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Chapter Author: Paul J. Taubman, Terence Wales

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Chapter pages in book: (p. 57 - 68)

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4. The NBER-TH Sample: A Description

Most of the empirical analysis in this study is based on a new and extremely important body of data, the NBER-TH sample. This sample is important both because of its size and because of its detailed information on such items as earnings, family background, education, and ability. While this sample is superior to the Wolfle-Smith sample in terms of size and information, it is less representative, having been drawn from the top half of the IQ distribution only and from a population probably less risk-averse and more specialized in other ways than the United States population as a whole. Thus, the results described in the previous chapter are in some ways complementary to those obtained with the NBER-TH data.

Since the sample is not representative of the entire population, it is necessary to ask to what extent its results are appropriate for generalization to the population as a whole. To answer this and other related questions, assume that the true relationships between earnings (Y), education (ED), and ability (A) can be represented by

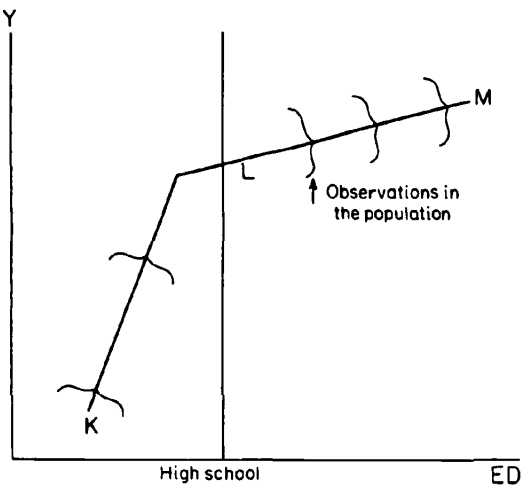
$$Y = \alpha ED + \beta A \tag{4-1}$$

The distribution of earnings will depend on the distribution of education and ability and on the coefficients α and β. Suppose for the moment that β equals zero and that ED is distributed normally. Then Y would also have a normal distribution, but with a mean and standard deviation α times as large as in the education distribution. Next, suppose that a study is undertaken in which only people above a certain education level are included and that a random sample is drawn from this truncated population. Since ED in the sample is no longer distrib-

uted normally, we would not expect the distribution of earnings in the sample to be distributed normally. In other words, we could not use such a sample to draw inferences about the distribution of earnings in the population. We can, however, use the information to estimate α. Suppose, for example, that Figure 4-1 illustrates the relationship between education and income in the population and in the sample. The relationship is more realistic than that of Eq. (4-1) because all the points do not lie on a line; that is, there is an error term, which we assume is distributed normally at every level of education. Thus a random sample including only people with a high school education or more will allow us to obtain an unbiased estimate of the slope of the line LM or of α. The earnings-education relationship in the figure was deliberately drawn as nonlinear to illustrate that a truncated sample does not necessarily provide information on the portion of the population that is not represented in the sample. Our sample not only is truncated but also has a much higher proportion of people with a college degree than is true of the general population. This does not create problems, however, because a stratified sample (with relatively heavier weights for some portion of the population than the others) will generate unbiased estimates of population parameters, provided the sample is random and the usual conditions for unbiased estimates exist.

Suppose next that β is not zero in Eq. (4-1) and that we measure A, although its range may also be truncated. A simple

FIGURE 4-1 *Hypothetical relationship between earnings and education*



THE SAMPLE

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extension of the above discussion indicates that we can still obtain unbiased estimates of α and β from the sample, but these estimates will not necessarily apply to the portion of the sample space of A or ED not measured. In summary, the coefficients obtained from a data base in which the range of some variables is truncated, and in which some strata are sampled more heavily than others, will provide unbiased estimates of the total population parameters for the data space sample. As discussed below, only people in the top half of the IQ distribution are in the sample; thus the effects of education are specifically for people with such IQ. But since we find little evidence of an interaction of education and mental ability, the education results may well apply for the whole range of IQ.

