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4. *Education as an Investment and a Screening Device*

by Paul Taubman and Terence Wales

INTRODUCTION A cursory examination of studies based on census data reveals that earnings increase with education and that the social rate of return to education is at least equal to the return available to society on other investments (Becker, 1964; H. 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 to be a major ingredient in studies of the sources of economic growth and the distribution of income (Becker, 1964; Denison, 1964; H. Miller, 1960; Schultz, 1963). Central to all these studies are two testable hypotheses. First, the (observed or adjusted) differences in earnings by educational level represent the net effect of education, rather than some other personal characteristics that have not been held constant. Second, these differences in earnings represent increases in productivity produced by education.

It has long been recognized that systematic differences in earnings may not be due solely to differences in educational attainment (Becker, 1964; Wolfle & Smith, 1956) and that the omission of a variable positively correlated with education and with a separate and positive influence on earnings biases the education coefficient upward. Many people have hypothesized that, in particular, the omission of mental ability and family background will result in such a bias. Although attempts have been made in a number of studies to standardize for family background and other determi-

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nants of earnings, no studies of education based on large samples contain the relevant earnings, ability, and education information.[1] Therefore, our first goal was to obtain good estimates of the rate of return to education at various ability and educational levels. Because of data limitations, specific estimates were restricted to returns for higher education, i.e., education beyond the twelfth grade. For the same reasons, only the education of males was considered.

Most studies of the rate of return to education are based on the premise that differences in earnings at different educational levels arise because of the various cognitive and affective skills produced by education. However, this need not be the case. The differentials might arise because the lack of educational credentials is a barrier to entry to high-paying occupations. If this is the case, the social rate of return to education is lower than the private rate, ignoring costs involved in other methods of sorting people.

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 the earnings differences due to productivity gains from those due to screening. Our second goal, therefore, was to examine the hypothesis that education adds to income by screening people with low education out of high-paying occupations.

A new and extremely rich data source allowed us to obtain substantially improved estimates of the (private and social) return to higher educational attainment and make crude estimates of the effect of screening on earnings differentials.

In brief, our findings, all of which are subject to qualifications as given in the text, are the following: First, the realized (real) rate of return—ignoring consumption and nonmonetary benefits—to the college dropout or graduate is 7½ to 9 percent and does not

[1] Studies for the United States include Ashenfelter and Mooney (1968); Becker (1964); Bridgman (1930); Cutright (1969); Duncan et al. (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 the Hause study, each of these studies suffers from one or more of the following serious problems: poor measures of education and ability, small and inadequate sample size, improper statistical technique, or too specialized a sample to permit the formation of 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.

vary with the level of mental ability. If we ignore the screening hypothesis, 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 upward 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.

Two caveats are in order. First, since this study is based primarily on a population that is much brighter and better educated than average, our results need not apply to the United States population as a whole. Second, because of space limitations, we do not fully document all our assertions here. For more details the interested reader should consult our larger manuscript (Taubman & Wales, forthcoming). Appendix A contains a more complete description of the sample, the follow-up procedures, etc.

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 classes) we allow for nonlinear effects, and by combining dummies we allow for interactions.[2] As noted earlier, there are scores on 17 ability tests for each person. Factor analysis indicates that four orthogonal factors could be extracted from these scores, two of which quite clearly represent spatial perception and physical coordination and the other two of which we treat as measuring mathematical and verbal ability.[3] We divide the factors into fifths and use a separate dummy for each interval because the effect of ability need not be linear. The main regression equations for both 1955 and 1969—including such measures as t-statistics, R^2, and standard errors—appear in Appendix B. The equations, estimated by ordinary least squares, include measures of education, mathematical ability, personal biography,

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

[3] The factor loadings of the tests are given in Appendix B, whereas the tests themselves are discussed in Thorndike and Hagen (1959). Thorndike believes our mathematical factor is close to IQ while the verbal factor contains too heavy a mechanical skills component to be identified.

health, marital status, father's education, and age; to account for nonpecuniary rewards such as shorter work year, they also include a dummy variable for teachers.[4] Nearly all these variables are significant at the 5 percent level in both years studied, although a few are significant only in one.

