases in 1969
Some college	11	17
*Undergraduate degree**	12	31
*Some graduate work**	15	26
*Master's**	10	32
Ph.D.	2†	27
M.D.	72	106
LL.B.	19	84

* For those not teaching elementary or high school.

† All table entries are significant at the 5 percent level except for this one. See Chapter 5 for the underlying equations.

Mincer (1970) has suggested that the more educated also invest more in on-the-job training and, as a consequence, have an age-income profile that could lie below the profile of the less educated for a period of time (after leaving school) that is less than the reciprocal of the rate of return on education. Our analysis of initial salary by education level (not presented here) is consistent with part of this explanation. We find that in 1946, 1947, and 1948 the starting salary of high school graduates is nearly the same as that of college graduates, graduate students receive less than college graduates, and, finally, those with some college may earn more than those with a college degree.[11] Since in any year the more educated among the initial job applicants will tend to be older and since experience adds to income, these results do imply that the age-earnings profile of the less educated initially lies above that of the more educated. On the other hand, the growth rates in income of those with a college degree, some graduate work, and a master's degree were essentially the same from 1955 to 1969 (although there was still a tendency for faster growth at higher education levels), which suggests that the difference in investment in on-the-job training was not very large at these levels.

[11] Of course, all the people in the sample received some vocational training in the Air Force. If this training is more important for people with no college, comparisons of starting salary would not be appropriate for the civilian population. However, some of the vocational training would also benefit those who went to college. Most of the high school graduates began work in 1946, but a few were discharged from the military at a later date.

THE ROLE OF MENTAL ABILITY

We have analyzed extensively the role of ability in the rate of return to education, using the factors mentioned above that represent mathematical ability, coordination, verbal ability, and spatial perception.[12] To allow for nonlinear effects, we divided each factor into fifths, which may be closer to population tenths for the verbal factor and for the mathematical factor, since only those in the top half of the mental-ability distribution were allowed into the test program. We find that, of these ability measures, only mathematical ability—which is based primarily on numerical fluency and only secondarily on problem-solving techniques—is a significant determinant of earnings.[13] The score a person achieves on the mathematical tests used here, or on IQ tests in general, can be determined by a combination of inherited skills (or capacities) and skills acquired through schooling, home environment, and so on. As described in detail in Chapter 5, however, the pretest variation in quantity and quality of schooling had little effect on test scores or earnings. Also, family environment is controlled for directly (though by a crude proxy). Thus, the ability coefficients should be closer to measures of the effect on earnings of inherited mathematical ability than anything else and should not incorporate part of the effect of the quantity and quality of education.

We also have estimated earnings equations within several different occupations. While these equations are discussed later in more detail, it is worth noting here that none of the ability measures were significant in the white- and blue-collar occupations, but mathematical ability was significant in the managerial, professional, technical, and sales groups.

In light of some recent literature on the distribution of income (Lydall, 1969), it is interesting to consider the relative importance of the effects of education and ability over time. In Table 1-2 we present estimates of the extent to which earnings of a high school graduate in each of the five ability levels differ

[12]The verbal measure is a weighted average of tests entitled (in order of importance in factor): Mechanical Principles, Reading Comprehension, General Information–Pilot, General Information–Navigator, Math B, and Spatial Orientation II. As described in Thorndike and Hagen (1959), these tests contain such elements as verbal fluency, reasoning, and mathematical skills. Knowledge of mechanical principles is contained in the General Information–Pilot and Reading Comprehension tests, as well as in the first item.

[13] The second fifth was not significant, but the other three were.