Because this is the first study to use the sample, we will describe it in some detail: the population from which the sample was drawn; the data-collection procedure; response biases; the accuracy of results; and what information was obtained by whom.[1] Much of the technical material appears in Appendixes E, F, and G, and a summary of the important results is given at the beginning of the next chapter. Appendix E indicates how we obtain the ability measures used in the regression analysis. Since there is some ambiguity in the interpretation of the ability measures, it is recommended that these pages be examined. This chapter concludes with a brief description of the sample distribution of earnings in 1955 and 1969 by education and ability, as well as by education and occupation.

THE SAMPLE

In 1969, the National Bureau of Economic Research (NBER) attempted to contact a sample of people originally surveyed by Thorndike and Hagen in the mid-1950s. The descriptions of the original sample in their report (Thorndike & Hagen, 1959) is the source of the following information. During World War II, the Army Air Corps accepted volunteers for the pilot, navigator, and bombardier training programs. The volunteers, of whom there were some 500,000, had to pass the Armed Forces Qualifying Test with a score equivalent to that of the median of high school graduates.[2] These people were then given a battery of 17

[1] As explained below, part of the sample was obtained and used in the mid-1950s by Thorndike and Hagen.

[2] This was about equivalent to the person's being able to complete two years of college. See Thorndike and Hagen (1959, p. 52)

tests that measured such abilities as mathematical and reasoning skills, physical coordination, reaction to stress, and spatial perception. While the tests were changed during the war, a given set of tests was used for 75,000 men in the period July to December 1943.

In 1955, Thorndike and Hagen undertook a study to determine the validity of the tests in predicting the subsequent vocational success of a random sample of 17,000 of these 75,000 individuals. Most of the 17,000 people responded to the questionnaire.[3] (The 2,000 people who were still in the military in 1955 were eliminated from our sample.)

Now let us consider the representativeness of the sample. Thorndike and Hagen (1959, p. 84) have shown that there was no significant difference in test scores between the 9,700 civilian respondents in 1955 and the 75,000 tested on the same battery. Since the test scores are also related to education, it is safe to conclude that there was no important response bias in terms of education. When compared to the United States male population aged 18 through 26 in 1943, however, the sample contains some biases. Not only was the air cadet group more educated, since all had at least a high school diploma, but the intelligence level was fairly high, since a score equivalent to the average for college sophomores was used as a preliminary screening device.[4]. Also, the tested group consisted of people willing to volunteer for the various programs. Thus, these people may be, on the average, less risk-averse than the population as a whole and thus more willing to choose self-employment and other risky operations which, on the average, pay a risk premium. However, as shown above, this will not bias out coefficients unless the degree of risk aversion, which is not measured, is

[3] In part, the high contact rate for people, most of whom were separated (initially) from the military for about a decade, occurred because many veterans maintained contact with the Veterans Administration through life insurance policies and disability claims. The authors were able to increase the response rate by hiring the Retail Credit Bureau to find various individuals. Some 1,500 people had died since 1943.

The questionnaire is reproduced on p. 86 of Thorndike and Hagen (1959) and in Appendix G of this volume.

[4] Some rough comparisons with the population as a whole can be found in Thorndike and Hagen (1959, pp. 110–111). The education distribution is discussed in detail below.

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correlated with education. The interruption of schooling and family life by the war and the GI Bill could affect the distribution of education by ability level. But, as shown above, we can still obtain estimates of the parameters as long as we hold education and the relevant ability constant. Also, we shall argue that this interruption helps to eliminate the bias in estimating the returns from some colleges. Finally, there may be an overrepresentation of the successful. (See Thorndike & Hagen, 1959, p. 14; also see the discussion below on success bias.) While the differences between the sample and the United States population complicate the extrapolation of our results, a substantial benefit in comparison with the census sample is that many items that could affect income are held constant by the Thorndike-Hagen sample design.