The net earnings differentials due to education at two points in the life cycle can be calculated from these equations (see Table 4-1). In 1955, when the average age in the sample was 33, annual earnings of those who attended college were generally 10 to 15 percent higher than 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.[5] 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, and a master's degree received 25 to 30 percent more.[6] Those with 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.[7] From 1955 to 1969 the differentials increased at all educational levels, with the greatest percentage increase occurring for the most highly educated. As explained in more detail later, 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 discussed above, whereas the coefficients for

[4] Father's education is included as a proxy for family background. The personal biography variable is a weighted average of the two indices labeled *pilot biography* and *navigator biography* by Thorndike and Hagen. These indices are in turn weighted averages of information collected in 1943 on hobbies, prior school studies, and family background. The weights used in constructing these indices depend on how well the item predicted success in pilot and in navigator school.

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

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

[7] If 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, whereas the some-college differential is unchanged.

completing the second and third years of college indicate no further increase in income.

Differentials in initial salaries are also worth examining. Mincer (1970) suggests that the more educated also invest more in on-the-job training. As a consequence they may have an income profile that initially lies below that of the less educated, remains below for several years dependent on the reciprocal of the rate of return on training, and rises above thereafter. Our analysis of initial salary by educational level (not presented here) is consistent with part of this explanation since we find that in 1946, 1947, and 1948 the starting salary of high school graduates is nearly the same as that of college graduates, that graduate students receive less than college graduates, and finally that those with some college may earn more than those with a college degree.[8] 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 earnings profile of the less educated initially lies above that of the more educated. On the other hand, from 1955 to 1969 the growth rates in income of those with a college degree, some graduate work, and a master's degree were essentially the same (although there was still a tendency for faster growth at higher educational levels), which suggests that differences in investment in on-the-job training were not very great at these levels.

The role of mental ability

We have extensively analyzed the role of ability, using the factors mentioned above that represent mathematical ability, coordination, verbal ability, and spatial perception.[9] To allow for nonlinear effects, we divided each factor into fifths, which may be closer to

[8] 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, the 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 later.

[9] In order of importance in factor, the verbal measure is a weighted average of tests entitled *mechanical principles, reading, 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 (see Appendix B). However, knowledge of mechanical principles is contained in the general information—pilot and reading comprehension tests as well as in the first item.

population tenths for the verbal and for the mathematical factors since only those in the top half of the mental-ability distribution were allowed into the test program. We found that of these ability measures, only mathematical ability is a significant determinant of earnings.[10]

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 4-2 we present estimates of the extent to which earnings of a high school graduate in each of the five ability levels differ from the earnings of the average high school graduate in our sample. In 1955 those in the top fifth earned about 9 percent more than the average, and those in the bottom fifth earned about 8 percent less, whereas in 1969 the corresponding figures were 15 and −10 percent.[11] Thus over time, the income of those in the top fifth has risen faster than the income of those at the low end of the ability scale, and 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 4-1). In 1969

[10] The second fifth was not significant, but the other three were (the omitted class was the bottom fifth).

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

TABLE 4-1
Extra earnings from education for the average high school graduate in 1955 and 1969

	Percentage increases over high school graduates in	
Education	*1955*	*1969*
Some college	11	17
*Undergraduate degree**	12	31
*Some graduate**	15	26
*M.A.**	10	32
Ph.D.	02†	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 Appendix B for the underlying equation.