TABLE 1-2 ***Percentages by which earnings of high school graduates of a given ability exceed those of the average high school graduate, 1955 and 1969***

Ability
1
2
3
4
5

NOTE:

TABLE 1-2
Percentages by which earnings of high school graduates of a given ability exceed those of the average high school graduate, 1955 and 1969

Ability fifth	*1955*	*1969*
1	− 7.6	− 10.0
2	− 3.0	− 3.9
3	− 1.0	− 0.4
4	2.4	2.9
5	9.2	15.0

NOTE: The top quality fifth is 5.

from the earnings of the average high school graduate. In 1955, those in the top fifth earned about 9 percent more, and those in the bottom fifth 8 percent less, than the average; in 1969, the corresponding figures are 15 percent and −10 percent.[14] Thus, over time, income of those in the top fifth has risen faster than the income of those at the low end of the ability scale; for those in the middle fifths, the growth rate has been about the same as that of the average high school graduate in this sample. In 1955, the 17 percent differential between the top and bottom ability fifths is greater than the differentials attributable to education, except for the M.D. and LL.B. categories (see Table 1-1). In 1969, the 25 percent differential is greater than the differential for some college and is quite close to the differentials at all education levels except LL.B. and M.D. Since our sample was drawn only from the top half of the ability distribution, it is almost certain that, for those in this cohort who are at least high school graduates, ability is a more important determinant of the range of the income distribution than is education.[15]

As far as interaction between ability and education is concerned, we find practically no evidence of any difference in the effect of ability at the various education levels in 1955, although we find some evidence in 1969 that those in the fourth and, to some extent, fifth ability groups who had graduate training received more income from ability than those at lower educa-

[14]The dollar effect of ability on education is the same at each education level (except in 1969 for high-ability people who attended graduate school); hence, these percentage figures would be lower at higher education levels.

[15]This comparison assumes that the bias from all omitted variables affects the education and ability coefficients in the same proportion. This assumption may be inappropriate for college quality, which is highly correlated with mental ability, as discussed below.

tion levels. However, we also find ability to be an important determinant of earnings even for high school graduates. Finally, in our study of initial salaries, we find that mental ability had no effect on income except for those with graduate training. Together with the results in Table 1-2, this indicates that ability initially has little effect on earnings, but that the effect grows over time, and perhaps grows more rapidly for those with graduate training and high ability.

Hause (1972) finds a significant interaction between IQ and education in the NBER-TH sample, and because this finding is at odds with ours, it is appropriate to compare the two studies. Hause began his work after we had finished this portion of our study; in the interval A. Beaton created the variable used by Hause, which was labeled IQ and which differs from any of our factors.[16] Tests we have conducted with our full sample indicate that if the test scores are entered linearly, the IQ variable yields a higher $\bar{R}^2$ in the earnings equation than does our first factor, but if the test scores are entered in the general nonlinear dummy-variable fashion, the reverse is true. Since the test scores are an ordinal index, it is appropriate that an allowance be made for general nonlinear effects. Hause did not allow for such effects, but instead specified a double-logarithmic earnings function. We conclude that the finding by Hause of an "interaction" between ability and education is attributable to his selection of a restrictive functional form.

These conclusions on ability and education suggest the following type of model for the labor market. For most jobs, firms either have little or no idea of what determines success or have to engage in so much training and testing that the initial output of all employees without previous experience is similar. In either case, firms pay all those in comparable positions the same amount initially and then monitor performances, basing promotions and income on accomplishment. Because the highly educated and able perform better and win promotions sooner, the model can be described as one of upward filtration. Such a model is consistent with the human-capital concept, but it suggests a somewhat different interpretation of empirical results and somewhat different directions for research. That is,

[16]In addition to this different ability measure, Hause's study differs from ours in that he excludes self-employed and certain other people from his analysis and does not include all the variables that we found significant.

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it provides an explanation other than learning by doing for the shape of the age-income profile, while a natural extension of the model in which firms try to minimize information costs leads to the screening model discussed below.

A criticism that has been made of many education studies is that the education coefficients are biased upward because relevant abilities and other characteristics have not been held constant. We can obtain an estimate of this bias by observing the change in the education coefficients that results when our equations are estimated with ability omitted. We have calculated the bias assuming, first, that each factor was the only type of ability that should be included and, second, that all abilities should be included.[17] In both instances we find that only the omission of mathematical ability leads to a bias of any magnitude. In 1955, the bias on the education coefficients from omitting mathematical ability is about 25 percent, varying from a low of 15 percent for some college to a high of 31 percent for a master's degree; in 1969, the biases are somewhat smaller, averaging about 15 percent and ranging from 10 to 19 percent.[18] The decline in the bias over time occurs because the coefficients on ability did not grow as rapidly between 1955 and 1969 as did those on education.[19] In some studies, rates of return have been calculated using differences in average income between education groups at various ages. In this sample, such a procedure would overstate the earnings differentials from higher education by 35 and 30 percent in 1955 and 1969, respectively. Because of the (contrary) effects of the GI Bill and pressing family responsibility on post-World War II educational attainment by ability level, these bias results need not apply to other groups in the population.

