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Chapter Author: Paul Taubman, Terence Wales

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Part One:

The Impact of Education on Earnings

2. Mental Ability and Higher Educational Attainment in the Twentieth Century

by Paul Taubman and Terence Wales

INTRODUCTION AND SUMMARY OF FINDINGS

Many important changes have occurred in higher education in the United States since 1900. At the turn of the century very few people finished high school, but most of those who did attended college. For example, only about 7 percent of the population born around 1880, but 70 percent of all high school graduates, entered college. After World War I there was a big increase in the number of students attending high school but a sharp decrease in the fraction of high school graduates attending college.[1] However, after World War II the fraction of high school graduates attending college increased, until by 1970 about 50 percent of the eligible age group and 60 percent of all high school graduates attended college.[2]

The organization of higher education also changed greatly. For example, many four-year colleges changed their status to universities, numerous two-year colleges were founded, and normal schools became teachers colleges, which in turn expanded into standard four-year colleges. As the number of institutions of higher learning has increased, attempts have been made (for example, in California) to integrate community colleges, four-year colleges, and universities into statewide systems of education.[3] Partly in response to the increased demand for higher education at a reasonable cost, state-operated institutions have expanded to become more important in terms of the number of students and the quality of faculties.

The introduction of new courses and a change in emphasis between general and technical education have also shifted the focus of higher education. In part, these changes reflect the formation of

[1] In part this represented a shift in educational policy toward supplying more education at all levels (Finch, 1946; Folger & Nam, 1967).

[2] These estimates are derived from the methods given in Taubman and Wales (1972*b*, App. B). See also Folger and Nam (1967).

[3] See Jencks and Riesman (1968).

new disciplines and the growth in knowledge. However, they also reflect shifts in the composition of the student population. In 1900, a large fraction of college graduates became medical doctors, lawyers, theologians, or engineers. Since 1900, there has been a marked shift in careers toward business and other professions.[4]

There were several basic causes for these changes. First, there was the need for the educational system to adapt to new conditions in society. These new conditions included the increased demand of the wealthy for education as a consumption or status good, a shift in the occupational mix toward scientific skills, and the belief that education was required to obtain a good job. Second, there was the desire to make as much high-quality education as possible available to all those who could benefit from it.

Change comes no more easily to the academic world than elsewhere. Any alteration in graduation requirements or course offerings raises substantial opposition and debate. Expansion in the size of the university has caused controversy paralleling that caused by the expansion of high school education.[5] Much of the debate has concerned the need for quality in education and the question of who would or should benefit from higher education.[6]

One particular argument against the expansion of higher and secondary school education has perhaps been raised more than any other. The basis of the argument is that the courses given at most higher-level institutions of learning are oriented toward training people to use mental facilities and certain learned tools to solve various abstract and practical problems. But to be able to acquire the tools and to learn how to solve problems, a person must have a certain threshold level of mental ability or IQ.[7] Therefore, if many students below this threshold level were admitted to institutions of higher learning, the resources they used would be wasted. In addition, the admission of unqualified students in large

[4] See Wolfle (1954).

[5] See, for example, the statement by the president of Harvard in Finch (1946).

[6] It is generally assumed that benefits from education can be measured by the additional future income attributable to education, by the consumption value, and by any external factors such as the value to society of a better-functioning democracy.

[7] It is sometimes maintained that the threshold level is at least one-half a standard deviation above the population mean.

numbers might interfere with the instruction of those who would benefit from the education.[8]

An argument in favor of expansion points to the "loss in talent" that occurs when many students above the required threshold level cannot enter college and therefore never have the chance to develop their talents. Some proponents of expansion indicate that excessive heterogeneity in ability levels could be avoided if expansion took the form of added variety in the types of educational institutions.

These viewpoints involve contradictory assertions that can be resolved only by reference to empirical evidence. For higher education in the United States, the facts under dispute are: (1) Did the expansion in college enrollment since 1900 lead to a decline in the average mental ability of college students? (2) Did the expansion lead to a reduction in the loss of talent? (3) At what minimum level of mental ability do individuals (or perhaps society) cease to receive any benefits from education? While these questions are important, very little research has been undertaken to answer them.[9]

Our main interest in this chapter is to examine the first two questions by determining the relationship, in various samples spanning the twentieth century, between the percent of high school graduates who enter college and their mental ability at the time of college entrance.[10] The samples used, which are often referred to by name, are drawn from the Project Talent study and the studies done by Barker, Berdie, Berdie and Hood, Benson, Little, O'Brien, Phearman, Proctor, Wolfle and Smith, and Yerkes. Each of these studies presents information on the number of high school graduates entering college by IQ or aptitude test score. To make the tests comparable, we converted the scores to a percentile basis.

The information obtained in answering these two questions can also be used in analyzing other important economic problems. For example, for many purposes in economics it is important to know whether the average ability level of persons with various amounts of education has remained constant over age groups. Thus we may

[8] This could occur with a class of a very wide range of abilities if teachers pitched their instructional level too low.

[9] Partial exceptions are Berdie et al. (1962) and Darley (1962).

[10] In a recently completed study addressed to the third question, we found that rates of return to higher education do not vary with ability for those in the top half of the ability distribution, except perhaps for people with graduate education and very high ability. See Taubman and Wales (1972*a*).

wish to determine how income varies over time for people with a given amount of education. If the average ability level of those with a given amount of education has remained constant over time, we can answer this question by studying income differences for various age groups with a given educational level, as available, say, in the 1960 census. But if the average ability level within an education level is not constant over age groups, the income differences in the census occur because of both age and ability differences.

