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Volume Author/Editor: Paul J. Taubman, Terence Wales

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Chapter Author: Paul J. Taubman, Terence Wales

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9. Education as a Screening Device

In Chapter 1, we hypothesized that a possible role of education is as a credential, license, or screen. By this we mean that entry into some high-paying occupations is not free to all, but generally requires that a person of a *given* skill level also possess a *minimum* level of educational attainment. In this chapter we consider reasons why firms might use education as a screening device, and we develop and implement a test for the existence of screening. If screening based on education occurs, then a person with more education earns more income partly because he is allowed to hold a high-paying job. Concomitantly, some people with low educational attainment who also want and could manage the high-paying jobs are excluded from them. Thus, part of the income differential attributed to education arises from an income redistribution due to restricted entry and not to an increase in skills. This implies that the returns to society from educational programs may be overestimated by conventional measures.[1]

REASONS FOR USING EDUCATION AS A SCREEN

A general assumption made in most research in the human-capital area is that each person is paid a (real) wage rate equal to his marginal product (less any costs for general training). Although this conclusion is valid in a perfectly competitive world, some deviations from competition, such as the existence of costs of obtaining information, may invalidate it. A firm may have knowledge about the marginal productivity of some factors of production; for example, a manager can determine that all models of a particular machine will produce 100 units of out-

[1]However, if education is not available for screening, other sorting devices have to be used, but should they be less expensive than education, the social rate of return will be overestimated.

put per hour. People, however, cannot generally be classified into types that produce specific numbers of units of output, because a person's productivity level depends upon a complex set of inherited and acquired skills. Further, not only are individual skills difficult to identify and measure, but various skills also are more useful in some occupations than others. These last two points are illustrated by the occupational regressions using both the Wolfle-Smith and NBER-TH samples. For example, the coefficients on mental ability and education are greater in the managerial and professional occupations than in the white-collar or blue-collar occupations. Moreover, as reported in Chapter 8, these variables, plus measures of family and personal characteristics, explain less than 30 percent of the earnings variance in any of our occupations. Thus, either luck or some other unmeasured variables are very important determinants of earnings in the occupations.

Even though an employer might find it impossible to predict in advance the marginal productivity of any worker in all possible positions in his firm, the competitive outcome could result if a trial-and-error procedure were followed. That is, the firm could pay a piece rate for each position and could allow individuals to fill the positions they desired. There are such jobs as fruit picker and some sales positions that are based on a piecework system, but most occupations are not. Instead, most positions pay a person a fixed amount each hour, day, week, month, or year, and indeed there may be good economic reasons for paying these fixed sums per period. If the output is produced by an assembly line or other team of workers or if there is no directly observable physical output, it may be extremely difficult or costly to measure the output of each worker.[2] But, in any event, firms agree to hire people for at least a limited time and pay them these fixed sums regardless of how well or how poorly they perform. Firms therefore have some incentive to try to hire people whose marginal product will be at least equal to the wage payment. Of course, workers also have an incentive to perform, since firms will try to fire those whose marginal product can be judged to be less than the wage (after training periods are over). Moreover, because of union rules or the expenses associated with hiring and firing, there is often an

[2]What, for example, is the marginal product of a bureaucrat?

explicit or implicit agreement by the firm to retain a worker for relatively long periods —subject to his not being grossly incompetent or insubordinate and to cyclical conditions. Finally, when there is a division of labor, it may be very costly to allow a trial-and-error system in which an individual demonstrates how good he is, since an error at one point might cripple a whole production line. Thus, when the labor market is one in which people are paid a fixed period wage and hired for a relatively long time, firms have an incentive to try to sort people by types and levels of skills to find the right person for the right job.

There are many ways in which firms can perform such sorting and matching. One way is to administer tests to measure skill levels, and another is to observe performance on a simpler job. Firms can also use such characteristics as neatness, sex, age, and so forth, as indicators of a person's productivity.[3] Another possible signal is education, upon which this chapter will focus.

Before proceeding with the discussion of education as a signaling or screening device, several comments are in order. Many people have long maintained that the United States has been, and is increasingly becoming, a country concerned with credentials, with education being one of the major credentials (Miller & Reissman, 1969). While economists are predisposed to find a rational explanation for business behavior, as for example in the preceding discussion, the use of education may be dictated partially by snobbery, ignorance, or irrational prejudices. Distinguishing between rational and irrational behavior is important, but since our test for the existence of screening is not based on the assumption of rational firm behavior, we have no way of knowing whether such behavior prevails.