[17]One of our important variables, however, is a mixture of background and ability; thus we can calculate only the upper and lower bounds of the bias resulting from omitting ability. For simplicity in this summary, we use the average of these bounds.

The bias is expressed below as the ratio of the difference in the education coefficients when ability is excluded and included to the education coefficient when ability is excluded.

[18]The 15 percent bias for the some-college category is higher than in other studies and may be due to our use of mathematical ability rather than IQ.

[19]The bias may also be expressed in terms of the coefficient on education in an equation relating ability to education, but since this equation would involve the same people in 1955 as in 1969, and since their education changed only slightly, the coefficient would be virtually unchanged in the two years.

OTHER VARIABLES

Several sociodemographic and background variables are statistically significant and are important determinants of income. For example, the difference between excellent and poor health in 1969 was worth $7,000 a year, and the 100 individuals who were single earned about $3,000 a year less than the others.[20] Those whose father's educational attainment was at least the ninth grade earned about $1,200 more in 1969 and $300 more in 1955 than those whose fathers had not entered high school. (In the format of Table 1-1, a bachelor's degree added $700 and $4,000 in 1955 and 1969, respectively.) Other background information is contained in a biography variable constructed by Thorndike and Hagen from data on hobbies, family income, education prior to 1943, and mathematical ability. We find the fourth and fifth and either the second or third fifths of the biography variable to be significant and of about the same magnitude as mathematical ability, thus being as important as differences in education in explaining the range of earnings. In 1955 the age variable was significant and numerically large, and in 1969 its effect was negative and insignificant, thus consistent with the common notion of a rising age-income profile reaching a peak after the age of 40.

Although the results discussed above were obtained from analyzing separate cross sections, it is possible to develop a combined measure of motivation, drive, personality, and whatever other characteristics persist over long periods of time by using the residuals generated in one cross section, denoted by Q, as a variable in the equations in another cross section. In each year, the inclusion of Q raised the $\bar{R}^2$ from about .10 to .33 and reduced the standard error of estimate by 15 percent, while leaving the other coefficients unchanged.[21] Thus, we conclude that about two-thirds of the variation in earnings in any year

[20]In 1969, the respondents were asked to indicate the state of their health as being poor, fair, good, or excellent. The effects of health were statistically significant and approximately linear in 1969 and, interestingly, also in 1955, although the 1955 t value is lower.

[21]The relatively low $\bar{R}^2$ occurs partly because of the very limited range of education in our sample and of age in each cross section. For example, merging the two data sets but allowing for separate coefficients in each would raise the $\bar{R}^2$ to about .30.

The other coefficients are the same because Q is necessarily orthogonal to the other independent variables in 1955, and these are essentially the same as the variables used in 1969.

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represents either random events, such as luck, or changes in underlying characteristics (or both). Further examination of the residuals from the regression equation leads to the following conclusions. First, although the equations do not explain well the very high incomes of the most successful, the estimates of extra income arising from education are only slightly altered if the very successful are excluded. Second, when the sample is divided up by education and ability, a test for constancy of the residual variance is rejected at the 5 percent level.[22] However, when the equation is estimated weighting each observation by the reciprocal of the standard error of its ability-education cell, the coefficients and conclusions reached above are changed very little.

QUALITY OF SCHOOLING

We have also explored briefly the effects of including an educational-quality variable in the NBER-TH regressions.[23] We used the Gourman academic rating, the intent of which is to measure the quality of undergraduate departments, in the form of fifths of the sample distribution.[24] At the some-college and B.A. levels, only the highest quality fifth affects earnings significantly; for graduates this is true for the top two undergraduate school fifths and the top graduate school fifth. The 1969 results, summarized in Table 1-3, indicate that differences in income at a given educational level attributable to college quality effects are very large. For example, the college dropout in the top quality fifth receives more income than anyone not in the top fifth except for those with a three-year graduate degree.[25] Similarly, the three-year-graduate-degree holder earns anywhere from 53 to 98 percent more than the average high school student, depending on school quality.