In addition, the coefficient of education in an equation relating education to mental ability plays an important role in determining the economic returns to education. It can be shown that when returns to education are estimated using data that do not include a mental-ability variable (such as the census data), the estimated effect of education on income will be biased upward if ability and education are positively related.[11] Further, if this relationship has changed over time, then the bias will change accordingly.

Subject to some qualifications, as given below, our major conclusions are as follows:

1 As shown in Figure 2-1, the average ability level of high school graduates

[11] If the true equation is

$$Y = \alpha A + \beta S + u \tag{2-1}$$

where Y is income, A is innate ability, S is educational attainment as measured by highest grade completed, u is a random-error term that is independent of A and S, and α and β are parameters to be estimated, then the estimation (by least squares) of the equation $Y = cS$ will yield a coefficient c, with expected value given by

$$E(c) = \beta + k\alpha \tag{2-2}$$

where k is the coefficient from the (least squares) regression

$$A = kS \tag{2-3}$$

Thus, as long as ability is positively related to income ($\alpha > 0$) and as long as educational attainment and ability are positively related ($k > 0$), then the estimate of c in Eq. (2-2) exceeds β, which, from Eq. (2-1), represents the true impact of variations in S on Y.

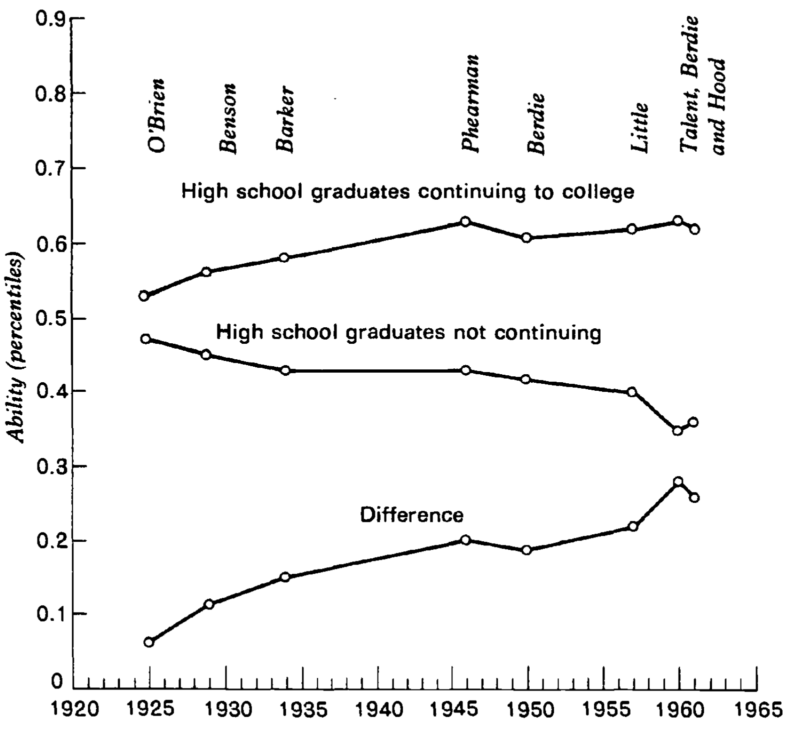
On the other hand, if we have estimates of the ability-education relationship for various time periods and if this relationship has changed for various cohorts, it is possible to obtain separate estimates of the effects of education and ability on income in a single cross section that includes the various cohorts.

Thus, Eq. (2-2) expresses the estimated education coefficient in terms of income differential due to education β, the income differential due to ability α, and the increase in ability associated with educational changes k. Since we can obtain an estimate of k, Eq. (2-2) has only two unknowns. If another estimate of Eq. (2-2) can be obtained in a cohort with a different k, then in principle the two equations can be solved for estimates of both α and β.

who entered college ($\bar{A}_c$) ranges from the 53d to the 63d percentile (measured upward from zero) for the period 1925–1961. Although in the 1930s there was a reduction in the percentage of students entering college, Figure 2-1 indicates that there was an increase in the average quality of college students compared with the 1920s. On the other hand, the postwar boom in higher education resulted in still higher-quality college students than in the 1930s and substantially higher-quality students than in the 1920s. The average quality level has increased because initially only about 60 percent of the most able students went to college, while, as shown below, the growth in the fraction entering college is concentrated in the high-ability groups. There is also evidence in Darley (1962) that existing schools have increased the quality of their students, while new colleges and community colleges have been started to meet the needs of the less able. Thus the more able students may be receiving a better education now.

2 There has been a significant reduction in the loss of talent since 1920. The loss of talent can be measured by the fraction of high school graduates who enter college at various ability levels. The selected values of ability, measured as percentiles (ranging upward from zero), are 25, 50, 75, and 90. At the 90th and 75th percentiles there has been a substantial increase over time in the percent entering college. At the 50th percentile the 1960 values

FIGURE 2-1 ***Average ability levels over time, adjusted***



are slightly higher than those for the 1920s, and the values during the 1930s and 1940s are substantially lower. At the 25th percentile the fraction of high school graduates entering college appears to have fallen during the 1930s and 1940s, but by the 1960s was back to the 1920 level. On the basis of this evidence, we conclude that the substantial increase in the fraction of high school graduates entering college since the 1920s occurred primarily at the 75th and 90th ability percentiles.[12]

It should be realized that these results are subject to a number of qualifications, of which the following are among the most important. Many of our samples are statewide rather than nationwide, and some of the states may be atypical. In addition, the samples use different ability tests that had to be converted to a common basis. Our results, which are based on IQ and aptitude tests, reflect only the mental abilities measured by these tests and not all types of mental ability. Finally, we are assuming that the average ability level of high school seniors in the population has remained constant over time. Although there is some evidence in Berdie et al. (1962) that this is true, it has not been completely verified.