Thorndike and Hagen's major conclusions are that, within narrow occupations there were very small differences in earnings associated with ability, but that, between occupations, there were important differences in ability and education. However, they did not present quantitative estimates of the effect of ability and education on income.[5]

In 1968, we communicated with Professor Thorndike and learned that he had retained much of the information collected for most people in the sample. Specifically, he had retained his completed questionnaires for 8,300 people; in addition, for the 9,700 civilian respondents in 1955, he had mailing addresses and a file of computer outputs. The computer output contained the test scores on each of the 17 tests, two indexes of background information whose weights were determined by the usefulness of the items in predicting success in pilot and navigational courses, respectively, monthly earnings in 1955, a three-digit job code, time on the job, number of people supervised, a job-success-evaluation code, and the army serial number. Besides some of the same items, the questionnaire included information on education *after* 1945, an occupation-earnings history, a seven-digit job code, and the social security number. After we received permission from the Air Force[6] to use the data that it had helped to collect, the NBER repunched

[5] See Thorndike and Hagen (1959, Ch. 3).

[6] Permission was granted by Col. John G. Dailey, Commander, Brooks Air Force Base, in a letter dated Apr. 30, 1969.

both the computer output and the educational information that Thorndike had kindly recoded from the questionnaires.

The information thus resurrected is extremely valuable because it is one of the largest samples (of people with at least a high school diploma) that contains detailed measures of income, ability, and education. The NBER decided to make this body of data even richer by conducting an additional survey of 1955 respondents to collect an occupation-earnings history through 1969, family (as opposed to individual) income in 1968, background data on the respondent, a complete post-high school education résumé (not just that of 1946–1955), health information, and other data about the individual's beliefs and activities. This questionnaire is reproduced in Appendix G. Clearly, the information on health, background, beliefs, and so on adds to the importance of the data. But from our viewpoint the reinterview was valuable because it provided information on occupations and income for up to 25 years after an individual finished his formal education.[7]

EARNINGS, EDUCATION, AND ABILITY

The NBER mailed a questionnaire in 1969 to the 9,700 civilian respondents of 1955. In discussing the response bias on this reinterview, it is useful to consider how many promptings were necessary to obtain a reply. The first mailing, which took place in June 1969, was made on the basis of the 1955 addresses. Approximately half the questionnaires were returned as not deliverable (although others were also not delivered and not returned). On this first mailing, about 1,400 replies were received.

Another mailing to the 1955 addresses brought the number of replies up to nearly 2,500. At this point, the NBER enlisted the aid of the Veterans Administration. Using army serial numbers, the Veterans Administration kindly provided (at no cost) nearly 4,000 new addresses. Two mailings to these addresses, in October and in November, yielded about 2,000 more replies. These 4,443 replies constitute the sample used in this study. In April 1970, however, another mailing was made to all nonrespondents. In this mailing, approximately 1,000 new addresses were obtained by examining the 1970 telephone directories of the

[7] As far as we know, the only studies that have a long span of individuals' incomes as well as measures of education and ability are those of Campbell (1965), Terman and Oden (1947), and Husén (1968). These samples are much smaller than ours and, in the case of Terman, apply to only the top 2 percent in the IQ scale.

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1955 place of residence of the people for whom there had been no new address since 1955. This mailing resulted in about 650 new replies.

We had about 7,500 up-to-date addresses. The 2,200 remaining people include 300 individuals who have died since 1955 and people for whom we do not have current addresses.[8] Of the 7,500 people, about 70 percent eventually answered our questionnaire, but, as noted above, we used only 85 percent of the responding sample.[9] As will be demonstrated below, the 1969 respondents tended to be more heavily concentrated than the 1955 respondents among the more educated and mentally more able. But, given education and ability, we do not find that it is the more successful who respond. Thus, we can think of the data as a random stratified sample that will yield unbiased coefficients.

EARNINGS, EDUCATION, AND ABILITY

In Appendix E, the reader will find some technical material that examines the accuracy of the responses on education; determines the extent of response bias by education and ability level; and indicates how the ability measure was constructed and determined to be mathematical ability. At this point, it suffices to say that the education and ability measures appear to be accurate. The information in the technical sections also indicates that roughly one-fourth of the sample falls into each of the categories of high school graduate, some college, college graduate, and at least some postgraduate work. Thus, the people in our sample are better educated than both the population as a whole and other veterans of World War II. As noted earlier, the people are also brighter, since only those in the top half of the IQ distribution were allowed to take the battery of 17 tests.