The quality variable may be important for several reasons. First, high-quality schools can impart different or additional in-

[22] Even when we use the log of earnings as our dependent variable or include Q in our equations, we reject the hypotheses of constant variance and of normally distributed errors.

[23] Since the quality data became available to us at a much later date than the other data, we have not attempted to incorporate the quality implications in the rate-of-return calculations. Of course, the direction of the effect is obvious. L. Solmon is currently examining the quality question in great detail.

[24] This rating is defined in Gourman (1956).

[25] This group includes Ph.D.'s, lawyers, and M.D.'s.

TABLE 1-3 ***Amount by which monthly earnings of those with higher levels of educational attainment exceed those of the average high school graduate, 1969 (in dollars)***

	Amount	*Percent**
Education		
Some college		
Undergraduate quality 1–4	161	14
Undergraduate quality 5†	442	37
Undergraduate degree		
Undergraduate quality 1–4	340	29
Undergraduate quality 5†	457	39
Some graduate work‡	166	14
Master's‡	194	16
Ph.D. and LL.B.‡	633	53
Additional income to graduate as a function of educational quality		
Undergraduate quality 4†	182	15
Undergraduate quality 5†	268	23
Graduate quality 5†	257	22

* Expressed as a percentage of the average income of high school graduates.

† Significantly different from earnings of comparable people who attended schools in the bottom quality fifths.

‡ For those at an undergraduate school in the bottom three quality fifths and a graduate school in the bottom four fifths.

NOTE: These regression results are based on a sample of 5,000 individuals. The top quality fifth is 5.

come-earning skills compared with low-quality schools. Second, as described below, the quality as well as the quantity of education may be used as a screening device.[26] Finally, one of Gourman's stated objectives in providing the quality ratings is to permit students to match their capabilities, as reflected by Scholastic Aptitude Test (SAT) ratings, with schools. If individuals' SAT ratings and school quality ratings were *perfectly* correlated, then the quality rating would reflect mental-ability differences rather than differences in the quality of education provided by the school. Evidence in Wolfle (1954) and Solmon (1969) indicates that school quality and the average IQ of those

[26] Some of the schools included in the top undergraduate quality fifth are Berkeley, Brown, Chicago, Columbia, Harvard, Michigan, Minnesota, MIT, Princeton, Stanford, Wisconsin, and Yale.

	Percent*
	14
	37
	29
	39
	14
	16
	53
	15
	23
	22

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attending are positively correlated, but that within schools there is a wide range in individual abilities. In addition, evidence in Astin (1968) indicates that schools are differentiated by characteristics of their students other than mental ability and that schools have different attitudes toward various forms of social and psychological behavior. Thus, the quality variable may reflect individual mental-ability differences not captured in our personal-ability measures, other personality differences, or quality-of-schooling differences.

THE RATE OF RETURN TO EDUCATION

The data for 1955 and 1969, as well as data on initial-job earnings, yield information at three points on the age-earnings profile for those in our sample. It is possible to interpolate for the intervening years on the basis of various data collected by the census and to extrapolate beyond 1969 (when the people in our sample averaged 47 years of age) to obtain "realized," or ex post age-earnings profiles by education level.[27] We have constructed such profiles for a person with the characteristics of the average high school graduate in the sample. The differences between those profiles, together with information on the costs of education, are used to estimate rates of return to education.[28]

Private rates of return may differ from social rates because some benefits accrue to individuals other than those who are educated, or because of market imperfections based on education. Ignoring the latter group of problems, which are discussed below, differences between our estimates of private and social rates of return occur because the private benefits are calculated after deducting income taxes from earnings, and because social costs include the total (per student) expenditures on higher education rather than just average tuition.[29] However, our estimated social and private rates are very similar because the before-tax income streams are the same, and because the largest

[27]For details, see Appendix J.

