Volume Title: Education, Income, and Human Behavior

Volume Author/Editor: F. Thomas Juster, ed.

Volume Publisher: NBER

Volume ISBN: 0-07-010068-3

Volume URL: http://www.nber.org/books/just75-1

Publication Date: 1975

Chapter Title: Ability and Schooling as Determinants of Lifetime Earnings, or If You're So Smart, Why Aren't You Rich?

Chapter Author: John C. Hause

Chapter URL: http://www.nber.org/chapters/c3695

Chapter pages in book: (p. 123 - 150)

5. Ability and Schooling as Determinants of Lifetime Earnings, or If You're So Smart, Why Aren't You Rich?

by John C. Hause

INTRODUCTION

The way in which ability influences earnings, either directly or by its impact on the productivity of schooling, is currently not well understood. Measurements of specific abilities (e.g., the enviable capacity to succeed consistently in obtaining large grants and comfortable per diems) and general ability (e.g., measured IQ) are the product of genetic, environmental, and experiential factors that are difficult to disentangle. For many important models it is probably unnecessary to break down measured ability into its components. Suppose that the prospective earnings E of an individual can be expressed as a function of measured ability A at time t_o, a set of

NOTE: This chapter has been neither reviewed nor approved by the directors of the National Bureau of Economic Research. The project underlying it has been supported by funds from the U.S. Office of Education channeled through the National Research Council. Research was carried out with the aid of grants from the Carnegie Commission on Higher Education and the National Science Foundation and with the general funds of the National Bureau. Computer time was provided by the University of Minnesota.

This chapter significantly extends (and heavily cannibalizes) an earlier version published in the May 1971 supplement to the *American Economic Review*. The empirical portion of this study would have been impossible without the generous cooperation of those assembling the important primary data. I am indebted to D. C. Rogers for allowing me to use his basic data tape. I am also indebted to Torsten Husén for allowing me to use the remarkable data on Swedish males from Malmö and to Ingemar Fägerlind for coordinating the collection of the Swedish earnings data. The American Institutes of Research prepared the Project Talent data tape. And Robert Thorndike was most cooperative in making available to the NBER his massive collection of data from 1955 on.

Comments by Finis Welch on the original version were perceptive and valuable. Computations were carried out by J. Sanguinetty, M. Sternfeld, and A. L. Norman. Norman also developed a very useful program for estimating missing observations that greatly facilitated the Project Talent calculations. Margareta Forselius and Karlis Goppers provided much assistance with the Swedish data.

other personal characteristics P_o at t_o, additional schooling or other investment to increase future earnings S, and time for $t \geq t_o$:

$$E(t) = F(A_o, P_o, S, t) \tag{5-1}$$

A_o and P_o specify the initial state of the person at t_o. Although A_o and P_o may include simple, easily measured factors (e.g., race or sex) as well as complicated functionals of factors operating before t_o, it may be that A_o and P_o adequately summarize the initial state *for the purpose of analyzing how* S *affects the earnings profile* E(t). If this condition is satisfied, so that a complete biography of the individual from conception until t_o is unnecessary, a value-added analysis of the schooling increment S is feasible.

This study takes a slightly less agnostic view of the role that ability plays in determining the earnings stream *E(t)*. The measure of A_o is a test score (or set of test scores). Loose hypotheses can readily be developed on how A_o is related to *E(t)* for additional schooling after t_o (including $S = O$). The main interest in these hypotheses stems largely from our ignorance of *how* schooling affects the earnings stream. If we reason that many people regard schooling as an important way of increasing their prospective earnings, we expect to find (and, in fact, do find) a significant tendency for earnings to rise with the level of schooling attainment. This discovery throws little light on the "technology" by which schooling augments subsequent earnings. An analysis of the role of ability, however, gives some insights into this black box.

The following section discusses some hypotheses on the roles of ability and schooling as they affect earnings. Later, some of these hypotheses are tested, using several cohorts of individuals for whom data are available on ability, achievement, other personal and background characteristics, and earnings.

SOME HYPOTHESES ON ABILITY AND EARNINGS

Ability is usually defined as the power to do something. Many of the tests designed to measure ability have been developed in an educational context where the relevant power is the capacity to learn and master cognitive tools. Learning through formal schooling and learning those things which increase a person's economic productivity, however, are not identical, although one would expect an empirically significant positive correlation between the two. There are, in fact, several well-documented empirical relationships that also point to a positive association between earnings and measured ability. An empirically significant positive relationship exists both between level of schooling attainment and earnings after people have been working for a few years (see Tables 5-2, 5-7, and 5-9, for example) and between measured ability and level of schooling attainment (see Tables 5-2, 5-5, 5-7, and 5-9). Our knowledge of the technological relationship between schooling and earnings is meager, but this lack has not impeded the making of sweeping conjectures. Several output components of schooling which may affect earnings have been suggested (or asserted). A casual catalog includes (1) specific skills to perform well-defined tasks, (2) general cognitive skills that enable people to locate and handle information more efficiently, (3) "social skills" that increase the capacity to deal with (or manipulate) others, (4) development of greater rational foresight and self-discipline, and (5) conditioning to certain attitudes (e.g., obeying orders, punctuality) and to the performance of routine tasks that increase personal productivity in modern economic organizations. From this list it seems likely that measured ability is associated primarily with general cognitive skills and with the capacity to acquire some of the more complex specific mental skills. Since these skills (and skill levels) depend upon both schooling and measured ability, one expects a positive interaction of schooling and ability on earnings, unless, of course, these skills have no effect on earnings.[1]

To my knowledge, neither learning theory nor economic theory has been developed to the point where a powerful theory of the earnings profile can emerge. Even so, interpreting ability broadly as "learning power" immediately suggests several simple hypotheses. Consider the earnings profiles of a cohort of people with the same schooling attainment. If people with greater ability learn the same job skills as others, but more quickly, their earnings profiles will rise more rapidly than the profiles of those with less ability as long as their economic productivity is increasing more rapidly.

If full job competence is attainable by people of lower and higher ability, the influence of ability disappears after a period long enough to allow those with lower ability to attain full productivity.

[1] It is beyond the scope of this chapter to investigate the other hypotheses on schooling outputs and earnings. Some of them appear to be difficult to evaluate because data for observing marginal changes are not available. For example, children are exposed to substantial experience related to conditioning of certain attitudes before they reach the legal age for leaving school. If further schooling has little effect on this dimension, then it will not be easy to measure directly the impact of schooling on earnings from this source.

On the other hand, differential ability may limit the complexity of skills that people are able to master. In this case, an ability effect on earnings can persist over time as long as more complex skills yield higher earnings. If one considers different schooling levels, it seems plausible that persistent ability differentials in earnings should become more important at higher levels of schooling. At the lowest levels of schooling attainment, jobs consist largely of well-defined tasks that do not require great cognitive ability, and output is easily measured in these jobs. At high levels of education, more jobs have no obvious upper limit, in terms of the degree of skill that is economically productive. Since the efficiency with which people can find and assemble economically relevant information depends significantly on cognitive capacity and skills, there is no reason why the marginal returns to such skills should become negligible in many "high-level" jobs.

