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Volume Title: Higher Education and Earnings: College as an Investment and Screening Device

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Volume Publisher: NBER

Volume ISBN: 0-07-010121-3

Volume URL: http://www.nber.org/books/taub74-1

Publication Date: 1974

Chapter Title: The Human-Capital Approach to Higher Education

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Chapter URL: http://www.nber.org/chapters/c3648

Chapter pages in book: (p. 25 - 36)

2. The Human-Capital Approach to Higher Education

The major purpose of this study is to determine the extent to which education increases an individual's lifetime income and why the increase occurs. By focusing on the monetary benefits we do not mean to imply that the consumption benefits of education are unimportant but only that their analysis is beyond the scope of the present study. The most complete and elegant model relating education to income was constructed by Becker (1964). At the risk of doing him an injustice, we present a simplified version of his model and indicate how it will be implemented empirically. We then discuss some alternative models based on different assumptions.[1]

THE HUMAN-CAPITAL APPROACH TO EDUCATION

Items purchased currently that produce benefits in the future are defined as "investments" by economists. For reasons to be spelled out shortly, education produces monetary and, perhaps, nonmonetary benefits and qualifies as investment in human capital. As the phrase "human capital" suggests, individuals have certain capacities or skills of a cognitive, physical, social, or psychological nature with which they earn a living. The level of any one skill possessed by an individual is partly determined by genetic inheritances and is partly acquired in the family, from friends, from formal education, and so on. The type of education in which we are primarily interested increases inherited skill levels by developing a person's cognitive and/or affective attainment levels. For example, higher education is capable of teaching a person general facts, the use of specific

[1]Thus, we indicate how different theoretical frameworks may yield divergent estimates of the return to education when used to interpret a given set of regression coefficients.

tools, and general problem-solving techniques. In addition, it can influence a person's behavior by making him more tolerant of diversity, better able to stand stress, a better leader, and more disciplined mentally. All these aspects of cognitive and affective behavior could make a person a more productive and effective worker.[2]

The skill function can be represented for the jth person as

$$\text{Skill}_j = f(A_j, ED_j, P_j, X_j) \qquad (2\text{-}1)$$

where A_j represents various types of innate mental abilities; P_j represents other innate characteristics such as personality, drive, and motivation; ED_j measures the extent of the individual's formal education; and X_j represents all other determinants of skill. Thus, provided people are paid for the skills they exhibit and provided education augments skills, increases in education will lead to higher income.[3] In principle it would be possible to estimate Eq. (2-1) for all skills that determine earnings, though we would still need to attach price tags to each skill. But we do not know what constitutes all the relevant skills, nor do we have measures of all of them. There are, however, indirect ways to estimate the effect of education on earnings. One method is to combine the human-capital approach with the theories of marginal productivity and perfect competition.

THE MARGINAL-PRODUCTIVITY THEORY OF INCOME DETERMINATION UNDER PERFECT COMPETITION

According to the marginal-productivity theory, perfectly competitive firms will hire any individual, provided the real wage rate paid to him (w) is less than, or equal to, his marginal product. By equating marginal productivity (MP) to all the skills described by Eq. (2-1) we have

$$w_j = MP_j = g(A_j, ED_j, P_j, X_j) \qquad (2\text{-}2)$$

Since earned income is equal to the hourly wage rate times the number of hours worked per year (H), income can be used to

[2] Although we do not try to distinguish between the affective and cognitive aspects of education in this study, we acknowledge that this is an extremely important question.

[3] For a thorough summary of research on affective development of college students, see Feldman and Newcomb (1969). A shorter summary is available in Simon and Ellison (1973).

measure the effect of education on skills, provided H is assumed constant as education varies.[4]

The effect of education on a person's lifetime income can be measured by examining the income earned in every year by two individuals who are alike in all characteristics (that produce skills) except for education.[5] However, since differences in income arising from education need not be the same in every year, it is customary to compute either the discounted value of the extra lifetime earnings from education or the rate of return earned over a person's lifetime on his educational investment.[6] Since these calculations involve the amounts of income earned by an individual, they are called individual, or private, rates of return.

The benefits that accrue to the individual from his education need not be restricted to extra earnings, but will also include nonpecuniary benefits. These might include, for example, the status or degree of risk in particular occupations.[7] When nonmonetary rewards differ by occupation, wage rates will be a poor guide to total benefits from education, especially if wages adjust to offset the nonpecuniary rewards.