[28]Earnings provide an inadequate measure of benefits from education if there are nonpecuniary returns that vary by education level. In our estimates, we in effect add to the incomes of elementary and high school teachers a large nonpecuniary return. Without this adjustment, the rates of return would be smaller at the undergraduate and master's levels. No other adjustments are made for nonmonetary returns or for consumption benefits.

[29]The details in constructing the cost estimates can be found in Appendix L. The forgone earnings are estimated from the sample.

cost component in each instance is forgone earnings.[30] In this discussion, therefore, we concentrate on estimates of the social rates of return calculated from nominal profiles and after deflation by the Consumer Price Index (CPI). These are presented in Table 1-4 along with nominal private rates.

Compared with those of a high school graduate with the same abilities and background, the social rates of return realized in our sample (before deflation) are 14, 10, 7, 8, and 4 percent for two years of college only, an undergraduate degree, some graduate work, a master's degree, and a Ph.D., respectively.[31] The most striking aspect of these results is the general decrease in the rate of return with increases in education, which holds even though we have adjusted for the large nonpecuniary reward to precollege teachers, who are concentrated in the B.A., some-graduate-work, and master's degree categories. On the other hand, nonpecuniary returns may be contributing to the low return in the Ph.D. category, which includes professors. Rates of return calculated without standardizing for ability and background, although not presented here, are generally about 20 percent higher; for example, the some-college return rises from 14 to 18 percent. These rates of return, based on current-dollar profiles, differ from those based on constant-dollar profiles because inflation increases the absolute differences between the profiles and alters the purchasing power of the investment "costs" and "dividends." Estimates of real rates of return, obtained by deflating by the CPI, are two to three percentage points lower.

A surprising result is that the rate of return to a college dropout exceeds that to a college graduate. This result might, in part, be attributed to the heavy concentration in the some-college category of self-employed individuals, whose earnings probably include a return to financial capital.[32] Including a

[30]These returns, which are not very sensitive to small changes in the data, are calculated under the following assumptions. First, we do not include GI education benefits as offsets to forgone earnings, since we want rate-of-return estimates applicable to the population as a whole. Second, we assume that, as in our sample, the average age of people about to undertake higher education in 1946 was 24. We also calculate a rate of return for people identical to those in the sample but who were 18 in 1946; but since these rates are about the same, we ignore this distinction in our discussion.

[31]The Ph.D. category does not include self-employed professionals.

[32]The questionnaire did not specify that "earnings" included profits, but it seems reasonable that some owners included some profits in their answers.

TABLE 1-4 ***Realized rates of return to education, NBER-TH sample, for people entering college in 1946 (in percentages)***

TABLE 1-4
Realized rates of return to education, NBER-TH sample, for people entering college in 1946 (in percentages)

Education	*Private (before taxes)*	*Social (before taxes)*	
	Not deflated	*Not deflated*	*Deflated*
High school to:			
Some college	15	14	11
B.A.	11	10	8
Some graduate work	8	7	5
Master's	8	8	6
Ph.D.	4	4	2
LL.B.	12	11	9
Some college to B.A.	7	7	5
B.A. to LL.B.	13	12	10

dummy variable for people who were business owners in 1969, we find that the earnings-differential percentage, compared to that for the average high school graduate, is unchanged for college dropouts but is increased by 25 percent for college graduates who are not business owners. Hence, if this 25 percent adjustment is appropriate (and holds at all ages), the rate of return to obtaining a B.A. but not becoming a business owner is about the same as for a college dropout.[33] Of course, even the finding that college dropouts receive as high a rate of return as bachelor's degree holders is not in accord with findings by such others as Becker (1964). This difference may be due partly to the fact that in other studies ability is not held constant, whereas many of those who drop out of college do so because they do not have the intelligence, drive, or other attributes to handle the work. That is, much of the earnings differential between the some-college and bachelor's degree levels may, in fact, be due to these characteristics and not to the education difference. The college dropouts in our sample, however, were in their mid-twenties in 1946 and about a year older than the college graduates. Also, those who were married before 1949 tended to have a half year less education. Thus, the dropouts probably had a family to support and could not afford (in the short run) a

[33]This dummy-variable procedure understates the true return to some college if obtaining that education level increases the likelihood that the individual will become a businessman. On the other hand, our sample information about the self-employed obviously does not include data on those who failed earlier in life; thus, the dummy-variable coefficient overstates the average return to being self-employed and may overstate the return to education.

college degree. This suggests that, in our sample, dropouts may be more like college graduates than is true in the population as a whole and that our result is the more reliable. In other words, dropouts may have been pulled out of college by their children and by attractive alternatives to education, rather than pushed out by lack of drive and motivation.