Attempts to understand the relative slope of the logarithm of the earnings profile of high- and low-ability people are not carried far by a priori argument (see Appendix C).

Initial earnings of people first entering the labor force could have a positive, zero, or negative simple correlation with ability. A positive correlation could indicate that those with higher ability are immediately more productive and that employers can observe this fact at the time of hiring. In this case, there is no guarantee that the percentage rate at which high-ability people acquire specific job skills exceeds the rate for less-skilled people. A low positive or zero simple correlation between initial earnings and ability could reflect the fact that employers have imprecise information about the current and future productivity of new members of the labor force at the time they are hired. After employees have gained experience, the reassessment of their productivity and the higher speed with which the more able workers acquire specific job skills should combine so that the percentage rate of increase in earnings will be higher for those with more ability (at least initially). A negative simple correlation between initial earnings and ability could arise if ability is a strong complement of on-the-job training which must be paid for by reduced initial earnings. In this case, at some point in time the relative earnings of high-ability people would have to rise more rapidly than those of less-able people to make worthwhile the former's greater investment in training.

In addition to determining the relationship between earnings, schooling, and ability at different points on the earnings profile, it is also useful to consider how these factors are related to lifetime (discounted) earnings. Even if people have identical ability and schooling, the growth of individual productivity over time may differ between jobs. In the absence of nonpecuniary occupational tastes, there would be a tendency for entry rates to different occupations to be governed by the condition that they lead to the same (net) present value of earnings. Thus significant dispersion of earnings at different points along the earnings profile is in principle compatible with relatively little dispersion in the net present values. Since people presumably take into account prospective profiles of earnings over time and not merely the earnings for a single year when they make decisions about schooling and occupation, the attempt to establish statistically the determinants of the present value of earnings (or closely related functions of the earnings profile) plays an important part in understanding these decisions. The preceding remarks on ability and how it may affect the earnings profile also imply that there is likely to be a positive correlation between ability and discounted earnings.

We consider next the relationship between ability and discounted earnings for different levels of schooling. A number of expository and statistical models express earnings (usually for a single year after earnings profiles have flattened out) as a linear function of schooling, ability, and an uncorrelated random variable:[2]

$$Y = \beta_0 + \beta_1 S + \beta_2 A + u \qquad (5\text{-}2)$$

This relationship does not seem plausible. It implies that schooling and ability are perfect substitutes in determining earnings (because of the linear form). More important, it implies that the marginal product of additional schooling is independent of ability (because of separability). The latter assumption is implausible for two well-known reasons. First, there is the systematic tendency of higher-ability people (as measured by IQ or other tests) to acquire more schooling than others. Second, the opportunity cost of forgone earnings is a large part (more than half) of the cost of obtaining higher levels of schooling for most people (Schultz, 1968). Equation (5-2) implies that the opportunity cost of acquiring additional schooling is greater for more able people; yet this schooling yields

[2] See, for example, Hansen, Weisbrod, and Scanlon (1970) or Ashenfelter and Mooney (1968).

the same increment to earnings to everyone, independently of ability. Thus the economic incentive to acquire additional schooling implied by this model is greater for those with less ability, and their expected rate of return would be higher.

An alternative specification that captures the opportunity cost of acquiring schooling in a more plausible way replaces the level of earnings Y by log Y in Eq. (5-2). In this formulation, the level of earnings for people with different ability increases equiproportionally with schooling. Even this specification, however, provides no economic rationale for the strong tendency of people with greater ability to acquire more formal education. Table 5-1 (which may contain some response bias) shows the strength of this relationship for male high school graduates of 1960. Although the sons of high-income families are more likely to enter college at all ability levels, the ability–college entrance relationship is very strong within family income classes. Tables 5-5, 5-7, and 5-9 show the same positive association between measured ability and terminal level of schooling.

Consider a simple model in which education is acquired solely to increase earnings and in which perfect foresight and a perfect capital market for funds to support schooling are assumed. For this model, equilibrium is attained when the flows of people of different ability to different terminal levels of schooling lead to relative wages such that net present values of earnings are the same for people with the same ability but different schooling attainment. In such a world, regressions of the logarithm of earnings on ability within each schooling class would result in coefficients of ability that are roughly the same for different schooling levels. However, the very imperfect market for educational loans (and perhaps uncertainty)

TABLE 5-1 ***Percentage of male high school graduate questionnaire respondents not entering college within one year of graduation, 1960***

	Family's finances				
Aptitude percentile	*Extremely wealthy or wealthy*	*Well-to-do*	*Comfortable*	*Have necessities*	*Barely make a living*
90–99.9	3.7	5.1	7.7	14.5	16.1
75–89.9	13.5	10.4	19.5	27.0	21.7
50–74.9	25.3	23.0	40.2	41.8	51.2
25–49.9	39.4	44.2	59.1	70.3	78.9
0–24.9	83.5	72.5	77.0	81.6	87.6

SOURCE: Project Talent, *The American High-School Student*, Final Report for Coop. Project 635, U.S. Office of Education, Washington, 1964, Tables 11–18.

might well result in coefficients of ability that rise with education. The hypotheses of this section are examined empirically below.

TESTING ABILITY AND EARNINGS HYPOTHESES

The four samples of cohort data used to study the ability-schooling-earnings relationship are described in detail in Appendix A. The samples differ substantially in size, in the populations from which they are drawn, and in supplementary variables. The small sample of Rogers has been studied more thoroughly than the others, but parallel calculations with the other samples confirm, qualify, and extend these results.

Results from Rogers's Data

The calculations from the important sample obtained by Daniel C. Rogers are based on a survey of 343 white males, primarily from Connecticut, who were eighth graders when tested for IQ in 1935. Table 5-2 shows mean values (and standard deviations of background variables) and the logarithm of earnings for different schooling levels at five-year intervals from 1950 through 1965. The five schooling levels are E_1, high school nongraduates; E_2, high school graduates; E_3, college nongraduates; E_4, college graduates with one degree (and perhaps additional study); and E_5, holders of two or more degrees. The intervention of World War II may make the E_3 group atypically heterogeneous since it includes men who started college shortly before the war, entered the military, and did not return to college thereafter. It also includes those college dropouts who initially entered college after completing military service, attracted in part by GI Bill subsidies that made out-of-pocket costs of college attendance relatively low. The motivations causing men to enter college but not graduate are diverse in any period, and they were probably unusually mixed in this sample. Therefore, one should interpret the results for this subgroup with caution.