SOURCE: All data in these tables are from NBER-Thorndike sample.

the 25 percent differential is greater than the differential for some college and is quite close to the differentials at all educational 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 who are at least high school graduates, ability is a more important determinant of the range of the income distribution than education is.[12]

As far as the interaction between ability and education is concerned, we find practically no evidence of any difference in the effect of ability at the various educational levels in 1955, although there is some evidence that in 1969 those with graduate training in the second-highest (and to some extent highest) ability groups received more income from ability than those at lower educational levels.[13] 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 has no effect on income except for those with graduate training. Together with the Table 4-2 results, this indicates that ability initially has little effect on earnings but that over time the effect grows, and perhaps grows more rapidly for those with graduate training and high ability.[14]

These conclusions on ability and education suggest the following

[12] This comparison assumes that the bias from all omitted variables is affecting 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.

[13] Interaction between ability and education would mean that the joint effects of particular combinations of ability and education subgroups are different from what would have been predicted by simply adding the separate independent effects of the two variables.

For example, if it were shown that those in the top ability fifth averaged $1,000 more income than those in the average ability fifth, *whether or not* they went to high school or college, there would be no interaction between education and ability. If, however, this $1,000 income differential was an average result of a $500 differential for those with a high school education and a $1,500 differential for those with graduate training (as compared with people in the average ability fifth), then interaction between ability and education would exist.

Although there appears to be a significant interaction between graduate education and the top two ability fifths, it is not shown among our measures because of lack of space.

[14] Hause (1972) finds a significant interaction between IQ and education in the NBER-TH sample, and since this finding is at odds with ours, it is appropriate to compare the studies. Hause began his work after we had finished this portion of our study, and in the interval the variable used by Hause and labeled

type of model for the labor market: For most jobs, firms either have little or no idea of what determines success or must 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 and base promotions and income on accomplishment. Since 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. It provides an explanation other than learning by doing for the shape of the age-income profile, whereas 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 how the

IQ was created; this IQ variable differs from any of our factors. Tests we have conducted with our full sample indicate that if the test scores are entered linearly, the IQ variable yields a higher R^2 in the earnings equation than our first factor does. 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. Thus the finding by Hause of an "interaction" between ability and education may be attributable to his selection of a restrictive functional form.

An alternative possibility is that the difference in results is due to the sample truncation procedures used by Hause. He excludes the self-employed from the analysis and also eliminates cases with reported incomes more than three standard deviations from the mean.

TABLE 4-2 ***Percentage by which earnings of high school graduates of a given ability exceed those of the average high school graduate in the sample***

Ability fifth (in ascending order of ability)	*Year* 1955	1969
1	−7.6	−10.0
2	−3.0	− 3.9
3	−1.0	−.4
4	2.4	2.9
5	9.2	15.0

NOTE: See Appendix B for the underlying equations. The average age in the sample is 33 in 1955 and 47 in 1969.

education coefficients change when ability is omitted from our equations.[15] We have calculated the bias in two ways: first, assuming that each factor was the only type of ability that should be excluded, and second, assuming that all abilities should be excluded. 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 due to omitting mathematical ability was 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 were somewhat smaller, averaging about 15 percent and ranging from 10 percent to 19 percent.[16] The decline in the bias over time occurs because the coefficients on ability did not grow as rapidly between 1955 and 1969 as those on education did.[17] In some studies, rates of return have been calculated using differences in average income between educational groups at various age levels. In this sample such a procedure would overstate the earnings differentials from higher education by 35 and 30 percent in 1955 and 1969, respectively.

Other variables

Several sociodemographic and background variables are statistically significant and 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 others.[18] Those whose fathers had at least a ninth-grade education earned about $1,200 more in 1969 and $300 more in 1955 than those whose fathers had

[15] However, one of our important variables is a mixture of background and ability; thus we can calculate the upper and lower bounds of the bias only by omitting ability. For simplicity in this summary, we use the average of these bounds. The bias is expressed later as the ratio of the difference in the education coefficients (with ability excluded and included) to the education coefficient when ability is excluded.

[16] 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.