Second, it should be recognized that our screening model does not imply that education is a license absolutely required for a position. If firms, while sorting and matching people, do not get enough applicants with the preferred education to fill positions, some people with less education will be accepted. Moreover, the number of such people accepted as, say, managers will depend on the business demand for managers and the

[3]For a lucid discussion of the economics of signaling see Spence (1972). Arrow (1972) has applied this theory to the education market. Both these papers, which appeared after we finished this work, go further than we do by arguing that people decide rationally whether to obtain the signal, that is, to go to college.

supply of college graduates to this occupation, both of which are likely to fluctuate over time. While it is possible in some time period for no one to be accepted whose education is too low, our test for screening requires some people with less than the normal amount of education to be working in the occupations in which education is used as a screening device.

Let us suppose that firms have a number of sorting devices available to match persons and positions. Each sorting method entails direct costs such as salaries of personnel interviewers and indirect costs such as mistakes made on the job. In a more formal sense, the firm should consider as the indirect costs the expected difference between the wage payments and the marginal product of all people who will be hired for a position by a given sorting method.[4] For any particular job, the firm should adopt the sorting method that is cheapest to use, but of course the method may differ for different jobs. Suppose that successful performance in, say, the managerial occupation depends upon the individual's possessing a complex set of talents and skills, including intelligence, leadership, and judgment. Firms might attempt to develop and use tests for these skills in recruiting people for the particular occupation. But the development of tests and the examination of recruits can be expensive and may not be very useful if the appropriate skills are not easily measured and mistakes on the job are expensive.

Suppose, however, that firms either know (from past experience) or believe that educational attainment is correlated with the necessary complex of skills.[5] This does not mean that all college graduates and no high school graduates have the necessary skills, but that a significantly larger percentage of college graduates are so endowed. Thus, to save on hiring costs, firms may decide to use information on educational attainment available at a near-zero cost as a preliminary screening device.[6] Other criteria may also be used in hiring a person, and retention and especially promotion may well depend on performance on the job.

[4]If the firm is risk-averse, it might also consider the variance in the mistakes.

[5]It is likely that in past decades high school was the screening level for high-paying jobs, as indeed it may be now for some types of lower-paying jobs.

[6]See Arrow's recent paper (1972) for a rigorous theoretical treatment of some of the problems involved in hypothesizing that education is used as a filtering device.

The case for screening based on education can be thought of as one of market failure arising from the cost of obtaining knowledge. Some people with whom we have discussed this argument believe that the expenses associated with hiring people (based on, say, a formula predicting who could finish college) would be small enough—given the proportion of earnings differentials we attribute below to screening, and the small return to a college degree—to make it profitable for some rational firms that rely heavily on the high-paying occupations to hire many (or only) high school graduates. Since these firms would have lower costs and higher profits, they would expand, other firms would 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.[7] 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.[8] Thus, the use of education as a screening device is certainly not a proposition which should be rejected out of hand.

As a corroborative bit of evidence, we note that in the last few years so-called diploma mills have become a matter of concern to the educational community. For a fee, these schools grant diplomas by mail without requiring attendance or much, if any, work. Consequently, it is difficult to see how these schools

[7]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.

[8]As an example, we offer the first part of this study. Two large and rich samples for investigating the rate of return to higher education net of the effect of ability and family background are the Wolfle-Smith and NBER-TH samples, both of which were available in the 1950s. The only prior analysis of the Wolfle-Smith data consists of the original few cross tabulations for males in the Wolfle-Smith report in 1956, with some slight extensions in Denison (1964). (Data were also collected for females but were used for the first time in Chapter 3 of this volume.) We have learned that the data for people of Minnesota were intact and accessible until 1966 at the University of Minnesota, 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?

could be adding much to a person's level of skills. Yet the fact that people are willing to pay the fees suggests that the diploma is useful to them, and clearly one possibility is that it is useful in passing an educational screen. It is also worth noting that the uproar over the diploma mills has not come from businesses that feel cheated, but from the more respectable members of the academic community. In addition, casual evidence—such as newspaper advertisements that list a college diploma as a prerequisite—suggests the existence of screening. However, this is far from conclusive, since many jobs may, in fact, require specialized knowledge attainable only in college.[9]

Because these suggestions are not in any way conclusive, it is necessary to construct a more formal test for the existence of screening. Before doing this, we shall define more precisely the concept of screening itself. *Screening based on educational attainment occurs when, because of lack of educational attainment, a person is excluded from an occupation in which he would have a higher marginal product or higher (discounted) earnings.* This definition introduces the idea of different occupations or jobs—a necessary concept because if a person's marginal product and wage rate do not differ across occupations, then he cannot be excluded on the basis of his education from all occupations in which his marginal product would be highest.