The background variables used in the analysis of Rogers's data are subpopulation dummy variables for social class ($SCH = 1$ for the highest two social classes, out of five, and $SCL = 1$ for the lowest two), religion ($RC = 1$ for Catholic background and $RJ = 1$ for Jewish background), private school attendance ($PS = 1$ for precollege private schooling), and marital status ($NM = 1$ if not married in 1965). No attempt will be made in this chapter to rationalize the precise role played by these variables in the earnings function. None of them were highly correlated with measured

TABLE 5-2 ***Means and standard deviations* of log earnings, IQ, and background variables by educational level, Rogers sample***

Educational level	*Sample size N*	*LE65*	*LE60*	*LE55*	*LE50*	*LDE4%*	*IQ*
E_1	60	8.857	8.708	8.664	8.569	11.836	95.9
		(.326)	(.281)	(.279)	(.335)	(.221)	(11.8)
E_2	117	9.001	8.764	8.662	8.550	11.872	102.3
		(.392)	(.336)	(.320)	(.338)	(.324)	(11.1)
E_3	51	9.262	9.057	8.900	8.668	12.070	107.8
		(.557)	(.439)	(.428)	(.478)	(.429)	(9.59)
E_4	68	9.456	9.253	9.008	8.689	12.211	115.8
		(.539)	(.479)	(.432)	(.535)	(.519)	(11.00)
E_5	47	9.640	9.414	9.061	8.525	12.262	117.3
		(.574)	(.607)	(.502)	(.624)	(.445)	(10.0)

* Numbers in parentheses are standard deviations.

SOURCE: Data tape of D. C. Rogers.

ability (IQ). They do, however, help to prevent an exaggeration of the role of ability in the regressions, and they also help to eliminate some sources of differential earnings that make it difficult to estimate an ability effect from the small samples that are available.

In Table 5-2 all the mean earnings estimates increase with schooling except in 1950, when the E_5 group had very little postschool experience. (There is one trivial reversal in 1955.) The standard deviations of the logs of earnings are substantially lower for E_1 and E_2 levels, which suggests, in principle, that weighted regressions should be used if all schooling classes are pooled in one regression. The table shows the positive association of IQ and schooling attainment, which suggests that schooling and IQ have a positive interaction on earnings—a hypothesis proposed above. Marital status is not systematically related to schooling attainment, but is included in the empirical work because of the strong tendency for unmarried men to have substantially lower earnings than married men. The entire set of background variables based on Rogers's data is frequently used in regressions in this chapter and is denoted by X^* in the following discussion and tables.

The size of the schooling subgroups in this sample is small, leading to large standard errors in many of the parameter estimates. Even so, there are some suggestive patterns that broadly conform to some of the hypotheses, although they cannot be confirmed with high statistical significance.

Several theoretical and empirical arguments in the preceding section explain why schooling and ability are unlikely to be perfect substitutes in producing earnings. Table 5-3 provides some

SCH	*SCL*	*RC*	*RJ*	*PS*	*NM*
.033	.917	.750	—	.033	.050
.034	.829	.650	.017	.094	.077
.196	.529	.431	.039	.235	.039
.412	.427	.325	.059	.470	.059
.446	.319	.298	.170	.383	.042

evidence for this by showing the linear regressions of 1965 earnings and discounted lifetime earnings (at 4 percent) on IQ and the background variables X^*.

The pattern of IQ coefficients (except in E_3) is broadly consistent with the belief that the coefficient of ability increases with educational level in linear regressions. IQ is only trivially related to earnings for the lowest schooling level, but appears to make a moderate empirical difference in earnings as the schooling level rises. An approximate chi-square test of the statistical hypothesis that the 1965 IQ coefficients are equal across educational classes (excluding the peculiar E_3 class) indicates that the probability of the null hypothesis is less than .05.[3] This result and the array of IQ coefficients in Table 5-3 suggest that there is positive interaction between IQ and educational level and that the linear model is misspecified because it does not allow for interaction when educational levels are pooled in one regression equation.

The low coefficient for the E_3 group (some college) is anomalous. This result may be sample-specific, for historical reasons already mentioned, or there may be some unobservable factor that leads to self-selection by those who terminate their schooling at this level. Still it is unclear why the effect of IQ on earnings should be this weak.

[3] For this test, a weighted mean was constructed from the IQ coefficients of the 1965 regressions in Table 5-2. Let $w_i = (1/\sigma_{\beta_i})/\Sigma_j\ (1/\sigma_{\beta_j})$, where σ_{β_i} is the estimated standard error of β_i, the IQ coefficient of schooling group E_i. Let the weighted mean $\beta_w = \Sigma w_i \beta_i$. Then $\Sigma[(\beta_i - \beta_w)/\sigma_{\beta_i}]^2$ is approximately chi-square with three degrees of freedom (for the four educational classes). In this case, the chi-square value is 9.5.

TABLE 5-3 ***Linear regressions of earnings on IQ and background variables (X*), Rogers sample***

Educational level	Sample size N	1965 earnings β_{IQ}	1965 earnings R^2	Discounted lifetime earnings (4%) β_{IQ}	Discounted lifetime earnings (4%) R^2
E_1	60	−3.5 (26.9)	.16	−115 (367)	.19
E_2	117	74.6 (35.8)	.19	756 (592)	.09
E_3	51	−2.2 (127.2)	.34	−589 (1,606)	.23
E_4	68	186.4 (94.7)	.29	1,668 (2,625)	.21
E_5	47	223.0 (154.5)	.19	1,968 (1,754)	.19

NOTE: Numbers in parentheses are standard errors.
SOURCE: Author's computations are from data in Rogers sample.

Table 5-4 contains regressions of the logarithm of earnings on IQ and the background variables X^* and is designed to explore the hypothesis that IQ differentials affect earnings equiproportionally at all educational levels. As before, IQ continues to have a very weak association with earnings of high school nongraduates, and we also get the continued anomaly of a small coefficient for E_3. Nonetheless, the pattern of IQ coefficients across schooling levels for 1965 earnings, and for discounted lifetime earnings, is consistent with the argument that ability should tend to increase earnings at least proportionally for increasing levels of schooling. Indeed, the IQ coefficient on 1965 earnings and discounted earnings appears to jump substantially for the highest educational level, a suggestive result, although the difference in the E_4 and E_5 coefficients in this small sample is not statistically significant.

To facilitate comparisons with other samples in which different tests are used to measure ability, the product of the IQ coefficient and one standard deviation of the test score for each schooling cohort is shown, in brackets, in the 1965 column of Table 5-4. Since the dependent variable is the natural logarithm of earnings and since the standardized IQ coefficient is usually small, the latter can be interpreted as being approximately equal to the relative increase in earnings associated with a change of one standard deviation in the IQ.