We turn now to a consideration of the measures of mental ability and education that we used in the analysis. This is followed by a discussion of the major conceptual and statistical problems inherent in the study, our conclusions, and then a detailed presentation of our estimate of the ability-education relationship for each sample.

MEASURES OF MENTAL ABILITY AND EDUCATIONAL ATTAINMENT

To measure mental ability it is necessary to know what is being measured and to define a set of units to differentiate between people. Following the approach of psychologists, we conceive of mental ability in terms of the capacity to retain ideas and comprehend and solve abstract problems. While there is no perfect empirical counterpart to this theoretical definition, there are several measures on which differential performance is partly determined by the theoretical construct. The more that differences on the measure are determined by mental ability, the more appropriate the measure is as a proxy.

The two most obvious measures which should be related to mental ability are rank in high school class and scores on a standardized set of tests. Although both measures are related to mental ability, one may be a better proxy than the other.

[12] The data (for males) prior to World War I, however, yield a picture similar to that of the 1950s and 1960s. Thus the big loss of talent at that time occurred prior to high school graduation.

Standardized tests can be divided into IQ and aptitude (achievement) tests. In principle, aptitude tests measure the amount of knowledge or skill acquired (primarily in school) in particular subjects. IQ tests are thought of as measuring general inborn ability, which does not depend upon previous schooling (or the factors noted above). However, a substantial body of evidence suggests that most IQ tests depend, among other things, on years of schooling, quality of schooling, and cultural background.[13] Thus the difference between IQ and aptitude tests is more a matter of degree than of kind, and we shall intermix information from both types of tests as long as the data can be converted to a common scale.

Consider also the differences between test scores and rank in class. One major difficulty of rank-in-class data is that they are computed on the basis of students in a given grade in a single high school, when in fact different schools in the same city often have students of different quality, and differences in quality generally exist also between urban and rural schools. Therefore, unless information on the quality of the students is available, it may be misleading to equate the ability of individuals who have the same rank in different schools. On the other hand, the same test may be used in all schools in a system, or, at a minimum, test scores can be standardized over a population. In either case students from various schools can be compared.

Another reason why rank in class can be a very poor proxy of mental ability is that rank may be determined much more by such things as docility in class, memorization, and grades in nonacademic courses. These factors may explain the well-known phenomenon that a disproportionately large percentage of girls are in the higher ranks in class in high school.

An individual's rank in class may, on the other hand, be more dependent on such things as drive and motivation, and these characteristics may be crucial for future academic and career success.[14] Thus some studies, such as Berdie and Hood (1963), have found

[13] See, for example, Learned and Wood (1938).

[14] Of course, genetic influences, prenatal and postnatal diet, home and school atmosphere, personal motivation, and drive can all affect an individual's intellectual performance as measured by IQ tests or rank in class. To the extent that all the factors that affect class rank or IQ scores are also relevant in determining income or in determining which are the talented students currently available for college training, our mental-ability index is appropriate in measuring the return to education. Our analysis, of course, is not suitable for determining such magnitudes as the loss of talent that would not have occurred if all children and expectant mothers had had adequate diets.

rank in class slightly more important than IQ or aptitude tests in determining which students enter college. However, contrary evidence exists in Folger and Nam (1967).

Although most studies find that knowledge of both IQ and rank in class significantly improves the prediction of college attendance, we rely on test scores because of the problem of standardization. In order to facilitate a comparison of results from different samples, we converted the ability measures to the same units for all samples. This enables us not only to compare results but also to combine small samples for estimation purposes, as discussed in detail below. The standardization method that we used was to convert the IQ measure for each sample into percentile terms, with the "norm" being the population of high school graduates. Since most of the samples involve statewide tests of graduating seniors (e.g., Minnesota, Kansas, Iowa), standardization consists simply of transforming the raw IQ measure into within-sample percentile terms. This treatment assumes that the distribution by ability of high school graduates is the same in all states. However, even if the sample distribution for a state differs from the national norm, the effect will probably be small, provided ability is used as the dependent variable.[15]

The main advantage of this conversion method is that it avoids the problem of using conversion tables to compare various raw IQ scores. Such tables contain only the major IQ measures and in many cases appear to be based on small samples. Another advantage of our method is that it permits use of results provided by other investigators in which data are presented only in percentile form. For samples that clearly are not representative of the high school graduate population, we converted the data in a more complicated way.

We assume that the different tests and testing procedures yield data that are comparable. This requires that the rankings of individuals be the same if given the same test at different times or different tests at the same time. Various studies have indicated high reliability (of most tests) for individuals. Even greater reliability should be expected when broad groupings are used; hence, there

[15] This follows because according to the standard results in errors-in-variable problems, if there is an additive measurement error in the dependent variable that is not correlated with the independent variable, we shall obtain an unbiased estimate of the slope coefficient. Because of the conversion method used, there is no clear reason for not expecting the measurement errors to meet the above conditions.

should be little difficulty in combining the samples. In order to compare and combine samples from different time periods, we make the additional assumption that the average ability level of high school graduates has remained approximately constant over time. Support for this hypothesis is contained in Berdie et al. (1962), which traces the average ability level of high school graduates in Minnesota from 1928 to 1960 and in which there appears to be no trend in the average ability level as measured by the ACE examination. Further supporting evidence is available in Finch (1946).