As explained earlier, except for those with graduate training, there is no evidence of an interaction between ability and education in determining earnings. Further, since the data on initial earnings—although they are "recalled" estimates and hence less accurate—indicate that ability does not affect initial earnings, forgone earnings do not vary by ability level. Therefore, except for those with graduate training, the rates of return discussed above apply to individuals at all ability levels in our sample. For those with graduate training, differences in the rates of return between those in the top two and those in the bottom mathematical-ability fifths are approximately two percentage points (centered about the average).[34]

Is it reasonable to expect the results from this sample to generalize to the population as a whole and to other time periods? While the sample is drawn from a rather special population, we see no reason why most results from our equations in which special characteristics of the people are held constant would not generalize. (This is not so true of the previous bias calculations, since these involve the relationship between education and the special characteristics.) Moreover, as just shown, one special characteristic of our sample probably aids us in obtaining generalizable results.

If the economy were on a balanced growth path, information over time for the people in our sample would yield an estimate of the rate of return for all cohorts. We doubt that the huge changes in educational attainment are consistent with a balanced growth path and would suspect that cohorts currently being educated will, on the average, do no better than the people in the NBER-TH sample.

[34]In this report we also calculate rates of return using data from the 1949 census and from 1946 in Miller (1960), but with adjustments for the omission of ability and other variables. The bachelor's rate of return in both of these cross sections and the some-college rate in the 1946 sample are close to the realized real rates given above. For the some-college group, the 1949 cross section yields a much smaller estimate than the time-series data.

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Are investments in education worthwhile? From a social point of view this involves comparing social rates of return 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, usually thought to be about 13 to 15 percent in real terms (Phelps, 1962; Taubman & Wales, 1969). Thus, ignoring consumption benefits and externalities, there is overinvestment in the education of males from society's viewpoint except, perhaps, for the some-college category and college graduates who are not self-employed. If society were to raise the funds through taxation or debt issues without affecting private investment, the risk-free discount rate (probably about 4 percent) would be the appropriate alternative marginal time-preference rate (Arrow & Lind, 1970). On these grounds, investments in education are worthwhile from society's viewpoint, especially since we have not allowed for either externalities or the consumption value of education.

From a private viewpoint, the appropriate alternative return is best represented by an after-tax, or ex post, rate of return on common stocks—say about 10 percent. Since the private after-tax rates differ from the before-tax rates by less than one percentage point, we conclude that (in addition to some college) obtaining a B.A. or LL.B. degree is a profitable investment, although—subject to the earlier qualifications on the college-dropout results—it would be better to drop out after two years of college. The private return to education is more profitable relative to alternative assets than is the social return because of the various subsidies given to higher education.

THE WOLFLE-SMITH SAMPLE

In the mid-1950s, Dael Wolfle and Joseph Smith collected information on a large group of people who had graduated from high school between 1933 and 1938. In their analysis, they generated about one thousand pages of detailed cross tabulations, but their well-known and extensively quoted article published only about ten tables. Professor Wolfle has graciously provided us with all his tabulations, enabling us to redo and to extend his analysis. Because of the form in which the information was retained, however, we could use only the Minnesota data. This sample was drawn from all high school graduates of 1938. The mental-ability test used was given to these students in high school and does not reflect the influence of further education.

According to Wolfle and Smith, there may have been a response-success bias in this sample, in which case we might expect the returns to education to be understated. However, the analysis of the 1953 earnings indicates greater net effects of education than those found in the NBER-TH sample for people of the same age. Part of the difference may arise from the fact that in the Wolfle-Smith sample the ability measure is the combined scores on the American College Entrance Examination (ACE), whereas in the NBER-TH study only the mathematical measure was important. More significantly, it was not possible in the Wolfle-Smith sample to eliminate the effects of family background and other variables that are significant determinants of earnings and correlated with education in the NBER-TH sample. The differences in type of test may also explain why a strong interaction between high ability and education is found in this sample but not in the NBER-TH. Another interesting finding is that the Wolfle-Smith mental-ability measure is a more important determinant of earnings than high school rank.