The total benefits accruing to all members of society from an individual's actions are called the social benefits. Since the increased education of only one person will not cause a readjustment of wages, society's income increases by the same amount as an individual's income. There may, however, be other monetary social benefits, such as inventions that are not patentable, or nonmonetary benefits, such as a better-functioning democracy, that an individual does not fully capture.[8] An examination of such benefits is beyond the scope of this book.

[4]If hours vary with education, then other adjustments must be made. Also, increases in education may reduce the likelihood of later unemployment. See the discussion in Becker (1964).

[5]These characteristics should include any on-the-job investments. Mincer (1970) has argued that such investments explain most of the variation in age-earnings profiles by education level.

[6]Both these concepts incorporate the costs of obtaining education as well as the extra income attributable to education.

[7]There are many other nonmonetary returns from education that an individual may receive, and the interested reader is referred to the recent survey by Simon and Ellison (1973) and the discussion in Hartman (1973).

[8]The interested reader should consult the papers of Hartman and Mundell in Solmon and Taubman (1973) for a recent discussion of the subject.

But as discussed and examined below, differences between the private and social returns may arise if education is used as a screening device.

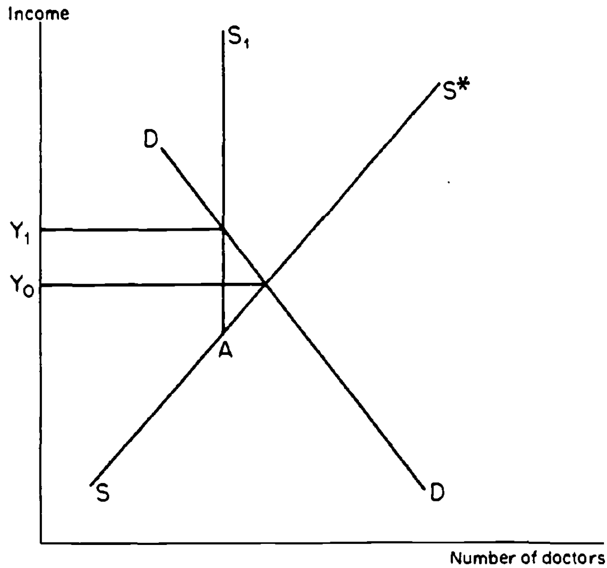
EDUCATION AS A MONOPOLY DEVICE

Since very few markets are perfectly competitive, the question of how various types of noncompetitive behavior affect our analysis and conclusions naturally arises. We consider first a model in which education is a prerequisite to entry into a particular occupation and in which entry is restricted. The medical profession is an example of such a model. To become a qualified M.D., it is necessary to attend medical school (which, in turn, requires some undergraduate training). Since the 1930s, however, the American Medical Association (AMA) has restricted medical school enrollments and has reduced the supply of medical doctors per patient.[9] Suppose that in the absence of these restrictions the supply curve of doctors would be SS^* in Figure 2-1, while the demand curve was DD with an equilibrium income per doctor of Y_0. Suppose that this earnings level were such that the rate of return was equal to that available on other assets, and thus that the supply curve was stable over time. If we limit college enrollment, and hence the number of doctors, to S_1, the supply curve becomes SAS_1 and income per doctor Y_1. The income level of Y_1 offers a rate of return on the costs involved in attending medical school above that on other assets, so that more people would like to enter the medical profession, but because of control over education the supply remains SAS_1.

Notice that because doctors have a college education and a high income, a sample of people that includes doctors would indicate a substantial return to a college education, even if all other college graduates received a rate of return that only equaled the interest rate on other assets. Imperfections such as are involved in the case of doctors do not introduce complications into calculations of the return to education; that is, since doctors are assumed to earn their marginal products (even though these are very high due to artificial supply restrictions), a comparison of earnings of individuals with various levels of education provides a basis for calculating the return to any individual.

[9]See, for example, the discussion in Lynch (1968).

FIGURE 2-1 ***Supply and demand for doctors***



Although this analysis was applied to doctors, it clearly applies to any other occupation in which education is a prerequisite for entrance and in which the current members can control the number of people who obtain the required education. Of course, there are relatively few occupations in which education has been an absolute prerequisite for entrance over a long period of time. In addition, very few professions have had the AMA's power to limit the number of people obtaining the necessary education. Thus, this type of imperfection is not widespread.

EDUCATION AS A SCREENING DEVICE

A model that does not satisfy the assumptions of competition but that is probably more widespread than the case of doctors is one in which education is used as a preliminary screening device. Because a formal discussion of screening appears in Chapter 9, the following treatment is primarily intended to indicate that different implications may be drawn from education-income data when the standard marginal-productivity and perfect-competition assumptions are dropped.