We are interested primarily in analyzing post-high school educational attainment. For this purpose it is useful to distinguish two stages in the educational process: entrance into college and length of stay in college. Our analysis is concerned with the former aspect, since the necessary data are more readily available. The basic education measure that we use in analyzing the relation between college entrance and ability is the percentage of high school graduates who enter college.

In this study we do not analyze vocational education because there are virtually no data of the form we need. This suggests that the results of our analysis require careful interpretation. For example, in discussing the loss of talent that results when high-ability students do not attend college, it would be important to know how many of these attended vocational school and whether the rate of return to such education was high. Such considerations are particularly relevant in view of the long time period under study and the accompanying changes in emphasis on vocational training. In the 1930s, for example, there was a strong emphasis on this type of education (Anderson & Berning, 1950), although we suspect that in more recent years many equivalent programs have been given by colleges, junior colleges, and community colleges.

CONCEPTUAL AND STATISTICAL PROBLEMS

A question that is of some importance in statistical considerations is the interpretation of the education-ability relationship. That is, does ability "cause" the educational attainment—or vice versa—or does the relationship arise for other reasons?

Causality versus Description

Let us assume that students and their families have a demand function for educational attainment—for both the consumption and investment aspects. Regardless of whether students want either or both of these aspects, plausible arguments can be made that the demand depends upon the student's ability. Indeed, whether one uses students' educational plans or their actual realization of these plans, a substantial body of evidence exists suggesting that the demand for education is a function of ability.[16] This demand will also depend on such other factors as the family's income level, job and scholarship opportunities, and tuition.[17]

On the other hand, educational authorities try to weed out people with low ability levels. What is considered too low may depend upon the physical and budget capacity of the institutions or governments involved. In any event, evidence exists that willingness to promote students to higher grades, to encourage them to stay in school, or to permit them to go to a higher education institution has varied over time.[18] Thus any observed relationship between educational attainment and ability is the outcome of the factors that affect supply and demand. Shifts in these factors can alter the observed relationship without implying any causation; therefore, we conclude that the data on education and ability should not be interpreted in a causal sense. We shall generally use the term *descriptive* to characterize this relationship.

The fact that we interpret the education-ability relation as descriptive provides no guidance for deciding which variable to use as the dependent one in regressions. However, there are two major reasons for using ability as the dependent variable.[19] First, the education-ability relation enables us to correct the bias (of the education coefficient) arising from the omission of ability in income equations. For this purpose we require the education-ability equation to be formulated with education as the independent variable.[20] Second, errors in measuring ability will not bias the coefficient in the regression if ability is used as the dependent variable. There will be a bias if ability is used as the independent variable. On the other hand, there is a rationale for using education as the dependent

[16] The plans may be more relevant because one reason students do not fulfill their plans is that the educational authorities exclude those with low ability. That is, the realization in part reflects supply conditions.

[17] The family's income level affects the demand relation because of imperfect capital markets, differences in tastes for present versus future consumption, and the luxury nature of the consumption of education.

[18] See, for example, Folger and Nam (1967) on the trends in the number of students who were not in the normal school grade of their age group. Consider, also, state and federal provision of support for college facilities.

[19] In addition, for samples in which individuals have different amounts of education when tested, it may be possible to correct the bias when ability is the dependent variable.

[20] This is necessary because, as shown in footnote 11, in Eq. (2-2) the estimate of k is obtained from estimating (by least squares) an equation in which education is the independent variable.

variable when dealing with certain nonlinear functional relations. That is, one way to test for nonlinearities is to include the independent variable in squared form. This can be accomplished only if ability is the independent variable.[21]

In general, there appear to be no sound reasons for preferring a particular functional form to relate education to ability.[22] For simplicity, we used the linear form. We have, however, tested for nonlinearities by regressing education on ability and ability squared. Where the nonlinearities are significant, we indicated the extent to which our conclusions are affected. We also experimented with the logarithmic form but have not presented the results, since this form does not fit well in the tails of the distributions, and the estimated coefficients appear to be very sensitive to the scaling of the ability variable—for example, using the midpoints or end points of the decile ranks.

There is one minor statistical point that can be dispensed with now. We have been talking interchangeably of the education variable as representing a situation in which an individual does or does not enter college and representing the fraction of high school graduates entering college. These two concepts can be reconciled as follows. We define a variable D_i as 1 if the ith person enters college and as zero otherwise. Our linear equation for the ith individual is therefore $A_i = h + kD_i$, where A_i is again the ability of the individual. Suppose that we now order the data by ability class and average the observations in each ability group. The education variable then becomes the percentage of people in each ability class who enter college (E_{12}), and the ability variable becomes the average ability level in the class (A).[23]

[21] The education variable cannot be included in both unsquared and squared forms as the independent variable because it is obtained by aggregating a zero-one variable, which when squared is still a zero-one dummy variable.

[22] However, for purposes of analyzing the relationship between income, education, and ability, it is necessary that the functional form for the side relation correspond to that of the basic relation. If a dummy variable for college entrance is used in the income analysis, then our linear equation is appropriate. If different dummies are used to represent various educational levels, then our linear equation provides the first step in determining the bias.

[23] Formally, this can be accomplished by multiplying by a grouping matrix G whose elements in the ith row (which corresponds to the ith ability group) are zero for all observations not in that ability group and $1/n_i$ for the n_i observations in the group. This gives $GA_i = hG + kGD_i$. In the ith ability group $GD = n^*_i/n_i$, where n^*_i is the number of people who enter college in that group. Since in the ith group D has n^*_i entries of one and $n_i - n^*_i$ values of zero, its average is n^*_i/n, which is equal to the percentage of people in that ability class who entered college. We denote this percentage as E_{12}.