EDUCATION AS A SCREENING DEVICE

Our analysis of earning differentials and rates of return to education was conducted without considering how education increases income. Becker and others have shown that if education produces additions to an individual's skills (cognitive or affective), his income will increase. A number of people, however, have asserted that a primary role of education is to serve as a credential, particularly in the highly paid managerial and professional occupations (Griliches & Mason, 1972; Hansen, Weisbrod, & Scanlon, 1970; and Thurow & Lucas, 1972).[35]

If education is used to screen people, then the extra earnings a person receives from education are due both to the skills produced by his schooling and to any income-redistribution effects resulting from supply limitations. Since income redistribution need not be a gain to society, the social return may be less than the private return to education. This conclusion, however, overlooks one particularly important component of the problem, which can best be considered by asking why firms use education as a screening device. There are several possible an-

[35]For lower-paying occupations, such as skilled laborer, the required credential may be a high school diploma.

swers, including snobbery and a mistaken belief in the true importance of education. On the other hand, the use of such credentials may be motivated by profit-maximizing behavior. Consider jobs in which a person is not paid on a piece-rate basis, but rather on a fixed wage and salary per period of time, and suppose that on these jobs successful performance depends upon a complex set of talents, skills, and motives only some of which can be measured easily by direct tests. Clearly, firms could attempt to develop and use tests in selecting employees with the necessary skills for particular occupations. But developing tests, examining recruits, and incurring performance errors can be expensive. Alternatively, in order to save on hiring costs and to reduce mistakes made on the job, firms might decide to use information on educational attainment, available at near-zero cost, as a preliminary screening device, if they either knew (from past experience) or believed that a significantly larger percentage of college graduates had the desired complex of skills.[36]

The implications for the social rate of return are clear—if educational screening were not permitted, additional resources would have to be used in order to sort people. Hence, any sorting costs saved by using education as a screen are a benefit to society and must be taken into account when comparing the social and private rates of return. In this volume, we do not attempt to estimate the magnitude of these costs, but we do obtain a rough estimate of the contribution of screening to income differentials, based on the logic outlined in Chapter 9.

Briefly, to test for the existence of screening, we compare the actual occupational distribution of individuals at various education levels with the "expected" free-entry distribution. The basic assumption made in estimating the expected distribution is that each individual selects the (broad) occupational category in which his income will be highest. To estimate earnings in other occupations, we make use of the estimated occupational regressions based on the NBER-TH sample presented and discussed in Chapter 8. The coefficients on the various ability and education variables can be thought of as the valuations of the extra skills produced by ability and schooling.

Using the occupation equations, we can estimate an individ-

[36]Note that the larger percentage could occur either because education produces skills or because the more talented receive the education.

ual's income in the *m*th occupation as the mean income of persons with the same education, ability, and other characteristics as this individual, but currently in the *m*th occupation. Since we do not have measures of all individual characteristics, the potential earnings for each individual will be distributed about this mean. We assume that the distribution of the residuals in our occupational regressions would also hold for people with any given set of personal characteristics currently in any other occupation. Finally, we assume that for any individual the earnings distributions about the mean in various occupations are independent. If residuals are positively correlated, the latter is a conservative assumption that biases our results against accepting the screening hypothesis; that is, if the distributions about the means are positively correlated, people who earn more in one occupation would do so in all others. Hence, fewer people would pick the occupation with the lower mean income.