Let us consider the relationship in this sample between education or ability and earnings. The average earnings levels are presented in Table 4-1 for the various education groups for 1955 and 1968.[10] Average earnings in 1955 at all higher education

[8] That is, for some 1,900 people, the questionnaire was returned as not deliverable, but no new address was obtained.

[9] While all the comments and results presented here apply to 4,443 people, some subsequent work has indicated there would be little difference if all 5,086 people were included.

[10] The 1968 figures are used in order to make comparisons with census data. The 1969 census data were not available when this was written. In some cases the education figures had to be corrected as described below.

TABLE 4-1 *Comparison of average income by education, NBER-TH sample, and census data (in dollars)*

	High school	*Some college*	*Undergraduate degree*	*Some graduate work*
NBER-TH				
1955	$6,000	$6,900	$7,056	$6,964
1968	13,944	16,920	19,044	19,506
Census				
1968	9,106	11,072	14,281	17,223

NOTE: These are mean incomes for those aged 45 through 54 in 1968. The average age in our sample in 1968 is 46.

levels are about 16 percent higher than those of high school graduates. In 1968, earnings of college dropouts are 20 percent greater than those of high school graduates. Earnings in 1968 are higher at the undergraduate and graduate levels. It can be seen that the sample contains people with high income by comparing the 1968 results with those for the same age group in the 1968 *Current Population Reports.* Although the data reported in our sample are for *earnings* only, they are substantially greater than the *income* estimates from the census. Since the ability level in the sample is quite high, it is not surprising that our sample is much more successful than the corresponding group of the population.

In 1968, only 1 percent of the sample received earnings below $5,500, while 10 percent received earnings less than about $9,000. On the other hand, 1 percent of the people received at least $70,000, and 10 percent had earnings above $30,000. These distributions clearly differ from those in the general population.

We now consider briefly the distribution of average earnings by mathematical ability and education.[11] In Table 4-2, earnings generally increase with ability within each educational level. It should be noted that the highest education category shown combines all Ph.D.'s, M.D.'s, and LL.B.'s. In 1955, within any ability category those with a high school degree only earn less than those with some college and those with one degree, but not necessarily less than those with some graduate work or an M.A. The highest earnings are received by those in the highest

[11] As explained in Chapter 5, mathematical ability is the only ability measure that we find to be an important determinant of income.

TABLE 4-2 *Average yearly*

	High school
1955: Mathematical-ability	
1	$5,750
	(212)
2	5,737
	(204)
3	6,238
	(159)
4	5,989
	(136)
5	6,736
	(97)
1969: Mathematical-ability	
1	$12,239
	(219)
2	13,929
	(214)
3	14,830
	(162)
4	14,849
	(152)
5	15,961
	(92)

NOTE: Sample sizes are giv

'ndergraduate igree	Some graduate work
$7,056	$6,964
19,044	19,506
14,281	17,223

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TABLE 4-2 ***Average yearly earnings, by ability and education, 1955 and 1969 (in dollars)***