The test for screening thus involves comparing the actual and expected fractions of people in different occupations at various education levels. If the actual fraction of people in the high-paying occupations is less than the expected fraction at low levels of education, but not at high ones, and if the occupations are ones in which we might a priori expect some screening, this suggests that screening is, in fact, present.

The initial step in determining the expected distribution is to estimate the potential income that any individual could earn in various occupations. If we then assume that the individual chooses the occupation that yields the highest income, we can estimate the distribution of individuals over occupations that would prevail with free entry. If we assume further that the po-

[9]In addition, firms may hire people at low hierarchical positions to sort people for high-level positions. Individuals with low education may be able to master the low-level job but not the high-level one; hence, firms would not be willing to hire them at all.

tential earnings in an occupation are equal to a person's marginal product in that occupation, we can estimate the portion of observed educational earnings differences due to skills produced by education and the portion due to screening.

POTENTIAL EARNINGS

Assume that there are n occupations and that for each individual, earnings in occupation i (y_i) are determined by a set of characteristics (X) as follows:

$$y_i = X\beta_i + u_i \qquad i = 1,n \quad (9\text{-}1)$$

where u_i is a random disturbance and β_i is a vector of coefficients for occupation i.[10] If all the variables (X) that influence income in a systematic way are observable, we can estimate the potential earnings of any individual in the ith occupation by substituting his X values in Eq. (9-1). As long as we can ignore the random-disturbance term, our model predicts that all individuals with identical X characteristics will choose the same occupation if occupational choice is based on maximum earnings.[11]

Is it proper to ignore the error term? If the disturbance is interpreted as a chance or luck factor about which the individual has no knowledge when he is making his decision, then we are justified in ignoring it when comparing potential income and occupational choice unless there is differential risk and people are not neutral toward risk. Also, if the disturbance term is the same in all occupations for an individual, then even if he is aware of the disturbance, the rankings of occupations by earnings will not change. In either of these cases, the expected distribution of individuals over occupations can be readily determined simply by evaluating Eq. (9-1) for each occupation for the known X's and selecting the maximum income. In this case,

[10] Of course, any individual has only one occupation, but we can estimate a separate equation for each occupation based on the people in that occupation. The problems involved in this method are discussed below.

[11] This result holds only because we assume that occupational choice depends solely on income. If the choice also depends on nonpecuniary factors valued differently by various individuals, then all individuals need not choose the same occupation. This problem is ignored in the following discussion, since it does not present any difficulties as far as our test for screening is concerned. See, however, the section below on risk aversion.

as just noted, all individuals with a given set of characteristics will be in one occupation.[12]

The problem is more complicated if one does not want to ignore the random-disturbance terms or interpret them in this way. If the jth individual is aware of his disturbance terms and if they differ by occupation, the incomes that must be compared are $X_j \beta_i + u_{ij}$ and not just $X_j \beta_i$. Since we do not know the u_{ij}, we cannot determine which occupation a particular person will choose, but by making various assumptions about the distribution of the error terms, we can estimate the probability that a person with a given set of X's will choose a particular occupation. An important question concerning the error terms is whether they are correlated for the jth individual over the various occupations. In some instances, a person will know that his particular job is paying him more than he could expect if working for another firm in the same or a different occupation. For example, a person would know if he married the boss's daughter, or if he had stumbled into a good job offer. Indeed, the theory of information costs in job search would lead to the occupational distribution described by Eq. (9-2).[13] When the errors arise for these types of reasons, we can assume that the disturbances are not correlated over occupations. A much more important explanation for the errors, however, is that there are some X's we have not been able to measure or hold constant. If these X's are important income determinants in different occupations, then the regression errors will be correlated across such occupations. We discuss below the importance of a nonzero covariance of errors across occupations.