Individuals, who possess different levels of different types of skills, are more productive at some jobs than at others. If there were no nonpecuniary rewards for such factors as status or risk attached to various occupations, then in a perfectly competitive world each person would end up in the occupation in which his productivity was highest. For such a market to function, however, it is necessary for the employer and employee to evaluate a person's productivity and to be able to determine his appropriate job slot. If the labor market functioned on a piece-rate basis, an employer could let the employee take any job he wanted, and then pay him by performance.[10] But only relatively small sections of the labor market are so organized. Instead, people are generally paid by the hour, week, month, or year and are hired for a relatively lengthy period—subject to certain conditions—because of the substantial costs of hiring and firing.

Firms must do some sorting to match persons and jobs, but subjecting people to prejob tests may be an expensive way to gain such information, especially if the tests are not particularly accurate. Even short probationary periods on the job can be expensive and uninformative if a breaking-in period is needed. Thus, suppose that for certain jobs, such as executive, engineer, and researcher, firms need people with a high level of cognitive and affective skills—especially for advanced positions.[11] If firms believe that college graduates are *more likely* than high school graduates to have the skills necessary for the advanced positions, then by excluding all people with a high school education only, they will not have to interview as many candidates. This screening process will, however, exclude some high school graduates who have the skills necessary for the position.

Firms do not have to know that, on the average, college graduates are better; they must merely believe this to be so. Even if education added nothing to a person's talents, the fact that it correlates with mental ability would mean that education is an indicator of relevant skills.[12] Firms in certain occupations may therefore decide to try to recruit solely from higher educational groups. However, to the extent that the number of people with a college degree desiring to work in an occupation is less than

[10]However, on an assembly line where one worker's productivity depends on the number of acceptable pieces supplied to him by workers earlier in the line, an employer cannot let anyone chosen at random work at a job even when a piece-rate system is in effect.

[11]Of course, the firms hire many people at the trainee and junior levels. For these positions not as much skill is required, but firms may fill these positions primarily to find talented individuals to promote.

[12]For evidence that they are correlated see Chapter 5.

the number of positions the firms wish to fill,[13] some hiring will have to take place from less educated groups. This represents an important difference between the screening and the M.D. exclusion models.

Both secular and cyclical developments on the supply and demand side can affect the level of education used as a screen. If in any time period studied the screen excluded everyone with less than a given amount of education, then the outcome would be very similar to, and indistinguishable from, an M.D. exclusion model. But if some people with less education get by the screen, it is possible to observe their wage payments and to calculate what other people with the same education and abilities would have earned if employed in this occupation.

Such a calculation is the heart of our test for screening, which is explained in detail in Chapter 9. At this point we merely note that screening implies that some people have been excluded from occupations in which they would have a higher productivity. On the other hand, any individual obtaining the requisite education can pass the screen; hence, observed earnings differences do represent the private return to education even though only a portion of the difference represents productivity augmented by education. From a social viewpoint, only the productivity gain is a benefit, but the social rate of return from education could still exceed the private return if alternative sorting systems were more expensive to operate.

It should be noted that if persons are excluded from earning a level of income commensurate with their skills, then in some sense the marginal-productivity theory is being violated. Although a person with education below the screening level is restricted to a lower-paying occupation, he is still paid his marginal product in this occupation, and thus the model is one not of exploitation, but of discrimination.[14]

The previous discussion has indicated that private returns to education can be calculated by relating earnings to measures of innate abilities, education, and other elements that produce

[13]Both the supply of and demand for jobs, of course, can depend on the wage rate being paid in the occupation.

[14]"Discrimination" is probably too strong a term, because it implies that firms pay a person less than they know he is worth. In our model, firms exclude people from certain occupations because of the high sorting costs associated with lower education levels.

skills.[15] There are, however, certain statistical problems that must be discussed before the empirical results are presented.

ESTIMATION PROBLEMS

While marginal productivity has been measured directly in a few instances (for example, Berg, 1971), nearly all existing implementation of the human-capital model has been based on the indirect method of income differences. As mentioned above, we can estimate the effect of education on earnings if we compute a regression of the form of Eq. (2-2). Suppose for the moment that all the assumptions made earlier in deriving this equation are actually met in the population from which our sample is drawn. If all the variables in Eq. (2-2) can be measured and the functional form specified properly, then the estimated coefficients can be used to calculate the extra income due to education. However, no existing samples contain measures of all the relevant variables. Thus, one explanation of the finding of many researchers that income is related to education may be that variables that should have been included in the regression were excluded because of the unavailability of data.