The linear equation that we estimate for the different samples is therefore $A = h + kE_{12}$. It may be useful at this point to interpret the coefficients h and k. The coefficient h indicates the level of ability at which the fraction of high school graduates entering college is zero. Since in nearly all our samples some students enter college at all ability levels, our estimates of h are generally negative. An alternative interpretation of h may be obtained by solving this equation for E_{12} to give $E_{12} = - h/k + 1/k\ A$. Provided that h is negative, some students will continue to college even at the lowest ability levels. From this equation, $1/k$ can be interpreted as the increase in the fraction of students entering college for each unit increase in A.

Effect of Education on Mental Ability

Our main interest is in determining the relationship between the percentage of high school graduates entering college and their mental ability at the time of college entrance. The ability measures that we use are various IQ and achievement test scores. These are determined in part by the amount of schooling the individual received prior to taking the tests.

The pioneering study of Learned and Wood (1938) clearly demonstrates the extent to which even IQ measures are affected by years of schooling. In this study nearly 28,000 high school seniors were given a 12-hour examination in 1928. One part of the examination was the Otis IQ test. Those students who went on to college were retested in eight-hour examinations in 1930 and 1932. Moreover, exactly the same Otis test was given on the last two occasions. Comparing test scores for those in the sample in 1928 and 1930 and those in the sample in 1930 and 1932, it was found that the average score on this test rose 7½ percent from 1928 to 1930 and 5 percent from 1930 to 1932. In other words, the Otis test (and presumably all other IQ tests) appears to measure educational attainment as well as mental ability.

Consequently, data from samples in which individuals are subjected to tests after having completed their formal education must be treated differently from those in which all individuals are tested as high school seniors. From a statistical viewpoint, the former problem may be analyzed as an error in variables.[24] In nontechnical terms, the problem may be described as follows:

[24] We wish to estimate the (descriptive) relationship between educational attainment S and mental ability A. Let the true relationship be expressed as

$$S = \gamma A + u \tag{2-4}$$

People with more education will score higher on tests because of this additional education. Thus it is difficult to distinguish between the effect of education on test scores and the relationship between the mental ability of students at, say, the end of high school and after additional educational attainment. In this case our regression analysis yields biased estimates of the parameters of the equation relating ability and education. However, as shown in footnote 24 when education is the independent variable, it may be possible to correct the estimate on the basis of a regression of IQ on additional education.

On the other hand, the relation between ability and education is not obscured if it is estimated from a sample in which IQ's are

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Suppose, however, that instead of observing A, we measure IQ where $\mathrm{IQ} = A + z$ and where $E(u,z) = E(A,z) = 0$ but $E(S,z) > 0$. If we use ordinary least squares to estimate the equation $S = g\mathrm{IQ} + v$, then

$$\operatorname{plim}(\hat{g}) = \operatorname{plim} \frac{\sum(S,z) + \gamma\sum A^2}{\sum(A^2 + z^2)} \tag{2-5}$$

Hence $\hat{g}$ from Eq. (2-5) will, in the limit, exceed γ provided that

$$\frac{\sum(S,z)}{\sum z^2} > \gamma \tag{2-6}$$

But the left-hand side of Eq. (2-6) can be interpreted as the least squares estimate of λ in the equation $S = \lambda z + v$. Thus our estimate of $\hat{g}$ exceeds or falls short of γ, as λ exceeds or falls short of γ, and not even the direction of the (asymptotic) bias is determinable without further information. However, studies such as Learned and Wood contain information on the change in z due to a change in education, and hence we can estimate λ using first differences. This permits us to determine the sign but not the extent of the statistical bias, which in general requires knowledge about $\Sigma A^2/\Sigma(A^2 + z^2)$.

This ambiguity in the sign of the bias is removed if we postulate the relationship as

$$A = \delta S + w \tag{2-7}$$

Once again, we measure A as IQ and regress $\mathrm{IQ} = ds$, which yields

$$\operatorname{plim}(\hat{d}) = \delta + \operatorname{plim} \frac{\sum(S,z)}{\sum S^2} > \delta \tag{2-8}$$

Thus with S as the independent variable, our estimate of δ will be biased upward and $\hat{d}$ can be used as an upper limit of δ. Of course it will be possible to estimate the extent of bias only if $\Sigma(S,z)/\Sigma S^2$ is known. But this term is the least squares estimate of Ψ in $z = \Psi S + v$, and as such it measures the contribution of schooling to knowledge of scores on tests. It may be possible to estimate this relationship from data in Learned and Wood.

measured for individuals with the *same* amounts of education at the time of the test.[25] This condition is satisfied by a follow-up survey, in which the individuals' further educational attainment is determined at a later date. Since all the students will have had the same amount of schooling when they are tested, there can be no differences in the IQ scores that are due to differences in years of schooling.

CONCLUSIONS

As indicated earlier in this chapter, we are interested primarily in answering two questions: Did the expansion in college enrollment since 1900 lead to a decline in the average mental ability of college students? Did it lead to a reduction in the loss of talent? A summary of our results follows.

For the first question, we consider the changes over time in the average ability of students who enter college ($\bar{A}_c$) and in the average ability of those high school graduates who do not enter

[25] That is, in terms of the errors-in-variables analysis, the bias arises because z varies between individuals. If z is constant for all individuals, then $(z - \bar{z})$ will be equal to zero for each person, and all sums involving z's will also be zero.