Assume for the moment that errors are not correlated over occupations and that the errors in each occupation are normally distributed. Then the *probability* that an individual chooses the mth occupation is given by[14]

$$P_m = \int_0^\infty f_m(z) \prod_{i \neq m} F_i(z)dz \qquad (9\text{-}2)$$

[12]All people with a given education level need not be in the same occupation. Other variables in X, in addition to education, can affect occupational choice.

[13]For an analysis of the effects of job-search costs on employment choice, see Holt (1970).

[14]Eq. (9-2) also holds for nonnormal distributions.

where $F_i(z)$ is the cumulative normal density and $f_m(z)$ is the normal density function with mean $\bar{Y}_m$ and variance σ_m^2.[15] Basically, P_m is the sum of all products representing the probability that potential income in the mth occupation takes on a certain value, times the probability that all other potential incomes, given by $\prod_{i \neq m} F_i(z)$, are less than this value. Unfortunately, P_m cannot be expressed in a simpler form even if the means and variances of all the incomes are known. However, an approximation to P_m can be obtained by numerical integration. Since an equation analogous to Eq. (9-2) holds for every occupation, we can obtain estimates of the distribution of individuals by occupation.

When there are only two occupations, the problem can be expressed in an alternative form that provides some additional insight. Let the two occupations be 1 and 2, with mean incomes $\bar{Y}_1$ and $\bar{Y}_2$ such that $\bar{Y}_1 < \bar{Y}_2$. We are interested in determining the fraction of people in the population for whom Y_1 will be greater than Y_2. If earnings in both occupations are normally distributed, then $Y_3 = Y_1 - Y_2$ will also be distributed normally. To find the probability that Y_3 is nonnegative, we need to integrate from zero to infinity the normal curve with mean $\bar{Y}_1 - \bar{Y}_2$ and variance $\sigma_1^2 + \sigma_2^2 - 2\sigma_{12}$. In the normal distribution, half the people are found to the right, and half to the left, of the mean. Thus, if the mean of $\bar{Y}_3$ were zero, that is, if $\bar{Y}_1$ equaled $\bar{Y}_2$, then half the people would choose each occupation, but if $\bar{Y}_1$ were less than $\bar{Y}_2$, fewer than half the people would choose 1. For a given variance of Y_3 and mean income in occupation 2, the proportion that will choose occupation 1 will decrease as $\bar{Y}_1$ falls. Also, for a given $\bar{Y}_1 - \bar{Y}_2$, the proportion that will choose 1 will decrease as the variance of Y_3 decreases.

This formulation also is useful in assessing the importance of the assumption of a zero correlation of the errors over occupations. Assuming that the errors in each occupation are indepen-

[15] As an estimate of this variance for the mth occupation (σ_m^2), we use the conditional variance based on $\hat{Y}_m - \bar{Y}_m$. The assumption that this variance is the same for people not in m as for those in m when estimating what those not in m would earn in m seems reasonable, since individuals are supposed to be identical on the average after standardizing for all the characteristics used in the regression analysis. We shall later discuss circumstances in which this assumption is not reasonable.

In the calculations, ∞ was replaced by the mean plus three standard deviations.

dent is the same as assuming that σ_{12} is zero. If, however, some variable X_1, whose coefficient is of the same sign in both occupations, is omitted, then σ_{12} will be positive and we shall overestimate the variance of Y_3 and the fraction of people in occupation 1, which has the lower mean earnings. Thus, if we improperly ignore positive values for σ_{12}, we will bias the tests against acceptance of the hypothesis of screening. On the other hand, if σ_{12} is negative because the coefficient of an omitted X is positive in one occupation and negative in another, then the test we use will be biased in favor of accepting screening. Such a bias might arise if, for example, initiative and independence were rewarded in the managerial category while their opposites were rewarded in white-collar or blue-collar jobs. We judge the positive correlation to be more likely. Now let us drop the assumption of only two occupations. When there are many occupations, the problem becomes intractable computationally if we assume that the distributions are not independent. That is, suppose that there is a positive correlation between the u's for an individual across occupations. In this case, the expression for the probability that an individual will choose a given occupation cannot be written in a simplified form such as Eq. (9-2), but must be expressed as a multiple integral, the evaluation of which, although possible numerically, would be very tedious. However, this is not a serious problem, since the independence assumption does not seem unreasonable, and as shown above, it biases the results in the direction of rejecting the screening hypothesis.