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

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

not entered high school. In Table 4-1's format those whose fathers had a bachelor's degree added $700 and $4,000 in 1955 and 1969, respectively. The 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 (highest) and either the second or third fifths of the biography variable to be significant—of about the same magnitude as mathematical ability—and thus to be as important as educational differences in explaining the range of earnings. In 1955 the age variable was significant and large numerically, while in 1969 its effect was negative and insignificant. This is consistent with the common notion that a rising age-income profile reaches a peak after the age of 40.

Although the results discussed above were obtained from analysis of 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 R^2 from about .10 to .33 and reduced the standard error of estimate by 15 percent, leaving the other coefficients unchanged.[19] Thus we conclude that about two-thirds of the variation in earnings in any year represents either random events, such as luck, or changes in underlying characteristics.

Further examination of the residuals from the regression equations 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.[20] However, when the equations are estimated weighting each ob-

[19] The relatively low 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 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.

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

servation 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 explored briefly the effects of including an educational quality variable in the NBER-TH regressions[21] by using the Gourman academic rating, which attempts to measure the quality of undergraduate departments, in the form of fifths of the sample distribution.[22] At the some-college and B.A. levels, only the highest quality fifth affects earnings significantly, whereas for graduate students, earnings are affected by the top two undergraduate school

[21] 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. Lewis Solmon is currently examining the quality question in great detail.

[22] This rating is defined in Gourman (1967).

TABLE 4-3 ***Relation between college quality and earnings: amount by which monthly earnings in 1969 exceed earnings of the average high school graduate in the sample***

	Amount ($)	*Percentage**
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‡	166	14
M.A.‡	194	16
Ph.D. and LL.B.‡	633	53
Additional income to graduates 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 fifths of quality.

‡ For those at an undergraduate school in the bottom three quality fifths and a graduate school in the bottom four. These regression results are based on a sample of 5,000 individuals.

fifths and the top graduate school fifth. The 1969 results, summarized in Table 4-3, 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.[23] Similarly, the three-year graduate degree holder, depending on school quality, earns anywhere from 53 to 98 percent more than the average high school student.

The quality variable may be important for several reasons. First, high-quality schools can impart different or additional income-earning skills as compared with low-quality schools. Second, the quality as well as the quantity of education may be used as a screening device, as we describe later.[24] Finally, one of Gourman's stated objectives in providing the quality ratings is to permit students to match their capabilities, as reflected by S.A.T. ratings, with schools. If individuals' S.A.T. ratings and school quality ratings were perfectly correlated, then the quality rating would be reflecting mental-ability differences rather than differences in the quality of education provided by the school. Evidence in Wolfle and Smith (1956) and Solmon (1969) indicates that school quality and average IQ of those attending are positively correlated, but that within schools there is a wide range of 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; it may reflect other personality differences or quality-of-schooling differences.

THE RATE OF RETURN TO EDUCATION

The data for 1955 and 1969, as well as the initial job earnings that have been mentioned briefly, 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 the sample averaged 47 years of age) to obtain

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

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

"realized" or ex post age-earnings profiles by educational level.[25] We have constructed such profiles for a person with the characteristics of the average high school graduate in the sample. The differences between these profiles together with information on the costs of education are used to estimate rates of return to education.[26]

Private and social rates of return may differ for a number of reasons, including the fact that earnings are subject to taxes, that costs of education are not necessarily borne by the one who is being educated, and that there are market imperfections based on education (as indicated earlier). If social nonmonetary returns and market imperfections are ignored, 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.[27] However, our estimated social and private rates are very similar because the (before-tax) income streams are the same, and the largest cost component in each instance is forgone earnings.[28] In this discussion, therefore, we concentrate on estimates of the social rates of return calculated after deflation by the CPI from nominal profiles. These rates are presented in Table 4-4 along with nominal private rates.

Compared with the social rate of return to a high school graduate having the same abilities and background, the social rates of return realized in our sample (before deflation) are 14, 10, 7, 8, and 4 per-

[25] For details see Taubman and Wales (forthcoming, App. J).