TABLE 2-1 *Average mental-ability level of high school graduates who entered, and did not enter, college, in various samples*

Sample	*Date*	$\bar{A}_c$	$\bar{A}_{nc}$	$\bar{A}_c - \bar{A}_{nc}$
O'Brien	1925	.54	.47	.07
		.53	.47	.06
Benson	1929	.57	.46	.11
		.56	.45	.11
Barker	1934	.64	.44	.20
		.58	.43	.15
Phearman	1946	.68	.44	.24
		.63	.43	.20
Berdie	1950	.62	.42	.20
		.61	.42	.19
Little	1957	.68	.43	.25
		.62	.40	.22
Talent	1960	.65	.37	.28
		.63	.35	.28
Berdie and Hood	1961	.65	.39	.26
		.62	.36	.26

NOTE: The first line for each entry is the value calculated from the sample; the second line is this value adjusted to the United States population as a whole. A detailed discussion of the adjustment method appears in Taubman and Wales (1972*b*, Appendix C).

college ($\bar{A}_{nc}$).[26] We have calculated $\bar{A}_c$ and $\bar{A}_{nc}$ for most of the samples described below.[27] These results for males and females combined are presented in Table 2-1 in both adjusted and unadjusted form, but only the adjusted values are plotted in Figure 2-1. The adjustments are made to take into account the difference between the percent of students entering college in each sample and in the country as a whole. A detailed description of this adjustment method is presented in Taubman and Wales (1972*b*, Appendix C). In the following discussion we use the adjusted estimates. The $\bar{A}_c$ data suggest a mean IQ of about the 53d to the 63d percentile for those who enter college. The highest $\bar{A}_c$ is .63 in the Phearman and Talent studies; the lowest is .53 in the O'Brien study.

The general pattern of $\bar{A}_c$ is as follows:[28] During the 1920s $\bar{A}_c$ was at its lowest value—approximately 55 percent. During the 1930s it rose to about 58 percent, and it reached a peak of 63 percent in 1946. It remained at approximately this level through 1961, although there may have been a slight dip in the early 1950s. (The dip is more pronounced in the unadjusted data.) While $\bar{A}_c$ was changing, there were also shifts in the fraction of high school graduates entering college. In particular, during the 1930s a smaller fraction of high school graduates attended college than in the 1920s, while during the 1950s and 1960s a larger fraction of graduates entered college than in either of these earlier periods. Thus the reduction in college enrollment in the 1930s resulted in an increase in the average quality of college students. However, the postwar boom in higher education resulted in still higher-quality students than in the 1930s, and in substantially higher-quality students than in the 1920s. This result for the 1950s and 1960s is substantiated in Darley (1962), in which the records of college freshmen in specified colleges have been examined.

[26] We define $\bar{A}_c = \Sigma A_i N_i / \Sigma N_i$ and $\bar{A}_{nc} = \Sigma A_i (N^*_i - N_i) / \Sigma (N^*_i - N_i)$. N_i is the fraction of high school graduates in the ith class who entered college times the *population* of high school graduates in the ith class (N^*_i).

[27] For this question the Proctor study is omitted because of its small size, the Yerkes study is omitted because the results are sensitive to the bias correction procedures, and the Wolfle and Smith data are omitted because of the rate-of-response problem noted below.

[28] One qualification of these results is, as discussed below, that they are drawn from studies involving different states. To the extent that there are differences between states in the college-going behavior of the students, the results may be misleading, although our adjustment method attempts to take this into account.

The data suggest a mean IQ of about the 40th percentile for those not entering college. There is a significant downward trend in $\bar{A}_{nc}$ over the period.[29] The value of $\bar{A}_c - \bar{A}_{nc}$, which describes how much more able the college students were, shows a very pronounced upward trend.

On the basis of these data it is apparent that the quality of college students has not declined. In fact, throughout this period of 40 years, during which a substantially greater percentage of high school graduates entered college, it has even noticeably increased. The basic explanation for this phenomenon is analyzed in the loss-of-talent discussion given below, but it can be summarized as follows: In the 1920s only about 60 percent of the most able high school graduates entered college, whereas by the 1960s the corresponding figure was about 90 percent.

To understand how $\bar{A}_c$ has shifted and to study the loss of talent

[29] $\bar{A}_c$ and $\bar{A}_{nc}$ need not move in opposite directions because of differences in their weights.

TABLE 2-2 ***Fraction of high school graduates entering college at selected ability levels for various samples***

		Percentile (A)			
Sample	*Year*	*.25*	*.50*	*.75*	*.90*
O'Brien	1925	.27	.36	.45	.51
		.36	.45	.54	.60
Benson	1929	.25	.36	.48	.54
		.34	.45	.57	.63
Barker	1934	.11	.23	.38	.46
		.26	.38	.53	.61
Phearman	1946	.12	.28	.46	.57
		.23	.39	.57	.68
*Berdie**	1950	.24	.37	.54	.66
		.25	.38	.55	.67
*Little**	1957	.14	.26	.44	.58
		.33	.45	.63	.76
*Talent**	1960	.24	.41	.65	.83
		.31	.48	.72	.90
*Berdie and Hood**	1961	.21	.37	.59	.74
		.34	.50	.72	.87

NOTE: The first line for each entry is the value calculated from the regression equation; the second line is this value adjusted to the United States population as a whole. A detailed discussion of the adjustment method appears in Taubman and Wales (1972*b*, Appendix C).