Table 9-1, (page 164) contains the expected and actual occupational distributions for the high school, some-college, and B.A. categories, together with the means and standard deviations of the corresponding existing income levels for 1969.[37] The most striking result is that, for the high school group, the actual fractions of people in the three lowest-paying occupations are considerably greater than the expected fractions. In the some-college group this result holds but is less pronounced, and for the undergraduate-degree holders the actual and expected distributions are essentially the same in the lowest-paying occupations. In general, then, if there were free entry into all occupations, very few people at any education level included in our sample would choose the blue-collar, white-collar, or service occupations. In practice, however, a substantial fraction (39 percent) of high school graduates, a smaller fraction (17 percent) of the some-college group, and only 4 percent of the B.A. holders enter these occupations. Since the discrepancy between the expected and actual distributions is directly related to education, we conclude that education itself is being used as a screening device to prevent those with low educational attainment from entering high-paying occupations.[38]

[37] There is almost no one with graduate training in the blue-collar, white-collar, or service occupations.

[38] Although not presented here, the same general pattern holds for 1955.

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We can also attempt to estimate what the rates of return to education would have been if there had been no screening.[39] These returns are of interest since they represent the extent to which those presented earlier reflect increases in productivity rather than discrimination in the job market. To calculate returns to education, we weight the income differences due to education in various occupations by the expected distribution of people across occupations. These returns are upper bounds to those that would actually occur, since they do not allow for income levels to adjust as the occupational distributions change. Also, they are unadjusted estimates in that they do not allow for differences in ability, background, age, and the like. They can, however, be compared with estimates obtained using the actual distributions, and the percentage differences between these two sets of estimates will probably be reasonable approximations to differences in returns, adjusted for relevant factors.

We have calculated the percentages by which income in the some-college and B.A. categories exceeds the income of high school graduates for the actual and expected distributions for 1955 and 1969. In 1955 the earnings differentials due to education under the assumption of no entry barriers are only about one-half to one-third as large as actual returns, and in 1969 they are about one-half as large. This suggests that the effect of screening on the returns to education is, in fact, substantial at these education levels and that, without screening, the returns might be 50 percent below those presented earlier.[40]

CONCLUSIONS Our results are helpful in determining whether society has over- or underinvested in education. Since none of the deflated social rates of return presented in Table 1-4 exceeds 11 percent and very few exceed even 8 percent, and since the before-tax return on physical capital is generally thought to be about 13 to 15 percent, it appears that society has invested too many resources in education if the supply of savings is fixed. Further, the rates are lower the higher the education level (excluding lawyers and

[39]As explained above, calculation of the social rate requires information on the sorting costs saved by screening. Since we are assuming these costs to be zero, the social (but not the private) rates will be underestimated.

[40]Moreover, if there were no screening, the forgone earnings of those at the high school level would have been greater.

M.D.'s), suggesting that the overinvestment is more severe at the higher levels.[41] However, we have not included in our analysis allowances for externalities or consumption benefits which, if they yield large enough returns, could justify expenditures on education. Further, we find that the rates of return at the some-college and B.A. levels are higher than they would be if there were free entry into the high-paying occupations; that is, since the part of the return to education that reflects the income redistribution due to the credential aspect of education does not benefit society, its effect should be subtracted from actual rates when studying the question of whether there has been overinvestment in education.[42] Since we find screening to be important quantitatively, our conclusion that overinvestment in education has occurred is strengthened.

Perhaps the best way to indicate what we consider to be the overall limitations of this study is to list the areas into which future research should be channeled. As noted earlier, we are worried by some of the differences in results between the Wolfle-Smith and NBER-TH samples. One reason for the result may be the differences in the conceptual and measurement bases of IQ. Thus, it is appropriate for research to determine what types of ability affect earnings and what are the best measures of these abilities. Second, in this study we have not tried to determine what affective or cognitive skills higher education augments or how education produces such changes. Many issues in education can only be resolved by looking into the black box called education. It would also be best for the NBER-TH results to be retested on samples with a wider spectrum of ability, education, and other characteristics, and on different cohorts to see if our results can be generalized to the population as a whole. Finally, the tests for screening are crude and would benefit from more detail on occupations and the different types of skills that influence earnings.

[41] To the extent that lower rates at high education levels reflect nonpecuniary returns, the overinvestment is diminished somewhat.

[42] However, as mentioned above, if screening were not practiced, the costs to firms (and society) of finding suitable employees would increase. These costs are therefore one of the benefits of the existing educational system and should be included when the income-redistribution aspects due strictly to screening are excluded.