	Education					
	High school	*Some college*	*Under-graduate degree*	*Some graduate work*	*Master's*	*Ph.D., M.D., and LL.B.*
1955: Mathematical-ability fifth						
1	$5,750	$6,351	$6,450	$6,000	$5,711	$5,415
	(212)	(185)	(123)	(21)	(34)	(16)
2	5,737	6,961	6,499	6,724	5,640	7,647
	(204)	(178)	(172)	(29)	(34)	(22)
3	6,238	6,727	6,651	6,233	6,261	9,116
	(159)	(178)	(229)	(36)	(58)	(28)
4	5,989	6,935	7,262	7,902	6,078	8,548
	(136)	(200)	(256)	(40)	(72)	(52)
5	6,736	7,837	7,669	7,448	7,144	7,402
	(97)	(161)	(365)	(61)	(84)	(70)
1969: Mathematical-ability fifth						
1	$12,239	$16,886	$18,610	$14,031	$14,403	$20,461
	(219)	(202)	(124)	(26)	(46)	(26)
2	13,929	17,029	18,738	16,813	15,405	22,653
	(214)	(179)	(160)	(38)	(42)	(41)
3	14,830	16,116	20,155	20,332	14,898	23,260
	(162)	(208)	(216)	(41)	(68)	(52)
4	14,849	17,570	19,348	19,917	17,333	27,284
	(152)	(208)	(263)	(37)	(84)	(74)
5	15,961	20,295	21,429	20,011	22,233	25,888
	(92)	(162)	(352)	(71)	(112)	(102)

NOTE: Sample sizes are given in parentheses below the dollar amounts. The top fifth is ranked 5.

education categories, with incomes of those with some college and an undergraduate degree about the same. As shown in Tables 4-3 and 4-4, the earnings of M.D.'s are substantially above the incomes of others in this group. In interpreting these results, it should be kept in mind that people with greater education have had less time on the job than those with less education, and that most of those with a B.A., for example, have been working five to seven years.

TABLE 4-3 ***Average yearly earnings, by occupation and education, 1955 (in dollars)***

	High school	*Some college*	*Under-graduate degree*	*Some graduate work*	*Master's*	*Ph.D., LL.B., and M.D.*
Managerial	$7,560	$7,860	$7,944	$8,460	$7,932	$7,776
	(245)	(357)	(378)	(48)	(40)	(15)
*Professional**	7,332	6,912	6,780	6,684	6,072	7,956
	(91)	(169)	(518)	(104)	(237)	(167)
Technical	5,796	5,892	5,016	5,880	5,340	
	(30)	(49)	(20)	(1)	(2)	†
White-collar	4,524	4,800	5,112	4,848	3,720	6,000
	(107)	(66)	(47)	(7)	(3)	(1)
Sales	6,456	7,740	7,200	6,696	7,128	6,048
	(85)	(133)	(150)	(29)	(9)	(8)
Service	4,908	4,980	5,712	5,760	7,500	7,896
	(36)	(25)	(14)	(3)	(2)	(4)
Blue-collar	5,292	5,604	5,556	5,400	4,440	4,800
	(362)	(155)	(46)	(3)	(1)	(1)
Farm	4,584	5,808	7,116	4,320	5,640	
	(30)	(22)	(23)	(2)	(2)	†
Medical		5,460	6,996	4,920	12,720	11,304
	†	(2)	(3)	(2)	(3)	(37)

* Including medical.

† No observations.

NOTE: Sample sizes are given in parentheses below the dollar amounts.

TABLE 4-4 ***Average yearly e***

	High school
Managerial	$17,937
	(420)
*Professional**	12,598
	(17)
Technical	15,270
	(107)
White-collar	8,513
	(30)
Sales	12,633
	(72)
Service	9,079
	(72)
Blue-collar	10,223
	(270)
Farm	11,823
	(38)
Medical	
	†

* Including medical.

† No observations.

NOTE: Sample sizes are giv

By 1969, those with more education had relatively more earnings than in 1955, compared with those at low education levels. Within any ability group, earnings increase with education except for the M.A. and some-graduate-work categories, but even in these two groups, earnings now exceed those of high school graduates—which was not true in 1955.[12] The tables also indicate that average ability rises with education. Consequently, the average earnings differences derivable from Table 4-1 will overstate the effects of education on income. Of course, the ef-

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[12] The average income of Ph.D.'s (excluding M.D.'s and LL.B.'s) is about equal to that of B.A.'s in 1969. Because of the small sample sizes, this result is not reported by ability level. There are more observations in 1969 because fewer people did not report their income.