In order to study how IQ affects earnings for a given schooling level, regressions can be run using as dependent variables the differences in the logarithm of earnings for distinct years. The co-

TABLE 5-4 Coefficients* on IQ from regressions of log earnings, by year or by discount rate, on IQ and background variables (X^*), Rogers sample

Educational level	Sample size N	1965	1960	1955	1950	4%
E_1	60	.024 (.35) [.0026]	.14 (.29)	.20 (.29)	−.27 (.36)	−.01 (.24)
E_2	117	.70 (.32) [.078]	.36 (.29)	.32 (.28)	.28 (.30)	.45 (.27)
E_3	51	.36 (.78) [.035]	.17 (.66)	.32 (.62)	.04 (.68)	.00 (.63)
E_4	68	.92 (.63) [.101]	.70 (.55)	.53 (.51)	.74 (.69)	.42 (.61)
E_5	47	1.32 (.90) [.132]	1.01 (.99)	−.18 (.97)	−.17 (1.11)	.78 (.75)
Pooled†	345	.49 (.23)	.46 (.20)	.29 (.20)	.15 (.22)	.35 (.19)

* Numbers in parentheses are standard errors. Coefficients and standard errors are multipled by 100. The bracketed figures are the product of the IQ coefficient and one standard deviation of IQ, from Table 5-1, and were *not* multiplied by 100. The 1965 IQ coefficient for E_5, for example, implies a 1.32% rise in earnings with a one-point rise in IQ, and since the standard deviation of IQ is 10 for E_5, this magnitude of IQ change implies approximately a 13.2% change in earnings.

† The pooled regression includes the background variables and the dummies for educational level.

SOURCE: Author's computations are from data in Rogers sample.

efficient of an independent variable can then be interpreted as the percentage change in earnings over time associated with the variable. The coefficients of IQ that would be obtained from this calculation can be read directly from Table 5-4 by taking the difference in the coefficients for any pair of years. For E_5 (two or more college degrees), IQ appears to have an effect that increases substantially over time. This tendency of ability to become more important as labor force experience increases is pervasive, but is weaker at lower levels of schooling. Although occupational information was unavailable, the larger rise in ability effects over time among the highly educated might be due in part to substantial earnings by high-ability professional men, whose earnings may increase rapidly after their lengthy training is completed. (The initial small negative correlations of IQ with earnings for this group in 1950 and 1955 may also be due partly to the late labor market entry of these professionals.

On the basis of Rogers's sample, what conclusions can be drawn about the important problem of bias in the returns to education when ability is ignored? It seems to be well established that mean IQ increases with schooling level. If IQ is positively correlated with earnings at each schooling level, an earnings differential calculated by taking the difference in mean earnings for each schooling level will exaggerate the potential gain for a person of given ability who acquires more schooling. For the Rogers sample, Table 5-2 indicates that mean IQ is about 13 points higher for college graduates than for high school graduates; the corresponding differential in IQ for college graduates with two degrees over high school graduates is 15 points. The coefficients on IQ for levels E_4 and E_5 in Table 5-4, multiplied by the corresponding IQ differentials, imply that lifetime earnings (discounted at 4 percent) of the average high school graduate would be 6 percent and 8 percent less than the earnings of those who attained the E_4 and E_5 levels, respectively. A similar calculation based on the 1965 earnings-IQ coefficients implies that the average high school graduate (who terminated his education with high school) would earn 13 percent and 18 percent less than the mean E_4 and E_5 individuals, respectively. Thus, this sample indicates the existence of an empirically significant bias in using earnings differentials to calculate the apparent increase in earnings for high school graduates who subsequently take one or more college degrees. Because the IQ-earnings relationship is negligible for high school nongraduates, there is no overstatement of the increased earnings of those who actually completed high school (although there would be an overstatement of the gains to a person whose ability is that of the mean high school nongraduate).

The sample provides a modest but positive rationalization of the strong association between schooling attainment and IQ. The discounted lifetime earnings coefficient for those with two or more degrees is larger in magnitude than the high school coefficient. The product of the difference in the coefficients and the difference in the mean IQ's indicates that lifetime discounted earnings increase 5.4 percent more for a person with IQ 117 than for a person with IQ 102, if both have two degrees.[4]

[4] This magnitude of interaction between IQ and schooling is considerably larger than the 1 percent increase obtained by Rogers (1969, Table 9, p. 115). The difference arises in part because Rogers used an age-in-school variable that is correlated with IQ and because of other differences in formulating a statistical model and handling the data. As explained in App. A., Rogers's sample of 364 was reduced by 21 observations to eliminate individuals with extreme personal

The IQ coefficients for high school graduates and for college graduates with one degree are almost identical for discounted earnings. However, the 1950 IQ coefficient for high school graduates is quite small in comparison with that for college graduates with one degree. The small IQ coefficient for high school graduates suggests that the opportunity cost of earnings while attending college differs little over a wide range of ability, whereas ability makes a larger relative difference early in the earnings career of college graduates. Clearly this provides some incentive for those with higher IQ to attend college.

Results from the Project Talent Data

These results are based on a sample of about 8,800 white males who were high school juniors in 1959, when they took ability and achievement tests and provided certain background information, and who in 1966 had full-time employment and responded to a mail questionnaire. Although most of the college graduates have not had more than one year of postcollege work experience, and although later points along the earnings profile are not yet available, it is interesting to compare this large sample with the Rogers evidence. Table 5-5 is analogous to Table 5-1 and provides data on earnings, weeks worked, and background variables by schooling level. The five schooling levels are E_1', high school nongraduates; E_2', high school graduates; E_3', college dropouts (with one to two years of college); E_4', college dropouts (with three to four years of college); and E_5', college graduates. A number of ability and achievement variables are available for this sample. The tests included in the table are C001 (a composite test score which is reported to be highly correlated with IQ), C004 (a quantitative test-composite score), R410 (arithmetic computation), and R430 (clerical checking). The background variables include high and low social class (SCH' and SCL', obtained from a composite socioeconomic status variable, P*801, developed by Project Talent), religion ($RC = 1$ for Catholic background, and $RJ = 1$ for Jewish background), nonpublic school attendance ($PARS = 1$ for parochial school attendance in 1959, and $PRVS = 1$ for private school attendance), not

characteristics. This procedure could lead to some modification of the IQ coefficients. Rogers measured social class by a four-valued single variable, whereas I trichotomized the sample by dummy variables. Finally, my results are based on coefficients from individual regressions by schooling level to allow for full interactions with the other variables. Rogers pooled his observations in a single regression in which the IQ-schooling interaction was allowed (but no other schooling-level differences).

married in 1966 *(NM)*, and a variable for region of school in 1959 ($S = 1$ for U.S. Office of Education, Region 5—Southeast).[5]

The logarithmic mean earnings for 1966 are irregularly ordered with respect to schooling attainment. The mean for high school nongraduates is slightly larger than the mean for high school graduates. This may reflect a differential response bias favoring nongraduates with high earnings, although direct evidence is not available on this point. The differences in the mean of log-weeks worked are partly responsible for the lower earnings means of the E_4' and E_5' schooling levels. If we assume that earnings per week are unaffected by the number of weeks worked and if we standardize all 1966 earnings to the 3.90 mean of log-weeks worked of the E_1' class, the five log-earnings figures for E_1' through E_5' are 8.54, 8.47, 8.42, 8.38, and 8.56, respectively.[6] This adjustment reduces the differentials between log-earnings of the schooling levels, although only the rank of college graduate earnings is changed. The ranking is probably influenced significantly by the productivity gains that have already been achieved by those in the lower levels of schooling attainment, and behavior of similar samples suggests that the rank-

[5] The Project Talent data bank does not include the 1966 place of residence of respondents. The only geographic information readily available is region of 1959 schooling.