[26] Earnings provide an inadequate measure of benefits from education if there are nonmonetary returns that vary by educational levels. 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 level. No other adjustments are made for nonmonetary returns or for consumption benefits.

[27] The details of construction of the cost estimates can be found in Taubman and Wales (forthcoming, App. L). The foregone earnings are estimated from the sample.

[28] 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 that are 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. However, we also calculate a rate of return for people who are identical to those in the sample but who were 18 in 1946. Since these rates are about the same, we ignore this distinction in our discussion.

TABLE 4-4
Realized rates of return to education, before tax (people entering college in 1946)

Education categories	*Private* *Undeflated by CPI*	*Social* *Undeflated by CPI*	*Social* *Deflated by CPI*
High school to			
Some college	15	14	11
B.A.	11	10	8
Some graduate	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

cent for two years of college only, an undergraduate degree, some graduate work, a master's degree, and a Ph.D., respectively.[29] 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, and master's categories. On the other hand, nonpecuniary returns may be contributing to the low return in the Ph.D. category, which includes college 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.[30] Including a dummy variable for people who were business owners in 1969, we find that the percentage earnings differential, compared with that of the average high school gradu-

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

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

ate, 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.[31]

Of course, even finding that college dropouts receive as high a rate of return as college graduates is not in accord with findings by others, such as Becker (1964). This difference may be due partly to the fact that in other studies ability is not held constant. The results are therefore influenced by those who drop out of college because they do not have the intelligence, drive, or other attributes to handle the work. But since the college dropouts in our sample were in their mid-twenties in 1946, many probably had a family to support and could not afford (in the short run) a college degree. Thus they may have been "pulled" out of college by attractive alternatives rather than "pushed" out by lack of drive and motivation. For example, a small number of respondents in the sample went on (understandably!) to become airline pilots, a well-paying occupation that does not require a college degree. The results reported here, however, do not depend on this special characteristic of the data.

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).[32]

[31] However, this dummy-variable procedure understates the true return to some college if obtaining that educational 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.

[32] In Taubman and Wales (forthcoming) we also calculate rates of return using data from the 1949 census and 1946 data in H. Miller (1960) but with adjustments for the omission of ability and other variables. The rate of return to college graduates in both 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.

Are investments in education worthwhile? From a social point of view this question involves comparing our 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, which is usually thought to be about 13 to 15 percent in real terms (see Phelps, 1962; Taubman & Wales, 1969). Thus when consumption benefits and externalities are ignored, 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. However, 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 (see 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. (See the chapters in Part Two of this volume for examination of a number of externalities.)

From a private viewpoint, however, the appropriate alternative return is best represented by an after-tax ex post rate of return on common stocks—say, about 10 percent. Since the private after-tax rates of return 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 qualifications on the college-dropout results mentioned earlier, 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 the social return because of the various subsidies given to higher education.

EDUCATION AS A SCREENING DEVICE

The analysis of earnings differentials and rates of return to education has been conducted without considering the ways in which education might increase income. Becker and others have shown that if education produces additions to an individual's cognitive or affective skills, his income will increase. However, a number of people have asserted that a primary role of education is to serve as a credential, particularly in the highly paid managerial and professional occupations.[33]

[33] See, for example, Griliches and Mason (1972), Hansen et al. (1970), and Thurow and Lucas (1972). For lower-paying occupations such as skilled laborer, the required credential may be a high school diploma.

Under what circumstances will such screening result in extra earnings for the more educated, and how will it affect the calculations of the social rate of return to education? Suppose that a person is paid his marginal product in any occupation in which he works and that education, mental ability, and other personal characteristics add to an individual's marginal productivity. As long as these factors affect marginal productivity differently in various occupations, we can speak meaningfully of high- and low-wage occupations. To demonstrate that education is being used to screen people out of high-paying occupations, we must show that some people with less education are not in the occupation in which their marginal product and earnings could be maximized and that, on the other hand, highly educated people are allocated more efficiently.