*The nonlinear form of the regression equation was used for these samples; the linear form was used for the others. All equations are presented in the detailed discussion of the samples in Taubman and Wales (1972*b*, Appendix A).

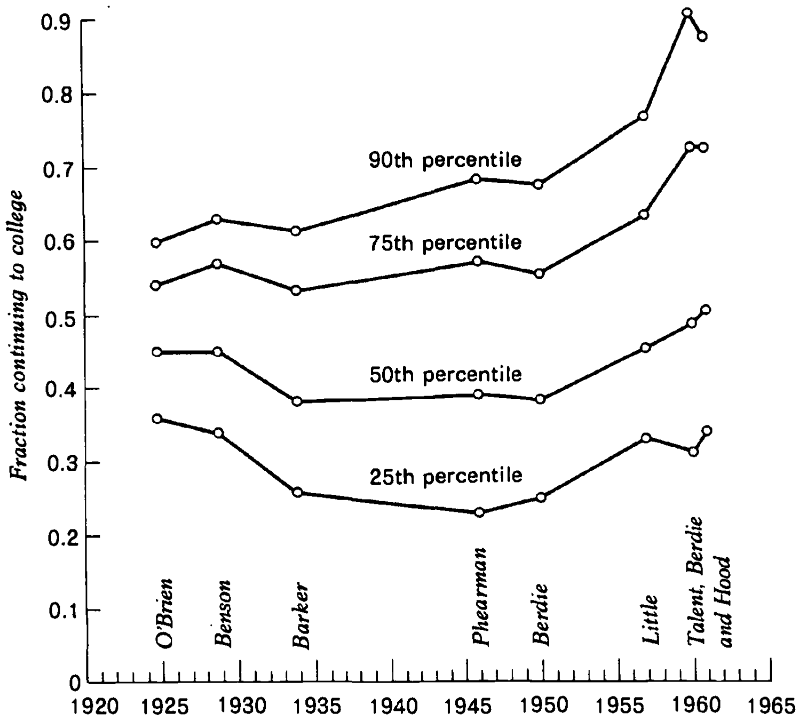
in various time periods, we evaluate the equations presented below to determine the fraction of high school graduates entering college (E_{12}) at selected ability levels (A).[30] The selected values of A are .25, .50, .75, and .90. The last point should certainly include those people who are talented, while .75 lies well above the mean IQ percentile of college entrants. The value of .50 is the median of the distribution, though less than $\bar{A}_c$, while .25 is certainly indicative of the less-able students. In Table 2-2 we present the results for various samples in both adjusted and unadjusted form, but in Figure 2-2 we present only the adjusted estimates.[31]

These results suggest the following general pattern: At the 90th

[30] We have estimated both linear and nonlinear equations and have used the latter in our calculations when nonlinearities are significant. However, nearly identical results are obtained from the linear equations. Moreover, for the linear equations the results are almost the same whether education or ability is used as the dependent variable.

[31] This adjustment, as in the case of average ability levels, is intended to take into account differences in the percentage continuing in the sample and in the population.

FIGURE 2-2 ***Fraction of high school graduates continuing to college at selected percentiles, adjusted***



and 75th percentiles, the percentage entering college has increased substantially over time. At the 50th percentile, the 1960 values are slightly higher than those for the 1920s and the values for the 1930s and 1940s are substantially lower. At the 25th percentile, the fraction of high school graduates entering college appears to have fallen during the 1930s and 1940s, but by the 1960s is back to the 1920 level. We do not have exactly comparable data for the pre-World War I era, but the information on men in Yerkes (1921) indicates that the loss in talent (at the various percentiles) for high school graduates was about the same as in the late 1950s. Since less than 10 percent of the population graduated from high school, the loss of talent occurred at earlier educational levels.

As noted above, we estimated both linear and nonlinear equations. In explaining the loss of talent, we find no evidence that the coefficient on the nonlinear term (A^2) is significant in the samples for the period 1920–1940. After the Second World War, however, the coefficient on this variable, which is always positive,