[6] In fact, this adjustment appears to be too large. Within schooling class, the regression coefficients on log-weeks worked are about .7. I shall not burden this footnote with ad hoc conjectures rationalizing this result.

TABLE 5-5 ***Means and standard deviations* of log earnings, ability, and achievement variables and background variables by educational level, Project Talent sample***

Educational level	*Sample size N*	*LE66*	*LE62*†	*LNWK (log of weeks worked)*	*C001 (IQ composite)*	*C004 (quantitative composite*
E_1'	183	8.535	7.913	3.90	139	72
		(.404)	(.555)	(.14)	(50)	(31)
E_2'	3,853	8.475	7.833	3.91	166	95
		(.454)	(.580)	(.13)	(44)	(36)
E_3'	1,914	8.411		3.89	192	121
		(.514)		(.20)	(42)	(42)
E_4'	793	8.302		3.81	202	135
		(.598)		(.32)	(38)	(42)
E_5'	2,097	8.271		3.61	217	156
		(.597)		(.50)	(31)	(40)

* Numbers in parentheses are standard deviations.

† Sample sizes for these two educational levels are 63 and 1,854.

SOURCE: Data tape on subsample of high school juniors, Project Talent.

ing will be altered in favor of those with more schooling in the future. I intend to test this conjecture in a future study.

The significant tendency of abstract ability (C001 and C004) to rise with level of schooling parallels the Rogers data. The more specific skills (R410 and R430) also tend to rise with schooling, but within schooling level, standard deviations for these variables are relatively much larger than the mean differences between schooling levels. The inverse relation between fraction married and level of schooling in these data is consistent with the young age of this cohort in 1966. The association (or lack of association) between the remaining background variables and schooling is also similar to Rogers's findings.

Regressions are reported for the logarithm of 1966 earnings on *one* of the ability or skill variables and $X'^* = (SCH', SCL', RC, RJ, PARS, PRVS, NM, S, LNWK)$.[7] Table 5-6 shows the coeffi-

[7] The variable *LNWK* (log of weeks worked) is included as an independent variable for two reasons. First, including it makes the results more comparable with the 1950 calculations from Rogers's data and the Thorndike sample (both of these give earnings on a full-time equivalent basis). Second, many individuals with E'_4 and E'_5 schooling attainment were relatively new to the labor force and worked less than a full year (as suggested by the considerably lower mean value of *LNWK* for these two groups). As far as this study is concerned, this source of variation of the log of earnings is largely "noise" at the higher educational levels.

Including *LNWK* reduces the magnitude of the ability and skill coefficients for the three lowest educational levels, but not by enough to greatly change the statistical or empirical significance of the coefficients shown in Table 5-6.

R410 (arithmetic computation)	*R430 (clerical checking)*	*SCL'*	*SCH'*	*RC*	*RJ*	*NM*	*S*	*PARS*	*PRVS*
38 (13)	39 (18)	.399	.279	.328	.016	.284	.137	.022	.011
40 (10)	40 (16)	.314	.283	.331	.015	.398	.165	.061	.012
42 (9)	41 (15)	.169	.465	.315	.041	.462	.159	.099	.026
44 (9)	41 (14)	.107	.603	.282	.062	.484	.160	.106	.039
47 (9)	42 (13)	.113	.621	.266	.078	.502	.157	.102	.044

TABLE 5-6 ***Coefficients* on ability and skill measures, from regressions of log earnings (1966) on an ability or skill and background variable (X'*), Project Talent sample***

Educational level	*Sample size N*	*Ability or skill variable*				
		C001	*C004*	*R410*	*R430*	*C004†*
E'_1	183	.04	.02	−.06	.00	.06
		(.059)	(.125)	(.222)	(.30)	(.088)
		[.012]	[.006]			
E'_2	3,853	.02	.06	.11	.12	.09
		(.013)	(.018)	(.073)	(.044)	(.019)
		[.009]	[.022]	[.011]	[.019]	
E'_3	1,914	−.03	.00	.16	.30	.02
		(.025)	(.100)	(.114)	(.071)	(.032)
				[.014]	[.045]	
E'_4	793	.04	−.03	.44	.44	.00
		(.051)	(.054)	(.200)	(.126)	(.090)
				[.040]	[.062]	
E'_5	2,097	−.01	.06	.47	.19	.06
		(.030)	(.027)	(.117)	(.080)	(.027)
			[.024]	[.041]	[.025]	

* Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the ability or skill coefficient and one standard deviation of the corresponding test by schooling level, and are *not* multiplied by 100.

For completeness, the 1961 coefficients for the first two schooling levels and first four columns are as follows: E'_1 (N = 63): .17 (.16); .08 (.25); −.83 (.57); and −.25 (.39). For E'_2 (N = 1854); −.08 (.033); −.07 (.037); .05 (.13); and .11 (.089).

† In this column, the other independent variables were *LNWK, RC, RJ,* and *NM.* Other variables more highly correlated with C004 are omitted.

SOURCE: Author's computation from Project Talent sample.

cients and standard error of the different ability and skill measures and (selectively) the product of the ability or skill coefficient multiplied by one standard deviation of the corresponding test measure for the appropriate schooling level. The C001 coefficient (general-ability composite) is very weak in its effect at all levels and, in fact, is negative (but not significant) both for college dropouts with one or two years of college and for college graduates. The C004 (quantitative composite) is significant and positive for high school and college graduates (and negative, but insignificant, for college dropouts with three or four years of college).

This pattern seems broadly consistent with the 1950 results from Rogers's data. The ability variables have a very weak association with earnings for high school dropouts. Their influence rises for high school graduates, declines for college dropouts, and rises again for college graduates. For all schooling levels, the quantitative effect of ability differentials on earnings seems to be quite small at early points along the earnings profile. These results also suggest that college dropouts differ in some way from high school and college graduates, and the earnings-ability relationship for them cannot be interpolated simply from results for high school and college graduates. Perhaps dropping out reflects differences in motivation, or perhaps the jobs that dropouts take require specific skills that are less complementary with general cognitive ability than the skills required for jobs taken by the high school graduates. This problem is not pursued further in this chapter. The last column in Table 5-6 shows the regression coefficient of C004 when the other independent variables are *LNWK, RC, RJ,* and *NM.* Since other independent variables that have greater correlation with ability have been left out, the figures indicate the maximum effect that C004 could plausibly exert on earnings. The size of the effect remains small at all schooling levels.

Consider next the more specific skills, R410 (arithmetic computation) and R430 (clerical checking). Not surprisingly, at this early point in earnings careers when people have not yet acquired highly job-specific skills from experience, these skill variables have a stronger effect on earnings than the broader-based ability measures and thus are probably better indicators of differences in current productivity than the ability measures. These measured skills probably increase personal productivity in a number of occupations, but not in all. Differences in the distribution of jobs by educational level may explain why the skill coefficients tend to be smaller for the $E_1^\prime$ and $E_2^\prime$ cohorts.