If education is used to screen people, the extra earnings a person receives from education are due both to the skills produced by schooling and to the income redistribution effect resulting from supply limitations. But since the latter is not a gain to society, the social return will apparently 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 answers, 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 a desire for profit maximization. Suppose that successful performance (in the managerial or sales occupation, for example) depends upon the individual's possessing a complex set of talents and skills, only some of which can be measured easily by appropriate tests. Clearly, firms could attempt to develop and use tests in recruiting people with the necessary skills for particular occupations. But developing tests, examining recruits, and incurring performance errors can be expensive. Alternatively, suppose that firms either know (from past experience) or believe that a significantly larger percentage of college graduates have the desired complex of skills.[34] They may then, to save on hiring costs and mistakes on the job, decide to use information on educational attainment, available at a near zero cost, as a preliminary screening device.

The implications for the social rate of return are clear: If educational screening was not permitted, firms would have to use addi-

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

tional resources in order to sort people. Hence any sorting costs saved by using education as a screening device are a benefit to society and must be taken into account when comparing the social and private rates of return. In this chapter 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.

The case for screening can be summarized as one of market failure, arising from the lack of knowledge or the cost of obtaining it. Some people with whom we have discussed this problem believe that firms could obtain the benefits of screening without paying the costs of hiring college graduates by hiring high school graduates on the basis of a test predicting whether they would succeed in finishing college. Although extra sorting costs would be involved, these would be small compared with the costs of hiring college graduates, given the earnings differentials we attribute below to screening. Since firms that hired only high school graduates would have lower costs and higher profits, other firms would soon stop paying a premium to college graduates, and the screen would be eroded. There are several responses to this argument. First, even if the screening function were to vanish in the long run, its consequences would be observable before then.[35] Second, even when there is a profit to be made by discovering and exploiting available information, the actual discovery may not occur for many years.[36] Thus, the use of education as a screening device is certainly not a proposition which should be rejected out of hand.

To test for the existence of screening, we compare the actual

[35] Analogously, in the long run with perfect competition there are no excess profits or rates of return on capital. But in the short run, while capital is being expanded, excess profits could exist and be measured.

[36] See, for example, the first part of this chapter. The two largest and richest samples for investigating the rate of return to higher education net of the effect of ability and family background are the Wolfle-Smith and the NBER-TH samples, both of which were available in the 1950s. The only prior analysis of the Wolfle-Smith data consists of their original few cross-tabulations for males (1956) with some slight extensions in Denison (1964). The data for people of Minnesota, we have learned, were intact and accessible at the University of Minnesota until 1966, but were permanently or temporarily lost when some operations were moved. The Thorndike-Hagen sample was sitting unused in a basement at Columbia Teachers College for over a decade, despite the fact that it is mentioned in Hunt (1963) and was known at least to Lee Hansen. Both samples would have provided data for a series of very useful and important articles in a highly competitive profession. Why did it take up to 15 years for these data sources to be resurrected?

occupational distribution of individuals at various educational levels with the distribution "expected" under free entry. The basic assumption made in estimating the expected distribution is that each individual selected the (broad) occupational category in which his income was the highest. Of course, an individual works in only one (main) occupation at a time. To estimate earnings in any other occupation, we make use of occupational regressions, examples of which are given in Appendix B. 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. The socioeconomic variables may be proxies for other dimensions of skills, and their coefficients interpretable in the same way, although other explanations are possible. Given the earlier discussion of the specificity of the skills produced by education, it is encouraging to find that education (and ability) has larger coefficients in the managerial, professional, and sales occupations than in the others.

Using the occupation equations, we can estimate the individual's potential income in a particular (mth) occupation as the mean income of people in that occupation who have the same education, ability, and other characteristics that he does. But 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. 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.