Since the effect on the other coefficients of omitting a variable has been extensively analyzed by others (see, for example, Theil, 1961), we present only a brief summary. To simplify matters, suppose that we abstract from all but the ability and education variables, thus giving an equation of the form

$$Y_j = \alpha + \beta ED_j + \gamma A_j + u_j \tag{2-3}$$

where u is a random error. If we use the ordinary-least-squares estimating technique but omit A_j, it can be shown that as an estimate of β we obtain b, which satisfies

$$E(b) = \beta + \gamma d \tag{2-4}$$

where d is defined as the least-square estimate of δ in

$$A_j = \delta_0 + \delta ED_j + v_j \tag{2-5}$$

[15]It would also be possible to relate earnings to measures of skills obtained after education was completed. To find the effects of education, we would then have to find the net effect of education on these abilities.

The one exception occurs when wages have adjusted to offset nonpecuniary rewards, but this problem can be solved by including a dummy variable for those occupations for which nonpecuniary rewards are suspected to exist.

and E denotes the expected value of a statistic. From Eq. (2-4), we observe that if A_j is omitted, then our coefficient on education will be a biased estimate of β unless either γ or d is zero.[16] If γ is zero, then ability does not influence income (or skills), while if d is zero, then ability and education are not linearly related to each other. In other words, unless either γ or d is zero, our estimate of the coefficient on education attributes to education the combined effect of ability and education.

While the above example was conducted in terms of the two variables ED and A, it is easy to demonstrate that if ED represents all the included variables and A represents all the omitted variables, the same general conclusions are reached. Thus, in assessing the reliability of various estimates of the returns to education, it is necessary to consider what variables have been omitted that are related to income and education.

Of course, the set of omitted variables differs from study to study. At this point, therefore, we will list the types of variables that in previous research have either been suggested to be or found to be significantly related to earnings.[17] The reader will note that the list of variables has been divided into those that have been included in our analysis of the NBER-TH sample and those that have not.

The determinants of earnings wholly or partially included in our analysis are

1. Educational attainment[18]
2. Quality of schools[19]
3. Various types of mental ability
4. Physical health
5. Age and on-the-job experience

[16]Bias is a statistical concept defined as follows. We are interested in estimating a coefficient whose true value is β. From any sample, a particular estimating formula will yield an estimate b of β. We could apply the same technique to other samples of the same size and obtain a b from each sample. We say technique is unbiased if the mean of the b_i's, $[E(b_i)]$, equals β.

[17]For there to be a bias it is also necessary for the omitted variable to be related to education.

[18]In Appendix A we discuss various possible measures of attainment.

[19]For a more thorough analysis of measures of the quality of colleges, see Solmon (1969) or Wales (1973).

6 Family background

7 Marital status

8 Nonpecuniary rewards

9 Sex and race (by sample design)

Some other variables that may determine income but have not been allowed for in our analysis or in the design of the sample include

10 Personality traits such as motivation, drive, and risk aversion[20]

11 Religious preference

12 Mental health

13 Migration

Of all the variables omitted in our analysis, we would judge personality traits to be the most likely to bias our education coefficients. This bias may in fact be fairly small, since, as discussed in Chapter 4, the population from which the sample is drawn is probably more homogeneous than the United States population as a whole. Further, while people with more motivation and drive may be better able to complete college, they may also be more impatient to drop out and begin earning income. In any event, we do present evidence suggesting the existence of a set of omitted variables that affect income and whose effects persist over time.

The above discussion was based on an equation in which the effects of education and ability were both linear and independent of each other. In many instances it is important to determine if, or how much, the effects of education vary with educational attainment and/or ability level. In this study we allow for nonlinear effects of education and ability and for interactions between these two variables. It is worth noting that if, for example, the effect of ability is nonlinear and if the relationship between schooling and ability is also nonlinear, omitting ability from our equation will cause a differential bias at the various education levels. Moreover, if the effects of education are

[20]The sample design may have minimized differences in traits.

nonlinear but no allowance is made for this in the estimation, then it would be possible to conclude that the effects of education varied with ability when, in fact, this is not the case.[21] With this background we are ready to consider some empirical results.

21 That is, the more able would be more concentrated in the high education groups in which the nonlinear effects of education would be observed.