Before we present the results of our calculations, two points should be considered. First, if some occupation-education cells are empty, we cannot estimate $\hat{Y}$ in these cells. For example, in the NBER-TH sample there are no individuals with Ph.D.'s in the blue-collar, white-collar, or service occupations. Thus, the calculations given below are based on the assumption that all occupations are open to those at the high school, some-college, and B.A. education levels, but that at the graduate levels—which will not be studied—some occupations are irrelevant. Second, we are assuming that the individual's occupational choice depends only on the monetary income he can expect to earn. If occupational choice depends also on such factors as nonmonetary returns and fringe benefits not included in money income and if these vary across occupations, then our expected distributions will be inaccurate. This problem is discussed in more detail below.

SCREENING: EMPIRICAL RESULTS

We consider first the results for 1969 for the seven broad occupational groups discussed in Chapter 8. The occupational regressions used for this purpose are those discussed in the preceding chapter, except that they include as an additional independent variable the residual from 1955.[16]

Table 9-1 contains the expected and actual occupational distributions for the high school, some-college, and B.A. education categories, together with the means and standard deviations of the corresponding earnings levels.[17] The entries in column 4 are the differences between the expected and the actual percentage of people in each occupation at each of three educational levels. 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, the same pattern is found, though less pronounced numerically, and 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 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 tentatively that education itself is being used as a screening device to prevent those with low educational attainment from entering the high-paying occupations.

We find a pattern of differences between expected and actual

[16]The reason for including this residual is that it represents "individual effects" (that persist over time) which, if omitted, would invalidate the assumption that errors are independent across occupations.

[17]These means differ slightly from those in Table 4-2, since in these we exclude individuals who in 1969 did not report the educational achievement of their fathers. The standard deviations are calculated *after* removing the effects of all variables included in our equations.

TABLE 9-1 ***Expected and actual distributions of individuals, by education and occupation, 1969***

	Number of people (1)	Actual percentage (2)	Expected percentage (3)	Col. (3) − col. (2) (4)	Mean income per month (5)	σ income (6)
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

fractions within the high-paying occupations that is not as readily explainable. The expected always exceeds the actual percentage by about 10 to 15 percent in the technical and sales occupations, while in the professional occupation the expected percentage is too high in all but the B.A. group. In the managerial occupation the expected percentage falls short of the actual by a substantial amount except at the high school level, where the two percentages are approximately equal. These consistent differences at all education levels might be explained by a combination of risk- and status-related nonmonetary rewards.

A risk-averse individual may select his occupation on the basis of the variance of income as well as the mean. Column 6 of Table 9-1 presents the (conditional) standard error of earnings for each occupation and education level, which we interpret as a measure of risk.[18] Since the standard errors in column 6 are positively correlated with mean earnings in column 5, our estimates of the expected fractions for the low-paying occupations may be too small for any particular education level. But unless high school graduates are more averse to risk, this does not explain the differences between actual and expected fractions that prevail *across* education levels, since occupational standard errors do not differ much by education. If there are differences in risk preference, then our previous estimates of the rate of return to education would be biased upward, because an income-determining characteristic correlated with education would not have been held constant.[19]

The differences in column 4 could also arise because of nonpecuniary rewards that vary by occupation. We would expect status, one form of nonmonetary return, to be highest for the managerial group, in which case our method will underestimate the fraction of people expected in the managerial category. Since the actual does exceed the expected percentage by about 20 percentage points at the some-college and bachelor's-degree levels, the extremely small difference at the high school level can be interpreted as limitations imposed by screening. Further, a much higher percentage (43 percent) of the people in the owner-manager group were owners at the high school level than at other education levels. Owners cannot be screened out of working for themselves if they can raise financial capital, which was available to those in our sample through the Veterans Administration.

The status and risk arguments may help to explain some of the actual occupational choices, but they do not necessarily weaken the evidence supporting the screening hypothesis.

[18]The standard error is not the only possible measure of risk. For a discussion see Tobin (1958).

[19]This assumes that education does not make people more willing to bear risk.

There are, however, some other possible objections to the test for screening that must be considered.