Although these skills appear to be associated with modest earnings differentials, they are not highly correlated with schooling attainment. Omitting them is therefore unlikely to be a significant source of bias in estimating returns from schooling.

Results from the NBER-Thorndike Data

The NBER-Thorndike sample includes white males who took and passed a battery of tests given by the United States Army Air Force to prospective pilots and navigators during World War II. Earnings data and additional information were obtained from questionnaires in 1955 and 1969. The results discussed here eliminate proprietors, teachers, pilots, and farmers and restrict attention to those born in the period 1921–1925 (which overlaps the Rogers sample).

The means and standard deviations of earnings and the test battery score means of the standard background variables are shown in Table 5-7. They follow patterns by schooling level that

BLE 5-7 Means and standard deviations* of log earnings, ability, and background variables by cational level, NBER-Thorndike sample

ucational el	*Sample size N†*	*LE69*	*LE55*	*TST43*	*FEDL (father's education, low)*	*FEDH (father's education, high)*	*RC*	*RJ*	*NM*	*S*
	489	9.128 (.362)	8.645 (.292)	−.62 (1.57)	.760	.035	.309	.022	.045	.121
	535	9.301 (.403)	8.743 (.312)	−.31 (1.58)	.600	.077	.230	.034	.047	.151
	900	9.517 (.376)	8.849 (.419)	.45 (1.83)	.536	.133	.231	.040	.044	.174
	211	9.600 (.436)	8.842 (.337)	.94 (1.91)	.530	.137	.180	.081	.047	.114
	128	9.885 (.494)	8.872 (.328)	.38 (1.83)	.515	.250	.266	.094	.047	.227
	53	10.061 (.387)	9.094 (.694)	.51 (1.62)	.472	.245	.264	.057	.057	.151

mbers in parentheses are standard deviations.

mple size is for 1969 earnings. Sample sizes for the original 1955 earnings for the six education classes 475, 520, 873, 209, 105, and 36.

URCE: Author's computations are from NBER-Thorndike data.

resemble the Rogers and Project Talent data. The six schooling classes are $E_1^\dagger$, high school graduate; $E_2^\dagger$, some college; $E_3^\dagger$, college graduate with one degree; $E_4^\dagger$, college graduate with two or more degrees; $E_5^\dagger$, lawyer; and $E_6^\dagger$, doctor. The last three classes are mutually exclusive. Because of the higher investment in professional training required by lawyers and physicians, these two occupations are distinguished for separate analysis. The ability measure TST43 is a composite of 17 Air Force tests taken in 1943. These statistics are from a subsample of people born between 1922 and 1925. Consequently, virtually everyone in this subsample had completed high school when ability was measured, whereas relatively few had higher schooling attainment at that time. This means that measured ability differentials in this sample cannot be attributed to schooling differentials prior to the testing in 1943.

The background variables include father's education (*FEDH* = 1 if father had at least a college degree, and *FEDL* = 1 if father did not graduate from high school), religion (*RC* = 1 if Catholic, and *RJ* = 1 if Jewish), marital status (*NM* = 1 if not married in 1969), and region (*S* = 1 if from U.S. Office of Education Region 5—Southeast).

In 1969 the logarithmic mean earnings for $E_1^\dagger$ through the $E_4^\dagger$ schooling attainment levels rise consistently and continue to rise for the two professions of law and medicine. One minor reversal of this pattern occurs in the original earnings means in 1955, where those with two or more college degrees ($E_4^\dagger$) earned about 7 percent less than those with one college degree. This irregularity may well reflect the relatively limited earnings experience in 1955 of those with high levels of formal education. The ability measure TST43 rises significantly with schooling attainment over the first four schooling classes. It does not separate the schooling levels (in terms of the extent to which one standard deviation of the test score overlaps the mean score from adjacent levels) as strongly as the Rogers and Project Talent samples because initial screening had already been imposed before these men were given the battery of Air Force tests. More specifically, this factor means that high school graduates in this sample have atypically high measured ability.

Table 5-8 shows the ability variable coefficients from regressions of the logarithm of earnings on TST43 and background variables $X^{\dagger *} =$ *(FEDH, FEDL, RC, RJ, NM, S).* Several patterns in these coefficients are strikingly similar to the results from Rogers's data in Table 5-3. In 1969 the coefficient for the group having some college is less than the coefficient for either high school graduates or college graduates, and it has lower statistical significance. The coefficient increases substantially for those with two or more college degrees over those with a single degree. This increase is much more dramatic in the Thorndike sample and is statistically highly significant. The two professional groups are small samples, which yield coefficients that lie between those for one-degree and two-degree college graduates, but closer to the one-degree level.

The tendency for ability coefficients to increase over time within schooling level is another common characteristic of the Thorndike and Rogers samples. (Compare the 1955-to-1965 increase in Table 5-4 with the 1955-to-1969 change in Table 5-8.) A substantial increase in the ability coefficient of high school graduates is observed in both samples. The substantial increases for lawyers and doctors resemble more closely the Rogers E_5 class (which includes doctors and lawyers) than the Thorndike $E_4^\dagger$ class (which excludes them). The 1955 coefficient for the Thorndike college graduates with two or more degrees seems surprisingly large. For comparable schooling levels, the Thorndike sample implies in most cases a

TABLE 5-8 Coefficients* on 1943 ability from regressions of log earnings on TST43 and background variables (X^{+*}), NBER-Thorndike sample

Educational level	Sample size N†	Year 1969	Year 1955
E_1^+	489	.0267 (.0102) [.042]	.0061 (.0085)
E_2^+	535	.0213 (.0110) [.033]	.0206 (.0086)
E_3^+	900	.0265 (.0067) [.048]	.0274 (.0053)
E_4^+	211	.0715 (.0144) [.137]	.0600 (.0113)
E_5^+	128	.0441 (.0242) [.080]	.0252 (.0177)
E_6^+	53	.0303 (.0336) [.049]	−.064 (.104)

* Numbers in parentheses are standard errors. The bracketed figures are the product of the TST43 coefficient and one standard deviation of the test score by schooling level. The ability variables had a different scaling in the original data, and the coefficients were not multiplied by 100.