For simplicity, we assume that the distribution of wages in the mth occupation (for individuals with the same characteristics as the ith individual) is normal, with $\hat{Y}_{im}$ and variance $\sigma_m{}^2$. Assuming income maximization, the probability that the ith individual will choose the mth occupation is given by

$$p_m = \int_0^\infty f_m(Z) \prod_{j \neq m} F_j(Z)\, dZ$$

where f_m is distributed as $N(\hat{Y}_{im}, \sigma_m^2)$ and F_j is the cumulative density of f_j.[37] If there is a large number of people at the educational level under consideration, then p_m can be interpreted as the expected fraction of individuals in the mth occupation at that educational level, and we have an estimate of the distribution of people by occupation and education that should occur with free entry and income maximization.

Table 4-5 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.[38] The most striking result is that for the high school group, where 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, whereas for the undergraduate degree holders the actual and expected distributions are essentially the same in the lowest-paying occupations.

In general then, under the assumptions of free entry and income maximization, very few people at any educational 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 the high-paying occupations.[39] Table 4-5 also indicates that at each educational level, the expected fraction exceeds the actual fraction for the technical and sales categories by about 10 and 14 percentage points, respectively. As explained later, such constant differences at each educational level would occur if there were occupation-specific skills or risk preferences uncorrelated with education.

A risk-averse individual may select his occupation on the basis

[37] In the calculations ∞ was replaced by the mean plus three standard deviations. If there are only two occupations, the calculations involve the joint probability of receiving a given wage in the mth occupation and a smaller one in the other occupation.

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

[39] Although not presented here, the same general pattern of results holds for 1955.

TABLE 4-5 ***Expected and actual distribution by education and occupation, 1969***

Occupation and educational level	*(1) Number of people*	*(2) Actual fraction*	*(3) Expected fraction*	*(4) Column 3 minus column 1*	*(5) Mean income (monthly)*	*(6) Standard error of income*
High school						
Professional	11	1.5	9.5	8.0	960	274
Technical	85	11.5	21.0	9.5	1,220	577
Sales	56	7.6	22.0	14.4	1,120	548
Blue-collar	211	28.6	1.3	−26.3	844	165
Service	50	6.8	1.4	−5.4	824	177
White-collar	24	3.3	.5	−2.8	754	127
Managerial	299	40.6	42.4	1.8	1,485	907
Some college						
Professional	49	5.8	14.8	9.0	1,260	501
Technical	82	9.6	19.1	9.5	1,285	579
Sales	80	9.4	21.8	12.4	1,300	614
Blue-collar	87	10.2	.8	−9.4	882	182
Service	32	3.8	1.2	−2.6	840	228
White-collar	21	2.5	.6	−1.9	785	194
Managerial	501	58.8	39.8	−19.0	1,680	884
B.A.						
Professional	257	25.0	17.8	−7.2	1,412	674
Technical	29	2.8	14.1	11.3	1,370	458
Sales	90	8.8	25.5	16.7	1,490	865
Blue-collar	18	1.8	.9	−.9	950	244
Service	11	1.1	.9	−.2	920	244
White-collar	11	1.1	.4	−.7	840	212
Managerial	610	59.4	38.3	−21.1	1,850	911

of the variability of income as well as the mean; thus it might be argued that our estimates of the expected fractions for the low-paying occupations are too small because we have not allowed for the attractiveness of the small standard error of income in these occupations (see Table 4-5, columns 5 and 6). This is a plausible reason for believing that our estimates of the expected fractions may be in error for any particular educational level. But unless high school graduates are more averse to risk, it does not explain the differences between actual and expected fractions that prevail across educational levels, since occupational standard errors do not differ much by education.[40] If there are differences in risk preference, then our previous estimates of the rate of return to education would be biased upward since an income-determining characteristic correlated with education would not have been held constant.