First, for the conclusion on screening to be meaningful, those with little education must be capable of working in the high-paying occupations. Clearly, some people with just a high school education are so capable, since over 60 percent of the high school group are employed in the managerial, technical, sales, or professional groups (although very few are in the last named).[20]

Second, the differences between expected and actual distributions reflect any existing entry restrictions or immobilities and any deviations from the principle of income maximization in addition to the type of screening mentioned above. But unless there are reasons to suppose that such factors are correlated with education, they cannot explain or justify the findings in Table 9-1.

Third, the earnings data used in the calculations are for individuals whose average age is 47 years. To the extent that lifetime earnings follow widely diverse patterns in different occupations at different education levels, the use of income from only one year may be an inappropriate indicator of lifetime earnings. However, the relative positions of occupations in terms of mean income and variance are fairly constant from 1955 to 1969, and as shown below, we also find evidence of screening in 1955. Furthermore, screening is hypothesized to take place when individuals first enter the job market, whereas the expected distributions calculated above refer to individuals at the average age of 47. Now, it might be argued that even if there were no initial job screening, many people might enter the white-collar, blue-collar, and service occupations at first simply because they involve well-defined, straightforward jobs and then move into other occupations such as sales and managerial in later years. However, it is hard to believe that such voluntary occupational switches into preferred jobs do not occur by the age of 47.

Fourth, suppose that the blue-collar, white-collar, and service occupations were substantially overrepresented in our sample

[20] Of course, the high school graduates employed in the lower-paying occupations may actually have less ability, but our calculations adjust income for the effects of ability.

at the high school level. Then the actual distributions in the population in these occupations could approximate our estimates even if no screening were practiced. There are two reasons for believing that nonrepresentativeness is not a serious problem. First, if the actual sample distribution differs from that of the population because the sample consists of more able (or otherwise better-endowed) people, then the expected sample distribution will differ in a corresponding manner from the expected population distribution. Second, there is no reason to suspect that the low-paying occupations are oversampled at the high school level, a condition that is required to be consistent with our observed results.

Fifth, there may be nonmonetary rewards other than status that differ by occupation. Suppose, for example, that those in the blue-collar, white-collar, and service occupations prefer (attach a value to) working in these jobs as compared with any others and choose their occupation on the basis of the monetary and nonmonetary returns. Because we have ignored the nonmonetary aspects in the calculations given above,[21] these expected distributions will underestimate the number of people in the blue-collar, white-collar, and service occupations. It would appear, then, that by assigning the appropriate monetary value to the privilege of working in the blue-collar, white-collar, and service occupations, we can explain the discrepancies between the actual and expected distributions in these occupations without relying at all on the screening hypothesis.

There are, however, a number of problems with this explanation. If we assign to all education levels the same nonpecuniary reward that allows us to explain the actual distribution of people at the high school level, we will overestimate the expected number of people in the low-paying occupations at the some-college and B.A. levels. Second, this argument ignores the possibility that those in the high-paying occupations may themselves be receiving a nonmonetary reward due to better working conditions or status differences.

Moreover, it should be recognized that if nonmonetary returns differ by occupation, it must also be argued that the monetary returns to education used in calculating rates of return overstate the total rate of return to education because the

[21]Except for pre-college teachers.

high school category contains the largest proportion of people in the low-paying occupations.

The final, and most important, qualification to the test for screening is that the calculations are based on the assumption that there are no unmeasured occupation-specific skills. Since we can only observe an individual in one occupation, we calculate his expected earnings in other occupations from the mean and variance of people with the same set of measured characteristics, for example, 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.

If X is more important for performance in one occupation than in others, we would expect both the effect of X on earnings to be higher in this occupation and more people with high X values to choose employment in this occupation. But unless X is correlated with education, we will underestimate or overestimate the potential earnings in the various occupations equally at each education level and will obtain an equal "misallocation" of people at all education levels. (We would not call such a misallocation evidence of screening.) Suppose, however, that both X and education are highly rewarded in a particular occupation; then the average error that arises from using the mean earnings of people in an occupation to estimate the potential earnings there of people in other occupations will be correlated with education. For example, suppose that high school graduates who are managers have compensated for their lack of education by being innately more able (in a broad sense not measured here) than other high school graduates and college graduates who are managers. Then, as long as this ability is an important and recompensed characteristic of a manager, we would assign in our calculations too high an earnings figure to high school graduates who were not managers and would improperly conclude that screening existed.