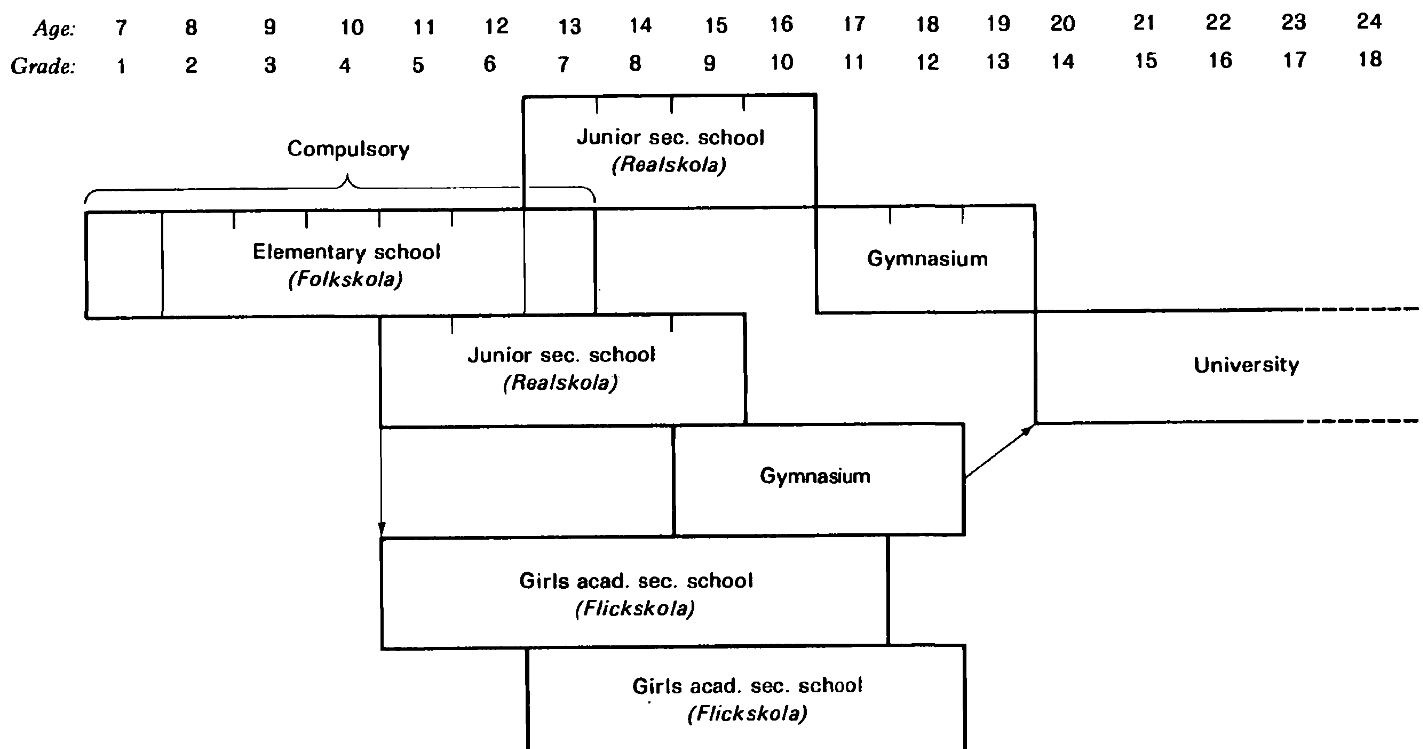
† Sample sizes for 1955 earnings regressions are slightly smaller than those for 1969 given in the table because of prior rejection of extreme observations. For these six education classes, they are 475, 520, 873, 209, 102, and 36.

SOURCE: Author's computations are from NBER-Thorndike data.

smaller earnings differential associated with one standard deviation of measured ability (within schooling level) than the Rogers data. However, at the highest schooling level—two or more college degrees—both samples suggest a 13 or 14 percent earnings differential with this much variation in ability.

Taking the sample means of TST43 for E_1^+, E_3^+, and E_4^+ individuals and multiplying them by the ability coefficients for college graduates with one degree and with two or more degrees leads to figures indicating that neglect of ability differences results in overstating the potential earnings gains to (average) terminal high school graduates by 2.8 and 11.1 percent, respectively. This is a substantial understatement of the bias for the population, since the Thorndike high school graduates had unusually high ability because of Air Force prescreening.

FIGURE 5-1 ***Structure of the Swedish school system, 1928–1950.***



SOURCE: Husén, 1969.

Results from Husén's Data

The Husén sample includes some 450 Swedish males who were third graders in Malmö when originally tested in 1938 and who answered a questionnaire in 1964. Earnings data were obtained by searching records of past income tax returns.

Table 5-9 summarizes the available earnings data and background variables by schooling attainment. The seven schooling levels are E_1'', *folkskola* completed (*folkskola* is the Swedish elementary school); E_2'', *folkskola* completed (usually at age 14); E_3'', some *realskola* (secondary school); E_4'', *realexamen* (*realskola* completed usually at age 16 or 17) and technical school graduate; E_5'', *studentexamen* (completion of the gymnasium, roughly junior college, at ages 19 to 21); E_6'', university degree (excluding E_7''; and E_7'', physician or dentist. The ability measure TST38 is the total score from four subtests and is highly similar in content to IQ tests. The background variables include dummy variables for social class ($SCH'' = 1$ for the highest of four classes of a discrete social-class variable and $SCL'' = 1$ for the lowest), private school

TABLE 5-9 ***Means and standard deviations[a] of log earnings, ability, and background variables by educational level, Husén Swedish sample***

Educational level	*Sample size N*[b]	*LE68*	*LE64*	*LE59*	*LE54*	*LE49*	*TST38*
E_1''	18	9.494	9.249	8.833[c]	8.986	8.154[d]	34.1
		(.278)	(.223)	(.267)	(.232)	(.458)	(12.7)
E_2''	235	9.455	9.208	8.996	9.033	8.225	44.3
		(.318)	(.305)	(.229)	(.182)	(.349)	(13.5)
E_3''	59	9.515	9.328	9.058	9.035	8.234	50.9
		(.380)	(.266)	(.239)	(.259)	(.450)	(13.9)
E_4''	66	9.849	9.562	9.191	9.042	8.133	56.3
		(.393)	(.322)	(.283)	(.245)	(.393)	(12.5)
E_5''	51	10.061	9.574	9.260[e]			59.6
		(.346)	(.491)	(.376)			(11.8)
E_6''	26	10.236					60.6
		(.286)					(9.2)
E_7''	5	10.529					66.8[f]
		(.167)					(4.6)

[a] Earnings means are deflated by the Swedish Consumer Price Index (1949 = 100). Numbers in parentheses are standard deviations.

[b] *N* is for 1968 earnings and all other nonearnings variables, and was lower in earlier years. Cells with very few observations are indicated.

[c] Sample size 120.

[d] Sample size 7.

[e] Sample size 20.

[f] Sample size 8.

SOURCE: Author's computations are from data in Husén Swedish sample.

attendance in 1938 (*PS* = 1), never married (*NM* = 1), and serious prolonged illness during the late teens or thereafter (*PHLTH* = 1).