FIGURE 2-3 ***Data points from O'Brien sample, 1925***

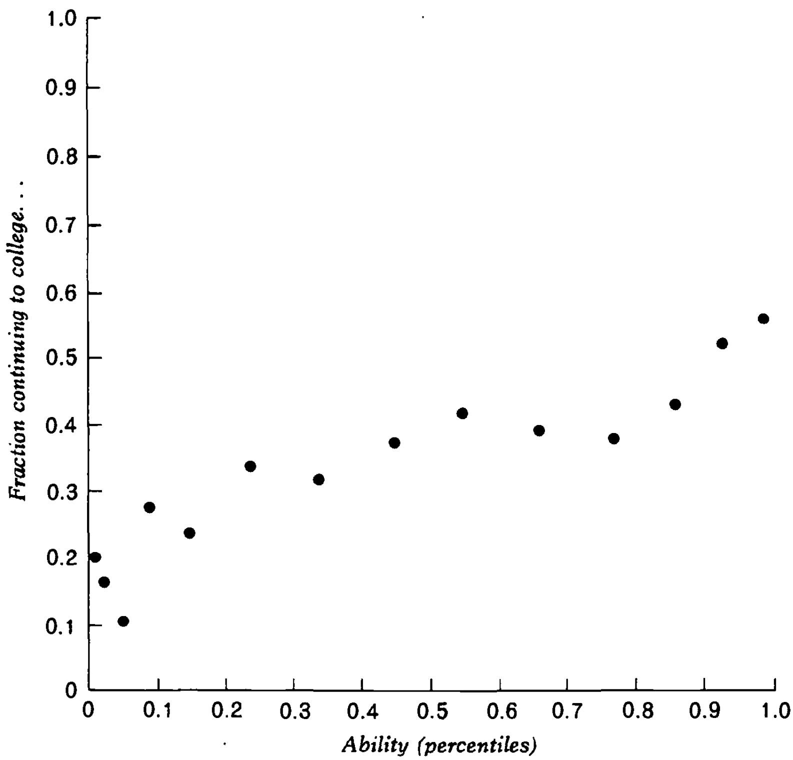
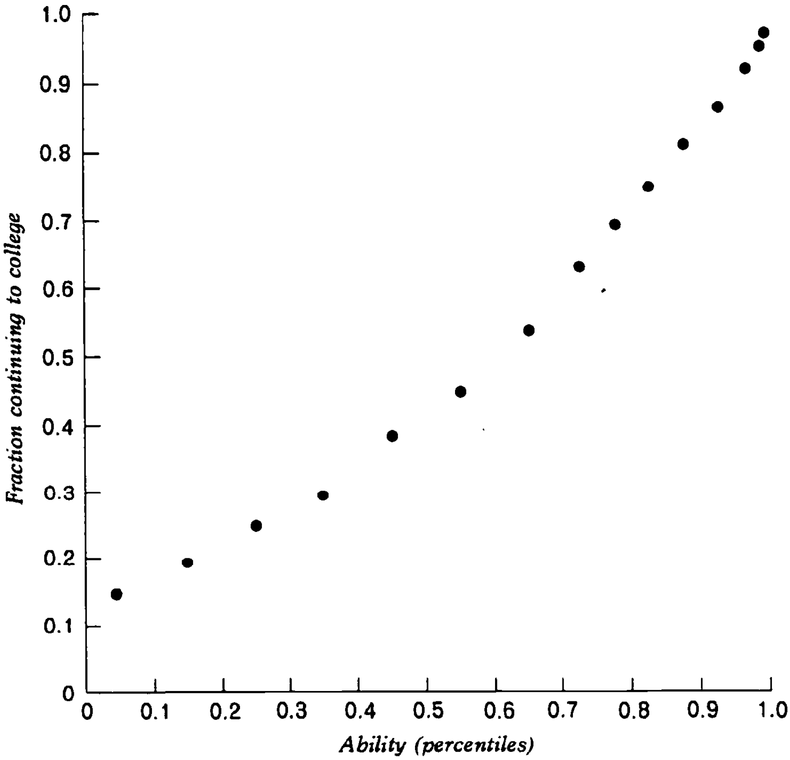


FIGURE 2-4 ***Data points from Project Talent sample, 1960***



is highly significant. To illustrate the difference between the prewar and postwar periods, we plot in Figures 2-3 and 2-4 (the O'Brien and Talent studies) the actual data points of two representative samples. The nonlinearity in the postwar sample is clearly evident.

On the basis of the percentage who enter college at various IQ levels, it is evident that in the 1950s and 1960s there was less loss of talent than in the 1920s and 1930s. It is interesting to speculate why less talent is lost now than earlier and why the average IQ level of college entrants has risen. To this end we have examined various histories of higher education in the United States, but except for certain comments in Jencks and Riesman (1968), none of these is very explicit on the subject.[32] We suggest that much of the shift occurred because of the changing financial

[32] However, the histories indicate that there was a growing trend over time in the amount of undergraduate training required by the traditional professional schools. In addition, many other occupations began to require a formal education as a prerequisite to entrance.

constraints applicable to high school graduates over time. Before World War I very few people completed high school, and very few parents could afford a college education, especially since depressions occurred frequently. In addition, the available data indicate that (for males) college education differed sharply by ability level. The middle to late 1920s was a period of prosperity in which the high school population and the middle and upper classes grew rapidly. Partly because their income permitted it and partly for social reasons, there was a tendency for the children of these groups to attend college.[33] But since the correlation between bright students and wealthy parents was not that high, the distribution of college entrants by IQ was reasonably flat (a low selectivity coefficient). In addition, Jencks and Riesman (1968) argue that in the 1920s colleges as a whole were willing to take any person who applied.

The 1930s generated a whole new set of pressures as income fell, unemployment became rampant, and the high school population continued to expand faster than the population. In the post-World War II era, the percentages of students continuing to college in the upper IQ brackets rose sharply, while those at the bottom rose only slightly. Some possible explanations for this development are that many more middle-class families both could afford to send their above-average children to school and wanted to send them because they believed schooling to be the road for advancement. In addition, the capital markets may have become more perfect with the advent of federal scholarships and loans. Finally, Jencks and Riesman suggest that, starting in the late 1940s, colleges that did not have enough facilities to accommodate the surging demand for space tried to select only the brightest students.[34]

Finally, separate results for males and females are available for some of the samples. The same general pattern over time holds for males and females separately and for the combined sample. The average ability levels of those continuing to college are approximately the same for males and females. As far as the loss of talent is concerned, the fraction of males continuing exceeds that of females at the selected percentiles discussed above, with the

[33] See Goetsch (1940) for a discussion of college-going patterns by parental income.

[34] Jencks and Riesman (1968) argue that the colleges initially assumed the increase in demand to be a temporary phenomenon connected with the GI Bill.

absolute differences becoming larger, the higher the percentile.

For the period prior to the 1930s, we also estimated our equations—with data from Benson (1940) and Yerkes (1921)—for each grade after the sixth. There is a sharp drop in the slope coefficient after the completion of the eighth and twelfth grades. Although average ability increases with educational development, most of the gain occurs from the seventh through the twelfth grades.

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