We have no way of determining the importance of the omitted variables, nor do we know of any studies that would be informative. Nevertheless, if the calculations had been performed with census data, mental ability 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 than do other variables in the higher-paying occupations. The omitted-variable argument would lead us to expect the fraction of people at each education level in the managerial occupation to be larger the higher the ability level, and to expect high school graduates who were managers to be more able on the average 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.[22] 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 consider very briefly now the results for 1955. Table 9-2 contains the expected and actual distributions for 1955, calculated in the same manner as were those for 1969.[23] Subject to the same qualifications, these results tend to support the screening hypothesis. The differences between the actual and expected percentages in the blue-collar, white-collar, and service occupations combined are about 40 percent, 12 percent, and 0 percent for the high school, some-college, and B.A. categories, respectively. Thus, as in 1969, people are apparently being screened

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

[23]Two general points should be made concerning the comparability of the two years. First, as mentioned in Chapter 8, the occupational classifications may differ slightly because the 1955 categories were determined by aggregating each individual's description of his job into broad groups, whereas in 1969 each individual selected the broad occupation that included his job. In particular, the distinction between the technical and professional groups may differ considerably between samples. Second, the number of individuals in a particular educational group will differ in 1955 and 1969, since about 7 percent of the sample attained more education in this period, and since there was a 10 percent response variation on education.

TABLE 9-2 ***Expected and actual distributions of individuals, by education and occupation, 1955***

	Number of people (1)	Actual per-centage (2)	Expected percent-age (3)	Col. (3) − col. (2) (4)	Mean income per month (5)	σ income (6)
High school						
Professional	77	9.9	5.1	−4.8	$580	$203
Technical	24	3.1	3.2	.1	469	114
Sales	72	9.2	8.9	−.3	576	191
Blue-collar	293	37.6	5.1	−32.5	439	102
Service	28	3.6	5.0	1.4	418	103
White-collar	91	11.7	1.8	−9.9	382	83
Managerial	195	25.0	67.5	42.5	625	282
Some college						
Professional	156	17.9	3.2	−14.7	603	172
Technical	45	5.2	3.5	−1.7	491	134
Sales	124	14.2	19.6	5.4	629	434
Blue-collar	135	15.5	5.1	−10.4	467	146
Service	18	2.1	5.6	3.5	457	167
White-collar	61	7.0	1.3	−5.7	398	74
Managerial	334	38.3	58.4	20.1	654	279
B.A.						
Professional	488	43.9	3.8	−40.1	576	171
Technical	20	1.8	3.7	1.9	438	124
Sales	139	12.5	10.5	−2.0	597	219
Blue-collar	44	4.0	4.3	−.3	479	113
Service	14	1.3	4.3	3.0	479	118
White-collar	45	4.0	1.4	−2.6	412	85
Managerial	362	33.0	69.6	36.6	664	280

out of the high-paying occupations at the low education levels, but not at the high ones.

The major difference between the two years is that in 1955 the expected number of owner-managers substantially exceeds the actual number at all three education levels; in 1969 the reverse is true except at the high school level (where the expected equals the actual). One possible explanation for the 1955 results is that many managerial positions are eventually filled by individuals who in their early years are in the professional, technical, and sales occupations.

EARNINGS DIFFERENCES DUE TO SCREENING

We can use these estimates of expected distributions to determine what income differentials attributable to education would have been in the absence of screening. Such returns are of interest because 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 earnings 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 because they do not allow for income levels to adjust as the occupational distributions change.[24]

In Table 9-3 we present the percentages by which earnings in the some-college and B.A. categories exceed high school earnings 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 the actual ones. In 1969, the expected differentials are about one-half as large as the actual ones. This suggests that screening accounts for a substantial portion of educational earnings differentials. The implications of this for rates of return to education are discussed below.

[24]These are unadjusted estimates in that they do not allow for differences in ability, background, age, and so on. Because they are compared with estimates obtained by weighting the same earnings figures by the actual distributions, however, the percentage differences between these two sets of estimates will probably be reasonable approximations to the adjusted income differentials.