There is, however, an alternative plausible explanation for our results. Since we can observe an individual in only one occupation, we calculate his expected earnings in other occupations from the mean and variance of people with the same set of measured characteristics, e.g., education, ability, and age. Unfortunately, these measured characteristics explain only a small portion of the variance in earnings in the various occupations. Some of the unexplained variance undoubtedly occurs because of luck or other temporary factors, but the rest occurs because some types of skills, talents, and abilities have not been measured. For simplicity, if all these unmeasured skills are represented by a single variable X, then in the implementation of the test for screening we are assuming that the mean and variance of X are the same in each occupation.[41]

If X is more important for performance in one occupation than in others, we would expect the effect of X on earnings to be higher in this occupation, which in turn should induce more people with X to choose employment in it. But unless X is correlated with education, we shall estimate an equal "misallocation" of people at all educational levels. However, if both X and education are highly rewarded in a particular occupation, then it is not appropriate to use the mean earnings of that occupation to estimate the potential earnings in it of people who are outside it (since the average level of X differs). To the extent that this problem is important, we overstate in our calculations the fraction of high school and some-college people in the high-paying occupations and thus obtain an upper bound to the importance of screening.

We have no way of determining the importance of the omitted variables, nor do we know of any studies that would be informative.

[40] The chapter by Lewis Solmon in this volume suggests that high school graduates may well be more risk-averse than college graduates.

[41] We actually require the equality of mean and variance of d_iX_i, where d_i is the effect of X on earnings in the ith occupation. But the most likely reason for X to have the same distribution over all occupations is that the d_i are equal for all i.

Nevertheless, it is of some interest to study the effect of omitting mental ability since, if the calculations had been performed with census data, this would have been an obvious candidate for the omitted (occupation-specific) variable. Indeed, in our equations we do find that mathematical ability has a bigger effect on earnings in the higher-paying occupations. The omitted-variable argument would lead us to expect that the larger the fraction of people at each educational level in the managerial occupation, the higher the ability level, and to expect high school graduates who are managers to be, on the average, more able than other high school graduates. Analysis of our sample indicates that both these expectations are borne out, but that the effects are not pronounced. For example, the mean ability level of managers is .47 and .62 for high school and college graduates, respectively, while the corresponding means for all high school and college graduates are .43 and .60.[42] Consequently, to the extent that the omission of other occupation-specific skills follows the same pattern as that of mental ability, the problems caused by their omission may not be serious.

We can attempt to estimate what the rates of return to education would have been if there had been no screening.[43] These are of interest because they represent the extent to which the returns 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 which 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, etc. However, they can 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 percent by which income in the some-college and B.A. categories exceeds high school income for the

[42] Those in the top fifth receive a score of .9, and each successive fifth declines by .2.

[43] 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 in our calculations, the social (but not the private) rates will be underestimated.

actual and expected distributions for 1955 and 1969. In 1955 the earnings differentials due to education, under the assumption of no entry barriers, were only about one-half to one-third as large as actual returns, whereas in 1969 they were about one-half as large. This suggests that the effect of screening on the returns to education is in fact substantial at these educational levels and that without screening, the returns might be 50 percent below those presented earlier.[44]

To sum up, the screening model implies that the supply of people to the high-paying occupations is artificially reduced, resulting in a redistribution of earnings to the more highly educated. Although this redistribution represents a private gain, a complete analysis of the social gain requires information on any extra sorting costs that would be incurred if education could not be used for that purpose.

CONCLUSIONS

Our results are helpful in determining whether society has overinvested or underinvested in education. Since none of the deflated social rates of return presented in Table 4-4 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, assuming that the supply of saving is fixed and that externalities are not of major quantitative significance. Further, the rates are lower, the higher the educational level (excluding lawyers and M.D.'s), suggesting that the overinvestment is more severe at the higher levels.[45] However, if the externalities or consumption benefits discussed in Part Two of this volume yield large-enough returns, or if educational investments tend to come out of increased savings, expenditures on education would be economically justified. 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 or not

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

[45] However, to the extent that lower rates at high educational levels reflect nonpecuniary returns, the overinvestment is diminished somewhat.

there has been overinvestment in education.[46] Since we find screening to be important quantitatively, our conclusion that overinvestment in education has occurred is strengthened.

[46] 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.

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