As Table 5-9 indicates, by 1968 (mean age 40) there are large differentials in earnings between some of the educational levels, with the more highly educated obtaining greater earnings. The table includes only those who responded to the 1964 questionnaire, and response bias may be partially responsible for the slightly higher mean of log-earnings for E_1'' over E_2''; another calculation not limited to questionnaire respondents yielded mean log-earnings for E_2'' and E_1'' of 9.401 and 9.320, respectively, in 1968. At the time members of this sample were in school, the Swedish educational system was organized strongly in the continental tradition, under which relatively few people obtain high levels of education. Most children terminated their formal study with the completion of the *folkskola* (elementary school) at the age of 14. The attrition rate of those starting the *realskola* was high, and only a little over half

SCH"	*SCL"*	*PS*	*NM"*	*PHLTH*
	.428		.111	.056
.017	.404		.089	.127
.068	.203	.017	.068	.051
.152	.136	.030	.106	.091
.294	.156	.059	.098	.078
.539	.039	.238	.077	.077

obtained the secondary *realexamen* degree (or equivalent past-*folkskola* degree from more vocationally oriented alternatives). This difference in educational systems probably explains why there is such a modest tendency for the 1938 test score to rise after E_4'' *(realexamen)* is achieved in this sample (except for the small E_7'' group—highly trained physicians and dentists). There is a very strong tendency for the highest socioeconomic class to become an increasingly important source of students attaining schooling beyond E_4''.

Almost all the direct schooling costs at the university level were absorbed by the Swedish government, and university admission was limited almost entirely to people who passed the *student-examen* (i.e., attained level E_5''). In this sample, slightly over a third of those passing *studentexamen* achieved a university degree (E_6'' and E_7''). These facts indicate that a relatively small proportion of those with middle and low socioeconomic backgrounds found it worthwhile getting a university degree even if they passed the *studentexamen.* In turn, this result suggests that those terminating formal education with the *studentexamen* did not believe that the higher earnings of university graduates were enough to offset the out-of-pocket living costs incurred while studying at the university and the opportunity cost of forgone earnings. Thus it may be that the investment motive for higher earnings played a less-important role in Sweden than in the United States in determining university attendance during this period.

Table 5-10 shows the pattern of the ability (TST38) coefficient by schooling attainment over time. Other independent variables are X''^* ($= SCH'', SCL'', PS, NM'', PHLTH$). All ability coefficients are positive for 1968, although the statistical significance of the individual coefficients is low. The pattern of coefficients over time and across schooling levels is much less regular than the comparable calculations from Rogers's data. This irregularity may be due partly to the very small size of the samples (especially for E_1'' and E_6'') and to earnings statistics' being based on actual annual earnings instead of the full-time annual equivalent earnings (or controls for weeks worked) available in the other samples. It appears that measured ability plays a more important role for E_4'' and E_5'' than for the lower E_2'' and E_3'' levels. The size of the ability coefficient is surprisingly large for E_5'' in 1964 and 1959, where a change of one standard deviation in the test score is associated with a change in earnings exceeding 13 percent. The

TABLE 5-10
Coefficients* on 1938 ability from regressions of log-earnings on TST38 and background variables (X''*), Husén Swedish sample

Educational level	Sample size N	Year 1968	1964	1959	1954	1949	1968†
E''_1	18	.39	−.23	−.86‡			
		(.61)	(.78)	(.68)			
		[.049]					
E''_2	235	.05	.13	.14	.19	.12	.32
		(.80)	(.16)	(.14)	(.12)	(.27)	(.19)
							[.037]
E''_3	59	.22	.32	.11	−.54	.04	.40
		(.38)	(.29)	(.27)	(.33)	(.71)	(.47)
		[.031]					[.050]
E''_4	66	.43	.46	.35	.62	−.84§	.03
		(.39)	(.38)	(.36)	(.51)	(.81)	(.58)
		[.054]					[.105]
E''_5	51	.58	1.19	1.09			1.06
		(.41)	(.86)	(.83)			(.78)
		[.068]					[.106]
E''_6	26	.22					
		(.66)					
		[.010]					

* Numbers in parentheses are standard errors. Coefficients and standard errors are multiplied by 100. The bracketed figures are the product of the TST38 coefficient and one standard deviation of TST38 by schooling level, and are *not* multiplied by 100.

† This column gives regression coefficients on IQ measured in 1948, 10 years after the original tests. The scaling is different from that in the 1938 tests, and so the coefficients are not strictly comparable, although the bracketed products are.

‡ Sample size 12.

§ Sample size 22.

SOURCE: Author's computations are from data in Husén Swedish sample.

peculiar apparent drop in this coefficient in 1968 is a small puzzle not yet resolved.

The modal E''_2 class (*folkskola* graduate) deserves serious attention because of the relatively large sample size of 235 (in 1968). Both the empirical magnitude and statistical significance of the ability coefficients are trivial for all years, indicating the small role played by measured cognitive capacity in determining earnings for members of this group. Special vocational schools, trade schools, correspondence courses, and the like are more important in Sweden than in the United States for teaching market-relevant skills. It is conceivable that there is a wide distribution of investment in such training not highly correlated with cognitive ability that tends to mask the ability variable, a hypothesis that will be tested soon with these data. The apparent decline in the ability coefficient in 1968, if genuine and maintained in subsequent years, is compatible with the conjecture that at this modest level of formal schooling, job performance can be mastered with experience to the point where marginal returns to measured ability are negligible. However, the larger positive, though small, effect of IQ as measured in 1948 on 1968 earnings indicates that the influence of ability does persist even at the E_2'' level.

Summary of Empirical Results

The data examined in this chapter imply that measures of cognitive ability are associated with an empirically significant, but modest, increase in annual earnings for those with high levels of schooling. In the three samples with earnings data for people with 15 or 20 years of earnings experience, ability coefficients are found at some level of advanced schooling for which one standard deviation of measured ability (within schooling level) is associated with an earnings differential of at least 11 percent. At lower levels of schooling attainment, measures of cognitive ability have a weaker association with earnings, becoming completely negligible for high school nongraduates or, in the Swedish sample, for those who have not obtained some training at the secondary *(realskola)* level.

In the three United States samples there appears to be a distinct tendency for the ability coefficients in earnings regressions to increase with labor force experience. The temporal pattern for the high school coefficients is especially relevant in considering possible bias in the opportunity cost (forgone earnings) of getting a college degree. For early years in the earnings profile, the ability coefficient is very small, and in most cases not statistically significant. This result implies that bias from this source is negligible. For those with 15 or more years of earnings experience, there is a more significant bias if ability differences are disregarded. Taking the product of the differences between the sample means of ability for two schooling levels and the regression coefficient on ability for the higher of the levels yields the bias in predicting the expected increase in earnings from the schooling increment to a person with the mean ability of those terminating schooling at the lower level. This calculation indicates a positive bias of 13 and 18 percent for average high school graduates who obtain one or several college degrees (Rogers's sample); the corresponding biases implied by the Thorndike data are (at least) 2.8 and 11.1 percent.

The modest contribution of measured ability in explaining the differences in earnings, in contrast with the strong association of measured ability and final schooling attainment, is not very surprising since most of the ability measures considered here are designed to forecast academic potential and achievement. The coefficients of determination of the within-schooling-class regressions are low, and (more important) the standard deviations of the residuals continue to be large, despite the homogeneity imposed by narrow age range, criteria for omitting observations, and the sets of background variables included in the regressions. In no regression of annual log-earnings does the standard deviation fall below .24. The task of identifying the main determinants of this residual variation remains a major challenge to students of the distribution of earnings.

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