[13] As b
prio

dollars)

Master's	Ph.D., LL.B., and M.D.
$7,932	$7,776
(40)	(15)
6,072	7,956
(237)	(167)
5,340	
(2)	†
3,720	6,000
(3)	(1)
7,128	6,048
(9)	(8)
7,500	7,896
(2)	(4)
4,440	4,800
(1)	(1)
5,640	
(2)	†
12,720	11,304
(3)	(37)

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TABLE 4-4 *Average yearly earnings, by occupation and education, 1969 (in dollars)*

	High school	Some college	Under-graduate degree	Some graduate work	Master's	Ph.D., LL.B., and M.D.
Managerial	$17,937	$20,438	$22,444	$21,815	$23,221	$26,678
	(420)	(628)	(729)	(125)	(157)	(48)
*Professional**	12,598	14,112	16,862	14,329	14,364	25,270
	(17)	(60)	(297)	(88)	(234)	(276)
Technical	15,270	15,034	15,107	18,669	19,745	10,000
	(107)	(101)	(36)	(4)	(5)	(1)
White-collar	8,513	9,554	9,637	9,911	16,100	
	(30)	(26)	(14)	(3)	(1)	†
Sales	12,633	15,618	18,192	14,420	11,387	18,415
	(72)	(45)	(13)	(1)	(2)	(1)
Service	9,079	9,802	11,881	12,000		21,000
	(72)	(45)	(13)	(1)	†	(1)
Blue-collar	10,223	10,509	11,577	13,000		
	(270)	(115)	(23)	(3)	†	†
Farm	11,823	17,647	18,308	19,500	15,000	20,000
	(38)	(36)	(24)	(2)	(1)	(1)
Medical		14,875	17,333	12,975	27,667	33,139
	†	(4)	(3)	(2)	(3)	(57)

* Including medical.

† No observations.

NOTE: Sample sizes are given in parentheses below the dollar amounts.

fects of education and ability on income are not accurately reflected in Table 4-2 either, because other determinants of earnings have not been held constant, as is done in Chapter 5.

It is also of some interest to study average earnings within broad occupational groups and education classes for 1955 and 1969. In Table 4-3, 1955 earnings, education, and occupation data are given for those people who responded in 1969; in Table 4-4, 1969 data are given for the same group.[13] We have attempted to aggregate the 1955 occupation categories into broad groups corresponding to those available in 1969. The results may not be

[13] As before, the 1955 education data have been corrected to account for education prior to 1946.

completely consistent, because the 1955 job code was assigned on the basis of detailed information supplied by respondents, and the 1969 code was obtained by having the respondents report their broad occupational category. In particular, the professional-technical distinction may differ between the two years.

In both years, the rankings of occupations by average earnings are the same. At the top are the managerial, professional, technical, and sales groups, while at the lower end are the farm, blue-collar, white-collar, and service workers.[14] In 1969, at every education level except Ph.D., income in the highest-paying occupation was about twice that of the lowest-paying occupation, while in 1955 it was about $1^1/_2$ times as much.

On the other hand, within occupations there is much less earnings variability between education levels. For example, if we exclude the graduate categories, which have few entries except for the managerial and professional groups, the differences between the high school and B.A. categories average about 10 percent of the lower income. In 1969, these differences are about 20 percent. At the Ph.D. level, the differences are larger: approximately 50 percent in 1969 for managers and 75 percent for professionals, excluding medical.

From 1955 to 1969, there was a general movement from the low-paying occupations to the managerial group. This is shown most clearly for high school graduates, in that the number of managers increased by 105 even though the total number of people with just a high school education declined from 1955 to 1969. The managerial group includes all business owners, who composed about one-third of the group in 1969.

A final interesting aspect of the table is the distribution of people over occupation by education groups. In 1955, about one-half of all high school graduates were in the high-paying occupations, while about 95 percent of those with some graduate work were in these occupations. This is very similar to the distribution of people by occupation given in the Wolfle-Smith discussion. In 1969, the fractions of people in the high-paying occupations at all education levels were higher. A more detailed discussion of earnings by occupation is presented in Chapter 8.

[14] Since "medical" is included in "professional," we do not discuss it separately at this point.