TABLE 9-3 ***Earnings differentials attributable to education, for actual and expected occupational distributions, 1955 and 1969 (as a percentage of high school income)***

	Actual distribution		*Expected distribution*	
	1955	*1969*	*1955*	*1969*
Some college	15.2	24.3	5.0	12.5
B.A.	17.4	42.3	7.4	24.3

SCREENING AND THE RATE OF RETURN TO EDUCATION

The private rate of return to education is higher when screening exists than it would be under conditions of free entry into all jobs. This follows directly from the finding just given that expected income differentials are about one-half to one-third as large as the actual ones, and from the fact that the private costs of education are not likely to change much as a result of screening.[25] Moreover, if firms respond to increases in the supply of educated people by raising the screening level, wages in the high-paying occupations need not adjust. This might explain why the private rate of return to college did not change much from 1939 through 1969.

The social rate of return to education, on the other hand, may or may not be higher when there is screening. The reason for this is that, although educational income differentials are again higher under screening, education also serves to provide firms with information that allows them to reduce sorting costs. Hence, if educational screening were not practiced, additional costs would have to be incurred by firms and by society in order to replace this sorting function of education. Calculation of a social return to education when screening is practiced thus requires that we subtract from costs an amount equal to the cost of the best alternative sorting technique. Hence, the social return may be high even if education does not substantially increase individual productivities. Since we have no evidence on the cost of alternative sorting techniques, we do not present estimates of the social rate of return that would prevail in the absence of screening. We conjecture, however, that this rate is substantially lower than the estimates given earlier in this book, in which no attempt was made to account for screening.

While the purpose of this study is to determine the effect of education on income and to examine the cause of this effect, we feel that it is important to explore briefly the implications of screening for educational policy.

We assume that screening has two major effects—it saves

[25]The existence of screening will affect opportunity costs because it will increase the number of individuals in the low-paying occupations, thus depressing average earnings of those at low education levels. Hence, when there are only two levels of education, screening will reduce the average earnings of those with low education, but when different levels of education are used as a screen for different jobs, it is not clear whether wages of high school graduates will increase or decrease as a result of screening.

businesses and society some of the costs of sorting people, and it redistributes income. If society is not in favor of such a redistribution, it can use its tax and transfer schemes to undo the effect of screening on the income distribution. Under this scheme, the private individual return to education would be reduced until it equaled the return that would exist if there were no screening. To the extent that individual demand and social supply of education are based on the rate of return, this would reduce the number of people obtaining higher education.

Since determining the exact taxes and transfers to use would be difficult, other approaches should be considered. The problem of redistribution arises when some qualified individuals are not allowed into occupations because of their education level, a practice that is followed because firms save on costs by using the free information on schooling to sort people. This suggests two possibilities: eliminate the informational content of the screen or charge businesses for the information.

The informational content could be eliminated either by not giving firms access to a person's education level or by giving everyone the same education. The problem with the former is that it is unrealistic. There are several objections to the latter. First, if the education were to be similar in nature and quality to that currently given, it would be a very expensive use of resources to achieve the stated purpose. Second, if everyone had the same education, firms either would base their screening on the quality of the education or would have to spend other resources in obtaining information. In either case the resources spent on education would only garner the skill benefits. Finally, it is likely that not everyone would want the same level of education or have the capacity to achieve it.

Alternatively, businesses could be taxed annually for employing educated people. They would then have to weigh these costs against the extra sorting costs in finding the appropriate people among the less educated. We would expect some additional hirings among the less educated as well as a partial sharing of this tax (through a reduction in income) by the educated. Both these shifts would tend to reduce the return on education toward the one implied by perfect competition.

As noted above, one effect of screening is to reduce sorting costs for individual firms. However, society as a whole pays for these costs by devoting resources to higher education, whereas if there were no screening, alternative sorting policies would have to be developed by firms. Presumably, employers, looking for specific employee characteristics in different occupations, would develop tests to provide information on these characteristics. Alternatively, the testing would not necessarily have to be developed and administered by individual firms, but could be done by one or a few centralized agencies or even by the government itself. This type of sorting procedure would probably be cheaper in terms of resource cost than using the educational system.

Finally, society could consider the redistributive return as equivalent to a monopoly return on a product that it supplied. Under this interpretation, the government could capture the excess return by substantially raising the tuition components of the investment cost. Such a scheme could be accompanied by an educational-loan plan, so that educational opportunity would be made available to all, and those who achieved an education would not receive an excess return due to entry restrictions into certain occupations.